Joint 9th IFSA World Congress and 20th NAFIPS International Conference

July 25-28, 2001
Vancouver, British Columbia, Canada
Coast Plaza Suite Hotel at Stanley Park

Sponsored by
International Fuzzy Systems Association
North American Fuzzy Information Processing Society

In cooperation with
IEEE Systems, Man and Cybernetics Society
IEEE Neural Networks Council

From the Honorary General Chair

Michael Smith, Bill Gruver, Larry Hall and all those who were substantively involved in the organization of IFSA/NAFIPS, deserve our congratulations and loud applause.

To me, IFSA/NAFIPS 200l brings back memories of the early days mostly in the seventies, when our meetings were small and narrowly focused. It was then that Madan Gupta came up with the idea of launching NAFIPS. He and Hans Zimmermann in North America and Europe, Kyoshi Asai, Toshiro Terano and the late Kokichi Tanaka in Japan were the vanguard of the pioneers who had the vision, faith and initiative to lay the foundation of what has become a worldwide community of contributors to fuzzy logic— in its broad sense— and its applications. There is an important bit of history, however, that many may not be aware of. Starting in the late seventies and early eighties, large conferences on fuzzy set theory and its applications were held in the Soviet Union and the People's Republic of China.

What stands out at IFSA/NAFIPS 200l is the large number of papers that deal with combinations of fuzzy logic with other members of soft computing such as neuro-computing, evolutionary computing and probabilistic computing. This is a natural trend that is likely to grow in visibility and importance in the years ahead.

What else do I see in my crystal ball? I see continued growth of applications of fuzzy logic in a wide variety of fields ranging from control, industrial systems and consumer products to medicine, finance and, above all, the Internet. In a different direction, I see a growing intrusion of fuzzy logic into science, with a gradual replacement of Aristotelian logic with fuzzy logic in the foundations. In this paradigm shift, the methodologies of granular computing and computing with words are likely to play pivotal roles.

What is certain is that as we move further into the age of machine intelligence and automated reasoning, fuzzy logic and soft computing will move closer to the center of the stage. This is the backdrop for our meeting in the magnificent city of Vancouver. To Mike, Bill and Larry go our thanks for organizing a conference at which we can exchange ideas in a setting of beauty, culture and conviviality.

Lotfi A. Zadeh

Message from the Organizing Committee

On behalf of the IFSANAFIPS 2001 organizing committee, it is our honor and pleasure to welcome the participants of the **Joint 9th IFSA World Congress and 20th NAFIPS International Conference**, the first joint conference of these two organizations. The goal of the conference organizers was to bring together as many researchers as possible in the fields of fuzzy systems and related areas in soft computing so that a global exchange of new research ideas and networking will occur.

This goal has been achieved. IFSA/NAFIPS 2001 will be the largest world conference in fuzzy sets and systems ever held with more than 550 registered delegates from over 41 countries. More than 800 submissions were received, and from these, a final program was developed, with 547 papers, 3 plenary lectures, 6 forty-minute overview talks in specialized research areas, a panel discussion, 12 exhibits and 3 tutorials. In addition, a half-day Open Forum will be held in which a panel of 9 distinguished specialists from industry, universities, R&D laboratories and agencies will explore with the audience the future of soft computing. This event will feature a live multicast transmission of the workshop to a worldwide audience using video and audio over the Internet.

We would like to thank the many people who have helped so much with this conference. We are especially indebted to the Mini-Track Organizers who organized sessions in important research areas and will present overviews of their research areas. We are also indebted to the Session Organizers who organized individual sessions in various areas of soft computing. These mini-track and session organizers are a major reason why this conference is so successful as they are responsible for more than 300 invited papers. We also thank the Tutorial speakers and panelists of the Open Forum for their valuable contributions. We especially thank Roger Jang, Janusz Kacprayk, John N. Mordeson, and Witold Pedrycz for serving as Area Chairs and refereeing a large number of contributed papers and helping to select papers for the final program. We thank the 77 members of the Program Committee for promoting the conference and assisting in the review process. We thank Michael Berthold for his excellent work in designing and administering the conference web site and organizing the Open Forum, and Toshio Fukuda and George Wang for their valuable help with planning of budgets and local arrangements, respectively. We thank Ljiljana Trajkovic and Milan Nikolic for providing computer and communications support of the Open Forum. We thank Peggy Shepard and Jeffrey Jang of Venue West Conference Services for their organizational help, Ruby Wells for her assistance with the program, and North Shore Venture Travel Services and Marlin Travel for assisting the delegates with hotel and travel arrangements. We thank IFSA, NAFIPS, and SMC for their continued support of this conference. We thank IFSA, NAFIPS, and SMC for their continued support of this conference. Finally, we thank all of the contributors to the conference, and, last but not least, the general co-chairs especially thank Larry Hall, who, as program chair, actually touched and dealt with more than 800 submissions.

We hope that IFSA/NAFIPS 2001, the largest fuzzy world conference ever held with the largest amount of technical information on fuzzy systems published in one set of conference proceedings, will be valuable and fruitful to all participants.

Michael H. Smith	**William A. Gruver**	**Lawrence O. Hall**
General Co-Chair	General Co-Chair	Program Chair

Conference Organization

Organizing Committee

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Pattern Recognition:	Witold Pedrycz (Canada)

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Ching-Chang Wong (Taiwan)
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Xuejing Wu (Canada)
D.S. Malik (USA)

Mini-Track Organizers

Patrick Bosc:	At the Crossroads of Database Systems and Fuzzy Sets
Witold Pedrycz:	Granular Computing: An Introduction
Kaoru Hirota:	From Fuzzy Control to Fuzzy Multimedia Information Technology
Vladik Kreinovich:	State-of-the-Art Interval Techniques and How They Help in Fuzzy Computations: Everything a Fuzzy Researcher Needs to Know about Interval Computations
Rudolf Kruse:	Introduction to Information Mining
Toshio Fukuda, Naoyuki Kubota:	Computational Intelligence-Fuzzy, Neural, and Evolutionary Computing

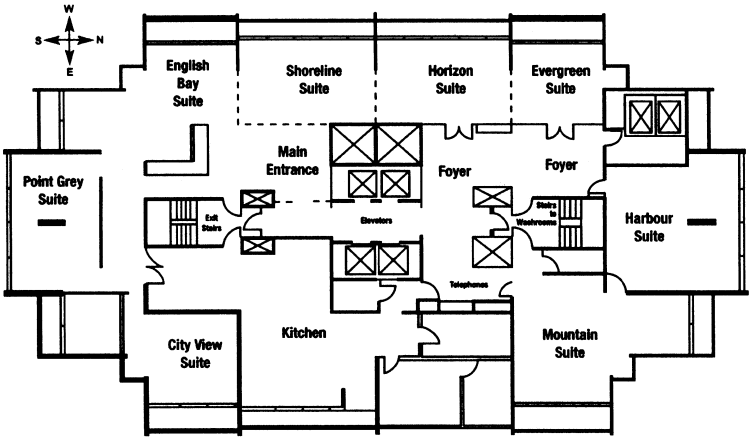
Invited Session Organizers

M. Ulieru	FM6	Soft Computing Applications to Intelligent Manufacturing and Fault Diagnosis
Y.M. Liu, M.K. Luo	MA4	Fuzzy Topology
M. Ulieru	MS1	Soft Computing Applications to Intelligent Manufacturing and Fault Diagnosis
R. Kruse	MS11	Information Mining
Y. Hata, S. Kobashi	MS3	Computer Aided Diagnosis in Medicine
Y. Hata, S. Kobashi	MS3a	Computer Aided Diagnosis in Medicine
I. Perfilieva	MS5	Fuzzy Logic and Approximation Models
R. Kruse	MS11a	Information Mining
I. Perfilieva	MS5a	Fuzzy Logic and Approximation Models
V. Kreinovich	MS7a	Interval Computations and Fuzzy Techniques
V. Kreinovich	MS7b	Interval Computations and Fuzzy Techniques
V. Kreinovich	MS7c	Interval Computations and Fuzzy Techniques
V. Kreinovich	MS7d	Interval Computations and Fuzzy Techniques
R. Kruse	MS11b	Information Mining
W. Pedrycz	MS14	Granular Computing
W. Pedrycz	MS14a	Granular Computing
W. Pedrycz	MS14b	Granular Computing
T. Fukuda, N. Kubota	MS17	Computational Intelligence - Perception to Action
T. Fukuda, N. Kubota	MS17a	Decision Making and Optimization
T. Fukuda, N. Kubota	MS17b	Action and Control
F. Hoffmann, O. Cordon, F. Gomide, L. Magdalena, F. Herrera	MS20	Genetic Fuzzy Systems: New Developments
F. Hoffmann, O. Cordon, F. Gomide, L. Magdalena, F. Herrera	MS20a	Genetic Fuzzy Systems: New Developments
P. Bosc	MS22	Database/Information Systems
P. Bosc	MS23	Database/Information Systems
W. Pedrycz	P1	Computational Intelligence and Software Engineering
M.R. Berthold	S1	Data Analysis
G. J. Klir	S2	Generalized Uncertainty-Based Information
G Lendaris	S3	Tuning Fuzzy Controllers via Adaptive Critic Based Approximate Dynamic Programming
H. Prade	S4	Fuzzy Set Techniques in Subjective Evaluation and Decision
K. Tanaka	S5	New Theory and Practice in Fuzzy Control in Japan
D.S. Yeung	S6	Some Recent Advances in Fuzzy Production Rules
D.S. Yeung	S7	Applications of Fuzzy Production Rules
M. Rast	S8	Financial Markets
S.-L. Wang	S9	Data Mining and Clustering
R.-C. Hwang	S12	Fuzzy Control Systems
M. Sato-Ilic	S10a	Recent Developments of Analyses on Uncertainty Information from the Aspect of Relations of Objects
M. Sato-Ilic	S10b	Recent Developments of Analyses on Uncertainty Information from the Aspect of Relations of Objects
T. Onisawa, H. Takagi	S11a	Applications of Soft Computing to Human Centered Systems Thinking

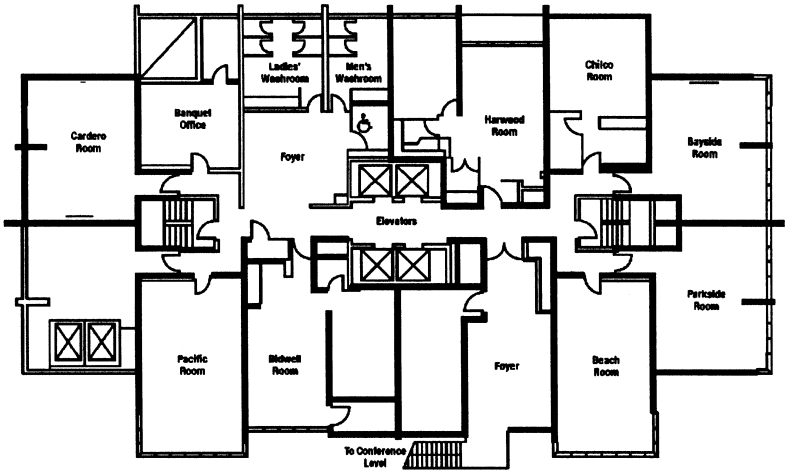
T. Onisawa, H. Takagi	S11b	Applications of Soft Computing to Human Centered Systems Thinking
F. Gomide, J. Niittymaki, J. Peters	S13	Fuzzy Set Applications in Transportation Systems and Fuzzy/Rough Petri Nets
F. Gomide, J. Peters	S14	On Advances on Fuzzy and Rough Petri Nets: Theory and Applications
V. A. Niskanen	S15	Information Granulation Modeling in the Human Sciences
K. Hirota	S16	Fuzzy Control/Modeling
K. Hirota	S16b	Soft Computing Applications
K. Hirota	S16c	Kansei Systems
Z.Z. Bien	S19	Multiobjective Decision Making and Control
Z.Z. Bien	S19a	Multiobjective Decision Making and Control
Z.Z. Bien	S20	Multiobjective Decision Making and Control
F. Mizoguchi, H. Nishiyama, H. Hiraishi	S21	Agents and Robotics for Real World Applications
K. Demirli	S22	Fuzzy Clustering Based System Modeling
F. Petry, M. Cobb, V. Robinson	S23	Uncertainty in GIS and Spatial Data
J. Buckley	S24	Applications of Fuzzy Sets/Logic to Operations Research
S. Dick	S25	Information Granularity and Computing with Words
J. Mendel, B. John	S26	Uncertainty and Type-2 Fuzzy Logic
R.K. Brouwer	S27	Recurrent Fuzzy Neural Networks
P. Baranyi, L.T. Koczy	S28	Fuzzy Modeling and Interpolation / Fuzzy Interpolation and Model Reduction
P. Baranyi, L.T. Koczy, D. Tikk	S28a	Fuzzy Modeling and Interpolation / Fuzzy Interpolation and Model Reduction
N.H. Phuong	S29	Soft Computing in Medicine
J. Lee, V. Cross	S30	Fuzzy Object Modeling
J. Keller	S31	Soft Computing in Image Processing
L. Godo, S. Sandri	S32	Advances in Possibilistic Logic and Related Issues
L. Godo, S. Sandri	S32a	Advances in Possibilistic Logic and Related Issues
L. T. Koczy, D. Tikk	S34	Fuzzy Modeling and Interpolation/Fuzzy and Hybrid Modeling
Q. M. J. Wu	S35	Intelligent Vision and Sensor Fusion
L. Trajkovic	S36	Intelligent Communications
J.M. Benitez, J.L. Castro, C.J. Mantas	S39	Neural Networks and Fuzzy Techniques
D. Filev	S40	Fuzzy Systems for Intelligent Control
W.A. Gruver	S41	Fuzzy Intelligent Systems

Hotel Floor Plans

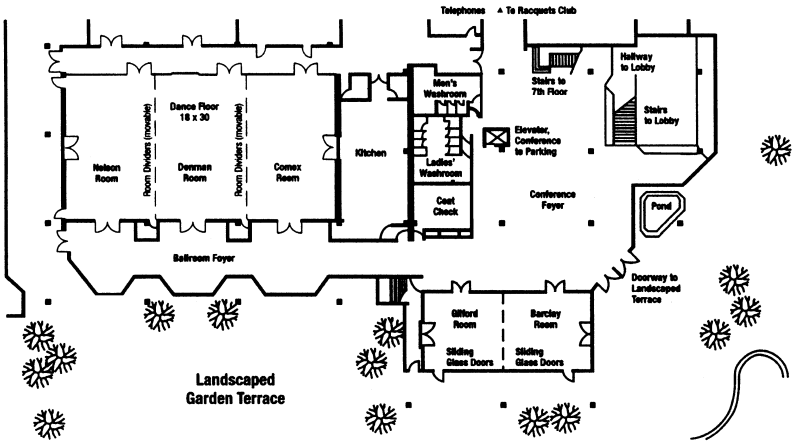
Windows on the Bay



Upper Conference Level



Conference Level



Program at a Glance

Wednesday July 25	07:30	18:30	Registration	Conference Foyer
	08:30	12:30	Tutorial: Computing with Words and its Applications	Barclay Room
	08:30	12:30	Tutorial: Non-linear and Fuzzy Systems Applications in Finance: A Practitioners View	Nelson Room
	08:30	12:30	Tutorial: An Introduction to Evolutionary Computation and its Application to Problems in Fuzzy Systems	Comox Room
	12:30	13:30	Lunch Break	
	13:30	17:30	Open Forum on the Future of Soft Computing	Denman Ballroom
	17:30	19:30	Open Forum Reception	Conference Foyer & Outside Terrace
Thursday July 26	08:00	16:30	Registration	Conference Foyer
	08:15	08:30	Welcome Ceremony	Denman Ballroom
	08:30	09:30	Plenary: Evolution of Fuzzy Logic - From Past to Future	Denman Ballroom
	09:30	16:30	Exhibition	Conference Foyer
	08:00	16:30	Internet Access	Harwood Room
	09:30	10:00	Coffee Break	Conference Foyer
	10:00	12:00	Fuzzy Relations, Robots and Optimization (ROR1)	Comox Room
	10:00	12:00	Optimization (OPT1)	Nelson Room
	10:00	12:00	Decision Making (DE1)	Denman Room
	10:00	12:00	Fuzzy Modeling I (FM1)	Gilford Room
	10:00	12:00	Math I (MA1)	Chilco Room
	10:00	12:00	Data Analysis (S1)	Bayside Room
	10:00	12:00	Control I (CT1)	Beach Room
	10:00	12:00	Applications I (AP1)	Parkside Room
	10:00	12:00	Soft Computing Applications to Intelligent Manufacturing and Fault Diagnosis (MS1)	Pacific Room
	10:00	12:00	Intelligent Vision and Sensor Fusion (S35)	Cardero Room
			Lunch Break	12:00 13:30
	12:00	13:30	NAFIPS Board Meeting	Nelson Room
	13:30	15:30	Computational Intelligence and Software Engineering (P1)	Barclay Room
	13:30	15:30	Fuzzy Relations I (FR1)	Comox Room
	13:30	15:30	Pattern Recognition I (PR1)	Nelson Room
	13:30	15:30	Data Mining (DM1)	Denman Room
	13:30	15:30	Fuzzy Modeling II (FM2)	Gilford Room
	13:30	15:30	Math II (MA2)	Chilco Room
	13:30	15:30	Recurrent Fuzzy Neural Networks (S27)	Bayside Room
	13:30	15:30	Tuning Fuzzy Controllers via Adaptive Critic Based Approximate Dynamic Programming (S3)	Beach Room

Program at a Glance

	13:30	15:30	Fuzzy Artificial Intelligence (FAI1)	Parkside Room
	13:30	15:30	Soft Computing Applications to Intelligent Manufacturing and Fault Diagnosis (FM6)	Pacific Room
	13:30	15:30	Intelligent Communications (S36)	Cardero Room
	15:30	16:00	Coffee Break	Conference Foyer
	16:00	18:00	Fuzzy Relations II (FR2)	Comox Room
	16:00	18:00	Pattern Recognition II (PR2)	Nelson Room
	16:00	18:00	Evolutionary Algorithms (EA1)	Denman Room
	16:00	18:00	Fuzzy Modeling III (FM3)	Gilford Room
	16:00	18:00	Math III (MA3)	Chilco Room
	16:00	18:00	Soft Computing in Medicine (S29)	Bayside Room
	16:00	18:00	Control II (CT2)	Beach Room
	16:00	18:00	Financial Markets (S8)	Parkside Room
	16:00	18:00	Fuzzy Set Techniques in Subjective Evaluation and Decision (S4)	Pacific Room
	16:00	18:00	Neural Networks and Fuzzy Techniques (S39)	Cardero Room
	16:00	18:00	Neural Networks and Pattern Recognition (NNPR)	Barclay Room
	18:30	20:30	Welcome Reception	Windows on the Bay and Conference Foyer
Friday July 27	08:00	16:30	Registration	Conference Foyer
			Plenary: Language-Based Computing Environment for Internet Communication between Brain and Society	Denman Ballroom
	08:30	16:30	Exhibition	Conference Foyer
	08:00	16:30	Internet Access	Harwood Room
	09:30	10:00	Coffee Break	Conference Foyer
	10:00	12:00	Fuzzy Systems for Intelligent Control (S40)	Comox Room
	10:00	12:00	Information Mining (MS11)	Nelson Room
	10:00	12:00	Soft Computing in Image Processing (S31)	Denman Room
	10:00	12:00	Fuzzy Modeling IV (FM4)	Gilford Room
	10:00	12:00	Fuzzy Topology I (MA4)	Chilco Room
	10:00	12:00	Genetic Fuzzy Systems: New Developments (MS20)	Bayside Room
	10:00	12:00	Control III (CT3)	Beach Room
	10:00	12:00	Data Mining and Clustering (S9)	Parkside Room
	10:00	12:00	Interval Computations and Fuzzy Techniques (MS7a)	Pacific Room
	10:00	12:00	Granular Computing (MS14)	Cardero Room
	12:00	13:30	Lunch Break	
	12:00	13:30	IFSA Council Meeting	Nelson Room
	13:30	15:30	Multiobjective Decision Making and Control I (S19)	Comox Room
	13:30	15:30	Information Mining (MS11a)	Nelson Room
	13:30	15:30	Image Processing (IP1)	Denman Room

Program at a Glance

	13:30	15:30	Fuzzy Modeling V (FM5)	Gilford Room
	13:30	15:30	Advances in Possibilistic Logic and Related Issues (S32)	Chilco Room
	13:30	15:30	Genetic Fuzzy Systems: New Developments (MS20a)	Bayside Room
	13:30	15:30	Fuzzy Logic and Approximation Models (MS5)	Beach Room
	13:30	15:30	Computer Aided Diagnosis in Medicine (MS3)	Parkside Room
	13:30	15:30	Interval Computations and Fuzzy Techniques (MS7b)	Pacific Room
	13:30	15:30	Granular Computing (MS14a)	Cardero Room
	13:30	15:30	Generalized Uncertainty-Based Information (S2)	Barclay Room
	13:30	15:30	Meet the Editors of Fuzzy Sets/Logic Related Journals	Mountain Suite
	15:30	16:00	Coffee Break	Conference Foyer
	16:00	18:00	Multiobjective Decision Making and Control II (S19a)	Comox Room
	16:00	18:00	Information Mining (MS11b)	Nelson Room
	16:00	18:00	Clustering I (CL1)	Denman Room
	16:00	18:00	Fuzzy Intelligent Systems (S41)	Gilford Room
	16:00	18:00	Advances in Possibilistic Logic and Related Issues (S32a)	Chilco Room
	16:00	18:00	Uncertainty and Type-2 Fuzzy Logic (S26)	Bayside Room
	16:00	18:00	Fuzzy Logic and Approximation Models (MS5a)	Beach Room
	16:00	18:00	Computer Aided Diagnosis in Medicine (MS3a)	Parkside Room
	16:00	18:00	Interval Computations and Fuzzy Techniques (MS7c)	Pacific Room
	16:00	18:00	Granular Computing (MS14b)	Cardero Room
	16:00	18:00	New Theory and Practice in Fuzzy Control in Japan (S5)	Barclay Room
	16:00	18:00	FSS Editorial Board Meeting	Mountain Suite
	18:00	19:00	NAFIPS General Meeting	Comox Room
	18:50	22:00	Buses depart for Vancouver Aquarium	Hotel entrance
	19:00	23:00	Conference Banquet	Vancouver Aquarium
	21:30	23:00	Buses depart for Coast Plaza Suite Hotel	Aquarium entrance
Saturday July 28	08:00	12:00	Registration	Conference Foyer
	08:30	16:00	Exhibition	Conference Foyer
	08:00	16:00	Internet Access	Harwood Room
	08:30	09:30	Plenary: Fuzzy Systems Applications in Operations Research and Management Science	Denman Ballroom
	09:30	10:00	Coffee Break	Conference Foyer
	10:00	12:00	Computational Intelligence - Perception to Action (MS17)	Comox Room
	10:00	12:00	Database/Information Systems (MS22)	Nelson Room
	10:00	12:00	Clustering II (CL2)	Denman Room
	10:00	12:00	Recent Developments of Analyses on Uncertainty Information from the Aspect of Relations of Objects (S10a)	Gilford Room
	10:00	12:00	Fuzzy Control/Modeling (S16)	Chilco Room
	10:00	12:00	Applications of Soft Computing to Human Centered Systems Thinking (S11a)	Chilco Room

Program at a Glance

10:00	12:00	Math V (MA5)	Beach Room
10:00	12:00	Fuzzy Object Modeling (S30)	Parkside Room
10:00	12:00	Interval Computations and Fuzzy Techniques (MS7d)	Pacific Room
10:00	12:00	Uncertainty in GIS and Spatial Data (S23)	Cardero Room
		Lunch Break	12:00 13:30
12:00	13:30	IFSA Council Meeting	Nelson Room
13:30	15:30	Decision Making and Optimization (MS17a)	Comox Room
13:30	15:30	Database/Information Systems (MS23)	Nelson Room
13:30	15:30	Fuzzy Modeling and Interpolation / Fuzzy Interpolation and Model Reduction (S28)	Denman Room
13:30	15:30	Recent Developments of Analyses on Uncertainty Information from the Aspect of Relations of Objects (S10b)	Gilford Room
13:30	15:30	Soft Computing Applications (S16b)	Chilco Room
13:30	15:30	Applications of Soft Computing to Human Centered Systems Thinking (S11b)	Cardero Room
13:30	15:30	Some Recent Advances in Fuzzy Production Rules (S6)	Beach Room
13:30	15:30	Agents and Robotics for Real World Applications (S21)	Parkside Room
13:30	15:30	Neural Networks I (NN1)	Pacific Room
13:30	15:30	Applications of Fuzzy Sets/Logic to Operations Research (S24)	Cardero Room
13:30	15:30	Applications II (AP2)	Barclay Room
15:30	16:00	Coffee Break	Conference Foyer
16:00	18:00	Action and Control (MS17b)	Comox Room
16:00	18:00	Fuzzy Control Systems (S12)	Nelson Room
16:00	18:00	Fuzzy Modeling and Interpolation / Fuzzy Interpolation (S28a)	Denman Room
16:00	18:00	Fuzzy Set Applications in Transportation Systems and Fuzzy/Rough Petri Nets (S13)	Gilford Room
16:00	18:00	Kansei Systems (S16c)	Chilco Room
16:00	18:00	Information Granulation Modeling in the Human Sciences (S15)	Bayside Room
16:00	18:00	Applications of Fuzzy Production Rules (S7)	Beach Room
16:00	18:00	Fuzzy Clustering Based System Modeling (S22)	Parkside Room
16:00	18:00	Neural Networks II (NN2)	Pacific Room
16:00	18:00	Information Granularity and Computing with Words (S25)	Cardero Room
18:30	21:30	Farewell Reception: Pow-Wow and BBQ	Garden Terrace
22:00	22:45	International Fireworks Competition: Celebration of Lights	English Bay Beach

Conference Information

Conference Site and Access
IFSA/NAFIPS 2001 will be held at the Coast Plaza Suite Hotel at Stanley Park, 1763 Comox Street, Vancouver, British Columbia, Canada.

Access to the hotel from the Vancouver International Airport is via taxi, rental car or shuttle bus. The Vancouver Airporter shuttle bus services the downtown hotels regularly (approximately every 30 minutes) beginning at 05:25 daily and stops across the street from the Coast Plaza Suite Hotel. The cost is $12.00 one-way or $18.00 round trip. Taxis are also available from the airport and will cost approximately $30.00.

The Coast Plaza Suite Hotel is located in the trendy West End of Vancouver adjacent to shopping and restaurants, the beaches of English Bay and the world famous Stanley Park. Along with the many walking trails around the 400-hectares of Stanley Park woodlands, are tennis courts, a pitch and putt golf course and the Vancouver Aquarium.

Other points of interest located only minutes away from the conference include Gastown, a restored area where the City began; Chinatown which is among the largest in North America and boasts the world's thinnest office building at only 1.8 metres (6 feet) wide; Robson Street, a delightful shopping section with a rich cosmopolitan flavour; nearby Robson Market with many specialty food and produce shops; Granville Island, with its large market and ethnic fast food; the Vancouver Museum, Art Gallery, the Orpheum and Queen Elizabeth Theatres, and the impressive new city library. For more information on things to do and see in Vancouver, visit www.tourism-vancouver.org or ask the staff at the registration desk or the hotel Concierge.

Visit the Tourism BC website at www.hellobc.com or phone 1-800-HELLO BC for other great destinations and tour options outside of Vancouver.

Restaurants
In addition to restaurants in the Coast Plaza Suite Hotel, nearly 100 restaurants and cafes line Denman Street, located a block away from the entrance to the hotel. There is a diverse range of food styles to appeal to everyone. The Conference Registration Staff and the Hotel Concierge would be happy to direct you to the various restaurants.

Registration Information
The Registration Desk will be open in the Conference Foyer of the Coast Plaza Suite Hotel during the following times:

Wednesday, July 25	07:30 – 18:30
Thursday, July 26	08:00 – 16:30
Friday, July 27	08:00 – 16:30
Saturday, July 28	08:00 – 12:00

Student Information
Although the student registration fee does not include banquet tickets, a limited number of free tickets, donated by delegates who are unable to attend the banquet, may be available for registered students at the registration desk.

Presentation Equipment
Overhead projectors and screens will be provided in all session rooms.

Session Chairs
All presenters should give their biographical information to the session chair prior to the start of their session. Session chairs should begin and end their session at the times listed in the Final Program.

Internet Access
Internet access for delegates will be available in the Harwood Room on the Upper Conference Level.

Exhibition
The IFSA/NAFIPS 2001 Conference Exhibition, to be held in the Conference Foyer of the Coast Plaza Suite Hotel, will include publishers, booksellers, and demonstrations of R&D projects. Exhibitor information, R&D demonstration times, and order forms will be available on-site.

Social Activities

Open Forum Reception
17:30 – 19:30 Wednesday, July 25
Coast Plaza Suite Hotel
Conference Foyer and Terrace

Welcome Reception
18:30 – 20:30 Thursday, July 26
Coast Plaza Suite Hotel
Windows on the Bay (35th Floor) and Conference Foyer

Conference Banquet
18:50 – 23:00 Friday, July 27
Vancouver Aquarium at Stanley Park

This will be an unforgettable gala affair with dinner inside the Galleries of the Vancouver Aquarium. Music will be provided by the Margaret Taylor Trio, Kach Chi, and Norm Stanfield. While you eat you can watch Beluga whales, sharks, piranhas, sea otters, Steller sea lions and seals, and extensive exhibits of marine life from the Amazon, Arctic, and Indo-Pacific tropical regions. A private show of whales/dolphins has been arranged for IFSA/NAFIPS 2001 delegates. The show is scheduled to begin at 19:15. Don't be late.

For details, visit the Gallery tour at www.vanaqua.org

Buses will shuttle guests from the front entrance of the Coast Plaza Suite Hotel to the Aquarium at 18:50. The last bus from the Aquarium will depart at 22:50.

Farewell Reception
18:30 – 21:30 Saturday, July 28
Coast Plaza Suite Hotel, Garden Terrace

A colorful performance with Native Indian drums and dancing will be featured at a BBQ dinner of duck, venison stew and salmon for all registered conference delegates and students. The "Celebration of Light" International Fireworks Competition featuring South Africa will follow at 22:00 (weather permitting). Delegates may view the fireworks from the beach of English Bay within easy walking distance from the hotel. 1,000,000 people are expected to watch this annual event. Personnel will be on hand to provide directions. Don't miss this spectacular evening of entertainment!

For details, visit www.celebration-of-light.com

Open Forum on the Future of Soft Computing

13:30-17:30 Wednesday, July 25
Denman Ballroom

Many activities involve the management of uncertain information ranging from the prediction of financial data to the understanding of biological or behavioral activity. The resulting data is always incomplete, poorly recorded, inconsistent, and often faulty. In addition, most of the data relies on subjective perceptions and is therefore inherently imprecise. Soft computing provides technologies for dealing with imprecise information using fuzzy logic, neural networks, evolutionary computation, and other intelligent system technologies.

This event, open to all registered delegates at IFSA/NAFIPS 2001 and to members of SMC, NAFIPS and IFSA via live broadcast over the Internet, will provide an open forum so that a distinguished panel of experts and the audience (both those at the forum and those attending via the Internet) can discuss and exchange their thoughts, concerns and ideas about soft computing. These panel members, drawn from industry, universities, R&D laboratories and institutes, and funding agencies, will also explore the future of soft computing. Issues such as the future needs and applications for soft computing in telecommunications, financial engineering, biotechnology, and the Internet will be addressed. Also, the direction of research funding, emerging research, and other professional interests related to soft computing will be emphasized.

The audience (both those at the forum and those attending via the Internet) will be strongly encouraged to participate in this Open Forum and the panel will focus on issues, comments, and concerns of the audience and the soft computing community in general. Other issues to be discussed will be solicited by e-mail from SMC, IFSA and NAFIPS members as well as from other researchers worldwide.

Moderator:
Lotfi A. Zadeh, University of California at Berkeley, USA
Professor and IFSA/NAFIPS 2001 Plenary Speaker

Organizer:
Michael R. Berthold, Tripos Inc., USA

Panel Members:
John Farrell, Harris Corp., USA
Information Assurance Design Lead

David Fogel, Natural Selection, Inc., USA
Chief Executive Officer

Gregg Garrison, Hanseatic Group Inc., USA
Head of Marketing

David Patterson, Tripos Inc., USA
Senior Fellow

Michio Sugeno, Brain Science Institute, Japan
Laboratory Head and IFSA/NAFIPS 2001 Plenary Speaker

I. B. Turksen, University of Toronto, Canada
Professor and IFSA/NAFIPS 2001 Plenary Speaker

Paul Werbos, National Science Foundation, USA
Program Director

Hans-Juergen Zimmerman, Aachen Institute of Technology, Germany
Professor Emeritus

Panel: Computational Intelligence and Software Engineering (P1)

13:30-15:30 Thursday, July 26
Barclay Room

Organizer:
W. Pedyrcz

Panelists:
A. Bargiela
Nottingham Trent University
J. F. Peters
University of Manitoba
J. Jahnke
University of Victoria
N. Pizzi
NRC Institute for Biodiagnostics
J. Kacprzyk
Polish Academy of Sciences
E. Roventa
York University

Meet the Editors of Fuzzy Sets/Logic Related Journals

13:30-15:30 Friday, July 27
Mountain Suite

Chair:
W. Pedrycz

Panel Members:
Piero Bonisone,
International Journal of Approximate Reasoning
Bernadette Bouchon-Meunier,
International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems
Lawrence Hall,
IEEE Transactions on Systems, Man and Cybernetics, Part B Electronic Option
James Keller,
IEEE Transactions on Fuzzy Sets
Henri Prade,
Fuzzy Sets and Systems
Ronald Yager,
International Journal of Intelligent Systems

Thursday, July 26

NAFIPS Board Meeting
Nelson Room 12:00 – 13:30

Friday, July 27

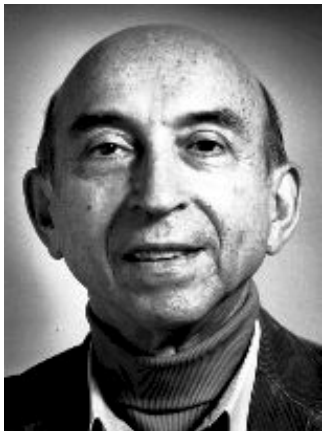
IFSA Council Meeting
Nelson Room 12:00 – 13:30

FSS Editorial Board Meeting
Mountain Suite 16:00 – 18:00

NAFIPS General Meeting
Comox Room 18:00 – 19:00

Saturday, July 28

IFSA Council Meeting
Nelson Room 12:00 – 13:30



Evolution of Fuzzy Logic - From Past to Future

08:30 – 09:30 Thursday, July 26
Denman Ballroom

Lotfi A. Zadeh
University of California at Berkeley
USA

Abstract: Fuzzy logic, FL, as we know it today, is much more than a logical system. Basically, FL has four principal facets: the logical facet, FL/L; the set-theoretic facet, FL/S; the relational facet, FL/R; and the epistemic facet, FL/E. The logical facet, FL/L, is fuzzy logic in its narrow sense, with the understanding that FL as a whole is fuzzy logic in its broad sense.

The set-theoretic facet, FL/S, has its roots in fuzzy set theory. The logical facet, FL/L, is rooted in multiple-valued logic, but has a very different agenda. The relational facet, FL/R, is the basis for most of the practical applications of fuzzy logic. And the epistemic facet, FL/E, relates to knowledge, language and meaning.

From a personal perspective, an important milestone in the evolution of fuzzy logic was the introduction of the concept of a linguistic variable and the concomitant concept of a fuzzy if-then rule. In one form or another, almost all applications of fuzzy logic employ these concepts. Another important milestone was the development of possibility theory and its penetration into many fields in which concept formation, recognition and reasoning play important roles.

During the eighties and into the nineties, we have witnessed a substantive migration of fuzzy logic— and especially its set-theoretic facet— into a wide range of fields in pure and applied mathematics, among them topology, algebra, logic, measure theory, and functional analysis. It should be noted that at this juncture, the Mathematical Sciences Net database lists over l0,000 papers in the mathematical literature which contain the word "fuzzy" in the title.

In the eighties and early nineties, a preponderance of applications of fuzzy logic—and especially its relational facet—related to control. Fuzzy control remains a major application area, but the emergence of many other areas such as resource allocation, decision support, recognition, databases, biomedicine and finance, has reduced its dominance of applications. Thus, fuzzy control is likely to grow in visibility, importance and acceptance within the field of control, but lose its position of centrality in fuzzy logic applications.

As one of the principal members of soft computing, fuzzy logic is increasingly used in combination with neurocomputing, evolutionary computing, probabilistic computing, chaotic computing and machine learning methodologies. This is a trend that is likely to grow in visibility and importance in the years ahead.

When I look into my crystal ball, I see a growing impact of fuzzy logic within the basic sciences, among them mathematics, physics, chemistry and, to a lesser extent, biology. In the long run, fuzzy logic may replace Aristotelian logic as a major component of the foundations of basic and applied sciences. This is likely to happen because the real world is much too complex to fit the Procrustean bed of bivalent logic and the underlying principle of the excluded middle.

In my view, the fuzzy-logic-based methodology of computing with words is likely to play a pivotal role in the transition from Aristotelean logic to fuzzy logic. As a methodology, computing with words lays the groundwork for a radical enlargement of the role of natural languages in science and engineering, and especially in information processing, decision and control. What will be recognized, eventually, is that the richness of natural languages will have to be harnessed to make it possible to build machines with much higher MIQ (Machine IQ) than those we can build today. This is a paradigm shift that we are likely to witness in coming years.

About the Speaker: Lotfi A. Zadeh is a Professor in the Graduate School, Computer Science Division, Department of EECS, University of California at Berkeley. In addition, he is

the Director of BISC (Berkeley Initiative in Soft Computing). He is an alumnus of the University of Teheran, MIT and Columbia University. He held visiting appointments at the Institute for Advanced Study, Princeton, NJ; MIT; IBM Research Laboratory, San Jose, CA; SRI International, Menlo Park, CA; and the Center for the Study of Language and Information, Stanford University. His earlier work was concerned in the main with systems analysis, decision analysis and information systems. His current research is focused on fuzzy logic, computing with words and soft computing, which is a coalition of fuzzy logic, neurocomputing, evolutionary computing, probabilistic computing and parts of machine learning. The guiding principle of soft computing is that, in general, better solutions can be obtained by employing the constituent methodologies of soft computing in combination rather than in stand-alone mode.

Dr. Zadeh is a Fellow of the IEEE, AAAS, ACM and AAAI. He is a member of the National Academy of Engineering and a Foreign Member of the Russian Academy of Natural Sciences. He is a recipient of the IEEE Education Medal, the IEEE Richard W. Hamming Medal, the IEEE Medal of Honor, the ASME Rufus Oldenburger Medal, the B. Bolzano Medal of the Czech Academy of Sciences, the Kampe de Feriet Medal, the AACC Richard E. Bellman Central Heritage Award, the Grigore Moisil Prize, the Honda Prize, the Okawa Prize, the AIM Information Science Award, the IEEE-SMC J. P. Wohl Career Achievement Award, the SOFT Scientific Contribution Memorial Award of the Japan Society for Fuzzy Theory, and other awards and honorary doctorates. He has published extensively on a wide variety of subjects relating to the conception, design and analysis of information/intelligent systems, and is serving on the editorial boards of over fifty journals.

Language-Based Computing Environment for Internet Communication between the Brain and Society

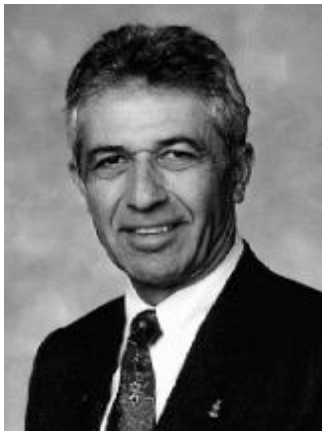
08:30 – 09:30 Friday, July 27
Denman Ballroom

Michio Sugeno
Brain Science Institute, RIKEN
Japan

Abstract: It is said that the brain has evolved in connection with language. We first survey human intelligence that is characterized by the use of language. Language has two features. It is social semiotic, and it is also concerned with higher order functions of the brain. This fact enables language to play a role of interfacing the brain with society. In order to develop human language technology, we suggest to apply systemic functional linguistics initiated by Halliday. We discuss a novel type of computing called "Everyday Language Computing" based on the idea of performing all information processing on computers using everyday language as a meta-language. In this context we are aiming at a paradigm shift from conventional number-based computing to language-based computing. With this computing environment, people could communicate using the Internet with other humans, agents, computer resources and other social resources with everyday language just as they think and act, and without any particular knowledge of computers.

About the Speaker: Michio Sugeno received his doctorate from the Department of Physics, University of Tokyo and served as Research Associate, Associate Professor and Full Professor at the Department of Control Engineering and Department of Systems Science, Tokyo Institute of Technology. Since 2000 he is Head of the Laboratory for Language-Based Intelligent Systems, Brain Science Institute, RIKEN in Wako, Japan. Dr. Sugeno is the recipient of the Pioneer Award from the IEEE Neural Network Council in 2000.

Plenary Lectures



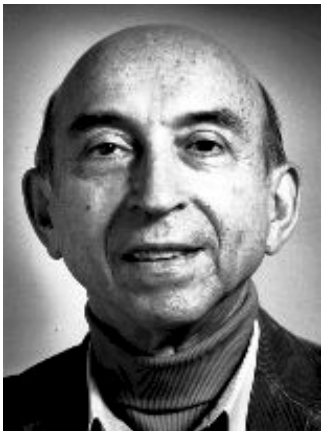
Fuzzy Systems Applications in Operations Research and Management Science

08:30 – 09:30 Saturday, July 28
Denman Ballroom

I. B. Turksen
Department of Industrial Engineering
University of Toronto
Canada

Abstract: A historical review of fuzzy system applications reveal that OR, Operations Research, and MS, Management Science, applications were started early in the development of fuzzy systems, even before the advent of fuzzy control applications. The phenomenal success of fuzzy control, with Japanese applications to consumer products, was a surprise even to L.A. Zadeh. But the development of fuzzy systems applications continued in OR and MS in the shadow of fuzzy control. It is forecasted that the novel application of fuzzy systems will appear more strongly in OR and MS for managerial decision support and control in the areas of strategic and tactical planning, resource allocation, scheduling, inventory control, logistics, etc., under the headings of fuzzy mathematical programming, fuzzy quality control, fuzzy network analysis and control, fuzzy consumer preference analysis, client credit worthiness, financial portfolio analysis, etc. Examples of these will be presented within a historical perspective and further potential will be predicted.

About the Speaker: I.B. Türksen received his Ph.D. degree in Systems Management and Operations Research in 1969, from the University of Pittsburgh, PA. He joined the Faculty of Applied Science and Engineering at the University of Toronto in 1970 and became Full Professor in 1983. Since 1987, he has been Director of the Information/Intelligent Systems Laboratory. During the 1991-1992 academic year, he was Visiting Research Professor of LIFE, Laboratory for International Fuzzy Engineering, Chair of Fuzzy Theory at Tokyo Institute of Technology. During 1993-1994 academic year, he was Visiting Research Professor at the University of South Florida and Bilkent University. Currently he is the President of IFSA. His current research interests are on the foundations of fuzzy sets and logics, in particular on Type 2 fuzzy knowledge representation and reasoning, fuzzy truth tables and fuzzy normal forms, and on applications of intelligent manufacturing and process system models, as well as, management decision support system models for analysis diagnosis, prediction and intelligent control.



Computing with Words and its Applications

08:30-12:30 Wednesday, July 25
Barclay Room

Lotfi A. Zadeh
University of California at Berkeley
USA

Abstract: Computing with words (CW) is an evolving methodology based on fuzzy logic— a methodology that is likely to become a widely used tool, with applications ranging from search and deduction in the Internet to decision-making in an environment of imprecision, uncertainty and partial truth. A concept that plays a key role in computing with words is that of precisiated natural language (PNL). PNL is a superset of the language of fuzzy if-then rules. Of particular importance is PNL's role as a concept-definition language. Computing with words opens the door to a far-reaching enlargement of the role of natural languages in scientific theories and, especially, in information processing, decision and control. The tutorial will cover the basics of both the theory of computing with words and its applications, and will clarify the relationship between computing with words with granular computing and the computational theory of perceptions.

About the Speaker: Lotfi A. Zadeh is a Professor in the Graduate School, Computer Science Division, Department of EECS, University of California at Berkeley. In addition, he is serving as the Director of BISC (Berkeley Initiative in Soft Computing). He is an alumnus of the University of Teheran, MIT and Columbia University. He held visiting appointments at the Institute for Advanced Study, Princeton, NJ; MIT; IBM Research Laboratory, San Jose, CA; SRI International, Menlo Park, CA; and the Center for the Study of Language and Information, Stanford University. His earlier work was concerned in the main with systems analysis, decision analysis and information systems. His current research is focused on fuzzy logic, computing with words and soft computing, which is a coalition of fuzzy logic, neurocomputing, evolutionary computing, probabilistic computing and parts of machine learning. The guiding principle of soft computing is that, in general, better solutions can be obtained by employing the constituent methodologies of soft computing in combination rather than in stand-alone mode.

Dr. Zadeh is a Fellow of the IEEE, AAAS, ACM and AAAI. He is a member of the National Academy of Engineering and a Foreign Member of the Russian Academy of Natural Sciences. He is a recipient of the IEEE Education Medal, the IEEE Richard W. Hamming Medal, the IEEE Medal of Honor, the ASME Rufus Oldenburger Medal, the B. Bolzano Medal of the Czech Academy of Sciences, the Kampe de Feriet Medal, the AACC Richard E. Bellman Central Heritage Award, the Grigore Moisil Prize, the Honda Prize, the Okawa Prize, the AIM Information Science Award, the IEEE-SMC J. P. Wohl Career Achievement Award, the SOFT Scientific Contribution Memorial Award of the Japan Society for Fuzzy Theory, and other awards and honorary doctorates. He has published extensively on a wide variety of subjects relating to the conception, design and analysis of information/intelligent systems, and is serving on the editorial boards of over fifty journals.

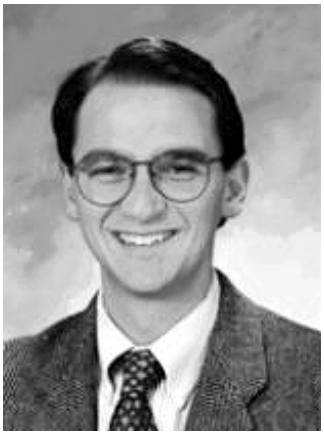
Non-linear and Fuzzy Systems Applications in Finance: A Practitioners View

08:30 – 12:30 Wednesday, July 25
Nelson Room

Gregg Garrison
Hanseatic Group, Inc.
USA

Abstract: The Hanseatic Group began business in 1977 as a Commodity Trading Advisor, taking its name from the medieval Hanseatic League. Hanseatic manages a variety of financial programs for institutions and high net worth individuals around the world through its SEC or CFTC-registered affiliates or other alternative investment firms. Hanseatic views markets as dynamically evolving nonlinear systems, a 20th century restatement of the insight at the heart of Adam Smith's invisible hand. Nonlinear systems occur whenever individual parts interact and create a whole that takes on a life of its own that is no longer reducible back to its original component parts. Because of their characteristic nonlinearity, Hanseatic believes markets have more in common with ecology, quantum mechanics, and linguistics, fields in which an array of mathematical tools have been developed to model nonlinear systems. The tools are designed to account for the complex relationships between the parts and the whole as well their interactive change going forward. Hanseatic uses these very same nonlinear tools to model markets quantitatively as well as qualitatively, applying the quantitative approach to its funds management and forecasting businesses and the qualitative approach to manage its private equity investments. These tools have proven very successful in managing various funds (these funds total over $100 million dollars), e.g., Hanseactic's Discretionary (managed futures) fund had a 181.52% return for 2000 and a 1,740.73% accumulated return for the past 5 years.

About the Speaker: Gregg Garrison attended the University of New Mexico, earning both a MBA in Finance and International Management and a MA in Latin American Studies (Economics and Political Science) in 1997. During his graduate studies, Mr. Garrison began working for Hanseatic Group on strategic marketing, a proposed international joint venture and a comparison of Hanseatic's methodology against other technical systems. He has also worked with Hanseatic and an academic institute to study non-linear systems, neural nets, financial engineering and other alternative approaches in finance and economics. Since June of 1998, Mr. Garrison has been Head of Marketing of Hanseatic's services to individual and institutional clients.



An Introduction to Evolutionary Computation and its Application to Problems in Fuzzy Systems

08:30 – 12:30 Wednesday, July 25
Comox Room

David B. Fogel
Natural Selection, Inc.
USA

Abstract: This tutorial is meant for people, with an interest in real-world applications of fuzzy systems and other soft computing technologies, who want to learn about the benefits that evolutionary computation can provide to these efforts. The course will provide an introduction to the central concepts that underlie evolutionary computation and detail examples of how to apply these methods to typical problems addressed with fuzzy systems, including time series prediction, classification, clustering, and control. Fundamental issues involving data representation, search operations, selection, and other facets of problem solving will be addressed.

About the Speaker: David B. Fogel is chief executive officer of Natural Selection, Inc., La Jolla, CA. He has been applying computational intelligence methods to real problems for 16 years. Dr. Fogel is the founding editor-in-chief of the IEEE Transactions on Evolutionary Computation and is the author of over 200 publications in computational intelligence, including six books. Most recently, he published "How to Solve It: Modern Heuristics," co-authored by Z. Michalewicz (Springer, 2001). He was elected a Fellow of the IEEE in 1999. Dr. Fogel is general chairman of the 2002 IEEE World Congress on Computational Intelligence, to be held May 12-17, 2002 in Honolulu, Hawaii.

Technical Program

Wednesday, July 25

OPEN FORUM RECEPTION
17:30 – 19:30 – CONFERENCE FOYER AND TERRACE

Thursday July 26

WELCOME CEREMONY
08:15-08:30 – DENMAN BALLROOM

EVOLUTION OF FUZZY LOGIC - FROM PAST TO FUTURE
LOTFI A. ZADEH, UNIVERSITY OF CALIFORNIA AT BERKELEY
08:30-09:30 – DENMAN BALLROOM

COFFEE BREAK
09:30-10:00 – CONFERENCE FOYER

FUZZY RELATIONS, ROBOTS AND OPTIMIZATION (ROR1)
CHAIR: V. CROSS
10:00 - 12:00 – COMOX ROOM

OPTIMIZATION (OPT1)
CHAIR: K. KATO
10:00-12:00 – NELSON ROOM

DECISION MAKING (DE1)
CHAIR: T. WHALEN
10:00-12:00 – DENMAN ROOM

FUZZY MODELING I (FM1)
CHAIR: L.J. KOHOUT
10:00-12:00 – GILFORD ROOM

Note: Invited papers are denoted by an asterisk (*).

MATH I (MA1)
CHAIR: S. GOTTWALD
10:00-12:00 – CHILCO ROOM

DATA ANALYSIS (S1)
ORGANIZED BY M.R. BERTHOLD
10:00-12:00 – BAYSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

CONTROL I (CT1)
CHAIR: W. WANG
10:00-12:00 – BEACH ROOM

APPLICATIONS I (AP1)
CHAIR: M. SCHNEIDER
10:00-12:00 – PARKSIDE ROOM

SOFT COMPUTING APPLICATIONS TO INTELLIGENT MANUFACTURING AND FAULT DIAGNOSIS (MS1)
ORGANIZED BY M. ULIERU
10:00-12:00 – PACIFIC ROOM

SPECIAL SESSION ON INTELLIGENT VISION AND SENSOR FUSION (S35)
ORGANIZED BY Q.M.J. WU
10:00-12:00 – CARDERO ROOM

LUNCH BREAK 12:00-13:30

NAFIPS BOARD MEETING 12:00-13:30 – NELSON ROOM

PANEL: COMPUTATIONAL INTELLIGENCE
13:30-15:30 – BARCLAY ROOM

FUZZY RELATIONS I (FR1)
CHAIR: H.PRADE
13:30-15:30 – COMOX ROOM

PATTERN RECOGNITION I (PR1)
CHAIR: R. KRISHNAPURAM AND O. KAYNAK
13:30-15:30 – NELSON ROOM

Note: Invited papers are denoted by an asterisk (*).

DATA MINING (DM1)
CHAIR: M. BERTHOLD
13:30-15:30 – DENMAN ROOM

FUZZY MODELING II (FM2)
CHAIR: I.S. JAWAHIR
13:30-15:30 – GILFORD ROOM

MATH II (MA2)
CHAIR: K. XU
13:30-15:30 – CHILCO ROOM

RECURRENT FUZZY NEURAL NETWORKS (S27)
ORGANIZED BY R.K. BROUWER
13:30-15:30 – BAYSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

TUNING FUZZY CONTROLLERS VIA ADAPTIVE CRITIC BASED APPROXIMATE DYNAMIC PROGRAMMING (S3)
ORGANIZED BY G.G. LENDARIS
13:30-15:30 – BEACH ROOM

FUZZY ARTIFICIAL INTELLIGENCE (FAI1)
CHAIR: J. YEN
13:30-15:30 – PARKSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

SOFT COMPUTING APPLICATIONS TO INTELLIGENT MANUFACTURING AND FAULT DIAGNOSIS (FM6)
ORGANIZED BY M. ULIERU
13:30-15:30 – PACIFIC ROOM

INTELLIGENT COMMUNICATIONS (S36)
ORGANIZED BY Lj. TRAJKOVIC
13:30-15:30 – CARDERO ROOM

COFFEE BREAK
15:30-16:00 – CONFERENCE FOYER

FUZZY RELATIONS II (FR2)
CHAIR: A. RYBALOV
16:00-18:00 – COMOX ROOM

PATTERN RECOGNITION II (PR2)
CHAIR: H. FRIGUI
16:00-18:00 – NELSON ROOM

EVOLUTIONARY ALGORITHMS (EA1)
CHAIR: F. HOFFMAN
16:00-18:00 – DENMAN ROOM

FUZZY MODELING III (FM3)
CHAIR: G. FACCHINETTI
16:00-18:00 – GILFORD ROOM

Note: Invited papers are denoted by an asterisk (*).

MATH III (MA3)
CHAIR: F. SONG
16:00-18:00 – CHILCO ROOM

SOFT COMPUTING IN MEDICINE (S29)
ORGANIZED BY N.H. PHUONG
16:00-18:00 – BAYSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

CONTROL II (CT2)
CHAIR: M. HANSS
16:00-18:00 – BEACH ROOM

FINANCIAL MARKETS (S8)
ORGANIZED BY M. RAST
16:00-18:00 – PARKSIDE ROOM

FUZZY SET TECHNIQUES IN SUBJECTIVE EVALUATION AND DECISION (S4)
ORGANIZED BY H. PRADE
16:00-18:00 – PACIFIC ROOM

NEURAL NETWORKS AND FUZZY TECHNIQUES (S39)
ORGANIZED BY J.M. BENITEZ, J.L. CASTRO, C.J. MANTAS
16:00-18:00 – CARDERO ROOM

NEURAL NETWORKS AND PATTERN RECOGNITION (NNPR)
CHAIR: U. KAYMAK
16:00-18:00 – BARCLAY ROOM

WELCOME RECEPTION
18:30 – 20:30 – WINDOWS ON THE BAY (35TH FLOOR) AND CONFERENCE FOYER

Note: Invited papers are denoted by an asterisk (*).

Friday July 27

LANGUAGE-BASED COMPUTING ENVIRONMENT FOR INTERNET COMMUNICATION BETWEEN BRAIN AND SOCIETY
MICHIO SUGENO, BRAIN SCIENCE INSTITUTE, RIKEN
08:30-09:30 – DENMAN BALLROOM

COFFEE BREAK
09:30-10:00 – CONFERENCE FOYER

FUZZY SYSTEMS FOR INTELLIGENT CONTROL (S40)
ORGANIZED BY D. FILEV
10:00-12:00 – COMOX ROOM

INFORMATION MINING (MS11)
ORGANIZED BY R. KRUSE
10:00-12:00 – NELSON ROOM

SOFT COMPUTING IN IMAGE PROCESSING (S31)
ORGANIZED BY J. KELLER
10:00-12:00 – DENMAN ROOM

FUZZY MODELING IV (FM4)
CHAIR: F. BONNAY
10:00-12:00 - GILFORD ROOM

Note: Invited papers are denoted by an asterisk (*).

FUZZY TOPOLOGY I (MA4)
ORGANIZED BY Y.M. LIU AND M.K. LUO
10:00-12:00 – CHILCO ROOM

GENETIC FUZZY SYSTEMS: NEW DEVELOPMENTS (MS20)
ORGANIZED BY F. HOFFMANN, O. CORDON, F. GOMIDE, L. MAGDALENA, F. HERRERA
10:00-12:00 - BAYSIDE ROOM

CONTROL III (CT3)
CHAIR: H. YING
10:00-12:00 – BEACH ROOM

DATA MINING AND CLUSTERING (S9)
ORGANIZED BY S.-L. WANG
10:00-12:00 – PARKSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

INTERVAL COMPUTATIONS AND FUZZY TECHNIQUES (MS7A)
ORGANIZED BY V. KREINOVICH
10:00-12:00 – PACIFIC ROOM

GRANULAR COMPUTING (MS14)
ORGANIZED BY W. PEDRYCZ
10:00-12:00 – CARDERO ROOM

LUNCH BREAK
12:00-13:30

IFSA COUNCIL MEETING
12:00-13:30 – NELSON ROOM

MEET THE EDITORS OF FUZZY SETS/LOGIC RELATED JOURNALS
CHAIR: W. PEDRYCZ
13:30-15:30 – MOUNTAIN SUITE

MULTIOBJECTIVE DECISION MAKING AND CONTROL I (S19)
ORGANIZED BY Z.Z. BIEN
13:30-15:30 – COMOX ROOM

INFORMATION MINING (MS11A)
ORGANIZED BY R. KRUSE
CHAIR: CHRISTIAN BORGELT
13:30-15:30 – NELSON ROOM

IMAGE PROCESSING (IP1)
CHAIR: J. KELLER
13:30-15:30 – DENMAN ROOM

Note: Invited papers are denoted by an asterisk (*).

FUZZY MODELING V (FM5)
CHAIR: B.C. GRANVILLE
13:30-15:30 – GILFORD ROOM

ADVANCES IN POSSIBILISTIC LOGIC AND RELATED ISSUES (S32)
ORGANIZED BY L. GODO AND S. SANDRI
13:30-15:30 – CHILCO ROOM

GENETIC FUZZY SYSTEMS: NEW DEVELOPMENTS (MS20A)
ORGANIZED BY F. HOFFMANN, O. CORDON, F. GOMIDE, L. MAGDALENA, F. HERRERA
13:30-15:30 – BAYSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

FUZZY LOGIC AND APPROXIMATION MODELS (MS5)
ORGANIZED BY I. PERFILIEVA
13:30-15:30 – BEACH ROOM

COMPUTER AIDED DIAGNOSIS IN MEDICINE (MS3)
ORGANIZED BY Y. HATA, S. KOBASHI
13:30-15:30 – PARKSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

INTERVAL COMPUTATIONS AND FUZZY TECHNIQUES (MS7B)
ORGANIZED BY V. KREINOVICH
13:30-15:30 – PACIFIC ROOM

GRANULAR COMPUTING (MS14A)
ORGANIZED BY W. PEDRYCZ
13:30-15:30 – CARDERO ROOM

GENERALIZED UNCERTAINTY-BASED INFORMATION (S2)
ORGANIZED BY G. J. KLIR
13:30 – 15:30 – BARCLAY ROOM

COFFEE BREAK
15:30-16:00 – CONFERENCE FOYER

MULTIOBJECTIVE DECISION MAKING AND CONTROL II (S19A)
ORGANIZED BY Z.Z. BIEN
16:00-18:00 – COMOX ROOM

INFORMATION MINING (MS11B)
ORGANIZED BY R. KRUSE
CHAIR: DETLEF NAUK
16:00-18:00 – NELSON ROOM

CLUSTERING I (CL1)
CHAIR: J.C. BEZDEK
16:00-18:00 – DENMAN ROOM

Note: Invited papers are denoted by an asterisk (*).

FUZZY INTELLIGENT SYSTEMS (S41)
ORGANIZED BY W.A. GRUVER CHAIR: DILIP KOTAK
16:00-18:00 – GILFORD ROOM

ADVANCES IN POSSIBILISTIC LOGIC AND RELATED ISSUES (S32A)
ORGANIZED BY L. GODO AND S. SANDRI
16:00-18:00 – CHILCO ROOM

UNCERTAINTY AND TYPE-2 FUZZY LOGIC (S26)
ORGANIZED BY J. MENDEL, B. JOHN
16:00-18:00 – BAYSIDE ROOM

FUZZY LOGIC AND APPROXIMATION MODELS (MS5A)
ORGANIZED BY I. PERFILIEVA
16:00-18:00 – BEACH ROOM

COMPUTER AIDED DIAGNOSIS IN MEDICINE (MS3A)
ORGANIZED BY Y. HATA, S. KOBASHI
16:00-18:00 – PARKSIDE ROOM

Note: Invited papers are denoted by an asterisk (*).

INTERVAL COMPUTATIONS AND FUZZY TECHNIQUES (MS7C)
ORGANIZED BY V. KREINOVICH
16:00-18:00 – PACIFIC ROOM

GRANULAR COMPUTING (MS14B)
ORGANIZED BY W. PEDRYCZ
16:00-18:00 – CARDERO ROOM

NEW THEORY AND PRACTICE IN FUZZY CONTROL IN JAPAN (S5)
ORGANIZED BY K. TANAKA
16:00-18:00 – BARCLAY ROOM

NAFIPS GENERAL MEETING

18:00-19:00 – COMOX ROOM

CONFERENCE BANQUET
19:00 – 23:00 – VANCOUVER AQUARIUM AT STANLEY PARK

Note: Invited papers are denoted by an asterisk (*).

Saturday July 28

FUZZY SYSTEMS APPLICATIONS IN OPERATIONS RESEARCH AND MANAGEMENT SCIENCE
I. BURHAN TURKSEN, UNIV OF TORONTO
08:30-09:30 – ROOM 1

COFFEE BREAK
09:30-10:00 – CONFERENCE FOYER

COMPUTATIONAL INTELLIGENCE - PERCEPTION TO ACTION (MS17)
ORGANIZED BY T. FUKUDA, N. KUBOTA 10:00-12:00 – COMOX ROOM

DATABASE/INFORMATION SYSTEMS (MS22)
ORGANIZED BY P. BOSC
10:00-12:00 – NELSON ROOM

CLUSTERING II (CL2)
CHAIR: J. A. DICKERSON
10:00-12:00 – DENMAN ROOM

RECENT DEVELOPMENTS OF ANALYSES ON UNCERTAINTY INFORMATION - FROM THE ASPECTS OF RELATIONS OF OBJECTS (S10A)
ORGANIZED BY M. SATO-ILIC
10:00-12:00 – GILFORD ROOM

Note: Invited papers are denoted by an asterisk (*).

FUZZY CONTROL/MODELING (S16)
ORGANIZED BY K. HIROTA
10:00-12:00 – CHILCO ROOM

APPLICATIONS OF SOFT COMPUTING TO HUMAN CENTERED SYSTEMS THINKING (S11A)
ORGANIZED BY T. ONISAWA, H. TAKAGI
10:00-12:00 – CHILCO ROOM

MATH V (MA5)
CHAIR: R. BELOHLAVE
10:00-12:00 – BEACH ROOM

FUZZY OBJECT MODELING (S30)
ORGANIZED BY J. LEE, V. CROSS
10:00-12:00 – PARKSIDE ROOM

INTERVAL COMPUTATIONS AND FUZZY TECHNIQUES (MS7D)
ORGANIZED BY V. KREINOVICH
10:00-12:00 – PACIFIC ROOM

Note: Invited papers are denoted by an asterisk (*).

UNCERTAINTY IN GIS AND SPATIAL DATA (S23)
ORGANIZED BY F. PETRY, M. COBB AND V. ROBINSON
10:00-12:00 – CARDERO ROOM

LUNCH BREAK
12:00-13:30

IFSA COUNCIL MEETING
12:00-13:30 – Nelson Room

DECISION MAKING AND OPTIMIZATION (MS17A)
ORGANIZED BY T. FUKUDA, N. KUBOTA
13:30-15:30 – COMOX ROOM

DATABASE/INFORMATION SYSTEMS (MS23)
ORGANIZED BY P. BOSC
13:30-15:30 – NELSON ROOM

FUZZY MODELING AND INTERPOLATION / FUZZY INTERPOLATION AND MODEL REDUCTION (S28)
ORGANIZED BY P. BARANYI, L.T. KOCZY
13:30-15:30 – DENMAN ROOM

Note: Invited papers are denoted by an asterisk (*).

RECENT DEVELOPMENTS OF ANALYSES ON UNCERTAINTY INFORMATION - FROM THE ASPECTS OF RELATIONS OF OBJECTS (S10B)
ORGANIZED BY M. SATO-ILIC
13:30-15:30 – GILFORD ROOM

SOFT COMPUTING APPLICATIONS (S16B)
ORGANIZED BY K. HIROTA
13:30-15:30 – CHILCO ROOM

APPLICATIONS OF SOFT COMPUTING TO HUMAN CENTERED SYSTEMS THINKING (S11B)
ORGANIZED BY T. ONISAWA, H. TAKAGI
13:30-15:30 – CARDERO ROOM

SOME RECENT ADVANCES IN FUZZY PRODUCTION RULES (S6)
ORGANIZED BY D.S. YEUNG
13:30-15:30 – BEACH ROOM

Note: Invited papers are denoted by an asterisk (*).

AGENT AND ROBOTIC FOR REAL WORLD APPLICATIONS (S21)
ORGANIZED BY F. MIZOGUCHI, H. NISHIYAMA, H. HIRAISHI
13:30-15:30 – PARKSIDE ROOM

NEURAL NETWORKS I (NN1)
CHAIR: T.Y. LIN
13:30-15:30 – PACIFIC ROOM

APPLICATIONS OF FUZZY SETS/LOGIC TO OPERATIONS RESEARCH (S24)
ORGANIZED BY J. BUCKLEY
13:30-15:30 – CARDERO ROOM

APPLICATIONS II (AP2)
CHAIR: H.-J. ZIMMERMANN
13:30-15:30 – BARCLAY ROOM

COFFEE BREAK
15:30-16:00

Note: Invited papers are denoted by an asterisk (*).

ACTION AND CONTROL (MS17B)
ORGANIZED BY T. FUKUDA, N. KUBOTA
16:00-18:00 – COMOX ROOM

FUZZY CONTROL SYSTEMS (S12)
ORGANIZED BY R.-C. HWANG
CHAIR: S-C. CHI
16:00-18:00 – NELSON ROOM

FUZZY MODELING AND INTERPOLATION / FUZZY INTERPOLATION (S28A)
ORGANIZED BY P. BARANYI, L.T. KOCZY, D. TIKK
16:00-18:00 – DENMAN ROOM

FUZZY SET APPLICATIONS IN TRANSPORTATION SYSTEMS AND FUZZY/ROUGH PETRI NETS (S13)
ORGANIZED BY F. GOMIDE, J. NIITTYMAKI, J. PETERS
16:00-18:00 – GILFORD ROOM

Note: Invited papers are denoted by an asterisk (*).

Note: Invited papers are denoted by an asterisk (*).

INFORMATION GRANULARITY AND COMPUTING WITH WORDS (S25)
ORGANIZED BY S. DICK
16:00-18:00 – CARDERO ROOM

Note: Invited papers are denoted by an asterisk (*).

Abstracts

001
Fuzzy Positive Implicative HyperK-Ideals of Type 5,6,7 and 8

R.A. Borzooei, M.M. Zahedi

In this note first we define the notions of fuzzy positive implicative hyperK-ideals of types 5,6,7 and 8. Then by given many examples we show that these notions are different. After that we state and prove some theorems which determine the relation between these notions and notions of fuzzy positive implicative hyperK-ideals of types 1,2,3 and 4. Finally by defining the concept of positive implicative hyperK-algebra and quasi alternate hyperK-algebra of type 1, we obtain another results.

002
Enhancing Fuzzy Robot Navigation Systems by Mimicking Human Visual Perception of Natural Terrain Traversability

Ayanna Howard, Edward Tunstel, Dean Edwards, Alan Carlson

This paper presents a technique for learning to assess terrain traversability for outdoor mobile robot navigation using human-embedded logic and real-time perception of terrain features extracted from image data. The methodology utilizes a fuzzy logic framework and vision algorithms for analysis of the terrain. A conventional optimization algorithm is applied to enhance a fuzzy system's capacity for mimicking human perception of natural terrain. The terrain assessment and learning methodology is tested and validated with a set of real-world image data acquired by an onboard vision system.

The paper presents the context in which fuzzy logic techniques are applied by explaining an approach to extracting terrain attributes from camera images, using these attributes as fuzzy inputs to infer a traversability index, and acting on this perceptual knowledge to facilitate intelligent autonomous navigation. Results revealing the extent of the classification performance improvements achieved using the approach are discussed. The underlying optimization approach can be generally applied to fuzzy systems of both the Mamdani and Takagi-Sugeno-Kang type. The general description of the methodology and its practical application permits one to assess its utility for enhancing fuzzy system performance in other domains of interest.

003
Application of Interval and Fuzzy Techniques to Integrated Navigation Systems

Antonio Tiano, Antonio Zirilli, Fausto Pizzocchero

This paper is devoted to the development of a new algorithm for Integrated Navigation Systems, potentially applicable to different types of vehicles, including cars and ships. The proposed algorithm combines a neuro-fuzzy Kalman filter with a map matching method. For this purpose some recently proposed methods for implementing a Global Positioning System based neuro-fuzzy Kalman filter are extended in order to improve the effective real-time system performances when low-cost hardware sensors, such as an odometer and a piezoelectric gyroscope are used. These extensions mainly concern the fuzzy rules used for the assessment of initial position and of sensor noises covariance matrix evaluation. In order to achieve a reliable computation, an interval arithmetic implementation of the Kalman filter is also considered. Once the neuro-fuzzy Kalman filter estimate of the vehicle's position has been determined, a real-time map-matching algorithm is then used for achieving a further improvement of the current estimate. The paper contains a number of experimental tests carried out by using a car travelling inside a city under normal traffic conditions. The results confirm that the proposed method allows to achieve a remarkable improvement of performances.

004
Using Rough Sets to Construct Sense Type Decision Trees for Text Categorization

Maria Zamfir Bleyberg, Arulkumar Elumalai

Accurate text categorization is needed for efficient and effective text retrieval, search and filtering. There is an increased interest in developing technologies for automatic text categorization. Finding appropriate categories and manually assigning them to existing documents is very laborious. In the present paper, we present an algorithm for the automatic construction of a taxonomy for a given a set of documents. The taxonomy is represented as a sense type decision tree, which has sets of nouns as nodes. Each node defines a primitive semantic category. The placement of a noun in a node set depends on the existing adjectives in the given documents. Some nouns appear to belong to the same node set due to the absence of certain adjectives in documents. We use the indiscernibility relation from the rough set theory to express the fact that some nouns cannot be discerned due to the lack of knowledge. Namely, we consider a collection of documents from which we retrieve the nouns and their associated adjectives. Given an adjective, two nouns are indiscernible (similar) with respect to that adjective, if each of them forms a meaningful adjective-noun expression. We use a lower approximation to find all nouns that surely belong to the same set and an upper approximation to find all nouns that possibly belong to the same set.

005
A Heuristic Adjustment to the Calculation of the Dissimilarity in the FCM Algorithm

E.O. Araujo

In this paper, one of the most widely used Fuzzy Clustering Model, Fuzzy c-means (FCM) is discussed. The FCM algorithm is based on the sum of intracluster distances criterion. This criterion is effective only when the data set contains clusters that are well-separated or have similar shape and volume. In order to minimize the objective function of the FCM algorithm, the small cluster grab some points belonging to the largest clusters. This article presents a simple and intuitive idea to aproach this problem. It consists of some heuristic adjustments to the calculation of the Euclidean distances employed in FCM algorithm. The heuristics change the distances from the points to the prototypes, based on the size and the orientation of the clusters. Benefits of the methodology are illustrated in the results of the simulations carried out using some artificial data sets.

006
Primal Algorithm of Fuzzy Posynomial Geometric Programming

Cao Bing-yuan

This paper aims at turning a fuzzy posynomial geometric programming into another one with variables limited by upper and lower bounds. By the aid of fuzzy geometric inequality, the latter is to be changed into a monomial fuzzy posynomial geometric one and, on the basis of fuzzy value sets, two direct algorithms are advanced in cutting plane method. Finally, its effectiveness is proved by numerical examples.

007
The Analysis of Searching Efficiency of Similartaxis

Chengyi Sun, Jianqing Zhang, Junli Wang

Mind Evolutionary Computation (MEC) is a new approach of Evolutionary Computation (EC). It is showed that MEC has much higher computing efficiency and convergence ability than Genetic Algorithm (GA). A new method of analyzing similartaxis process is presented in this paper. We got the relation between calculated amount in similartaxis and the parameters of MEC including the parameters of probability density function for scattering individuals, the size of group, the precision of solution and the distance between initial searching position and local optimum by this method. The experiment shows that analysis result accords with experimental data and the analysis method is correct. The experiment also analyzes the influence of different sizes of groups on searching efficiency and a reasonable range of the size of groups is gotten. The analysis can also be used to direct to improve the performance of MEC. To sum up, this analysis method is reasonable, feasible and directive.

008
Interactions among Paths in Fuzzy Shortest Path Problems

Shinkoh Okada

We concentrate on a shortest path problem on a network in which a fuzzy number, instead of a real number, is assigned to each arc length. As this type of problem is so called ``ill-posed''problem, each arc merely identified as on the shortest path or not. Therefore, based on the possibility theory we introduce the concept of ``degree of possibility'' in which an arc is on the shortest path. Some pair of paths from the source node to the other is considered to be interactive (which corresponds to dependence in probability theory) because there may exist common arcs in both paths. An new algorithm for the problems is proposed by taking interaction among paths into consideration. The degree of possibility for each arc on a network is obtained by this algorithm. Finally, an illustrative numerical example is shown.

009
Progressive Optimization of a Fuzzy Inference System

H. Maaref, C. Barret

The paper describes an automatically on-line tuned fuzzy navigation system for an autonomous robot using modular structure to generate the angular and linear speeds in function of the sensor data. The building of the navigation controller is done entirely on-line by the optimization of a zero order Takagi-Suguno fuzzy inference system by a backpropagation-like algorithm. The optimization of the controller is performed in two steps. The first one is done on a miniature robot or on its dedicated simulator. Then the obtained controller is carried on the real robot and a further optimization step is performed. At the end of the procedure, it is possible to extract the knowledge by interpreting the result parameters of the consequent part in a symbolic form. One can remark that the two tables deduced on the miniature robot and on the real robot are very close with respect to the linguistic concepts. Moreover, these two automatically extracted tables of rules are quite close to thos! e empirically written. But, we c an observe that some human expertise rules work wrongly because the expert doesn't expect particular situation. This method is simple, economic and safe. It leads to a very quick and efficient optimization procedure.

010
Interactive Fuzzy Programming for Decentralized Two-Level Multidimensional 0-1 Knapsack Problems Through Genetic Algorithms with Decomposition Procedures

Kosuke Kato, Masatoshi Sakawa, Ichiro Nishizaki

In this paper, we focus on a decentralized two-level multidimensional 0-1 knapsack problem with block angular structure involving a single decision maker (DM) at the upper level and multiple DMs at the lower level and apply an interactive fuzzy programming to derive a satisfactory solution in cosideration of balance between the satisfactory level to the DM at the upper level and those to the DMs at the lower level. Since it is shown that all of problems solved in the interactive fuzzy programming have block angular structures, we propose the introduction of a genetic algorithm with decomposition procedures for the purpose of utilizing the special structure of the problems.

011
An Interactive Fuzzy Satisficing Method for Multiobjective Stochastic Linear Programs through Simple Recourse Model

Masatoshi Sakawa, Kosuke Kato, Ichiro Nishizaki, Kouichi Wasada

In this paper, we focus on multiobjective linear programming problems with random variable coefficients in objective functions and/or constraints. For such multiobjective problems, after reformulation of them on the basis of simple recourse model, incorporating fuzzy goals of the decision maker for the objective functions, we propose an interactive fuzzy satisficing method to derive a satisficing solution for the decision maker as a fusion of the stochastic programming and the

fuzzy one. An illustrative numerical example is provided to demonstrate the feasibility of the proposed method.

012
Fuzzy Optimization Problems by Parametric Representation in the Two-Dimensional Metric Space

Seiji Saito, Hiroaki Ishii

In this study we give a new representation of fuzzy numbers with bounded supports and also we show that fuzzy number means a bounded continuous curve in the two-dimensional metric space. We consider definitions of the addition, subtraction and product which are defined by the extensions principle due to Zadeh and many other theoreticians of fuzzy logic as well as we show parametric representation of the operations between fuzzy numbers. Our aim of this research is to establish solving fuzzy optimization problems which consist of nonlinear or linear objective functions and constraints including fuzzyness. We have two important problems. One is to deal with some order relation, which are linear or the other. The other is to get criterion for the optimal solutions by considering saddle points of the Lagrangian functions.

013
Probability-Possibility Transformation Based on Evidence Theory

Koichi Yamada

Transformation between probability and possibility has been studied by many researchers. Most of those studies examined the principles that must be satisfied for the transformation, and devised an equation satisfying them in a heuristic way. They did not show that the proposed transformation was the only one satisfying the principles.

The paper devises three new transformation methods based on Evidence theory. Each starts from some principles in the same way as the previous research, but finds the only transformation satisfying the principles. One of them considers that possibility is an ordinal scale of uncertainty, and obtains the possibilistic order from a given probability distribution. The remaining two regards possibility as a ratio scale, and transforms a probability distribution into a possibility one.

All of the three generate the same ordinal structure of possibility. However, two of them generate different possibility distributions. Thus, the paper examines which of the two is more valid from the point of the given principles.

014
A Group Decision Making Fuzzy AHP Model and its Application to a Plant Location Selection Problem

Chian-Son Yu, Chien-Kuo Li

The major shortcoming of conventional fuzzy AHP methods is not the requirement of repeated extension principal processes or tedious arithmetic computations, but the ignorance of the interactions both among fuzzy variables and decision-makers. Besides, within a group decision making fuzzy AHP problem, traditional fuzzy AHP methods can not adequately tackle group conflicting judgment. This study proposes a goal programming model capable of straightly treating the interactions among both fuzzy values and decision-makers. With the trade-off consideration of optimizing decision makers’ group consensus and individual desirability or opinion, the extracted corresponding priority vector not only reflects the preferred information from the pairwise comparison values for a set of objects under a group decision making, but also best reflect what a majority of the involved individuals prefer and is progressively less sensitive to realizations of the group conflicti! ng judgment. A plant location se lection problem is employed to demonstrate the effectiveness and practicability of this study.

015
A Personalized Web Search Engine Using Fuzzy Concept Network with Link Structure

Kyung-Joong Kim, Sung-Bae Cho

There has been much research on link-based search engines such as google and clever. They use link structure to find precision result. Usually, a link-based search engine produces high-quality result than text-based search engines. However they have difficulty to produce the result fit to a specific user's preference. Personalization is required to support more appropriate result. Among many techniques, the fuzzy concept network based on user profile can represent user's subjective interest properly. This paper presents another search engine that uses the fuzzy concept network to personalize the results from a link-based search method. The fuzzy concept network based on user profile reorders five results of the link-based search engine, and the system provides personalized high-quality result. Experimental results with three subjects indicate that the system developed searches not only relevant but also personalized web pages on user's preference.

016
Fuzzy Set-Based Decision Support System for Transactions of Electricity in a Deregulated Environment

T. Niimura, K. Ozawa, O. Hirano

In this paper, the authors present a decision-making support system for electricity transactions under a deregulated industry environment. Recent deregulation of electrical power industry has introduced a market-based system of electricity transactions where electricity is traded as a commodity resulting in wild fluctuations in price, while consumers have a choice of purchasing electricity by a bilateral contract with a fixed price. In this approach, the uncertain market prices are represented by an autoregression model with fuzzy parameters. The extended autoregression model represents a market price by a fuzzy number with the most likely price as a mean value and the interval encompassing the range of possible highest and lowest prices with varying degrees of possibility. On the other hand, consumer's preference for a desirable bilateral price range with degrees of satisfaction is represented by a separate fuzzy number. The value of the bilateral transaction is then examined! by a fuzzy decision involving t he possible market price range, bilateral price offered, and consumer's preferred price range. By aggregating the composite fuzzy index for

the entire time frame of contract period, the most desirable bilateral contract for the consumer could be found.

017
Empirical Comparison of Techniques for Linguistic Approximation

Thomas Whalen, Brian Schott

This paper presents the results of am experiment comparing the degree to which two systems of linguistic labeling correspond to the way that human beings interpret quantitative linguistic terms. Subjects with minimal training in fuzzy mathematics consistently preferred the output of a new system based on piecewise decomposition to an older system based on the convex hull.

018
An Interactive Fuzzy Decision Making Method for Decentralized Multiobjective Programming Problems

Hitoshi Yano

In this paper, we focus on decentralized multiobjective programming problems where multiple decision makers called the leader and the followers make decisions in their hierarchical positions and each of them have multiobjective functions. Under the cooperative relationships between the leader and the followers, the original problem is formally decomposed into the leader's multiobjective programming problem and the followers' ones. In order to deal with such multiobjective programming problems, the extended Pareto optimal concepts are introduced, called the leader's Pareto optimal solutions and the corresponding followers' ones which are defined in membership function space. An interactive fuzzy decision making method is proposed to obtain the satisfactory solution which reflects not only their preferences but also their relationships in some sense. The numerical example illustrates the proposed method under the hypothetical interactions between the leader and the followers!

019
A Comparison of Five Approaches for Lithium Dose and Serum Concentration Prediction

Kemal Kilic, Beth A. Sproule, I. Burhan Turksen, Claudio A. Naranjo

Various methodologies are proposed in the literature to predict lithium dose or serum concentration. In this paper we compare the performance of the fuzzy system modeling algorithm that is proposed by our group with four other algorithms in terms of their performance based on serum lithium concentration prediction. The first method is the "Zetin method" proposed by Zetin et al. (1986), which is based on stepwise multiple linear regressions and designed specifically for lithium pharmacokinetics Secondly, the more recent method proposed by Terao et al. (1999). Third method is a new formula developed from the data on hand by using stepwise multiple linear regressions. Fourth, comparison will be between the well-known fuzzy system modeling algorithm proposed by Sugeno-Yasukawa. Our proposed method is the fifth alternative to be considered in this comparison. Published data from 30 patients (Terao et al. 1999) were used in our analysis. The performance of the algorithms with respec! t to precision as measured by th e root mean square error are as follows: 0.54, 0.34, 0.36, 0.31 and 0.24 mmol/L, respectively for the Zetin method, Terao method, stepwise multiple linear regression, Sugeno-Yasukawa approach and the new algorithm.

020
Development and Application of Fuzzy Probability to Expert Witnessing in Warning Theory

John Kreifeldt

If an expert when questioned in court judges it to be "more probable than not" that a person will read a warning and furthermore judges it "more probable than not" that that person will then heed it, does it therefore necessarily follow that he should conclude that it is "more probable than not" that the person will read and heed a warning? A yes or no answer to such questions commonly figures prominently in multimillion dollar awards to parties seeking compensation for injuries through the courts. Although probability theory would permit such a computation if the individual probabilities were known, no one is likely to be able to defend any particular set of exact values. Or, an expert may opine that the probability of reading such a warning could have been any value between 0 and 1 and the probability of following the warning advice also any probably between 0 and 1 and therefore no conclusion could be drawn one way or another. Does the conclusion "no conclusion could be drawn one way or another" follow fr om the premises? It is possible to give definitive and reasonable numerical and/or categorical answers to such questions and in the process elucidate the underlying bases for an expert's conclusions.

021
Soft Data Analysis for Evaluating Regional Environment

Sayoko Kawano, Miyuki Shakato, Mina Ryoke, Yoshiteru Nakamori

There is a plenty of statistical data related to environmental issues nowadays, which is called hard data in this paper. These numerical data, however, cannot cover all information required in the studies of environmental problems.

Sometimes opinions of residents are much more informative than the hard data. The subjective data obtained by a questionnaire survey is called soft data in this paper.

This paper tries to identify the relation between hard data and soft data with the fuzzy modeling techniques. After introducing a questionnaire survey we have carried out, the paper will present a classification of districts based on hard data.

Then, a rule-based environmental evaluation model will be developed in each cluster. This process includes a new fuzzy modeling technique to deal with soft data. Especially, a selection method of data points as well as indicators or attributes will be proposed by consulting the data mining technique.

022
Fuzzy Rule Based Innovation Projects Estimation

Alexander Rotshtein, Serhiy Shtovba, Illja Mostav

Estimation of innovation project quality level is an important task of any Innovation Fund. Instant and correct solution of this task allows to manage of financial resources optimally. Innovation project quality estimation is used for making one of the following decisions: d1 - to finance, d2 - to finance after retrofit, d3 - to finance when means are available, d4 - to reject.

To estimate innovation project quality we use the following enlarged parameter: level of the enterprise - applicant; technical economic level of the project; expected sales level; financial level of the enterprise-applicant.

For enlarged parameters assessment we use partial ones such as: level of enterprise leader, enterprise assets, enterprise liabilities, enterprise balance profit, enterprise debt receivables, enterprise indebtedness under credits, project scale, project novelty, development trend priority, degree of perfection, juridical protection, ecology level; ratio of internal funds to innovation funds; innovation fund means return etceteras .

The task of estimation is in bringing one of the decisions d1 - d4 into correspondence with some innovation project with known partial parameters.

For the task solution was created decision making model, based on fuzzy logic inference. The approach to the model design suggested in this paper is based on: presentation of state parameters in linguistic variable form; formalization of linguistic terms by fuzzy sets; formalization of expert's nature language expressions about relationship "parameters - decision" by fuzzy knowledge bases.

Partial and enlarged parameters are considered as linguistic variables. To estimate the introduced linguistic variables we use the unitary scale of qualitative terms: very low, low, lower than average, average, higher than average, high, very high. Each of these terms represents some fuzzy term preset using corresponding membership function. Expert's expressions about relationship "parameters - decision" was represented by 5 hierarchical knowledge bases.

Suggested model make the basis on the expert system which provides intelligent support in decision making about quality of innovation projects. This expert system is realized on basis of software shell FuzzyExpert. Results of decision making by the system is good concordant with expert assessments of quality.

023
Fuzzy Modeling via Sector Nonlinearity Concept

Hiroshi Ohtake, Kazuo Tanaka, Hua O. Wang

This paper presents a fuzzy modeling technique via the so-called sector nonlinearity concept. The sector nonlinearity concept guarantees to exactly represent the dynamics of any smooth nonlinear functions globally or at least semi-globally. To fully take the advantage of sector nonlinearity concept, we propose a new type of fuzzy model which consists of local Takagi-Sugeno fuzzy models (T-S fuzzy models) represented in each region. Each region basically corresponds to each quadrant. The local T-S fuzzy model in each region has two rules. The algorithm of the proposed fuzzy modeling technique consists of two parts. The purpose of the first part is to find multi-dimensional sectors, i.e., to determine coefficients of multi-dimensional sectors, from input-output data. The second part identifies membership functions from the determined sector coefficients and the input-output data. The membership functions are identified using neural networks. Identification examples illustrate the utility of this approach.

024
A Study on the Estimation Method of Target Design Engineering Quantity Considering Client Satisfaction

Kazutoshi Tsutsumi, Kazuya Hayashi, Masaru Teraoka, Atsushi Takizawa, Hiroshi Kawamura, Akinori Tani

Based on the reflection of Hanshin Awaji big earthquake disaster, the target of this study is the development of performance based design method from the point of view of clients. That development aims to propose the estimation method of the rational target design engineering quantity that gives higher performance of satisfaction against the earthquake by using soft-computing method. In this study, the story deformation is adopted as a design engineering quantity.

025
Fuzzy Graph Analysis for Sociometry on Latticed Display

Akira Satoh, Yoshiyuki Makino, Hajime Yamashita, Hiroshi Suda, Hiroaki Uesu, Kensei Tsuchida

The fuzzy graph will make it possible to quantitatively analyze fuzzy information such as expression of human relations and mental processes. In order to clarify the main feature of a fuzzy graph, we would represent it as an approximate graph and extract its characteristics such as similarity and connectivity structures. Therefore we must proceed to analyze many kinds of information concerning the structure of a fuzzy graph, such as drawing and displaying comprehensively fuzzy graphs in the process. We have developed a computer-aided method for analyzing fuzzy graphs through user-machine interaction. Our system can quickly and comprehensively draw a partition tree and display a fundamental shape of fuzzy graph. And we can analyze fuzzy graphs using the lattice type of fuzzy graph display. Here, it plays an important role in this system.. In this paper, we describe fuzzy graph model, analysis principle and user interface of this system, and their application to sociometry analysis.

026
The Concept of n-cut Cube Fuzzy Numbers and Embedding Theorem

Guixiang Wang, Congxin Wu, K.P. Shum

In this paper, we introduce the concept of n-cut cube fuzzy numbers and discuss their properties and operations. Also, we define a complete metric D_L on the n-cut cube fuzzy number space L(E^n) and prove that D_L \leqslant D \leqslant \sqrt{n} D_L. Some representation theorems for cube fuzzy numbers are established and in particular, we obtain an embedding theorem which shows that the space (L(E^n), D_L) can be embedded isometricially into a concrete Banach space \Pi^{2n}_{i=1} \tau_I [0,1]. As an application of our embedding theorem, we also consider the differential of the n-cut fuzzy number value mapping F: [a, b] \longrightarrow L(E^n), for the real interval [a, b].

027
T-Norm Based Residuated Logics - Some Recent Results

Siegfried Gottwald

In the intertwined fields of many-valued and fuzzy logics recent years have seen interesting and important developments related to the topic of infinite valued systems which are essentially based on given triangular norms.

For adequate axiomatizations of such logics, algebraic semantics have reached central importance.

The present paper surveys some of the core approaches and results of these developments.

028
Choquet Integral Type Fuzzy Switching Functions: Adjustment of Fuzzy Measures and Complementary Law

Eiichiro Takahagi

We propose Choquet integral type fuzzy switching functions with constants (CI-Fuzzy/C) which satisfy the complementary law. CI-Fuzzy/C has true and false inputs for each input and fuzzy measures values are assigned by outputs of a switching function of binary inputs. So, CI-Fuzzy/Cs are taken over from binary switching functions such as the complementary law. Lastly, we discuss the properties of CI-Fuzzy/C, such as, extension of binary logic, monotoneity conditions and liner outputs.

029
Cumulative Prospect Theory on Countable State Space

Yasuo Narukawa

The cumulative prospect theory (CPT) holds if the preference on the set of prospects is represented by the difference of two Choquet integral. The CPT with countable state space and finite support of a prospect is considered. It is shown that the functional with the comonotonic additivity and comonotonic monotonicity , which is weaker condition than monotonicity, is is a rank- and sign-dependent functional (for short a r. s. d. functional), that is, the difference of two Choquet integrals. Applying this result, we present the conditions for a preference relation to be CPT.

030
Space of Fuzzy Measures and Representation of Choquet Integral

Yasuo Narukawa, Toshiaki Murofushi, Michio Sugeno

The space of fuzzy measures with topology introduced by Choquet integral is considered. We show that the subspace of fuzzy measures which is less that and equal to 1 is compact. The space of nonnegative fuzzy measures is a locally convex space. Applying the theorems mentioned above, we obtain the additive representation of Choquet integral. The similar theorems are shown in various contexts. In this paper it is shown that these theorems are partially equivalent. But they are not perfectly equivalent. The differences among them are stated in the forms of the table.

031
A Heuristic for Feature Selection for the Classification with Neural Nets

Fridtjof Feldbusch

Feature selection is a very important task in classification. But feature selection is a NP-hard optimization problem that is often approximated by heuristic search for a good feature subset. To compare different feature subsets according to their relevance for a classification problem two approaches are used. Filters compute scores on general characteristics of the data without reference to a classifier. Wrappers generate a set of features, build a classifier using these features and use the classification rate to evaluate the feature set. Wrapper models are computationally more expensive than filter models, but for a given classifier the result of a wrapper is more reliable. The idea in this work was to use a wrapper with a fast statistical classifier for feature selection, while for the later online classification in the application a neural net was used. Some requirements must be met to ensure a correspondence between the classifiers such that the feature subset evaluated by the statistical classifier correlates to the features needed by the neural net for the differentiation of classes. Combined with different search methods this approach was used to build a small classifier for acoustic signals that can be implemented in hearing aids.

032
Training Fuzzy Logic Software Components: A Spacecraft Flight Attitude Control Application

Junda Chen, David C. Rine

A proposal for applying the software component training approach to spacecraft flight attitude control is presented. A software component is fuzzy logic based. Each component has two levels, the abstract (fuzzy logic rules) level and the concrete (fuzzy membership function) level. The concrete level is modified by adaptation algorithms. Properties of the fuzzy logic based software components are investigated.

033
Optimization of Piecewise Linear Networks (PLN) by Pruning

Wolfgang Eppler, Thomas Boettger

PLNs are neural networks with linear and metric neurons that separate a non-linear input space into several linear regions. The separation is done by LVQ-like metric neurons. Linear output neurons provide a linear mapping from input to output space. Unlike other neural networks there is a 3-dimensional weight matrix between input, hidden and output. For training of PLNs different training strategies like gradient descent or linear regression exist that are combined with a constructive method producing hidden units. Incremental training means that the network weights are refreshed after each presentation of a pattern. One drawback of this method is the non-smooth approximation of the objective function, especially for those spots corresponding to the first few patterns of a linear region. One bad effect is an insufficient generalization in this region. Pruning solves this problem. Different strategies are known like Optimal Brain Damage or Optimal Brain Surgeon. Both are very time consuming. A novel algorithm demonstrates a good trade-off in respect of generalization quality and computing effort. Applications are seen mainly in approximation tasks and here, especially, in control tasks and system identification.

034
Credit Scoring for Billions of Financing Decisions

Masoud Nikravesh

When you apply for credit, whether it's for a new credit card, a car, a student loan, a mortgage, or financing, about forty pieces of information from your credit card report are fed into a statistical model. That model provides a numerical score designed to predict your risk as a borrower. In this presentation, we will introduce fuzzy query and ranking as an alternative to predict the risk in an ever-changing world and an imprecise environment which includes subjective considerations for credit scoring. Fuzzy query and ranking is robust, provides better insight and a bigger picture, contains more intelligence about an underlying pattern in data and provides the ability of flexible querying and intelligent searching. This greater insight makes it easy for users to evaluate the results related to the stated criterion and make a decision faster with improved confidence. Fuzzy query is very useful for multiple criteria and when users want to vary each criterion independently wit! h different degrees of confidenc e or weighting factor.

035
Refine and Merge: Generating Small Rule Bases from Training Data

Thomas Sudkamp, Jon Knapp, Aaron Knapp

The characteristics of a fuzzy model are frequently influenced by the method used to construct the rules. Models produced by a heuristic assessment of the underlying system are generally highly granular with interpretable rules. Generating rules using algorithms that analyze training data has the potential of producing highly precise models defined by rules of small granularity. This paper presents an algorithm designed for constructing models of high granularity within a prescribed precision bound. An initial domain decomposition is produced and a rule base is generated. If the error between the resulting model and training data exceeds the precision bound, the domain decompositions are refined and the process repeated. When a sufficiently precise model is generated, a greedy strategy is used to combine adjacent rules to increase the granularity of model. A suite of experiments has been run to demonstrate the ability of the algorithm to reduce the number of rules in a fuzzy model.

036
Data Discovery Using Rough Set Based Reductive Partitioning: Some Experiments

Aijing He, Yaoyao Zhu, Lawrence J. Mazlack

An experimental investigation into unsupervised database mining was conducted. A novel para-digm for autonomous mining based on recursive, reductive partitioning was tested. The speculation is that in-creasing coherence will increase conceptual information. This in turn will reveal previously unrecog-nized, useful and implicit information. To assist our partitioning heuristics, a rough set based methodology called Total Roughness was designed to measure the crispness of a partition. This methodology was used in our experiments to help in partitioning as well as perform non-scalar data clustering. What is particularly noteworthy is that our approach sometimes partitions on multiple attributes. The feasi-bility of integrating rough set theory in unsupervised partitioning is evaluated and addressed. This pa-per focuses on the use of rough sets. It also provides some discussion of our other experiments.

037
A Self-Tuning Fuzzy Control System Design

Hsuan-Ming Feng

A self-tuning fuzzy control system is proposed such that the output of the controlled system has the desired output without knowing the mathematical model of the controlled system. In this control structure, a parameter tuning algorithm based on the technology of reinforcement learning and decision making mechanism is constructed to enable it to tune the consequent parameters of the fuzzy controller such that the fuzzy controller has the self-tuning ability. In this paper, a state evaluator is considered to play the role of a critic

element to evaluate the current state of the controlled system. A functional-type evaluator is used to produce a scalar value, which is provided to a parameter modifier to tune the adjustable parameters of the fuzzy controller. A decision making mechanism work as a director to select a appropriate parameter and fed a better action such that the controlled system has a better performance. The goal of the parameter tuning algorithm is to maximize the! evaluation value of the current state such that the control objective can be attained. Finally, the inverted pendulum control problem is used to illustrate the effectiveness of the proposed control system structure.

038
Interactive Fuzzy Programming for a Decentralized Two-Level Transportation Planning and Work Force Assignment Problem

Masatoshi Sakawa, Ichiro Nishizaki, Yoshio Uemura

In this paper, we deal with a transportation problem in a housing material manufacturer. The housing material manufacturer entrusts transportation of its products to two forwarding agents which handle regular transportation and small lot transportation. There are two objectives of the housing material manufacturer: one is to minimize the transportation cost and the other is to minimize the opportunity loss with respect to transportation time. Each of the two forwarding agents assigns drivers the transformation tasks so as to maximize its profit. We formulate the problem as a decentralized two-level integer programming problem and apply interactive fuzzy programming.

039
Relaxed Stability Conditions for T-S Fuzzy Systems

Wen-June Wang, Chun-Shiun Sun, Leh Luoh

It is well known that the general stability condition for a T-S fuzzy system is Ai'*P+P*Ai<0 (for continuous systems) or Ai'*P*Ai-P<0 (for discrete systems), i=1,2,r, where r is the number of system's rules and Ai' is the transpose matrix of matrix Ai. If rules' number r of the fuzzy system is large, the problem for finding the common P to satisfy r inequalities is not easy, even Linear Matrix Inequality (LMI) is used. However, in practical, when inputs are singletons, the number of the fired rules at the instance is always very less than (at most equal to) r. Those rules, which are not fired, have zero fired grade membership values. Therefore it is not necessary to consider them into the system's stability condition. This paper will investigate the problem to relax the stability condition, that is, the common P only needs to satisfy h inequalities instead of r inequalities, where h (less than or equal to r) is the number of the fired rules by each input sets. Thus, th! e new and relaxed stability cond ition is established.

040
Stability of Slowly Varying Takagi-Sugeno Fuzzy Systems

Renata Pytelkova, Petr Husek

This paper presents a method analyzing stability of slowly varying Takagi-Sugeno fuzzy systems with linear submodels in the consequents of rules. This method can be used for both continuous-time and discrete-time systems. It is supposed that the plant is described by the Takagi-Sugeno fuzzy system with linear state-space or input-output submodels in the consequents of rules and the controller by the Takagi-Sugeno fuzzy system with linear state feedback submodels or dynamic output feedback controllers in the consequents of rules. The problem of the stability analysis of such systems can be transformed to the problem of the stability analysis of polynomials with polynomic structure of its coefficients. This problem can be solved by the Modified Jury (for discrete-time systems) or by the Modified Routh or Hurwitz criterion (for continuous-time systems).

041
On the Use of Recurrent Neuro-Fuzzy Networks for Predictive Control

A.R. Sadeghian, J.D. Lavers

This paper presents the application of recurrent neuro-fuzzy networks for the predictive control of nonlinear, multi-variable, complex systems such as electric arc furnaces. The main objectives are to investigate the capability of adaptive neuro-fuzzy networks to predict the v-i characteristics of electric arc furnaces and to compare the performance of the proposed predictors with that of the feedforward neuro-fuzzy predictors. The novelties of this work are to propose the notion of approximate prediction and to implement it using a recurrent neuro-fuzzy structure suitable for long-term prediction. Successful implementations of recurrent neuro-fuzzy predictors are described and their performances are illustrated.

042
Data-Driven Construction of Sugeno Controllers: Analytical Aspects and New Numerical Methods

Martin Burger, Josef Haslinger, Ulrich Bodenhofer

In this paper, the general problem of identifying the parameters describing Sugeno controllers from example data is addressed. It is shown that this approximation is ill-posed. This means that the solution of the problem depends upon the data samples in a discontinuous way; therefore, so-called regularization methods have to be used in order to obtain a stable approximation of the solution. Usual test beds for data-driven construction of fuzzy controllers assume only low noise and a generous coverage of the input domain with a lot of data samples. In such environments, ill-posedness is usually of low impact. In practice, however, such good conditions are virtually impossible to satisfy, making ill-posedness a serious practical problem. We show how the ill-posed problem can be approximated by a well-posed problem which can be solved in a stable and robust way. For this purpose, smoothing techniques and Tikhonov regularization are considered. Finally, we propose an efficient numerical algorithm for solving the

general regularized approximation problem, followed by numerical examples with real-world data.

043
Active Power Line Conditioner Optimum Placement Using Fuzzy Controller

Mohsen Kalantar

Application of APLC to minimize the load harmonic distortion in the power system is one of the most effective and useful techniques to conflict with harmonics. Previous papers on APLC's focuses largely on minimizing harmonic voltage distortions across an entire network by using properly located APLC. This paper discusses the optimum placing of an APLC into the power system by designing a fuzzy system. The fuzzy system designed is very useful for this purpose. Optimal placing of an APLC not only depends on topology of network, constrained injection current and kind of objective functions but also depends mostly on the experiences obtained from an expert person and his ability to know the network. Application of fuzzy system having advantages of using fuzzy experiences are wide in the area of control theory and power system planning. Results of an fuzzy system designed to be used in an active power systems are presented in this paper.

044
Application of Fuzzy Logic for Automatic Shape Control in Stainless Rolling Process

YoneGi Hur, DaeKeun Rhee

The shape control of the stainless steel rolling has difficulty in obtaining symmetric shape and stabilizing strip shape despite an abnormal state that shows asymmetric shape pattern with respect to strip lateral direction. The objective of the shape control is to stabilize shape and material flow. The method for the strip shape recognition uses neural network (NN) and least squares method (LSQ). NN extracts symmetric component from the shape error. Moreover, LSQ does curve fitting and classifies the shape error into asymmetry. Fuzzy control method utilizing operator's knowledge will be proposed in this paper. The experiments are carried out on line and then the results show very efficient performance on tracking of the target shape.

045
Fuzzy Logic Control of an Industrial Robot

Muhammad Suzuri Hitam

In this paper, the application of fuzzy logic to control of an actual industrial robot in real time is described. A transputer based technology was adopted to enable a short sample time to be used. The relevant issues and difficulties arising in the real-time implementation of the control algorithm are discussed. Suggestions for the practical solution of the problems that arose are made which will be of interest to both the researcher and industrial practitioner alike. In conclusion, this paper presents a methodology for the application of fuzzy logic to control of an actual industrial robot.

046
Applications of Fuzzy Sets in Personalization for E-Commerce

Vivek Jain, Raghuram Krishnapuram

Personalization is central to Business-to-Consumer (B2C) e-commerce. In the B2C domain, the number of attributes required to address the problems effectively tends to be extremely large. Also, many business-specific attributes cannot be defined precisely. At the same time, the amount of data available for learning/building the personalized B2C system is fairly small. Therefore, approaches that can combine information from sparse data with business-specific knowledge that merchants can provide are perhaps the only viable option. Since fuzzy sets can model uncertainty associated with attributes/customer segments, require less data and at the same time can integrate vaguely specified linguistic information, they are ideally suited for this application. In this paper, we formulate the main problems of B2C e-commerce. We suggest a modular architecture for a personalized e-commerce system, and describe some ways in which fuzzy sets can play a role.

047
Generation of a Fuzzy Logic Controller using Evolutionary Strategies

Tao-Yuan Huang, Yung-Yaw Chen

In this paper, the authors propose a fuzzy logic controller (FLC) generation scheme using a modified (mu+lambda) evolution strategy (ES) with parental population sizing. The object variable portion of each ES individual represents a control rule of the FLC to be optimized. Therefore, the parental population along constitutes one and only one candidate FLC rulebase improved over the generations. The improvement is attributable to an increase of better-fitted individuals in the parental population. Fitness values of individual rules are calculated symbiotically. At each generation, offspring rules compete with their parents to form a new rulebase, which then strives to replace the original candidate rulebase according to elitist principle. In this aspect, the proposed FLC generation scheme practices (1+1) ES on the rulebase level. Furthermore, size of the candidate rulebase is simultaneously adjusted via parental population sizing to reflect system demands. The resultant scheme not only can construct FLC's with better performance but also provide additional flexibility to their rulebase structures. Simulations on several control examples have been conducted to demonstrate the virtue of this FLC generation scheme.

048
Advanced Mountain Clustering Method

Jung W. Lee, Seo H. Son, Soon H. Kwon

We introduce an advanced mountain clustering method (AMM), which uses a normalized data space, a gaussian type mountain function and a destruction method based on a mountain slope. This advanced method is more useful than Yager's mountain method (MM) because it needs just one parameter to tune instead of three and finds out more reasonable cluster centers having no another centers neighboring to first center. In addition, we present an adequate selection

method for the only parameter w. Finally, computer simulation results on numerical examples are presented to show the validity of the advanced mountain method.

049
State of the Art of Neuro-Fuzzy Systems and their Applications to Intelligent Manufacturing and Fault Diagnosis

Madan M. Gupta

In this paper we give some basic principles of fuzzy neural computing using synaptic and somatic operations. We first briefly review the neural systems based upon conventional algebraic synaptic (confluence) and somatic (aggregation) operations. Then we provide a detailed neuronal morphology based upon fuzzy logic and its generalization in the form of T-operators. For such fuzzy logic based neurons, we then develop the learning and adaptation algorithm.

050
Knowledge-Based Signal Analysis and Case-Based Condition Monitoring of a Machine Tool

Joseph Aguilar-Martin, Ludwig Haenlein, Ramon Sarrate Estruch, Julio Waissman

This paper describes an innovative methodology for knowledge-based signal analysis and interpretation. The force sensors introduced in a rotative machine-tool are used for the monitoring and supervision of the functional state of the tool and the possible faults in the environment, as lubrication, correct speed,… The monitoring turning processes gets the torque data from the force measurement directly for the main spindles and feed axes given by a piezo-electric sensors, they are analysed having in mind the knowledge of the experts about the semantically weighted patterns in order to monitor the operating conditions of the machine-tool. The proposed system consists on 2 parts : 1. ABSALON: (ABStraction AnaLysis ON-line), 2. LAMDA (Learning Algorithm for Multivariable Data Analysis) The first one is an "abstraction" or transformation of the signal into features to be interpreted, this is done by the sliding windows methodology; the second is performed by a fuzzy classifier, including a learning procedure from cases defined by expert knowledge: ABSALON transforms the raw signal into a vector whose components are significative features to be classified by LAMDA. Industrial experimental results are shown in the paper.

051
Fuzzy Classification for Fault Isolation in Gas Turbine Engines

Ellen Applebaum

RSLExpert is a fuzzy expert classifier for fault identification that is based upon expert reasoning and diagnosis of trend case residuals that are formed during an airplane's first ten seconds of flight. The fuzzy classifier assigns a residual vector of possible fault symptoms (called a Trend Case) to the type(s) of faults and faulty characteristics that may have caused it. The implementation of the classifier allows an expert to modify the fuzzy rule base "on the fly" so that no further recompilations of the model are necessary. This paper will address the fuzzy diagnosis strategy in the context of building RSL's Total Health Usage and Monitoring Systems (THUMS) for the cost-effective safety monitoring of gas turbine jet engines. Alternative and complementary soft computing approaches are also reviewed in the context of building robust THUMS systems.

052
Stochastic Analysis of Chaos Dynamics in Recurrent Neural Networks

Noriyasu Homma, Masao Sakai, Madan M. Gupta, Ken-ichi Abe

This paper demonstrates that the largest Lyapunov exponent of recurrent neural networks can be controlled efficiently by a stochastic gradient method. An essential core of the proposed method is a novel stochastic approximate formulation of the Lyapunov exponent as a function of the network parameters such as connection weights and thresholds of neural activation functions. By a gradient method, a direct calculation to minimize a square error needs gradients collection through time which are given by a recursive calculation from past to present values. The collection is computationally expensive and causes unstable control of the exponent for networks with chaotic dynamics because of chaotic instability. The stochastic formulation derived in this paper gives us an approximation of the gradients collection in a fashion without the recursive calculation. This approximation can realize not only a faster calculation of the gradients, but also stable control for chaotic dynamics. It is also shown by simulation studies that the approximation is a robust formulation for the network size and that proposed method can control the chaos dynamics in recurrent neural networks effectively.

053
Dynamic System Failure Detection and Diagnosis Employing Sliding Mode Observers and Fuzzy Neural Networks

Walmir M. Caminhas, Ricardo H.C. Takahashi

A strategy for dynamic system failure detection and diagnosis is proposed in this paper, based on sliding mode observers, employed for residual generation with discrimination among the error subspaces, and a fuzzy neural network, used for pattern classification. A control reconfiguration scheme is proposed, employing both the fault dianosis information and the robust observer generated data. The resulting structure has been evaluated in a simulated D.C. electric drive.

054
Web-Centric Diagnosis and Prediction System for Global Manufacturing

Mihaela Ulieru

A FIPA-enabled diagnosis and prediction system is proposed for dealing with disturbances in the flow of information and production at al levels of the holonic collaborative enterprise. Built on the power of integrated soft computing technologies the system acts as a proactive

agent to continuously update its fuzzy diagnostic model by accessing remote databases found on the sites of the collaborative partners. The web-Centric implementation enables advertisement of the system's services for interested parties inside and outside its area of collaboration. The system provides continuous feed-back to the production planning and operation scheduling at the intra-enterprise level by updating the maintenance schedule according to the fault predictions it performs while evaluating the evolution in time of the machine status. System's capabilities are illustrated on a simple scenario.

055
Intelligent Fusion of Sensor Data for Product Quality Assessment in a Fish Cutting Machine

A. Jain, C.W. de Silva, Q.M.J. Wu

This paper presents two intelligent sensor fusion techniques, which have been implemented in an automated machine for mechanical processing of salmon, to determine the level of product quality (i.e., the quality of processed fish). An automated fish cutting machine with advanced sensor technology is employed in the present work. The fish cutting process is complex, and ill-defined, and quality assessment methods are subjective. Two knowledge-based fuzzy fusion methods based on: a) regular Mamdani dot-max composition, b) the degree of certainty are implemented to achieve improved results. The data available from disparate sensors like CCD cameras, optical encoders and ultrasonic displacement sensor of the machine are fused using the two methods. An illustrative example for a good and a bad cut is presented. The results indicate that the two methods are equally effective, but method (a), which is more sophisticated, has a slight advantage in performance over the other, at the expense of added complexity.

056
A Hybrid Neural Network Based Vision-Guided Robotic System

Kevin Stanley, Jonathan Wu, William A. Gruver

There are two primary methods for mapping an input image to robot motion: computed kinematics and visual servoing. Computed kinematics uses a kinematic transform between the image plane and the world frame. Computed kinematics algorithms require only a single iteration, but are sensitive to calibration errors. Visual servoing uses a control law to regulate the image to a desired state. Visual servoing is more robust, but requires more computation to reach a solution. To balance these opposing factors, we proposed a hybrid system that uses an initial computed kinematics move followed by a visual servoing correction, thereby providing a compromise between speed and accuracy. A linear approximation model and a neural network were used to approximate the kinematic transform between the image and world frames. A PD control system is used to regulate the image to its final state.

057
Implementation of Sensor Selection and Fusion Using Fuzzy Logic

M.F. Ricky Lee, Kevin Stanley, Q.M. Jonathan Wu

The distribution of different sensors contains of means and variances, which are fused to single measurement for the process parameter. Different sensors contains various degrees of uncertainty and may be only reliable in particular situation, therefore the invalidation and redundancy of the sensor will be very critical to the high sensor data quality. This paper proposed a genetic algorithm using fuzzy logic methods for validation and fusion of uncertain sensor data. The sensors data are first validated by the Validation-Fussy-Engine and next the validated sensors data will go through Fusion-Fuzzy-Engine for fusion. The users according to the experiences can easily adjust the fuzzy parameter.

058
Intelligent 3-D Sensing in Automated Manufacturing Processes

Q.M. Jonathan Wu, M.F. Ricky Lee, Clarence W. de Silva

This paper focuses on the design of an intelligent, three-dimensional (3-D) sensing system applying artificial intelligence methodologies for quality assurance in automated manufacturing processes. An efficient 3-D object-oriented knowledge base and reasoning algorithm is developed. A fast and reliable assurance of product quality may be achieved through fault detection and diagnosis, using symbolic knowledge processing combined with numerical analysis of data. Incorporated with the reasoning algorithms, the knowledge base assists in the design process anticipating manufacturing problems and assuring specified end product properties. The knowledge base is regularly updated using feedback of the inspection results. An inexpensive and accurate, non-contact 3-D range data measurement system is developed. In this system, multiple laser light stripes are projected onto the product and a single CCD camera is utilized to record the scene. The distortions in the projected line pattern are due to the orientation variations and surface curvature of the object. Utilizing a linear relation between the projected line distortion and surface depth, range data is recovered from a single camera image. The surface terrain information may be converted into the curvature, orientation, and depth of the shape to incorporate into the symbolic 3-D object-oriented knowledge base and reasoning algorithms.

059
ANFIS Synthesis by Hyperplane Clustering

M. Panella, A. Rizzi, F.M. Frattale Mascioli, G. Martinelli

Adaptive Neuro-Fuzzy Inference Systems (ANFIS) are one of the most popular type of fuzzy neural networks. An usual approach to the synthesis of ANFIS networks is based on clustering a training set of numerical examples of the unknown mapping to be approximated. Several different clustering procedures can be adopted for this purpose, but most of them are affected by serious drawbacks. In the present paper, we propose a novel clustering approach in order to overcome these problems. It determines directly the consequent part of ANFIS rules; successively, the fuzzy antecedent part of each rule

is determined by using a Min-Max classifier. The resulting ANFIS architecture is optimized by means of a constructive procedure, which we further propose in this paper. It allows to determine automatically the optimal number of rules by applying well-known results of learning theory. Simulation tests and comparison with other techniques are discussed in order to prove the validity of the proposed approach.

060
Super High Resolution 3D Imaging and Efficient Visualization

Anup Basu, Irene Cheng

In this paper we describe and demonstrate our technology for creating super high resolution (SHR) & 3D digital content in a variety of applications including museum artifacts and galleries, archeology, anthropology, art design and heritage conservation. Our hardware can capture minute details of static scenes in a composite panoramic format with details surpassing the human eye. We also propose an approach to storing SHR images for efficient retrieval over bandwidth limited networks, such as the Internet. Regions of interest (ROIs) specified by users are stored in multiple levels of detail hierarchy. This hierarchy can be created by analyzing the contrast, texture or other feature changes with varying levels of resolution and creating a hierarchy of ROIs. The depth of the hierarchy for a given ROI is determined by following the changes in the contrast (or other feature) gradient over adjacent levels. An implementation of the browser for Virtual Museums is also presented. In addition to browsing images, our software provides the ability to support "interactive story telling." As viewers interact with a picture using a mouse, the descriptions of objects in the scene appear depending on the location of the mouse & the level of detail in the scene. Finally, the "Zoomage" tools can be used by academic researchers for various applications including object recognition, digital archiving, accurate stereo reconstruction, and 3D visualization.

061
Multivalued Dependencies in Extended Possibility-Based Fuzzy Relational Databases

Z.M. Ma, W.J. Zhang

Fuzzy values have been employed to model information imprecision in databases since Zadeh proposed the concept of fuzzy sets and the classical relational databases have been thereby extended. Data dependencies play a crucial role in logical database design as well as database manipulation. Many attempts have been made to represent the functional dependencies in various fuzzy relational databases. Multivalued dependencies in fuzzy relational databases, being another form of data dependencies, however, receive little attention. Based on the fuzzy relational databases where fuzziness of data appears in attribute values in forms of possibility attributions as well as proximity relations in attribute domain elements, called extended possibility-based fuzzy relational databases, a notion of semantic equivalence of fuzzy data is introduced in this paper. Following this notion, we will focus on the issues of fuzzy multivalued dependencies (FMVDs). A set of sound inference rules, which are similar to Armstrong's axioms for classical cases, for fuzzy multivalued dependencies are proposed.

062
The Majority Order of Fuzzy Numbers

Jinsheng Liu, Xuzhu Wang, Zhongming Han

In this paper, we extend a method for the ranking of vectors to that of fuzzy numbers. By introducing concept of majority order, a family of order relations is defined among fuzzy numbers. In essence the approach tranforms comparison of two fuzzy numbers into that of interval numbers. We verified that the derived order relations fulfil many rational properties. Particularly, the ordering indices are mathematically interpreted with the Lebesgue measure.

063
Implementing Fuzzy Reasoning with Closeness and Negligibility Relations

Allel Hadj Ali, Didier Dubois, Henri Prade

A set of inference rules describing the properties of fuzzy relations for modeling orders of magnitude in terms of closeness and negligibility relations, and their behaviors with respect to arithmetic operations. This inference machinery can be automated for simplifying complex equations with a view to solve them approximately. This paper presents a proposal for the efficient implementation of this machinery which mainly takes advantage of the equivalence between closeness and negligibility. Implementation issues, especially, the encoding of pieces of information and the inference method are discussed. The inference strategy, is both goal-driven and data-driven. An example is introduced to illustrate the basic steps of the reasoning.

064
Sociometry Analysis Applying Fuzzy Node Fuzzy Graph

Hiroaki Uesu, Hajime Yamashita, Michiko Yanai, Masatoshi Tomita

The sociometry is one of the measurement and evaluation methods of social structure which we could effectively analyze by applying fuzzy graph theory. According to the data obtained from a simple questionnaire, we could measure a fuzzy relation among the members of a group and observe its human structure by applying it. In this paper, we shall explain a fuzzy node fuzzy graph, its analysis system and its effective application to a fuzzy sociogram analysis.

065
Acquisition of Explicit and Implicit Knowledge in Fuzzy Systems

Alexander Rybalov

As people acquire knowledge, part of it becomes explicit and forms common domain. Other part is implicit and is unique for each person. These two types of knowledge can be represented as fuzzy system with two types of rules. However, aggregation in this system of two types of rules, representing explicit and implicit knowledge can lead to inconsistency. This paper shows that using uni-norm and heterogeneous operators we can overcome these difficulties. Another problem

that arises in knowledge acquisition is that usually fuzzy systems deal with predicates that can be represented as fuzzy sets, and this feature limits their application to representation and acquisition of human knowledge. In this paper it is shown that this problem can be resolved by extension of the above method to set-like alternatives that constitute essential part of human decision-making.

066
Transitivity-Related Properties of Fuzzy Strict Preference Relations

Xuzhu Wang

Given a fuzzy relation, there are several ways to get a fuzzy strict preference relation among which Ovchnnikov and Roubens, definition is general.In this paper, various transitivity-related properties of fuzzy strict relations introduced by Ovchinnikov and Roubens are investigated in detail. Under a certain condition, we proved that acyclicity and consistency,etc of fuzzy strict preference can be derived from corresponding properties of the fuzzy relation.

067
Soft Computing Design for Speech-Based Diagnosis of the Human Throat

M.P. Beddoes

The speech wave passes through the glottis and the vocal tract and finally arrives at the lips. The shapes of these organs modify the sounds we hear. A "tube model" can represent the vocal tract, and the various cross-sections progressing from the glottis to the lips characterize differing sounds. Such cross-sections may be linked to patient state. This may be NORMAL or ABNORMAL, damaged by cancer or unfortunate surgery or just old age. Here, we are interested in using vowel sounds as a possible diagnostic tool.

Cross-sections of the vocal tract model can be calculated from the constants of a Linear Prediction Coder, LPC, trained with a suitable vowel. This paper shows that an Artificial Neural Network version of the LPC gives lower error than the original which should make it more useful for calculating cross-sectional areas.

Two stages of Fuzzy variables are used to diagnose a patient into two levels, NORMAL or ABNORMAL. Further analysis reinforces the diagnosis by using adverbs LIKELY or UNLIKELY to end up with one of four categories.

068
Electrical Machine Fault Detection using Adaptive Neuro-Fuzzy Inference

Zhongming Ye, Bin Wu, A.R. Sadeghian

In this paper a new integrated diagnostic system for induction machine electrical fault diagnosis is proposed using neuro-fuzzy inference. New features are obtained by wavelet packet decomposition of the stator current. These features are of multiple frequency resolutions and obviously differentiate the healthy and faulty conditions. Features with different frequency resolutions are used together with the slip speed of the induction motor as the input sets for a neurfuzzy inference system. Two common electrical faults, the rotor bar breakage and the air gap eccentricity are considered. The system is validated on a 5 HP three-phase induction motor. The results show that this system has high diagnostic performance. The system is applicable to a variety of industry situations where continuous monitoring and prompt maintenance is required.

069
An Intelligent Web-Page Classifier with Fair Feature-Subset Selection

Hahn-Ming Lee, Chih-Ming Chen, Chia-Chen Tan

The explosion of on-line information has given rise to many manually constructed topic hierarchies. But with the current growth rate in the amount of information, manual classification in topic hierarchies results in an immense information bottleneck. Therefore, developing an automatic classifier is an urgent need. However, the classifiers suffer from the enormous dimensionality, since the dimensionality is determined by the number of distinct keywords. More seriously, most classifiers are either working slowly or they are constructed subjectively without learning ability. In this paper, we address these problems with a fair feature subset selection algorithm and an adaptive fuzzy learning network (AFLN) for classification. The fair feature subset selection algorithm is used to reduce the enormous dimensionality. It not only gives fair treatment to each category but also has ability to identify useful features, including both positive and negative features. On the other hand, the AFLN provides extremely fast training and testing and, more importantly, it has the ability to learn the human knowledge. Experimental results show that our proposed feature selection algorithm can be used to reduce a surprising number of dimensions. Besides, experimental results also show the adaptive fuzzy learning network with high-speed classification and high accuracy rate.

070
Unsupervised Clustering and Feature Discrimination with Application to Image Database Categorization

Hichem Frigui, Nozha Boujemaa, Soon-Ann Lim

We introduce a new algorithm that performs clustering and feature weighting simultaneously and in an unsupervised manner. The clustering approach is based on a model of mutual synchronization of pulse-coupled oscillators. The feature set is divided into logical subsets of features, and a degree of relevance is dynamically assigned to each subset. In each iteration, we first compute a partial degree of similarity for each subset of features. Then, based on these values, a degree of relevance is assigned to each subset. Finally, the partial degrees of similarity and their weights are aggregated to generate an overall degree of similarity. We investigate two techniques to assign a relevance weight. The first one is based on a fuzzy membership degree, and the second one is based on the ordered weighted averaging operator (OWA). The dynamic and cluster dependent feature weights have two advantages. First, they help in partitioning the data set into more meaningful clusters. Second, they can be used as part of a more complex learning system to enhance its learning behavior. The

performance of the proposed algorithm is illustrated by using it to categorize a collection of images using three sets of features.

071
Automatic Fuzzy Encoding of Complex Objects

G. Castellano, A.M. Fanelli, C. Mencar

In this work we propose an approach to encode real objects represented by feature vectors into fuzzy concepts. A system is designed, whose main component is an adaptive fuzzy encoder which learns object membership degrees to fuzzy concepts from a set of objects and the expert's crisp assignment to a concept. To properly use the expert's crisp choices, the learning is performed with the help of a fuzzy decoder that translates the membership values provided by the fuzzy encoder into crisp information. Moreover, a mapping is defined to improve the interpretability of the knowledge acquired through learning by the fuzzy encoder.

072
EEG Alpha Activity Detection by Fuzzy Reasoning

E. Huupponen, M. Lehtokangas, J. Saarinen, A. Varri, A. Saastomoinen, S-L. Himanen, J. Hasan

Automated systems are needed to assist the tedious visual analysis of polygraphic recordings. Most systems need detection of different electroencephalogram (EEG) waveforms. The problem in automated detection of alpha activity is the large inter-individual variability of its amplitude and duration. In this work, a fuzzy reasoning based method for the detection of alpha activity was designed and tested. The ranges of the fuzzy rules were determined based on feature statistics. The advantage of the presented detector is that no alpha amplitude threshold needs to be selected. The performance of the alpha detector with four modifications was assessed with ROC curves. When the true positive rate was 85%, the false positive rate was 13%, which is sufficient for sleep EEG analysis.

073
Similarity-Based Agents for EMail Mining

Vincenzo Loia, Sabrina Senatore, Maria I. Sessa

With Internet use continuing to explode, and due to the simplicity to send e-mails to many persons, recent years have seen the time spent in dealing with unnecessary and irrelevant e-mails to reach an increasing rate. In general, we note that the efforts of the scientific and industrial communities have been focused on the proposal of smart filtering services. Our approach is different: the user wishes to send an E-mail to an appropriate reader, that is an user whose ``profile" is compatible with the content of the E-mail itself. The profile is described in terms of topics that are related with the E-mail argument through a similarity-based network. The E-mail writer establishes this cognitive frame at client-side, exploiting the similarity-based reasoning. Then a search engine, based on mobile computation is triggered: a number of autonomous agents are created and sent on the network. The agents work as a Web-crawling spider not exploring the net indiscriminately, but searching domain-relevant documents directly on potential reader hosts. On this kind of document the agent extracts logic-based knowledge that is processed via the similarity deductive engine. As result, the agent returns an evaluation of the users' degree of interest in receiving the potential E-mail. At client-side a collector receives the different evaluations in order to define, through a flexible mechanism, the final user mailing list.

074
Discovering Quantitative Associations in Databases

A. Shragai, M. Schneider

In this paper we introduce a technique for mining association rules from quantitative data tables. The proposed method integrates the fuzzy set concept and the apriori algorithm. In this algorithm, the design of the membership functions avoids discriminating the importance level of the points. Additionally, our method incorporates the bias direction of an item from the center of a membership function region. Also, the method emphasizes the distinction between three important parameters: the support of a rule, its strength, and its confidence. It avoids missing the distinction between small number of occurrences with high support intersections and large number of occurrences with low support intersections.

075
Mining User's Web Searching Skills Through Fuzzy Cognitive State Map

George Meghabghab

The vast majority of college students have been reared as researchers in an environment where boundaries for information have been clearly marked, i.e., that of books and paper text. How do they learn to surf the web? What strategies do people use when surfing through the unbounded space of the web? In order to effectively teach students new surfing skills we must be able to understand the cognitive neurological networks that result in a mental pathway, or cognitive map, that is formed by navigating the web. A markovian modeling of users behavior is introduced and compared to a fuzzy cognitive map (FCM) that represents the opinions of experts on how users surf the web. Experts are divided on what causes users to fail their queries on the web. This paper shows that a viable FCM model can be developed and some limit-cycle equilibria are uncovered. A FCM limit cycle repeats a sequence of events and actions. Limit cycles can reveal cognitive and behavioral patterns of users on the web. An adaptive FCM is built to reflect user's changing behavior while searching the web. This change reflects the cognitive behavior as their knowledge of the web increases with time. Users lean new patterns and reinforce old ones.

076
An Intelligent Approach to Mining the Related Websites

Yo-Ping Huang, Yen-Chun Lee, Kent Lin

We propose an intelligent meta-search engine that bases on user's query keyword(s) to find the more related websites in this paper. Instead of listing a lot of candidate websites waiting for users to search, our approach automatically pops up only the most related doc-

ument for the user to read. The most related document appeared in the dialogue window is derived from the proposed method. User's satisfaction of the search result gives a feedback to our system for further improvement of the designed model. In case the user is not satisfied with the recommended document, we also have the options for user to choose. The options are listed in descending relations to the query keyword(s). We will present the architecture of designed model and illustrate how the proposed system works in finding the desired websites.

077
Incremental Mining of Association Patterns on Compressed Data

Vincent To-Yee Ng, Jacky Man-Lee Wong, Paul Bao

Introducing data compression concept to large databases has been proposed for many years. In this project, we propose a new algorithm for the compression of large databases. Our goal is to optimize the I/O effort for finding association rules. The algorithm partitions the databases into two parts and all transactions will be compressed with the help of a reference transaction found in the small partition. We also compared the proposed compression algorithms with a normal compression algorithm, the binary compression. Empirical evaluation shows that the proposed algorithm performs well both in reducing the storage space and the I/O process required to find the large itemsets for association rules.

078
Rule Discovery using Hierarchical Classification Structure with Rough Sets

Chul-Heui Lee, Seon-Hak Seo, Sang-Chul Choi

In the proposed method, the procedure for a classification rule discovery from data consists of two parts; the reduction of attributes and the rule discovery. Rough set theory is used to classify the objects of interest into the similarity classes and to investigate the granularity of knowledge for reasoning of uncertain concepts, and the hierarchical granulation structure is adopted to find the classification rules effectively. The proposed classification method generates minimal classification rules and an explicit and effective structure is achieved in consequence. Also the computational burden for the classification rule discovery is considerably reduced. Therefore it may offer an easy way to analyze the information system. To show the effectiveness of the proposed method, a simulation is performed on Wisconsin Breast Cancer data. The simulation result shows that the proposed method gives a good performance in spite of very simple rules and short conditionals.

079
Fuzzy Seismic Facies Detection with Interactive Defuzzification Method

L. Valet, G. Mauris, Ph. Bolon, N. Keskes

This work addresses the problem of seismic facies detection in order to understand the subsoil organization. A fuzzy fusion system is used to achieve this task. In this paper, an interactive defuzzification, based on alpha-cut analysis, is proposed. This method allows to involve interpreters in the final decision. Associated with this interactivity between interpreters and the detection process, a performance measure is defined to assess the result quality.

080
Estimation of the Degree of Functional Disability Through a Fuzzy Model

Antonio Jose Leal Costa, Eduardo Massad, Neli Regina Siqueira Ortega, Abelardo de Q-C Araujo

Measures of functional levels are commonly used to assess the quality of life of individuals and populations. Although essentially subjective, such measures have not yet been derived from a fuzzy framework. A fuzzy linguistic model (MISO) was developed to measure varying levels of functional disability, based on definitions of an individual's social and physical activities and mobility, considered together. >From the fuzzy model, one year of an adult´s life who works but performs restrictively other social activities, needs help to use public transport and walks with physical limitations was judged to be equivalent to 0.575 years of well life, in the absence of any kind of functional disability. The amount of well years of life can be used as a common denominator to assess the impact of medical and public health interventions, both preventive and curative. When applied at a population level, it serves as a useful tool for priority setting and decision making purposes in public health.

081
Diagnostic technique for classifying the quality of circuit boards using infrared thermal image

Kuo-Chao Lin, Wen-Liang Chen, Shing-Chia Chen, Fu-Sung Wang

In this paper, an advanced method for diagnosing the quality of the electronic circuit from thermal image of the circuit board based on the image processing and pattern recognition is described. The implementation of this diagnostic scheme requires the successful combination of several technological issues into a complete system that has the capability of diagnosing qualities of the important components in the observed system. An infrared window is first used to view the components within enclosures to avoid heat radiation and conduction effects, and then the maximum temperature of each component within the pre-defined area on the thermal profile of the electronic circuit is processed to reduce the processing data number. For further feature extraction, a principal component transform method is employed to extract the principle features of the measured thermal images. Finally, adaptive neural-fuzzy inference system (ANFIS) are utilized to recognize the thermal patterns corresp! onding to different quality cate gories. In the experimental implementation, we take the thermal images of a switch mode power supply for seven quality categories and verify our design notion to diagnose its quality from these measured thermal images. In this setup, the classification accuracy by our designed diagnostic system is 88.6%, which reveals the feasibility of using infrared-thermal-image-based diagnostic system to classify the quality of the circuit boards under the specified quality categories.

082
Evaluating Software Project Similarity by using Linguistic Quantifier Guided Aggregations

Ali Idri, Alain Abran

Software projects are often described by linguistic variables such as the experience of programmers, the competence of analysts and the complexity of modules. Because the existing software project similarity measures take into account only numerical data, we have proposed a set of measures based on fuzzy logic to evalute the similarity between two software projects when they are described by linguistic values. In this work, we improve the proposed measures by using linguistic quantifiers such as 'most', 'many' and 'few' in the computing process for the various measures.

083
Automatic Implementation and Simulation of Dynamic Qualitative Systems Using Fuzzy Boolean Networks and Fuzzy Rule Based Cognitive Maps

Joao Paulo Carvalho, Jose A.B. Tome

Due to several factors, like the difficulty of formulation of a mathematical model or the existence of numerous feedback links, Realworld Dynamic Qualitative Systems, like those that involve Social or Economic Problems, are incredibly difficult to model and simulate. There are currently no tools available to adequately represent the dynamics of these systems. Even if we had these tools, a different issue would be the building of a qualitative model. The standard methodology for acquisition of the necessary data relies usually on lengthy processes of individual and simplistic information collection: the result ends up being a list of quantitative relevant world concepts displayed as a matrix where weights represent the relations between those concepts. Therefore we end up with quantitative models where any vestiges of a system with realworld rich qualitative entities and relations were simply ignored. Besides, there is the additional problem of combining the views of different analysts into one single model, which is usually done by simple math operations. This paper presents the overview of an ongoing project which goal is to obtain and simulate the dynamics of Realworld qualitative systems through the combination of the properties of Fuzzy Boolean Networks and Fuzzy Rule Based Cognitive Maps.

084
L-R Fuzzy Numbers and Quantifiers in Type-Two Fuzzy Sets

L.C. Jang, J.D. Jeon

Zadeh [9], A. Ralescu [6], D. Ralescu [7], Dubois and Prade [1,2,3] investigated concepts of cardinality of a fuzzy set and obtained some properties of these fuzzy cardinalities. In this paper, we define concepts of some set-theoretical operations of L-R fuzzy numbers and discuss some properties of these operations. By using these properties, we define a concept of cardinality of a type-two fuzzy set and discuss some results of type-two fuzzy cardinalities. And also, we study the possibility of type-two fuzzy quantified statements of the form "Gx's are F", where G is a type-two fuzzy quantifier and F is a type-two fuzzy set. This possibility is one of concepts of aggregation functions of type-two fuzzy sets.

085
An Extension on Sugeno Integral and Pettis-Sugeno Integral

Congxin Wu, Traore Mamadou

In this paper,we extend the concept of Sugeno integral from nonnegative fuzzy measurable functions to extended real-valued fuzzy measurable functions;several necessary and sufficient conditions of absolute (S)-integrability for extended real-valued fuzzy measurable functions are given.Meanwhile,the space (S(mew),rho)of all fuzzy measurable measurable functions will be proved to be a metric space under a necessary and sufficient condition.Finally,as an application of this extension the Pettis-Sugeno integral will be introduced.

086
A Natural Interpretation of Fuzzy Set Theory

Mamoru Shimoda

We present a new and natural interpretation of fuzzy set theory in a cumulative Heyting valued model for intuitionistic set thoery, where basic notions and operations of set theory can be easily defined. We distinguish generalized fuzzy sets, fuzzy subsets of crisp sets, and membership functions of fuzzy sets on crisp sets. In the interpretation the canonical embedding from the class of all crisp sets into the model plays an important role. The model is one of the so called sheaf models studied by Grayson, Takeuti-Titani etc., but our interpretation is original and unique. By the interpretation we can deduce most of the standard defining equations of basic notions and operations of fuzzy sets and fuzzy relations. We can consider notions such as operations of fuzzy subsets of different universes, fuzzy relations and mappings between fuzzy subsets. Our interpretation of fuzzy mappings seems to be unique and quite natural, and the famous extension principle of Zadeh can be naturally deduced. As far as fuzzy sets and fuzzy relations are considered as extensions of crisp sets and relations, this interpretation seems to be most natural.

087
Injection of Human Knowledge into the Rejection Criterion of a Neural Network Classifier

Xuejing Wu, C.Y. Suen

The purpose of unconstrained handwritten numeral recognition is to assign a numeral to one of ten classes or reject it. The challenge is to maintain a high performance and not to misrecognize confusing patterns. In some applications, it is desirable to reject a pattern instead of running the risk of misclassifying it. In order to improve the reliability of a single neural network classifier on confusing numerals, knowledge from five human experts is gathered and analyzed. A new way to construct database and represent the required output values in the output layer of MLP's training process is given in this paper. Experiments on a synthesized confusing database and a real database show that the proposed approach will facilitate the design of a highly reliable single neural network classifier.

088
Using Generalized Choquet Integral in Projection Pursuit Based Classification

Kebin Xu, Zhenyuan Wang, Pheng-Ann Heng, Kwong-Sak Leung

A generalized Choquet integral with respect to a nonadditive sign measure is proposed, and serves as an aggregation tool to project the points of feature space onto a real axis to reduce an n-dimensional classification problem into a one-dimensional classification problem. The learning procedure of this new classification algorithm, GCIPP (Generalized Choquet Integral based Projection Pursuit), is just pursuing an appropriate projection direction optimally according to a criterion of minimizing the global misclassification rate. Such a nonlinear projection is characterized by the nonadditive sign measure and two weight vectors. The nonadditive sign measure is a proper representation of the contribution rate of each combination of the feature attributes, including each singleton, toward the classification, and its nonadditivity reflects the interactions among the feature attributes. Optimizing the sign measures and the weights is realized by an adaptive genetic algorithm. This new classifier is successfully tested on some simulated training data generated from the preset sign measures and weights, and it also performs well on several real-world data sets.

089
A Fuzzy Cauchy Problem Modelling the Decay of the Biochemical Oxygen Demand in Water

G.L. Diniz, J.F.R. Fernandes, J.F.C.A. Meyer, L.C. Barros

A very important physical-chemical parameter of water is the concentration of dissolved oxygen necessary for all living aquatic organisms. In this work, we have proposed a fuzzy model to describe the decay of the dissolved oxygen concentration in water using fuzzy differential equations, the classic analytic solution of which is well known. We use the Euler and Runge-Kutta 4th order methods to obtain an approximate solution of an initial value problem of a fuzzy linear ordinary differential equation modelling decay. We compare numerical results with the fuzzy analytic solution presented by Barros et al for the similar fuzzy differential equation.

090
Neurofuzzy Approaches to Intelligent Collision Avoidance Problems in (Semi) Autonomous Transportation

C.J. Harris, X. Hong

Model based methods for state estimation and control of linear systems is well established and applied. In practice the systems are non-linear, stochastic, temporal and only partially known. An alternative approach based upon empirical data based methods, which incorporate prior knowledge utilising linear additive 'non-linear' models based upon neurofuzzy algorithms are introduced. For control and tracking, there is a surfeit of techniques, which could be applicable to non-linear problems if appropriate linearisation is achieved; here various forms of local neurofuzzy networks are discussed via a class of adaptive neurofuzzy networks. It is shown that they have good approximation, convergence and stability properties, as well as parametric parsimony making them ideal in control and tracking. It is then shown how these algorithms have been successfully applied to collision avoidance problems in cars, helicopters and ships.

091
Recurrent Neuro-Fuzzy Networks for the Modelling and Optimal Control of Batch Processes

Jie Zhang

A recurrent neuro-fuzzy network based strategy for batch process modelling and optimal control is presented. The recurrent neuro-fuzzy network allows the construction of a "global" nonlinear long-range prediction model from the fuzzy conjunction of a number of "local" linear dynamic models. In this recurrent neuro-fuzzy network, the network output is fed back to the network input through one or more time delay units. This particular structure ensures that predictions from a recurrent neuro-fuzzy network are long-range or multi-step-ahead predictions. Process knowledge is used to initially partition the process nonlinear characteristics into several local operating regions and to aid in the initialisation of the corresponding network weights. Process input output data is then used to train the network. Membership functions of the local regimes are identified and local models are discovered through network training. In this paper, a recurrent neuro-fuzzy network is used to model! a fed-batch reactor and to calc ulate the optimal feeding policy.

092
A Truncated Normalized Max Product Set of Equations and its Solution for a Recurrent Fuzzy Neural Network

Roelof K. Brouwer

This paper defines a truncated normalized max product operation based on the operations of product, maximization, normalization and truncation in that order. The paper describes an iterative method for solving a set of equations based on this operation. The operation defined may serve as the transformation for the set of fully connected units in a fully recurrent network that generally consists of linear threshold units. Component values are not restricted to binary values as would be the case if the network consisted of linear threshold units but can now take on the values in the sets {0,0.1,..0.9,1} with cardinality 11 or similar sets of higher cardinality depending upon the degree of truncation specified and granularity desired. Due to truncation and normalization the network acting under this transformation has a finite number of states and components of the state vector are bounded. The operation defined here can form the basis of transformations in a recurrent network with a finite number of states. This means that fixed points or cycles are possible and the network based on this operation for transformations can be used as an associative memory or pattern classifier with fixed points taking on the role of prototypes.

093
Performance of a Recurrent Neuro-Fuzzy ART Based System for Pattern Recognition and Modeling of Dynamical Systems: RFasArt

G.I Sainz Palmero, J. Juez Santamaria, Y.A. Dimitriadis

In this paper two ART based neuro-fuzzy systems, FasArt and its recurrent version RFasArt, are compared in order to test the performance of the recurrency in this type of architecture. Both models has been employed in several areas such as pattern recognition and modeling/identification of systems. In the first area, the document understanding was involved, here the documents components should be classified according to the relationships amongst them. In the second area a waste water treatment plant and AC electrical motor have been selected.

Better successful rates, non ambiguities in the classification process and a reduction of the number of fuzzy rules or the complexity have been some of the main advantages founded.

094
Noisy Speech Segmentation with Multiband Analysis and Recurrent Neural Fuzzy Network

Gin-Der Wu, Chin-Teng Lin

This paper addresses the problem of automatic word boundary detection in the presence of variable-level background noise. Commonly used algorithms for word boundary detection always assume that the background noise level is fixed. In fact, the background noise level may vary during the procedure of recording. In order to solve this problem, we propose the RTF-MiFre-based RSONFIN (a recurrent neural fuzzy network) algorithm. Since the RTF and MiFre parameters can extract useful frequency energy and RSONFIN can process the temporal relations, this RTF-MiFre-based RSONFIN algorithm can find the variation of the background noise level and detect correct word boundaries in the presence of variable background noise level. Our experiment results have shown that the RTF-MiFre-based RSONFIN algorithm has good performance in the presence of variable background noise level presence.

095
Support Vector Recurrent Neurofuzzy Networks in Modeling Nonlinear Systems with Correlated Noise

W.C. Chan, C.W. Chan, K.C. Cheung, C.J. Harris

Good generalization results are obtained from neurofuzzy networks if its structure is suitably chosen. To select the structure of neurofuzzy networks, the authors proposed a construction algorithm that is derived from the Support Vector Regression. However, the modeling errors are assumed to be uncorrelated. In this paper, systems with correlated modeling errors are considered. The correlated noise is modeled separately by a recurrent network. The overall network is referred to as the support vector recurrent neurofuzzy networks. The prediction error method is used to train the networks, where the derivatives are computed by a sensitivity model. The performance of proposed networks is illustrated by an example involving a nonlinear dynamic system corrupted by correlated noise.

096
Dual Heuristic Programming for Fuzzy Control

George G. Lendaris, Thaddeus T. Shannon, Larry J. Schultz, Steven Hutsell, Alec Rogers

Overview material for the Special Session (Tuning Fuzzy Controllers Using Adaptive Critic Based Approximate Dynamic Programming) is provided. The Dual Heuristic Programming (DHP) method of Approximate Dynamic Programming is described and used to the design a fuzzy control system. DHP and related techniques have been developed in the neurocontrol context but can be equally productive when used with fuzzy controllers or neuro-fuzzy hybrids. This technique is demonstrated by designing a temperature controller for a simple water bath system. In this example, we take advantage of the TSK model framework to initialize the tunable parameters of our plant model with reasonable problem specific values.

097
Using DHP Adaptive Critic Methods to Tune a Fuzzy Automobile Steering Controller

Larry J. Schultz, Thaddeus T. Shannon, George G. Lendaris

The approximate dynamic programming method known as Dual Heuristic Programming (DHP) is applied to the design of a fuzzy controller for a 4-wheel, 2-axle vehicle. This controller is designed to guide an autonomous automobile on a curved road while maintaining lateral acceleration at comfortable levels. Nonlinear effects in the vehicle model are identified and addressed through the design of fuzzy rule antecedents. Rule consequents are specified as linear control laws with coefficients tuned using the DHP process to achieve approximately optimal performance (in the sense of minimizing a predefined cost function over time). Learning curves are illustrated wherein the controlled vehicle at first runs off the road. As the controller learns the controlled vehicle is able negotiate roadways with varying curvature at varying velocities. Analysis of the tuned controller illustrates that different control laws appropriate for different road / vehicle conditions have ! been learned.

098
Long Term Prediction of Tehran Price Index (TEPIX) using Neural Networks

Hamid Khaloozadeh, Ali Khaki Sedigh

Abstract It has been previously shown that the dynamics governing the share prices in Tehran Stock Exchange can be considered as a chaotic time series. Due to the initial sensitivity of the price generating process, it is shown that linear classical models such as ARIMA and ARCH are notable to efficiently model the dynamic of share prices in Tehran stock exchange for long term prediction purposes. However, non-linear neural network models are proposed to model the Tehran price index (TEPIX) daily data process and it is shown that such nonlinear models can successfully be used for the long term prediction of TEPIX daily data. Real data for the period of 1996 to 1999 are used to validate the prediction results.

099
Adaptive Critic Based Adaptation of a Fuzzy Policy Manager for a Logistic System

Stephen Shervais, Thaddeus T. Shannon

We show that a reinforcement learning method, adaptive critic based approximate dynamic programming, can be used to create fuzzy policy managers for adaptive control of a logistic system. Two different architectures are used for the policy manager, a feed forward neural network, and a fuzzy rule base. For both architectures, policy managers are trained that outperform LP and GA derived fixed policies in stochastic and non-stationary demand environments. In all cases the fuzzy system initialized with expert information outperforms the neural network.

100
Hierarchical Tuning of a Fuzzy Pitch Controller for an Unstable Airframe

Thaddeus T. Shannon, George G. Lendaris

In this paper we demonstrate the use of Approximate Dynamic Programming for the design of a pitch control system for an unstable aircraft using a hierarchical tuning approach. The aircraft model is based on an experimental wave rider design. We consider the full nonlinear longitudinal model and design a pitch controller for low speed, low altitude flight. Given the unstable, nonlinear nature of our plant, key elements of our implementation are the manner in which we provide learning experience for our controller, and the way we target different controller parameters at different points in the tuning process.

101
A Comparison of DHP Based Antecedent Parameter Tuning Strategies for Fuzzy Control

Alec M. Rogers, Thaddeus T. Shannon, George G. Lendaris

In the context of fuzzy control, antecedent parameters are used to provide a segmentation of the state space so that different regions can be modeled appropriately. In Adaptive Critic methodologies, two modules (the critic and the controller) must properly segment the state space to insure good performance. In this paper, we explore the effects of tuning antecedent parameters that are shared between these controller and critic networks (as opposed to tuning separate parameter sets). The results indicate that training shared antecedent parameters can be as effective as training separate antecedent parameters.

102
A New Method for Student Project Assessment Using Fuzzy Sets

Duanning Zhou, Ron C.W. Kwok, Quan Zhang, Jian Ma

The aim of this paper is to give a generalized approach for student project assessment in which criterion-referenced assessment techniques are often used. In order to provide the flexibility in assessment using criterion-referenced techniques, the proposed approach allows evaluators to express assessment information within different formats, including ordered vector, utility vector, linguistic term vector, selected subset, fuzzy selected subset, normal preference relation and fuzzy preference relation, in different assessment criteria. Then the assessment information in different formats is unified and aggregated, and the raking of the projects is obtained. The mark distribution of student projects is awarded based on the ranking of the projects.

103
Option Pricing in a Stochastic and Fuzzy Environment

Yuji Yoshida

A mathematical model for American put option and European options with uncertainty is presented and the randomness and fuzziness are evaluated by both probabilistic expectation and fuzzy expectation defined by a possibility measure from the viewpoint of fuzzy expectation, taking account of decision-maker's subjective judgment. Two models in American options with uncertainty, the case with an expiration date and the perpetual option case, are dealt with under a reasonable assumption. Prices of European call/put options with uncertainty are given and their valuation and properties are discussed under a reasonable assumption. The buyer's/writer's (seller's) rational range of optimal expected price in the options are presented and the meaning and properties of the optimal expected prices are discussed. The hedging strategies are also considered for marketability of the European options for portfolio selection.

104
Fuzzy Adaptive Rules in the Forecasting of Short Memory Time Series

L.Y. Fong, K.Y. Szeto

Fuzzy rule extraction is performed on an artificial time series with memory generated with a given covariance matrix using the inverse whitening transformation. The covariance matrix is defined with a definite range of memory using the short memory form of exponential decay. Vector quantization is performed on this real-valued time series to convert it into a digitized sequence of finite number of classes. The sequence is then divided into two subsets: training and testing sets, and the problem of forecasting the time series given the past data corresponds to the construction of a set of prediction rules that will make a classification on the class of the data today given the past sequence. We then construct an adaptive classifier using simple genetic algorithm with fixed selection ratio and construct a set of hierarchical rules for the classification of patterns. Since fuzziness exists for data close to the boundary between two classes, we modify our classifier by introducing! in the triangular membership fu nction associated with each class of data. The fuzzy region between neighboring classes is the overlapped region of these triangular functions and is parameterized by the degree of fuzziness, f. After training, the best rule from the genetic algorithm is measured for a given degree of fuzziness. Two distinct phases in the degree of fuzziness, separated by a critical value at f=0.18 for a short memory time series with decay constant of 5 days are found and understood as the result of two distinct best rules in two different phases. Application of this fuzzy adaptive classifier to real financial time series is discussed.

105
Some Issues on the Coherence of Min-Based Possibilistic Causal Networks

Nahla Ben Amor, Salem Benferhat, Khaled Mellouli

This paper focuses on Min-based possibilistic graphs which are natural counterparts of probabilistic causal networks. In particular, we discuss the coherence problem which concerns the non-recovering of initial data provided by the expert. We show that the coherence problem should not be seen as a drawback, and has no influence neither on independence relations nor on propagation algorithms.

106
Using Fuzzy Ontology for Query Refinement in a Personalized Abstract Search Engine

Dwi H. Widyantoro, John Yen

Recommending alternate queries during information seeking activities is an important feature in a Web-based search engine because users often do not know the exact terms to locate the information relevant to their interests. This paper describes our approach to construct automatically a fuzzy ontology that can be used to refine a user's query. The method has been incorporated in a domain-specific search engine namely Personalized Abstract Search Services (PASS). Preliminary results suggest that the basic approaches adopted as well as the technique developed for practical use are intuitively promising.

107
On-Line Investment Using Soft Computing: Prototype Development

York Fang Choo, Atsushi Inoue

A feasibility study on developing a web site that automatically generates asset allocation portfolios for personal investors is described. The target customers are novice investors, i.e. people who have little knowledge on how investments work. We try offering such a service by providing a simplified questionnaire (simple, natural linguistic expressions are used both in questions and choices of answers) similar to the one on 'accutrade.com.' Unsharp boundaries on classes of portfolios such as conservative, moderate and aggressive as well as uncertainties that reside in such linguistic expressions by their nature are handled by soft computing. In particular, we attempt to provide solutions on uncertainty management using evidential logic reasoning in Fuzzy Relational Inference Language (FRIL). The implementation of the web site consists of Perl scripts using CGI and DBI, FRIL, MySQL (a relational DBMS) and HTML files on a PC running LINUX OS. The design of the knowledge structure consisting of evidential logic rules and definitions of fuzzy sets mapped to linguistic terms used in the questionnaire and the recommendations is focused in this paper. Scenarios of possible entries to this site are described in order to demonstrate the natural behavior, i.e. human-friendliness, of this web site.

108
Knowledge Networking for Decision Making About Affordability of Engineering Design with OpenMath Protocol Support

Ladislav J. Kohout, Eunjin Kim, Andreas Strotmann, Ernest McDuffie

Complex manufacturing environments of the 21st century require a new level of analysis to be globally competitive. The large number of highly complex variables (often compounded by significant levels of uncertainty) encountered in decision making activities related to such environments, demand the advanced methodology represented by our application of Fuzzy Relational Methods. We present a methodology that utilizes current high-level web enabling programming languages to implement software tools in a manner that lends itself to the easy distribution and sharing of knowledge via the Internet. Extended OpenMath communication structures have a key role to play in the advancement of this approach. Relational mathematics and computational science combine to provide the necessary unification of data analysis and computational methods needed to address the complexities of decision making in such multi-dimensional engineering design domains.

109
Test Formalism in Relational Diagnosis - A Possibilistic Approach

Cristina Segal

The present paper proposes a new approach of "test" and "test plan" concepts for hypothesis discrimination generated during the abductive step of the diagnosis reasoning process. The originality of the present approach consists into fact that we discuss the test concept and test properties for a relational diagnosis problem and in particular for the possibilistic context. Our objective is constructing an "optimal" test plan to discriminate the hypothesis space.

110
Robust Fuzzy Modeling Based on L2 Gain Criterion

Tsuyoshi Hori, Tadanari Taniguti

This paper presents a robust fuzzy modeling based on L2 gain criterion.The most important thing is that fuzzy modeling executes using LMI conditions. We derive an LMI condition to identify the parameters of a Takagi-Sugeno fuzzy model (T-S fuzzy model). The LMI guarantees to minimize the summation of the upper bound of the identification error (SUE) between outputs of a real plant and those of a T-S fuzzy model. More importantly, we derive L2 gain based fuzzy modeling conditions. It achieves robust parameter identification for the data contaminated by noise. An example shows the utility of the proposed iterative LMI approach to L2 gain based fuzzy modeling.

111
Learning Rules Approach to R-FNN

Zhi Wen Mo, Dan Hu, Lan Shu

By the help of rough set theory,this paper puts forward a new way of machine learning-LBR(Learning by rough set theory).Based on this new algorithm,we can design a modal of R-FNN(Rough-fuzzy neural network).The presentation of this new modal gives us a intellectual approach to deal with data.Through practice in forcast,the R-FNN has a good effect.

112
Linguistic Association Rules

Shounak Roychowdhury, Witold Pedrycz

The class of Apriori algorithms are popular association rule mining techniques. However, these algorithms are computationally expensive. In this paper we propose a another novel approach to extract association rules. The method represents an itemset information as a cell of a hypercube. The hypercube encodes associations between the items of each transaction. Apart from proposing the main result we also propose Linguistic Association Rules. Linguistic Association Rules encode Fuzzy information and represent summarized rules.

113
A Linguistic Evaluation Approach for Strengthened Safeguards Relevant Information

Jun Liu, Da Ruan, Roland Carchon

This paper focus on the synthesis and evaluation analysis of nuclear safeguard relevant information based on the linguistic assessment. After a hierarchical analysis of States´ nuclear activities on the basis of the IAEA Physical Model, the objective addressed is divided into several less complex levels. Then we focus on the aggregation process in every level with consideration of the different kinds of qualitative criteria, like the strength degree of indicator, reliability of information, while we consider symbolic approach acts by the direct computation on labels instead of the approximation approaching using the associated membership function. In this context several kinds of presented aggregation operators within symbolic approach are analyzed. The overall evaluation of objective can be obtained step by step from aggregation of several lower levels. A case-study on application of these aggregation operators to the fusion of safeguards relevant information is provided.

114
Computing with Words =? New Mathematical Theory of Descriptions, Part 1: Description of Paths (Spiral Data, Kolmogorov Theorem and Neural Networks, Chess, Salesman)

Fatiha Karbou

Computing with words was originally introduced by Zadeh to capture the idea of computation based on linguistic terms rather than numerical quantities. Now, suppose one wants to indicate a path to a person who wants to make some shopping (the person supposed ignorant of this path). One starts by marking a number of reference points. And one describes the path in the following manner: “follow your right in bottom until the reference point A then turn left and follow downward until the point B,… With this type of description, one arrives to find our path. So, we are (human) using a specific and power “computing with words”. How can a machine do the same thing? A path can be defined as a function evolving following some directions. Thus, any function can be described using the four directions (left, right, bottom, below) in a predefined order. This description is a supple means to extract only useful information. We will define natural solutions to different functions such as spiral data, kolmogorov theorem, chess and salesman.

115
Toward a Computational Environment for Everyday Language Communication

Ichiro Kobayashi, Michiaki Iwazume, Michio Sugeno, Noriko Ito

The aim of this study is to provide all people, from small children to aged persons, with a computational environment for everyday language communication. In order to achieve this, we propose a framework for a language operating system. In this paper, we explain our approach to dealing with the meaning of language, the architecture of the language operating system and its components. In particular, we describe the notion of language protocol and its resource representation (i.e., semiotic base), compared to the other protocols and their resource representations. We argue that by processing meaning of language rather than processing information, we attempt to provide a more human-like computer system and an intelligent computational environment to all people.

116
Learning User Models for an Intelligent Telephone Assistant

T.P. Martin, B. Azvine

User modelling is becoming ubiquitous in new “information appliances” and services. Mobile phones routinely include features such as predictive text input and voice recognition, tailored to a specific user. It is likely that, as with other AI technologies, user modelling will gradually become part of mainstream computing and products. This paper outlines a novel approach to user modelling, by means of prototypes, implemented as support logic programs which exhibit typical behaviour. The user model is expressed as a dynamic distribution of supports over this set of prototypes. The new approach has been tested on a model application, the n-player iterated prisoner’s dilemma, and on a telephone assistant system. Prediction success rates of over 80% have been achieved using simple prototypes, although further investigation is required to confirm the validity of this approach in the telephone assistant.

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A Fair Scheduling Discipline for Cellular Data Services with Location-Dependent Errors

Ming-Hua Yao, Jiann-Liang Chen, Hao-Chin Cheng

Abstract-To provide cellular data services with differentiated QoS in a high data error-rate environment, a £f-WFQ scheduling discipline, based on the WFQ mechanism and LaGrange l-calculus was developed. The air resources are allocated using l-calculus and the WFQ mechanism is then responsible for the transmission scheduling.£f-WFQ discipline compensated for the penalty derived from the location-dependent errors using the equivalent efficiency concept. This discipline can generate a fair schedule for a diverse mix of traffic with diverse QoS requirements in a limited radio spectrum. The experimental results show that as much as a 5% improvement in the mean acceptance rate is obtained relative to the other existing WFQ-based schemes at the expense of a small blocking performance. Keywords: Scheduling discipline, Cellular data service, Quality-of-Service (QoS), Weighted Fair Queue (WFQ), LaGrange£f-calculus, Resource reservation, Blocking performance.

118
Using BK-Products of Fuzzy Relations in Quality of Service Adaptive Communication

Ahmed S. Moussa, Ladislav J. Kohout

This paper is meant to be a foundational paper for establishing a new approach for attacking QoS communication problems. Our approach is based on using soft computing techniques, which we believe is a better modeling and problem solving scheme for this area than crisp, non-fuzzy models. Since QoS is a fuzzy term and its measures are linguistic fuzzy measures, we try to model the communication mechanism as a fuzzy system and utilize the BK-products of relations to compute its attributes. We also analyze some of the currently used approaches presenting points of strength and weakness and how our approach can improve modeling and computation of the system. The main contributions of our approach are substantial computational savings and more realistic modeling that lead to better routing decisions. The savings in computations are achieved by developing equivalence classes of QoS. Therefore, the computation can be done on equivalence classes rather than individual values. Hence, computation is to be done only when one QoS measure changes status from equivalence class to another. So, by employing fuzzy equivalence classes we reduce the cardinality of the ordered set, which provides the scale for measurement of QoS metrics, hence computational saving is achieved.

119
Mapping the Internet

Arman Danesh, Ljiljana Trajkovic, Stuart H. Rubin, Michael H. Smith

Discovery of a network topology is a challenging task. Available algorithms that rely on simple hop-limited, traceroute-style probes give different performance in terms of the completeness (fuzziness) of the resulting map, the speed of mapping, and the efficiency of mapping. In this paper, the authors provide a brief overview of the types of mapping abstractions that have been used and review available techniques for generating maps of the Internet's infrastructure. A small study conducted in order to compare two of these techniques is described. Results of this study indicate that informed random address probing offers more complete network maps quickly and more efficiently. They also suggest that probing from multiple sources and amalgamating the results may improve the completeness of maps.

120
Compression and Decompression of Fuzzy Relations in the Basic Logic over [0,1]

Vincenzo Loia, Salvatore Sessa

In this paper we improve the mathematical contents of two previous papers using the axioms of the Basic Logic over [0,1] due to P. Hajek. We make use of the theory of fyzzy relation equations for getting lossy compression and decompression of images. These are understood as two-arguments fuzzy matrices of sizes m * n, compressed to two-arguments fuzzy matrices of sizes h * k, h <= m and k <= n. We are widely inspired from two papers of H. Nobuhara, W. Pedrycz and K. Hirota, but we propose several slight modifications illustrating an algorithm implemented in JAVA.

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Uniformity on the Preference Information on Alternatives in Multiple Attribute Decision Making

Quan Zhang, Jian Ma, Zhiping Fan, Jingtai Wu, Qi Sun, Jun Meng

This paper investigates the multiple attribute decision making (MADM) problem with preference information on alternatives, in which multiple decision makers (DMs) can give their preference information in different representation forms. DMs' preference information on alternatives is often used to rank or to select the most acceptable alternatives. However, due to their different culture and education backgrounds, the DMs' judgements vary in form and depth. A DM may express his/her preference on alternatives in specific style. Different DMs may use different ways to express their preference information. The following representation forms are provided for the DMs to express their preference information on alternatives, i.e., preference orderings, utility value vector, fuzzy preference relation, selected subset, fuzzy selected subset, normal preference relation, linguistic term vector, and pairwise comparison. These preference representation forms are uniformed into fuzzy preferen! ce relations respectively and fu rther aggregated into a social fuzzy preference relation. To select the alternative, the quantifier guided dominance degree (QGDD) and the quantifier guided non-dominance degree (QGNDD) for each alternative are calculated based on the social fuzzy preference relation. The contribution of this paper is to provide eight preference representation forms to the DMs, which provides the flexibility in eliciting DMs' subjective judgments.

122
Renewal of the Causes by Observed Effects by Means of Fuzzy Relations Matrix and Genetic Algorithm

Alexander Rotshtein, Hanna Rakytyanska

Application of the inverse logical inference in the expert systems of diagnosis is considered. The inverse logical inference allows to restore the causes by observed consequences using fuzzy relational matrix. Diagnosis decision finding requires fuzzy logical equations system solution. In this study the search for equations system solution amounts to optimization problem. The genetic algorithm of optimization based on crossover, mutation and selection of the initial set of chromosomes is proposed for fuzzy logical equations system solving. Computer simulation illustrates the algorithm efficiency. The suggested genetic algorithm can find application in expert systems of technical and medical diagnosis and quality control.

123
An Intelligent Navigation System for AUVs using Fuzzy Relational Products

Young-il Lee, Yong-Gi Kim

This paper describes a heuristic search technique carrying out collision avoidance for Autonomous Underwater Vehicles(AUVs). Fuzzy relational products are used as the mathematical implement for the analysis and synthesis of relations between obstacles that are met in the navigation environment and available candidate nodes. In this paper, we propose a more effective evaluation function that reflects the heuristic information of domain experts on obstacle clearance, and an advanced heuristic search method performing collision avoidance for AUVs. The search technique adopts fuzzy relational products to conduct path-planning of intelligent navigation system. In order to verify the performance of proposed heuristic search, it is compared with search method through simulation in view of the CPU time, the optimization of path and the amount of memory usage.

124
Query Term Expansion and Reweighting Using Term Co-Occurrence Similarity and Fuzzy Inference

Byeong Man Kim, Ju Youn Kim, Jongwan Kim

To improve the effectiveness of the classic relevance techniques for the vector model, in this paper, a new technique for term expansion and term reweighting is suggested. The advantages of the classic techniques are simplicity and good results. However, due to the simplicity, the term occurrence pattern is not considered explicitly. To supplement the classic relevance techniques, we introduce the term co-occurrence similarity as a measure of how similar the distributions within the feedbacked documents of a given term and the initial query are. With this similarity and additional information, the weight in the new query of the term is calculated by fuzzy inference. Although the experiments are performed on the small collection, the results show that the technique proposed in this paper yields substantial improvements in retrieval effectiveness.

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The Inconsistency of Fuzzy Triangular Relational Products in the Light of Pseudo-Strictly Monotonic Fuzzy Connectives

Nasreddine Hallam, David Chek Ling Ngo

The theory of Fuzzy Relational Products (a relatively new inference scheme) was pioneered by Bandler and Kohout. The original definitions of triangular products as set by Bandler and Kohout were modified by DeBaets and Kerre after they proved that the original ones were bearing the shortcoming of the non-emptiness requirements and cannot be trusted as a proper deductive scheme. An attempt to apply the improved inference definitions in a real life field, namely medical diagnosis, produced unexpected results. This is because the fuzzy connectives [Kliene-Dines and Luckasievic] do not exhibit the strong property of pseudo-strict monotonicity. The purpose of this paper, apart from being an empirical-oriented research study, is to try the improved definitions by instanciating them with well-known Pseudo-Strictly Monotonic fuzzy connectives.

126
Improvement of Speech Processing Using Fuzzy Logic Approach

Zygmunt Ciota

The latest development of multimedia systems demands new methods of speech processing, like effective coding, recognition and synthesis. The vocal communication between computer and man has nowadays a lot of gaps, because language is very essential evidence of humanity. Therefore, it is difficult task to translate spoken idioms and other human ambiguities using “computer language”. In this paper two detailed problems have been discussed and solved. The first, how to improve the signal-to-noise ratio owning to digital structure of computer voice. The proper shape of sampling noise spectrum can be achieved using fuzzy logic approach. Recognition of whole words is the second topic discussed in the paper. The appropriate words can be selected from the vocabulary using tree structure. In the case of ambiguity, it is necessary to expand selection process using the context of neighboring words. Very often, using only deterministic methods, the above procedure has been broken in an i! ntermediate level of the selecti on. If such problem occurs, an expert-knowledge approach will be helpful. This expert knowledge can be displayed in a fuzzy rule matrix using linguistic variables.

127
Multiresolutional Training of RBF Networks for Enhanced Approximation

O. Ciftcioglu, S. Durmisevic, S. Sariyildiz

In the radial basis function (RBF) network, selection of width parameter of the basis functions is considered. The effect of the width parameter on multivariable discrete function approximation is analysed in the Fourier domain and based on this, an appropriate selection method for the width parameter is presented. The method basically takes the orthogonal multiresolutional decomposition by

wavelet transform of the function subject to approximation and to each decomposed component, a separate RBF network having a suitable width parameter matching to the appropriate resolution level, is employed. Each outcome from these multiresolutional RBF networks is added to that from the others and final approximation result is obtained. Marked enhancement on approximation is achieved which implies the enhancement on the generalisation capability of the network performing robust estimation at the same time.

128
Design of Multi-Agent System Using Fuzzy Disclosure Model

SoJeong Youn, KyungWhan Oh

Nowadays, security is an important issue for agent systems since each agent can move from one system to another, and interact with other agents and host systems. So many security technologies are used to make agent system more secure. In this paper, we will focus on information control in agent system and propose a fuzzy disclosure model to prevent disclosure of information. Also we will design a multi-agent system with middle agent as a reference model.

129
A Class of Reject-First Possibilistic Classifiers

Laurent Mascarilla, Carl Frelicot

Classical pattern classifiers aim at partitioning the feature space where patterns x are lying into mutually exclusive areas, each of them being associated with one class among the c ones of the problem. Whatever the mathematical model they rely on, such classifiers are limited by a closed-world definition of the classes and the sharpness of the classification boundaries. Reject options can be designed in order to reduce the misclassification risk by either allowing the pattern not to be classified in any class (distance rejection associated with an outlying area) or allowing it to be classified in several classes (ambiguity rejection associated with inlying areas). Recently, we proposed the so-called reject-first strategy for the design of rejection-based classifiers. It operates in two sequential steps, which starts with testing for exclusive classification and, if it fails, continue by testing for the kind of rejection encountered, i.e. ambiguity or distance. We adress the problem of defining a general class of such reject-first possibilistic classifiers. It relies on the use of fuzzy XOR operators based on dual triples (t-norm, t-conorm, complement). Such classifiers own properties that one can demand for a rejection-based classifier.

130
Performance Augmentation of Low Cost Sensors

Abraham Abershitz, Kelly Cohen, Rafael Rubinets

Micro Electro Mechanical Systems (MEMS) devices can be used for aviation applications as being low cost and low weight. As such they can be used for navigation and autopilot systems assuming its performance can be augmented to desirable accuracy. However they are inaccurate sensors so they are unacceptable for applications, such as aerospace where the sensors are required to meet the high accuracy demands. The proposed approach involves the introduction of Soft Computing (SC) methods, such as Neural Networks (NN) and Fuzzy Logic for the augmentation of low-cost sensor performance. These methods may serve as universal approximators, thereby enabling any non-linear mapping (between the measured signal and the sensor output signal). This main aspect of the developed strategy is the introduction of a stage of learning, whereby a high-performance (high-cost) sensor is used to teach the desired non-linear mapping to a low-cost MEMS sensor. Within the framework of a proof-of-concept project at the Israel Aircraft Industries (IAI) experiments were conducted to evaluate the potential of this approach. An ADXL202 accelerometer of Analog Devices was selected as the candidate low-cost MEMS.

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Methods of Learning Rules Based on Rough Set: LBR and LEM3

Shu Lan, Zhi Wen Mo, Dan Hu

By the help of rough set theory,this paper puts forward a new way of machine learning-LBR(Learning by rough set theory),and then compares it with the algorithm-LEM1 that proposed before.From the results of comparision,we find a new method of learning rules from examples named LEM3,which is more flexible than LEM1. LBR and LEm3 have extensive applied prospect in AI.

132
An Interactive Fuzzy Satisficing Approach using Genetic Algorithm for Multi-Objective Problems

Takanori Kiyota, Yasutaka Tsuji, Eiji Kondo

This paper describes a fuzzy satisficing method for multi-objective optimization problems using Genetic Algorithm (GA). First, a multi-objective design problem with constraints is expressed as a satisficing problem of constraints by introducing an aspiration level for each objective. Next, in order to handle fuzziness involved in aspiration levels and constraints, the unsatisfying function is introduced, and the problem is formulated as a multi-objective minimization problem of unsatisfaction ratings. By using the unsatisfying function instead of the membership function, fuzziness in the design process can be treated comparatively easily. As the optimization method, GA is employed, and a new strategy is proposed to obtain a group of Pareto-optimal solutions in which the decision maker (DM) is interested. The DM can seek a satisficing solution by modifying parameters interactively according to his/her preferences. Since the DM's intention is reflected on the problem formu! lation and the iteration procedu re, the selection of the final solution becomes easier comparing to that of conventional methods. Finally, the proposed method is applied to a simple design problem of a four-bar plane truss.

133
Research on Path Planning for Mobile Robot Among Dynamic Obstacles

Wu Wei, Zhang QiSen, J.B. Mbede, Huang Xinhan

This paper presents the method of mobile robot's path planning based on probabilistic path planner (PPP) and Artificial Potential Fields

(APF). We propose an Intelligent Reactive Path Planning based on fuzzy rules for idea of obstacle avoidance using APF. The simulation results show that our method is effective. The first one is applied to holonomic path of arm manipulator. This local planner is based on fuzzy rules for idea of artificial potential fields using analytic harmonic functions. The second local planer takes into account the nonholonomic constraints of mobile platform in Reeds and Shepp metric system. This last local planner is also based on fuzzy rules but for idea of the concept of elastic band in Reeds and Shepp metric system, which consists in maintaining a permanent flexible path between two nodes in G. In order to consider the compatibility of stabilization and manipulation, we derive a coordinated local planner algorithm so that the mobile manipulator can avoid stably unknown or dynamic obstacles.

134
A Generic Algorithm for Fuzzy Constraint Satisfaction Problems

Pei-Lun Hsu, Robert Lai

In this paper, we present a generic algorithm of solving a FCSP based on the notion of adaptive level-cut. The essence of our algorithm is to apply local propagation for solving different level-cut CSPs. The task mainly involves the repair operations to speed up the fuzzified local propagation by reusing as much of the computational efforts from the previous level-cut as possible.Besides in dealing with a discrete domain, the algorithm can also be extended into handling a continuous domain based on interval arithmetic.

135
Evolutionary Robust Fuzzy Control for the Rejection of Sinusoidal Disturbances with Unknown Frequency

Yu Tang, Daniel Velez-Diaz

This paper presents a fuzzy control to reject sinusoidal disturbances in a dynamical system. First, the fuzzy rules used in the fuzzy control are automatically tuned by the evolutionary programming. These fuzzy rules are then used to reject the disturbances in a dynamical system. The robust control technique [Corless and Leitmann, 1981] is applied to compensate the uncertainties arising from unknown optimal weight matrix and reconstruction error using a fuzzy logic system. Simulation results are presented to illustrate the performance of the proposed control.

136
Incremental Best Estimate Directed Search - A Case Study for Symmetrical Systems

Feijun Song, Samuel M. Smith

Incremental Best Estimate Directed Search (IBEDS) is an effective search algorithm for controller optimization. It combines random search and directed search together IBEDS is very fast when there is some information about the optimal control surface. However, when there is no such information is available, the search is pseudo-random, and may take very long. Since most physical systems are symmetrical, we can use that property to speed up IBEDS. To take advantage of a symmetrical system, when we update an entry in the training set, if the corresponding symmetric point is not in the training set, we add the symmetric point into the training set with its corresponding control command. If the corresponding symmetric point is already in the training set, we will compare the local performance of both points, and chose the one with better local perfor-mance, and update the training set accordingly. Similarly, when we train a rule base, we train it symmetrically, so the rule base wi! ll remain symmetrical. Those steps will ensure that both the training set and rule base will take full advantage of a symmetric system.

137
On the Cooperation of Fuzzy Neural Networks via a Coevolutionary Approach

Andre L.V. Coelho

This paper brings effort on the characterization of Cooperative Fuzzy Neural Networks (CFNNs). CFNNs encompass any conceptual or architectural aggregate in which two or more Fuzzy Neural Networks (FNNs) work cooperatively for the accomplishment of high-level objectives. In such context, the behavior of an FNN is, by some means, influenced by the behavior of its peers, and the performance of the whole group should contribute as complementary guidance for its individual training. A coevolutionary approach is presented as an auxiliary mechanism for the design and implementation of CFNNs. Implementation issues are described as a means to attest the applicability of the proposal.

138
Experimental Data About Knowledge Evaluation in a Distance Learning System

Tatjana Vasileva, Vladimir Trajkovic, Danco Davcev

In this paper, we present an algorithm for testing and knowledge evaluation of the users in a web based distance educational system. The algorithm employs fuzzy logic techniques, thus offering linguistic expression of the estimated level of the user's knowledge. A prototype of thge system is built in Java language. The experimental results expose compatibility in the evaluated expert levels given by the system and the tutor, but also emphasize the benefits of the system from the pedagogical point of view.

139
Some Properties of t-Conorm Fuzzy Additives

H.M. Kim, J.D. Jeon, L.C. Jang

In this paper, we will introduce new concepts of S-fuzzy additive and Sw-fuzzy additive measures and discuss some properties of S-possibility measures and their dual measure T-necessity measures.

140
Representation, Ranking, Distance, and Similarity of Fuzzy Numbers with Step Form Membership Function using k-Preference Integration Method

Shan-Huo Chen, Chien-Chung Wang

In this paper, the modified k-preference integration method is applied to treat the representation, ranking, distance and similarity of fuzzy numbers with step form membership function. At first, the representation value is computed by using the modified k-preference integration method. Then two or more fuzzy numbers with step form membership function are ranked by comparing their representation values. The distance between two fuzzy numbers with step form membership function is the absolute value of the difference between their representation values, while the similarity between them can be derived from their distance. Finally, some properties regarding the representation, ranking, distance, and similarity have been proved.

141
Risk Analysis in Electronic Commerce Development using Fuzzy Set

F.K.T. Wat, E.W.T. Ngai

Electronic commerce (EC) over the Internet is a new way of conducting business and is growing exponentially. We believe that the expansion of EC is creating a series of risks that need to be addressed. For those who want to conduct EC, it is necessary to carry out a thorough risk analysis before implementation. Although risk analysis has been widely applied and used in the context of financial and engineering problems, it has seldom been adopted in EC development. In this paper, a model of risk analysis in EC development using fuzzy set is proposed. The model assists EC practitioners and decision-makers to formalize the kinds of thinking required in assessing and understanding the current risk environment of their EC project in a more nature way.

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Valuing Strategic Investments with a Fuzzy Expert System: An Italian Case

Gisella Facchinetti, Carlo Alberto Magni, Giovanni Mastroleo, Marina Vignola

This paper makes use of a fuzzy expert system for valuing a strategic investment. In particular, the model proposed aims at replicating the actual decision process accomplished by Florim S.p.a., an Italian ceramic tile firm which recently had the opportunity of buying a firm in the USA. The model is perfectly consistent with the evaluation process conducted by Florim's experts and on the basis of the same data available to the expert's panel our expert system provides the same investment value and therefore the same solution to the decision process. The model has been tested by means of a sensitivity analysis, in order to show that is a reliable tool for any project of such a kind. We have then considered many different situations, which possibly the decision maker may encounter, and see what answers the system provide. The simulations conducted seem to corroborate the model in that it is able to replicate the way of reasoning of Florim's experts in any situation, and the resu! lts provided by the system is se lf-consistent.

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Case-Based System: Indexing and Retrieval with Fuzzy Hypercube

Jose Ricardo Pelaquim Mendes, Ivan Rizzo Guilherme, Celso Kazuyuki Morooka

In some applications with case-based system, the attributes available for indexing are better described as linguistic variables instead of receiving numerical treatment. In these applications, the concept of fuzzy hypercube can be applied to give a geometrical interpretation of similarities among cases. This paper presents an approach that uses geometrical properties of fuzzy hypercube space to make indexing and retrieval processes of cases.

144
Regularity of Continuous-time Fuzzy Martingales

Yuhu Feng

Compared with discrete-time fuzzy martingals, which has been discussed extensively by many authors, the properties of trajectories for continuous-time fuzzy martingals are more complex. Generally, it is supposed and required that a continuous-time fuzzy martingale has right-continuous trajectories as the case of real-valued martingales. It is of interest to investigate conditions under which a continuous-time fuzzy martingale has right-continuous adapted modification. This paper focuses on solving this problem. The necessary and sufficient conditions of that a continuous-time fuzzy submartingale has a right-continuous adapted modification are given. Especially, any continuous-time fuzzy martingale has a right-continuous adapted modification. The results are a generalization of the counterpart results of classical martingale theory and the proof is completely difference. The principal technique is based on a key Theorem by Feng, it states that the convergence in uniform metric of fuzzy numbers is transformed into the pointwise convergence of the real-valued functions. It should be noted that the approach is an example of discussing the convergence of fuzzy numbers or fuzzy random variables in uniform metric by means of pointwise convergence of the corresponding support functions.

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High Reliability Neural Networks Structure with Application to Spacecraft ASMS Tone Detection

Kourosh Rahnamai, John Maleyeff, Payman Arabshahi, Tsun-Yee Yan

In this study we will show that the research on N-version high-reliability software structures can be extended to neural networks architecture. In addition, we will explore the possibility of applying this structure to a spacecraft tracking problem. One such system is the Automated Spacecraft Monitoring System (ASMS), a beacon-monitoring or detection system. Four neural networks, each trained for various operating environments, are implemented in an N-version structure. The results of the networks are combined to form a composite outcome. The combined outcome is used as part of a hypothesis

testing procedure to distinguish between the presence or absence of the beacon signal. The results show that any of a number of composite outcomes outperforms the use of any single neural network. Further, the simple average of network results provides the composite outcome with best performance.

146
Generalization of Some Fuzzy Ideals in BCK-Algebras

Celestin Lele, Congxin Wu

A BCK-algebra introduced by Imai and Iseki arose from the algebra of non classical logic in the same way as boolean algebra arose from the algebra of classical logic. One of the main problem in fuzzy algebra is how to carry out the ordinary concept to the fuzzy case. The difficulty lies in how to pick out the rational generalization from the large number of available approaches. It is worth noting that fuzzy ideal is different from the ordinary ideal in the sense that one can no say which set element either belong or neither belong to the fuzzy ideal under consideration. In this paper, we generalize some fuzzy ideals in BCK-algebras and discuss the relation among them.This approach of fuzzy ideals in BCK-algebras based of the concept of fuzzy point has many advantages. It enables us to develop adequate theory of fuzzy algebra parallel to the ordinary algebra theory . It provides some links between the classical fuzzy approach and the ordinary case. Through this similarity, we can reformulate many concepts and many results of the ordinary algebra theory and carry it to fuzzy case in the natural way.

147
Computing with Words =? New Mathematical Theory of Descriptions, Part 2: Description of Patterns (Handwritten, Face and Solid Object Recognition)

Fatiha Karbou

Handwritten recognition is not a new technology. Many different initiatives were taken to solve this problem and the results are still not perfect because, everybody has his own personal style and there should be no constraints on what and where one writes and no constraints on size or the orientation of the typewriting. Nevertheless, there are some basic information that everybody is accustomed to and that are required for making a text readable by other people. The fuzziness in handwritten comes from the variability of human drawing. How can this fuzziness be defined and controlled? What are the basic forms necessary for the recognition process? And what is the best way to extract these basic forms? In addition, a criminology designer can draw a typical profile (or reconstitute the face of a suspect) using some descriptive words. The number of these words will have an inferior size than the classical matrix of pixels generated form a camera. This matrix do not give generally useful information while in linguistic descriptions, one can isolate each component of a face and process it differently. Thus, we will resolve the problem of the image acquisition conditions. How can one make the same thing and be liberated from sensor's acquisition conditions? One will process only useful information. What are tools of the description? numbers, intervals, functions…. Are there other methodologies? Or other type of tools? This paper propose natural solutions to this type of problems based on description by words.

148
Balanced Random Search and Directed Search for Takagi-Sugeno Type Fuzzy Logic Controller Automatic Optimization

Feijun Song, Samuel M. Smith

This paper presents a new cell state space based Takagi-Sugeno (TS) type Fuzzy Logic Controller (FLC) automatic optimization algorithm. It is a new version of Incremental Best Estimate Directed Search (IBEDS) algorithm. IBEDS starts with an initial training set that may be empty, then an FLC with randomly initialized rule output parameters is trained by Least Mean Square (LMS) learning algorithm in an iterative procedure. In each iteration, the trained FLC is evaluated with cell state space based global and local performance measures, the training set is then updated based on the evaluation under Best Kept Policy, which only keeps the best control commands for each cell center found so far. Originally, in IBEDS, all the FLCs with progressively better performance was discarded. This paper proposes to reuse and re-organize the rule bases of all the FLCs being evaluated to further expedite the search. In the new approach, the training set and the parameter set of a rule base are optimized simultaneously. Simulation results with a 4D inverted pendulum show that the new version of IBEDS is much faster than IBEDS when the initial training set is empty and the search needs to bootstrap itself.

149
Construction of Modal Choice Model with a Descriptive Utility Function using Fuzzy Reasoning

Kaori Mizutani, Takamasa Akiyama

Establishment of detailed descriptive travel behaviour models has been an important tool in evaluating transport policy such as Travel Demand Management (TDM) in the field of traffic demand estimation. For description of travel behaviour, statistical methods such as logit models and various techniques of soft computing techniques have been proposed. Since the logit models and fuzzy reasoning have advantages, hybrid models have been proposed in order to describe various aspects of travel behaviour. A fuzzy logit model for modal choice that is one of the hybrid models is discussed in the study. The overall structure is a logit model. A utility function in the fuzzy logit model is described using fuzzy reasoning instead of using mathematical functions such as a liner function in order to reflect human decision with vagueness into discrete choice models. As binary fuzzy logit models have been studied in former studies, maltinominal fuzzy logit models are constructed to discuss complex human decisions in the study. In particular, Genetic Algorithm is introduced to construct fuzzy reasoning rules and estimate parameters as an efficient technique. It may be observed that the hybrid approach would make travel

behaviour models more precise and accurate in estimation of modal choice.

150
The Use of Linguistic Information in Operational Research

F. Herrera, E. Herrera-Viedma, L. Martinez

The use of linguistic information has been applied successfully to many areas. In the literature we can find three different linguistic computational models for representing linguistic information and defining linguistic aggregation operators. In this contribution we shall review the use of the linguistic information in different areas of the Operational Research as decision-making, scheduling, management, etc. And finally, we shall make a comparative analysis of the results obtained combining informaiton using the different linguistic computational models in operational research problems.

151
An Algorithm for Two-Dimensional Reconstruction of a Discontinuous Density from its Radon Transform

Dinh Thuc Nguyen, Doan Khanh Bui

X-ray tomography is an important way of finding the density of objects, in medical imaging evaluation. In many applications of computer tomography, one can be interested not in complete inverse of tomography data but only in determining discontinuities of the unknown piecewise continuous 2-dimensional density, from its Radon transform.

In this paper, we propose a new computational filtered back projection algorithm for solution of this problem. A function fM is defined and computed from Radon transform of the density function f; one can recover locations and values of jumps of the original density f from these of fM.

152
Convex Hull Approach to Fuzzy Regression Analysis and its Application to Oral Age Model

Junzo Watada, Yoshihiro Toyoura, Seung Gook Hwang

Fuzzy multivariate analyses including linear regression analysis fuzzy time-series analysis, fuzzy possibilistic linear model, etc. are formulated in terms of the extension principle. One objective of a fuzzy linear regression model is to build a model using fuzzy numbers which represent the possibilities included in the system. Therefore, the fuzzy regression model is also named a possibilistic regression model. Hitherto, it is hard for us to measure the goodness of a fuzzy regression model. As there is no index to evaluate the fuzzy regression model, it is not easy to evaluate the possibility of a fuzzy regression model.

In this paper we propose two indices to evaluate a fuzzy regression model. Our indices make us understand the distribution of data and explain the relation of the distribution of data with the possibilistic interval of a fuzzy regression model.

The paper also exemplifies the characteristics of an Evaluation Index and builds an oral age model on the basis of real data about the age and the number of sound teeth.

153
Case Based Reasoning using Fuzzy Set Theory and the Importance of Features in Medicine

Hoang Phuong Nguyen, Ba Tu Nguyen, Liya Ding, Kaoru Hirota

In recent years, we have developed an expert system for diagnosis of lung diseases using cased based reasoning [7]. At present , the case base of this system consists of 1026 patient records of 18 types of lung diseases and it applies successfully at the Vietnam National Institute of Tuberculosis and Lung diseases. An improvement of the case based reasoning for medical diagnosis using fuzzy set theory (Nguyen H. P. et al. 2000) is proposed by including the importance of features. A feature in the former work is a symptom and all importance of symptoms for the disease take value 1 that mean the important degree of all symptoms are the same. In this paper an important degree for each symptom according to each disease is included. The fitness of this method is confirmed by experiments in the real medical applications.

154
Approach to Generating Rules for Expert Systems using Rough Set Theory

Hoang Phuong Nguyen, Le Linh Phong, Pratit Santiprabhob, Bernard De Baets

The problem of data mining and knowledge discovery as generating rules from databases becomes a great research interest of many researchers. There were many methods such as induction learning, ID3 etc developed. Recently, a new approach based on rough set theory has been proposed. Rough set theory has been proposed by Zdzislaw Pawlak in years 1980 to deal with inconsistent problems. Our work is to apply this theory in extracting rules from given medical databases. This results with a set of decision rules, which will be provided to one of our diagnostic systems as a part of its knowledge base.

155
Approach to Combining Case Based Reasoning with Rule Based Reasoning for Lung Disease Diagnosis

Hoang Phuong Nguyen, Nadipuram R. Prasad, Dang Huu Hung, Jeffrey T. Drake

In the last decade, in some Asian countries, the new kind of clinics called the mixed clinic was opened, where medical doctor, acupuncturists and traditional practitioners work together in order to make diagnosis and treatment better by integrating western and eastern medicine methods. Our research is to simulate a thinking of human experts in integrated medicine using soft computing techniques. In this paper we present a design of a rule based fuzzy expert system for integrated western and eastern medicine using interval computations.

We extend the idea of interval computations [1,6,7,9] for the diagnosis and treatment of Western and Eastern medicine. A general structure of the system is described. We focus on knowledge acquisition using rough set theory and on knowledge representation and inference mechanism of the system. We also show an example to illustrate how to generate rules from patient database and how to combine the different inferences of western and eastern medic! ine in diagnosis and treatment.

156
An Adaptive Fuzzy Sliding-Mode Controller Design for Induction Servomotor System

Chih-Min Lin, Chun-Fei Hsu

An adaptive fuzzy sliding-mode control (AFSMC) design method is proposed to control an induction servomotor system. The proposed AFSMC system is comprised of a fuzzy controller and a compensation controller. The fuzzy controller is used to mimic an ideal computational controller. The compensation controller is designed to compensate for the difference between the ideal computational controller and the fuzzy controller. All parameters in the proposed AFSMC system are tuned in the Lyapunov sense; thus the stability of the system can be guaranteed. Simulation and experimental results verify that the proposed design method can achieve satisfactory control performance with regard to parameter variations and external disturbance.

157
An Approach to Design Fuzzy PI Supervisor for a Nonlinear System

R. Sehab, M. Remy, Ch. Renotte

This paper presents an approach to design fuzzy supervisor for PID controllers used for control of nonlinear systems. In this approach, the design is based on an output performance criterion, namely a response with minimum settling time and without overshoot, whatever the operation conditions may be. The application used for a demonstration is a three-tank-system where the connection between the tanks and the leakage in each tank are simultaneously taken into account (MIMO system). According to the proposed approach, two fuzzy PI supervisors are designed in order to modify on-line the parameters of two PI controllers. The implementation of this type of control in the simulator of the three-tank-system model confirms, through the simulation results, that the output performances are reached whatever the set points, the configuration and the initial water levels in the three-tanks may be.

158
Design of Distance-Based Fuzzy Sliding Mode Controller with Adaptive Fuzzy Rule Insertion

Chung-Chun Kung, Feng-Sang Chen

In this paper, an adaptive distance-based fuzzy sliding mode controller is developed. In the process of designing the proposed fuzzy controller, we firstly calculate the distance between the actual state and the sliding line, and then define a new variable called the signed distance. Then we adopt the signed distance as the unique input variable for the fuzzy controller, which is called the distance-based fuzzy sliding mode controller (D-FSMC). Hence, both the number of fuzzy rules and the complexity in the D-FSMC are greatly reduced compared to those of in the conventional FSMC. We can show that the stability of the control system is guaranteed under the Lyapunov sense. Finally, an adaptive process is employed to systematically develop the effective fuzzy rules for the D-FSMC. Computer simulations will be given to verify the validity of the proposed adaptive D-FSMC.

159
A Fuzzy Arithmetical Approach to Robust Control

Michael Hanss

A fuzzy arithmetical approach to effectively control systems with uncertain model parameters is presented. The approach is mainly based on a combination of classical controller design and fuzzy arithmetic. The uncertainties in the system model are expressed by fuzzy-valued model parameters with their membership functions derived from experimental data or expert knowledge. Subsequently, classical controller design is used to determine the parameters of the controller, making use of fuzzy arithmetic to evaluate the fuzzy-valued controller equations. To avoid the overestimation effect as the major problem of standard fuzzy arithmetic, a special implementation of fuzzy arithmetic, namely the transformation method, is introduced in the paper. On this basis, a robust, fuzzy-parameterized linear-quadratic regulator is developed and finally applied to stabilize an inverted double pendulum with uncertain model parameters in its upright position.

160
ANFIS-based PRML system for read-out RF signal in DVD-ROM

Wen-Liang Chen, Chia-Chi Chen, Shing-Chia Chen

In DVD-ROM, how to equalize the read-out radio frequency (RF) signal to reduce the jitter ratio has been an important issue so far. In this paper, we investigate the characteristic of the optical channel model in DVD-ROM and propose an Adaptive Neuro-Fuzzy Inference System (ANFIS) based equalizer together with a viterbi detector to form as a partial response maximum likelihood (PRML) system for DVD-ROM. Jitter performance using ANFIS based equalizer is compared with that of other linear filter based equalizers. By computer simulation, it shows that the proposed equalization method has better jitter performance than conventional linear filter based equalizers for the optical channel in DVD-ROM.

161
Exact High Precision Control of Actuated Compliant System

Michel J. Cotsaftis

High precision positioning is an important primary task in modern industrial systems where strict accuracy is often a mandatory constraint for machining or inserting execution. High stiffness structure

in less demanding situations can no longer be used because of unlikely perturbations outside actuator frequency range, and ''active'' robustification is used in modern controllers. However, a limit exists on preciseness for fixed power input and a compliance material should be added to ''passively'' damp extra perturbations outside actuator frequency range. Then the problem is the optimum search on both controller and compliance parameter, to deal with contradictory constraints of filtering perturbations and transmitting precise displacement commands. As resulting compliance value is not necessary small, a study of full compliant system is developed so that it can be analyzed for any parameter value, and not only asymptotically close to 0. Important property is obtained in cor! rection ordering as lower order compliance effect is completely determined by rigid dynamics, limiting power requirement and reducing control structure to simple PD one instead of usual more advanced intelligent one.

162
Mining the Customer Credit by Using the Neural Network Model with Classification and Regression Tree Approach

Ling Jing Kao, Chih Chou Chiu

In this study, a combination of classification and regression tree (CART) and neural network techniques is proposed to determine whether the predictive capability can be enhanced in credit scoring model. To demonstrate the effectiveness of the proposed approach, these techniques are applied to data from a large bank in Taiwan. In the approaches of neural network and the combined model, the back-propagation learning technique with various learning rates is extensively studied to determine the connection weights between neurons. The number of hidden neurons is also varied to see its effect on the converge rate. Our results indicate that the proposed combined approach predicts much accurately and converges much faster than that the conventional CART method or the neural network approach.

163
A New Fuzzy-Fractal Approach for Forecasting Financial and Economic Time Series

Oscar Castillo, Patricia Melin

We describe in this paper a new method for the estimation of the fractal dimension of a geometrical object using fuzzy logic techniques. The fractal dimension is a mathematical concept, which measures the geometrical complexity of an object. The algorithms for estimating the fractal dimension calculate a numerical value using as data a time series for the specific problem. This numerical (crisp) value gives an idea of the complexity of the geometrical object (or time series). However, there is an underlying uncertainty in the estimation of the fractal dimension because we use only a sample of points of the object, and also because the numerical algorithms for the fractal dimension are not completely accurate. For this reason, we have proposed a new definition of the fractal dimension that incorporates the concept of a fuzzy set. This new fuzzy-fractal approach was applied to the problem of forecasting the prices of two consumer goods in the U.S., for the 1994-2000 period, with! very good results.

164
Fuzzy Sets in Political Science

Gleiber Fernandes Royes, Rogerio Cid Bastos

Several computational intelligence (CI) paradigms have been popularized by their broad use in industry. The practical value of these techniques is seldom questioned in traditional areas like engineering and medicine. However, there are other fields still waiting to be better explored. Relatively new paradigms in CI that can deal with uncertainty has facilitated the construction of advanced expert systems. Treating uncertainty with Fuzzy Logic (FL) in politics is an exercise that may demonstrate a promising use of expert systems, opposing to the idea that vagueness is a source of great complexity, only approachable by human experts. The paper will explore the applicability of FL for politics via a practical experiment, that also will be useful to discuss some important details about implementation. The area known as social science, which for a long time has been held in reserve for human specialists, can now be aided by intelligent systems regarding decision making.

165
Fuzzy Mathematics Applied to Insurance Game

Yuchu Lu, Li Zhang, Zhiying Guan, Hanji Shang

This article builds a game model of two insurance companies who try to determine which product the Unit-Linked or the Par, to exploit and provides a decision-making method for the companies to determine their product development orientation in a competitive market. The two companies should consider their utilities not only by their own decision but also that of the opponent. Due to the fuzziness of the factors affecting the utility, we use linguistic operator to deal with this problem. Then we can get the Matrix of the Grade of Membership about Importance and the Matrix of the Grade of Membership about Superiority. By use of there matrixes we can construct the utility pair matrix. Finally the knowledge of complete information static game is used to get an equilibrium of both sides.

166
Detecting Noise Trading Using Fuzzy Exception Learning

Jan van den Berg, Uzay Kaymak, Willem-Max van den Bergh

This paper analyses noise trading, a phenomenon observed in financial markets when technical traders forecast financial price movements based on recent prices and volumes. Due to noise trading, financial returns show - during a few and unknown periods in time - certain deterministic behavior besides the usual random behavior predicted by the efficient market hypothesis. Our goal is to unmask the (fuzzy) deterministic part, that is, to discover the special circumstances called ‘regimes’, under which noise trading takes place.

To reach our goal, we use the Competitive Fuzzy Exception Learning Algorithm (CELA). In order to analyze the properties of our method, we apply it on an artificially made, yet quite hard to analyze financial time series. Even in a very general setting, CELA appears to be able to discover various important ‘regimes’ corresponding to exceptional

price developments. These occurrences are collected in a fuzzy rule base.

167
Fuzzy Neural Networks for Modelling Commodity Markets

Martin Rast

The paper describes a method for forecasting the price of crude oil. This market sector is important for both, forecasting the market for trading the commodity (crude oil or its derivatives) itself, and for its effect on other market segments.

For the presented approach a certain effect of two observable market states is used, which allows for establishing a combination of two neural networks – or specialist models - each of which is specialized on a different market state. The model used here is a fuzzy neural network which is trained to determine the state of the market and then uses the output of the respective "specialist" model for forecasting.

The two states are called contango and backwardation respectively and can quite easy be determined by looking at the prices of the two futures contracts which are due next.

Establishing a model based on the market states allows to increase the accuracy of prediction (in comparision to a classical model).

168
Further Evaluation of Pruning in Learning Boolean Functions

Maria do Carmo Nicoletti, Arthur Ramer, Maria Carolina Monard

This work continues an earlier analysis of the problem of pruning, within a framework of automated feature construction, when learning boolean functions. Automated feature construction is implemented through three different biases - root, fringe and root-fringe. It presents an empirical evaluation of two pruning techniques (Reduced Error Pruning and of its variation) based on their application to trees generated through an automated feature construction. These techniques, although at first studied only for classical boolean functions, appear very promising for an analysis of fuzzy boolean connectives.

169
A Possibilistic Logic Handling of Strong Preferences

Salem Benferhat, Souhila Kaci

This paper presents a possibilistic logic encoding of strong preferences of the form "in the context p, q is always preferred to not q". We first present a semantics algorithm which allows to rank-order different possible solutions with respect to a set of strong preferences. Then we provide its syntactic counterpart where we show that any set of strong preferences can be transformed into a possibilistic knowledge base.

This provides a practical and efficient machinery to deal with strong preferences.

170
Nearest Neighbor Rules Using Ordinal Information

Ronald R. Yager

We focus on the task of obtaining missing information about some object using nearest neighbor type methods. These approaches mediate this problem with the aid of a collection of data objects about which we have full knowledge. These methods require the calculation of the similarity between the target and the data objects and then the fusion of the known values guided by the similarities. Here we concentrate on a mixed scale situation, the similarities are numeric values but the missing information is drawn from an ordinal scale. We shown that the weighted median provides a fusion operation that can be used in this mixed scale environment. We look at some classes of nearest neighbor rules that can be expressed using this framework. Finally we turn to the problem of learning weighted median type rules and provide a learning algorithm.

171
Fuzzy Logic Best Represents Causation for Disease Process and Physician Behavior

Cathy M. Helgason, Thomas H. Jobe

We hypothesize that the mechanism of normal and pathogenic varialbe interactions in nature, that is, the causal process involved in disease and its treatment, is best represented by Fuzzy Logic rather than Probability Theory. The key concept is causality. In medicine, physician decisions regarding diagnosis and treatmetn must be based on the understanding of causal mechanisms in human physiology. Causal mechanisms in nature is best measured by fuzzy logic when compared to probability-based statistics because: 1) fuzzy logic allows for the lack of constraint on variable value range when considered in the context of other variables, 2)fuzzy logic does not require the separation of variables from the object of interest, 3) the 'fuzzy' hypercube allows for generation of new variables in the context of old and for an easily visualized measure of causality,and 4)Hume showed causation cannot be directly observed and there is an irreducible element of uncertainty about what causes what. Since probability is a measure of certainty, it is less equipped to measure and describe complex causal interactions. Fuzzy logic allows for the measure of contingent and constitutive causality.

172
A Fuzzy Search Method for Rough Sets in Data Mining

Osei Adjei, Li Chen, Heng-Da Cheng, Don H. Cooley, Rei J. Cheng, Xander Twombly

This paper proposes a method that combines a fuzzy search method called \lambda-connected search and rough sets in data mining technology. \lambda-connected searching was originaly proposed to search seismic layers in seismic data processing. Although, \lambda-connected searching is designed for digital spaces, or numerical data analysis, it can be used for any domain, as long as, that can be described by a graph. \lambda-connectedness is an equivalence relation, therefore all searched components form a partition of the base domain. On the other hand, rough sets, a new methodology to data

mining, is based on a certain classification or an equivalence relation R on a base set U, namely the universal set. Then, any subset of U can be represented by the approximation based on the union of some classes with respect to R. For data processing, U usually is a digital space, the value of each point is often a vector of real/rational numbers. The base domain classification is also the key to the rough set system. Theoretically, any equivalence relation R can be defined by a \lambda-connected classification. \lambda-connectedness can provide the principal needs for rough sets in some applications. In order to use the concept of \lambda-connectedness in rough sets and data mining, this paper proposes a limited multi-level \lambda-connected search. In addition, some properties of rough sets using \lambda-connecteness and their applications to data mining are also investigated.

173
A Multicriteria Decision Making Framework in Ordinal Context Based on Sugeno Integral

Michel Grabisch, Sambia Dia, Christophe Labreuche

The paper presents a construction of a multicriteria decision model in a purely ordinal context, based on the use of Sugeno integral. The construction is built on the preference relation of the decision maker over a set of prototypical acts. The construction can cope also with "negative" ordinal scores, due to the introduction of a symmetrical ordinal scale with suitable operators, which leads to the concept of symmetric Sugeno integral.

174
Multi-Step-Ahead Monthly Streamflow Forecasting by a Neurofuzzy Network Model

R. Ballini, S. Soares, M.G. Andrade

Analysis and forecast of seasonal streamflow series are of utmost importance in the operation planning of water resources systems. One of the greatest difficulties in forecasting of those series is the seasonality nature of streamflow series due to wet and dry periods of the year. Moreover, the real world data are noisy, and may contain contradictions and imperfections. Tolerance for imprecision and uncertainty is also required to achieve tractability and robustness. Fuzzy sets based data analysis models have been especially suitable for these purposes. This suggests the application of neurofuzzy network models to seasonal streamflow forecasting.

In this work, a class of neurofuzzy network is applied to the problem of seasonal streamflow forecasting. This model is based on a constructive, competition learning method where neurons groups compete when the network receives a new input, so that it learns the essential parameters to model a fuzzy system, which are the fuzzy rules and membership functions.

Database of average monthly inflows from Brazilian hydroelectric plants were used. The performance of the model was compared with conventional approaches and the results show that the model proposed here provide a better performance than the others methodology considering one-step-ahead forecasting and multi-step-ahead forecasting.

175
On Some Logical Aspects of Numerical Fuzzy Inference

E. Trillas, S. Guadarrama

This paper partially considers the annoying problem of reaching outputs contradictory with the inputs in a inference process conducted by Zadeh's Compositional Rule of Inference. It is considered the case in which there is more than one rule, more than one universe of discourse, and implication is taken as a Mamdani-Larsen's generalized operator. The main reason to consider these operators is that they do not force to accept rule's symmetry but allow it as a particular case.

As the usual definition of N-Contradiction among fuzzy sets cannot be directly used with rules, it is defined when an inference is contradictory. It is shown that under some restrictions on the input's values inferences without contradiction can be reached. The obtained results can be of major interest in those "search problems" where many many inferences are to be performed.

The paper ends with a numerical example whose results are discussed.

176
A Neuro-Fuzzy Approach for Feature Selection

J.M. Benitez, J.L. Castro, C.J. Mantas, F. Rojas

In this paper, a method for feature selection based on a combination of artificial neural network and fuzzy techniques is presented. The procedure produces a ranking of features according to their relevance for the network. This ranking is used to perform a backward selection by successively removing input nodes in a network trained using the complete set of features as inputs. Irrelevant input units and their connections are pruned. The remaining biases are adjusted in such a way that the overall change in the behavior learnt by the network is under control. When the problem is too hard to be modeled by a single network, several of them are used to generate rankings which are aggregated by using a fuzzy logic operator. The proposed method is applied on a number of real-world classification problems. Empirical results show that the feature selection enables the network to improve its generalization ability. Besides, this procedure offer several advantages with respect to other feature selection methods, especially improved efficiency.

177
A Weighted Grey CMAC Neural Network with Output Differentiability

Chih-Ming Chen, Chin-Ming Hong

The Cerebellar Model Arithmetic Computer (CMAC) is a table lookup neurocomputing technique. It can be viewed as a basis function network (BFN) and performs well in terms of its fast learning speed, local generalization capability for approximating nonlinear functions. However, a disvantage is that the derivative of its output cannot be preserved due to the CMAC uses a constant basis function within each quantized state. This creates the limitation and inconvenience while the derivative information is needed in in real-world applications. This paper proposes a Weight Grey CMAC (WGCMAC) that includes the conventional CMAC weight addressing scheme and

the weighted grey prediction model to reslove this problem. Based on the weighted grey prediction model, we present an efficient learning algorithm for the proposed WGCMAC. Experiments confirm that the WGCMAC not only has a faster learning speed than the conventional CMAC, but also provides output derivatives and more precise learni! ng result. Besides, compared with other enhanced CMAC models providing output derivatives, the proposed method has fastest learning speed.

178
A Real Time Neuro-Fuzzy Production System for ITAIPU Binacional

Teresinha Arnauts, Roseli Aparecida, Francel Romero

This paper presents the developing of an expert system modeled by using connectionist and fuzzy paradigms for fault detection in the Itaipu Hydroelectric. For this purpose, a rule-based knowledge already in use by Itaipu operation has been taken as reference. The main aim was the development of NEUFI Production System (NEUro-Fuzzy for Itaipu), which knowledge base contains the rules modeled by neuro-fuzzy architecture.

To make the implementation of NEUFI Production System easier, a simulator, entitled Neuro-Fuzzy Simulator, was also developed, which it allows the training and writing of neuro-fuzzy networks.

The tests already performed were based on modeling and training of the rules by the network. The modeling and the training were performed considering either individually or in-group of rules, depending on the rule characteristics (similar rules were grouped).

179
Self-tuning Neurofuzzy Control for Nonlinear Systems with Offset

C.W. Chan, X.J. Liu, W.K. Yeung

A self-tuning neurofuzzy controller with an ability to remove offsets is derived in this paper based on the self-tuning integrating controller derived for the local linear model. The training target for the proposed controllers is derived, and they can be trained by the simplified recursive least squares (RLS) method with a computing time that is linear instead of geometric in the number of weights in the network. Further, the simplified RLS method not only has the same convergence property as the RLS method, it also has a better ability in tracking varying parameters. The performance of the self-tuning neurofuzzy controller is illustrated by examples involving both linear and nonlinear systems.

180
Automated Quality Control in Sound Speaker Manufacturing Using a Hybrid Neuro-Fuzzy Approach

Patricia Melin, Oscar Castillo, Fernando Sotelo

We describe in this paper the application of a hybrid neuro-fuzzy approach to the problem of automated quality control in sound speaker manufacturing. Traditional quality control has been done by manually checking the quality of sound after production. This manual checking of the speakers is time consuming and occasionally was the cause of error in quality evaluation. For this reason, we developed an intelligent system for automated quality control in sound speaker manufacturing. The intelligent system has a fuzzy rule base containing the knowledge of human experts in quality control. The parameters of the fuzzy system are tuned by applying the ANFIS methodology using, as training data, a real time series of measured sounds as given by good sound speakers. The intelligent system has been tested in a real plant with very good results.

181
Implementation of Artificial Neural Network Using Counter for Weight Storage

Chen Qiong, Zheng Qilun, Ling Weixin

A proposal is brought forward to implement an artificial neural network (ANN) by using digital counters for weight storage. Digital counters are utilized to store the weights, while synapse and neuron are constructed with analog circuits. Through Pulse Width Modulation (PWM) circuit, the digital weight is converted into pulse signal as the input of the analog synapse circuit. In this way, the weight can be long-term stored and easily modified, meanwhile the synapse and neuron have small size in silicon area. By combining the advantages of both analog and digital realization of the ANN, this method is a meaningful way to the implementation of ANN and fuzzy processors including on-chip learning.

182
Fuzzy Target Selection using RFM Variables

Uzay Kaymak

An important data mining problem from the world of direct marketing is target selection. The main task in target selection is the determination of potential customers for a product from a client database. Target selection algorithms identify the profiles of customer groups for a particular product, given data about the clients and a test sample of customers known to possess or have interest in the product. In addition to the numerical performance of the target selection models, model transparency is also important for evaluation by experts, for obtaining confidence in the model derived, and for selecting an appropriate marketing channel. Fuzzy models for target selection are interesting in this respect, since they can be used to obtain numerically accurate models, while providing a linguistic description as well. Fuzzy clustering is a suitable method for obtaining fuzzy target selection models. This paper describes how fuzzy target selection models can be developed when using customer features based on recency, frequency and monetary value. Both a segmentation

approach and a scoring approach are considered. The two approaches are illustrated on a case by using data from the target selection campaigns of a large charity organization.

183
Adaptive Neuro-Fuzzy Control of Systems with Time Delay

H.F. Ho, Y.K. Wong, A.B. Rad

In this paper, we present an adaptive fuzzy logic controller, which learns about the dynamic of the system under control from an on-line Neural Networks (NN) identification algorithm. The identification is based on the estimation of parameters of a First-Order-Plus-Dead-Time (FOPDT) model. The outputs of the NN are three parameters: gain, apparent time delay and the dominant time constant. By combining this algorithm with a fuzzy logic controller with rotating rule-table, an adaptive controller is obtained which -with very little a priori knowledge- can compensate systems with time delay. The simplicity and feasibility of the scheme for time delay control provides a new approach for a variety of control applications. Simulation result included to demonstrate the adaptive property of the proposed scheme.

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Fuzzy Pattern Recognition and Classification of Animal Fibers

L.X. Kong, F.H. She, S. Nahavandi, A.Z. Kouzani

Several techniques, including chemical and physical approaches, have been previously developed to differentiate between animal fibers. Since all animal fibers are comprised of essentially the same keratin, they cannot be effectively distinguished by existing physical or chemical technique. In this paper, a fuzzy neural pattern recognition system is developed to classify two typical animal fibers - mohair and merino. Two multilayer networks are used with the unsupervised network being used for automatic feature extraction while the supervised network serving as the classifier based on the information extracted from unsupervised network. It is found that this hybrid network can accurately classify the two fibers and the accuracy improves with the increase in the features being extracted from the unsupervised network.

185
Identity Uncertainty

Stuart Russell

We are often uncertain about the identity of objects. This phenomenon appears in theories of object persistence in early childhood; in the well-known Morning Star/Evening Star example; in tracking and data association systems for radar; in security systems based on personal identification; and in many aspects of our everyday lives. The paper presents a formal probabilistic approach to reasoning about identity under uncertainty in the framework of first-order logics of probability, with application to wide-area freeway traffic monitoring.

186
Evolving Rule-Based Models: A Tool for Intelligent Adaptation

Plamen Angelov, Richard Buswell

An on-line approach for rule-base evolution by recursive adaptation of rule structure and parameters in is described in the paper. An integral part of the procedure is to maximize the model transparency by simplifying the fuzzy linguistic descriptions of the input variables. The rule base evolves over time and utilising direct calculation approaches and hence minimising the reliance on the use of computationally expensive techniques, such as genetic algorithms. An on-line version of subtractive clustering recently introduced by the authors is used for determination of the antecedent part of the fuzzy rules. Recursive least squares estimation is employed to determine the parameters of the consequent part of each rule. The use of these efficient non-iterative techniques is the key to the low computational demands of the algorithm. The application of similarity measures improves the interpretability and compactness of the resulting eR model, with no significant detriment to the model precision. A time series prediction problem on data from a real indoor climate control system has been considered to test and validate the proposed model simplification method.

187
Rule-Base Guided Adaptation for Mode Detection in Process Control

Dimitar Filev

This paper deals with the problem of control of systems with multiple operating modes. Multiple operating modes are common in industrial control environment. Conventional adaptive algorithms can hardly handle complex systems with multiple operating modes since it takes long time after every drastic change in the plant to relearn model parameters and to subsequently adjust controller parameters. One more efficient approach is based on the idea of guided adaptation - selection of alternative control strategy in accordance with the identified environment and subsequent adaptation. Adaptive control systems of this type belong to the class of intelligent control systems. We expand the concept of rule-based guided adaptation to the case of dynamic systems. An algorithm that dynamically summarizes the models, which successfully approximate plant dynamics, is developed. A dynamic model bank that is used to guide and re-initialize the adaptive control is proposed.

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Scaling a Neuro Fuzzy System and Applications to 3D Visualization and Robot Path Planning

Deok Nam, Harpreet Singh, Steven Muench-Casanova, Grant Gerhart, Rich Goetz

In this paper, we present a new scaling technique for neuro fuzzy system by implementing an equivalently reduced order system from the given data. This technique is developed for designing a reduced rule-based neuro fuzzy system by simultaneously reducing the number of observations and the number of variables from the original data. Performance and accuracy of the approach have been established through the data from search time of target detection with correlation

coefficients between the actual output from the lab experiment and the estimated outputs from neuro fuzzy systems using reduced data sets and the original data set. First, factor analysis is used to extract a set of hidden feature vectors that are used to linearly combine the elements of the full feature vector of the original variables (measurements). Then, fuzzy c-means (FCM) clustering analysis is applied to map the clustered observations from 44 digitized color images along with the associated target and back! ground metrics for the targets. The estimated output by the proposed algorithm is compared with the actual output from the experiment system through the behaviors of reduced rule-base neuro fuzzy systems from the original data set and the reduced order data sets. The paper also discusses some possible applications of the proposed technique for the robot path planning and its 3D visualization. More work is progress in this area.

189
Neuro-Fuzzy Approach to Mode Transitioning in Aerospace Applications

George Vachtsevanos

A real-time adaptation scheme is proposed for the online customization of mode transition controllers designed off-line via blending local mode controllers. It consists of the desired transition trajectory model, the active plant model and the mode transition controller. The active plant model, which incorporates local mode information, is initially trained off-line to capture the desired transition trajectory and controls. Afterwards, the active plant model is adapted online via structure and parameter learning to capture the input/output relationship of the nonlinear system to be controlled. The proposed adaptation scheme is illustrated for a hover to forward flight mode transition control of a helicopter encountering parametric changes and wind disturbances.

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Stability of Slowly Varying Takagi-Sugeno Fuzzy Systems Using Zero Exclusion Theorem

Petr Husek, Renata Pytelkova

A method for stability analysis of Takagi-Sugeno fuzzy systems with linear transfer submodels in the consequents of rules is presented. The Takagi-Sugeno fuzzy model of a plant is supposed where the consequents of rules are linear input-output subsystems. A PDC controller with d ynamic output feedback is used. The method can be applied if the parameters of the model do not vary “too rapidly”. The analysis is based on stability test of corresponding frozen-time systems using a fact that those systems are l inear. Stability analysis of such uncertain linear systems is performed testing the corresponding value sets using Zero exclusion theorem. Overbounding the value set by a convex polygon a sufficient condition of stability is obtained. The method can be also used for stability analysis of an uncontrolled Takagi-Sugeno fuzzy model of a plant. As an arbitrary stability region can be chosen the procedure can be used for both continuous-time and discrete-time systems.

191
Visualization in Java, the performance of Control System, based on Fuzzy Inference System, with a front-end built in Visual Basic

D. Kaur, Kalpesh Shah

The paper presents a technique to visualize the performance of a control system fine- tuned by fuzzy inference. The control problem picked for this paper is the problem to control the swing of a crane when it is in motion. The conventional model for controlling the swing in cranes is based on differential equations or discrete transforms and is unable to control the swing within the acceptable range. The mathematical model of the problem is implemented in the Simulink. The fuzzy model for the crane control is developed and then embedded in the Simulink. The fuzzy model is fine tuned to reduce the swing of the crane. The output of the Simulink Model is the power supplied to the motor of the crane. For the visualization of the crane swing in runtime, Java applet has been designed which is interfaced with the Simulink model to give the animation effect on the screen. The applet could be run using any Internet browser. The performance of the system is tested for the entire range of input parameters. The input parameters are the angle of the swing of the crane and the distance remains to be traveled. A front end in Visual Basic is developed for the Fuzzy Inference System to facilitate the user not familiar with Fuzzy Technology.

193
Subsampling Conflicts to Construct Better Fuzzy Rules

Michael R. Berthold

Many fuzzy rule induction algorithms have been proposed during the past decade or so. Most of these algorithms tend to scale badly with large dimensions of the feature space because the underlying heuristics tend to constrain suboptimal features. Often noisy training instances also influence the size of the resulting rule set. In this paper an algorithm is discussed that extracts a set of so called mixed fuzzy rules. These rules can be extracted from feature spaces with diverse types of attributes and handle the corresponding different types of constraints in parallel. The underlying heuristic minimizes the loss of coverage for each rule when a conflict occurs. We present the original algorithm, which avoids conflicts for each pattern individually and demonstrate how a subsampling strategy improves the resulting rule set, both with respect to performance and interpretability of the resulting rules.

194
On Some Fuzzy Extensions of Association Rules

Patrick Bosc, Olivier Pivert

This paper discusses the semantics of two fuzzy extensions of the classical concept of an association rule. Both extensions are based on the aggregation of sufficiently close data into fuzzy sets, by means of user-defined fuzzy partitions of the domains, thus leading to fuzzy generalized association rules. The first approach is based on fuzzy cardinalities whereas the second one relies on gradual rules. The issue

related to the evaluation of the validity of such rules is discussed and the principles of two discovery algorithms are outlined.

195
HISS - A New Approach for Intelligent Supervision

Kai Michels

Despite of the high level of today's sensor technology in modern process plants, human supervision is still necessary to minimize the risk of disturbances. HISS is developed to reduce the necessity of human supervision. The idea of HISS is to emulate the human senses and human intelligence by high-tech sensor systems and an adaptive self-learning sensor fusion software. At the first prototype of this system, installed at a natural gas facility close to Hannover, Germany, a video analysis system, an audio analysis system and a gas detection system are used to emulate the human senses watching, listening, and smelling. The information from the sensor systems is collected, connected, processed and learned by a software called HISS Logic. HISS Logic compares the incoming information to a data base with fuzzy methods and gives a qualified message to the operator in case of a disturbance in the plant.

196
Fuzzy Sequence Pattern Matching in Zinc Finger Domain Proteins

Bill C.H. Chang, Saman K. Halgamuge

This paper proposes a new pattern matching algorithm - Fuzzy Sequence Pattern Matching - for sequence data. Often, in real world sequence data pattern matching, exact matches do not occur and an approximate match is needed. The proposed algorithm obtains an “similar” match by the use of fuzzy membership function. Especially, in the case of approximate matching with wild cards, current sequence alignment methods are often ineffective. The sequential dataset, “Zinc Finger domain proteins”, is used for simulation and the result shows that the proposed algorithm is useful in approximate pattern matching.

197
Analyzing and Extending Hierarchical Systems of Linguistic Rules

O. Cordon, F. Herrera, I. Zwir

In this paper we propose an approach to design linguistic models which are accurate to a high degree. To do so, we use an extension of the structure of the Knowledge Base of Fuzzy Rule Base Systems, i.e., a more flexible Hierarchical Knowledge Base. This flexibility will allow us to have linguistic rules defined over linguistic partitions with different granularity levels, and thus to improve the modeling of those problem subspaces where the former models have bad performance.

The methodology proposed in this paper has been thought as an extension of a previous Two-level methodology -two hierarchical levels-. First, we extend it by developing an Iterative Hierarchical Systems of Linguistic Rules learning methodology with the purpose of performing an accurate refinement of linguistic models in each step of an iterative process -more than two levels-. Later, we extend the Hierarchical Rule Base structure making it more flexible, reinforcing the action of a rule in the subspace where it is defined. This will be performed by allowing the use of weighted and double-consequent reinforced rules.

198
Blind Detection of Targets from LADAR Data

J.C. Bezdek, Nikhil R. Pal

We propose a method of blind detection of targets of defense interest from LADAR images. Each pixel of the image is represented by a feature vector computed from a co-occurrence matrix defined over a neighborhood of the pixel. Usual co-occurrence based features are modified to make them independent of gray-scale quantization and a new feature based on Weber's law of contrast perception is suggested. A set of 14 features are first computed and from there a set of 5 features are selected using a feature-selection multilayer perceptron (FSMLP) network. A classifier is trained using only the selected features; we use a multilayered perceptron (MLP) here, but our system will work with almost any crisp or fuzzy classifier. For an image with unknown content, we then compute the five selected features for each pixel and assign a class label using the trained classifier. Then we find the ``dense'' regions in the image - that is, regions having high membership to the target class and declare each such dense region as a possible target. Our simulation results are quite encouraging.

199
Abnormal Cell Detection Using the Choquet Integral

Ronald Stanley, James Keller, Charles W. Caldwell, Paul Gader

Automated Giemsa-banded chromosome image research has been largely restricted to classification schemes associated with isolated chromosomes within metaphase spreads. In normal human metaphase spreads, there are 46 chromosomes occurring in homologous pairs for the autosomal classes, 1-22, and X chromosome for females. Many genetic abnormalities are directly linked to structural and/or numerical aberrations of chromosomes within metaphase spreads.

Cells with the Philadelphia chromosome contain an abnormal chromosome for class 9 and for class 22, leaving a single normal chromosome for each class. A data-driven homologue matching technique is applied to recognizing normal chromosomes from classes 9 and 22. Homologue matching integrates neural networks, dynamic programming and the Choquet integral for chromosome recognition. The inability to locate matching homologous pairs for classes 9 and 22 provides an indication that the cell is abnormal, potentially containing the Philadelphia chromosome. Applying this technique to 50 normal and to 48 abnormal cells containing the Philadelphia chromosome yields 100.0% correct abnormal cell detection with a 24.0% false positive rate.

200
Segmenting Polarimetric SAR Images using Robust Competitive Clustering

Paul R. Kersten, Roger R-Y. Lee

Polarimetric Synthetic Aperture Radar (POLSAR) Images have great potential for land-use management, provided the images can be efficiently segmented. This paper describes the application of the robust competitive agglomeration (RCA) clustering algorithm to POLSAR images to segment the images. Examples are presented and future efforts are discussed.

201
Fast Fuzzy Clustering of Infrared Images

Steven Eschrich, Jingwei Ke, Lawrence O. Hall, Dmitry B. Goldgof

Clustering is an important technique for unsupervised image segmentation. The use of fuzzy c-means clustering can provide more information and better partitions than traditional c-means. In image processing, the ability to reduce the precision of the input data and aggregate similar examples can lead to significant data reduction and correspondingly less execution time. This paper discusses brFCM, a data reduction fuzzy c-means clustering algorithm. The algorithm is described and several key implementation issues are discussed. Performance speedup and correspondence to a typical FCM implementation are presented from a dataset of 172 infrared images. Average speedups of 59 times traditional FCM were obtained using brFCM, while producing identical cluster output relative to FCM.

202
Roads and Pipes Detection within LADAR Intensity Images through Fuzzy Techniques

P. Sobrevilla, J. Keller, E. Montseny

In previous works, the authors introduced an approach to automated image labeled-segmentation algorithms, which pretend formalize expert's knowledge and its uncertainty. This is why the algorithms were defined based on descriptions of perceptual features of the objects to be segmented. To retain as much vagueness as possible, these algorithms take benefit of fuzzy techniques modeled by the data of a set of training images. This work presents part of our on-going research on labeled-segmentation algorithms, applied to images wherein the main, and almost the only, information is the brightness of the pixels. Our system was trained on four LADAR intensity images, and tested on 44 images. The data were provided by the Naval Air Warfare Center (NAWC), China Lake, Ca. Because of unseen images can contain new objects, or objects sufficiently different from those in training data, rules that attempt to capture human expertise are used to gain low-level segmentation. Segmenting the relevant peaks of the gray level histogram carries out the definition of the fuzzy sets associated to the labels of the brightness' perceptual features of the objects. Furthermore, erosive and dilative FMSEs were applied to get a suitable segmentation, showing to be effective eliminating misclassifications due to noise.

203
Region Based Fuzzy Neural Networks for Face Detection

Frank Chung-Hoon Rhee, Changsu Lee

In this paper, we propose a fuzzy neural network method for face detection. In the proposed method, fuzzy membership degrees are assigned to preprocessed 20x20 window face and non-face image regions. These fuzzy membership degrees are then inputed to a neural network to be trained using the error back propagation training method. After training, the output value of the neural network is interpreted as the degree of which a given window is a face or non-face region. If the window is determined to contain a face, post processing is then performed. Experimental results show that the proposed method can detect face images more accurately than using conventional neural networks. Also, the proposed fuzzy neural network architecture is shown to require less number of hidden neurons than when using conventional neural networks.

204
The Choice of Information Diffusion Function with Optimum Parameters

Hanji Shang, Xiyun Wu, Yuchu Lu, Ye Shen

To deal with a small sample problem appeared in the estimation of prevalence rate of hypertension, this paper presents an unlimited information diffusion method with a special kind of function, which is called normally structural information diffusion function with parameters. Based on the supposal that the variation of prevalence rate with the variation of age and BMI (two main risk factors) should be smooth and have no great fluctuation, this paper introduces a new method to optimize the parameters according to minimal fluctuation principle.

205
About MIMO System with Fuzzy Inference

Bohdan S. Butkiewicz

Many different reasoning methods are described in literature. Generally, modus ponens reasoning with triangular norms is used for multi input multi output (MIMO) systems. Author carry on discussion about necessary conditions and usefulness of some operations possible to use for approximate reasoning. Main attention is applied to properties of B-operations, introduced earlier by author, mean operations and some others. It is shown that traditional requirements (triangular norms) for operations interpreting connectives "and", "or", "also" are too restrictive. Illustrative examples of a system with fuzzy controller PD or PID type, and with three different plants are presented. Comparison of different reasoning and defuzzification methods is accomplished.

206
Maps Between Indistinguishability Operators

J. Jacas, J. Recasens

Indistinguishability operators generalize crisp equivalence relations to the fuzzy framework. They have been widely studied and they have proved to be useful in different contexts such as fuzzy control, approximate reasoning or cluster analysis. Depending on the authors and on the t-norms used, they have received other names such as fuzzy equivalences, fuzzy equalities or similarity relations, among others. In this paper, we will study some kind of morphisms between indistinguishability operators. Among all possible types of morphisms between indistinguishability operators,the paper will be focused on the following two special cases: a) The maps in the unit interval changing a T-indistinguishability operator into another one with respect to the same t-norm T being T is an archimedan t-norm or the minimum t-norm. b) Maps between indistinguishability operators with respect to isomorphic t-norms. As a side bonus, we recover in the examples , some well known families of t-norms.

207
Fuzzy Modeling of Traffic Noise Annoyance

A. Verkeyn, D. Botteldooren, G. De Tre, R. De Caluwe

This paper presents a fuzzy rule based model for the prediction of traffic noise annoyance on an individual person basis. The assesment of noise annoyance does not only depend on noise exposure, but is also importantly influenced by other contextual variables (e.g. age, expectations,...). The outcome of the system is a linguistic term that denotes a level of annoyance. Much attention is paid to the construction of the fuzzy sets that will represent those linguistic terms (e.g. “not at all”, “slightly”, “moderately” and “highly” annoyed”). To be able to test rule hypotheses, each rule is attached a certainty degree. Those certainty degrees are optimized to achieve an optimal prediction on a sample data set. For this optimization, a genetic algorithm is applied. Several approximate reasoning and inference schemes are compared for their performance in prediction capabilities as well as in speed. It is shown that the fastest implementation does an equally good job, after optimization of the certainty degrees.

208
Fuzzy Analysis of Users’ Interest in Computing using Fril

Namdar Mogharreban

In this paper we utilized Fuzzy Relational Inference Language, Fril, to develop a logic program to analyze the validity and reliability of a 20-item questionnaire that measures the attitude and perception of the usefulness of the Internet. Fril is a logic programming language with a capability of uncertainty management based on Mass Assignment Theory. The questionnaire is a five point Likert scale with 1 indicating poor attitude and perception and 5 indicating good attitude and perception. Positive attitude and high perception of usefulness have been shown to correlate highly with individuals using and benefiting from technology. To the extent that a great amount of resources are being spent on developing and delivering more instructional and training materials on the web a better understanding of who benefits from technology based instruction is crucial. The results of this show that the questionnaire is valid and reliable and Fuzzy analysis techniques can be used successfully for analysis of data of this sort. Further fine tuning of the analysis, thus generating a better questionnaire, is easily possible with the fuzzy tools.

209
Evaluation of a Fuzzy System-based Automotive Copilot Dedicated to Lateral Guidance

Frederic Bonnay, Claude Lemarchand, Zyed Zalila, Florent Coffin

A fuzzy copilot system called RPV has been developed to lighten the driver’s task in the lateral control of his vehicle. Fuzzy systems were designed and embedded with various sensors on a passenger car to perform the lateral control of the vehicle. A fuzzy controller outputs a torque command, which is applied to the steering column to steer the vehicle along a desired immaterial trajectory, while a fuzzy diagnosis monitors the driver’s steering actions and intentions. This enables a supervisor to trigger the adequate driving strategy in accordance with driver expectations. This paper presents encouraging results from field-test experiments based on drivers’ point of view, taking benefit from a positive cooperation of fuzzy logic and ergonomics.

210
On Exponential Lowen Spaces

Yingming Liu, Dexue Zhang

Let L be a completely distributive lattice. A Lowen space is a special kind of L-topological space which has a base consisting of one-step functions. In the case L = [0, 1], a Lowen space is just a fuzzy neighbourhood space introduced by Lowen in 1982. By introducing some natural L-topologies for function spaces in the spirit of Isbell topology, it is proved, in this note, that if the top element 1 in L is a prime and the open sets lattice of a Lowen space X is a continuous lattice, then X is exponential in the category of Lowen spaces.

211
Existance of Lattice-Valued Uniformly Continuous Mappings

Mao-Kang Luo, Ying-Ming Liu

In L-fuzzy topology, the theorem of existence of uniformly continuous mappings is very essential for the theory of uniform spaces and theory of metric spaces. In fact, the main and basic theorem “An L-fuzzy topological space is uniformizable if and only if it is completely regular” is just based on the theorem of existence of uniformly continuous mappings. But the widely accepted skeleton of its proof never has a concrete verification. In this paper, a complete and concrete proof for the existence of lattice-valued uniformly continuous mappings will be given, the errors appeared in some bypast proofs will be corrected; they seem to mean that the widely accepted skeleton of proof is not correct.

212
Embedding Problem of Noncompact Fuzzy Number Space $E^{n\sim}$

Wu Congxin

It is well known that functional analysis is a very useful tool in many branches of mathematics science. Puri and Ralescu made use of Radstr Gm's embedding theorem, isometrically embedding the n-dimensional fuzzy number space En into some Banach space. Following this embedding theorem, Puri and Ralescu and Kaleva discussed the measurability, integrability and differentiability of fuzzy number-valued mappings.

By using Goetschel and Voxman's representation theorem of one-dimensional fuzzy number, Wu and Ma also obtained an embedding theorem.

213
Fuzzy Memberships via Model-Relations

Yi-Xiang Chen

Since the birth of fuzzy topology, the fuzzy membership between fuzzy point and fuzzy subset has been drawn attention, and various fuzzy memberships have been introduced,e.g., Pu and Liu's quasi-coincidence, Wang's remote-neighbourhood, and Johnstone's locale-wise membership. In this paper, the author will show that those fuzzy memberships above could be unified into the model-relation in Vickers' topological systems. Basing that, the author could like to exhibit a little permeation between fuzzy topology and topological systems. The author's aim is to introduce another approach to study fuzzy topology.

214
Fuzzy Positive Implicative HyperK-Ideals of Type 1, 2, 3 and 4

M.M. Zahedi, R.A. Borzooei, H. Rezaei

In this manuscript first we define the notions of fuzzy positive implicative hyperK-ideals of types 1,2,3 and 4. Then by given many examples we show that these notions are different. After that we state and prove some theorems which determine the relation between these notions. Finally by defining the concept of scalar element and fuzzy additive condition we obtain another results.

215
Omega-Sets and Fuzzy Prototypes

Joseph M. Barone

Omega-sets and M-valued sets provide frameworks for investigations into categorical and algebraic properties of fuzzy sets as well as for generalizations of fuzzy sets. For the most part, such investigations have not considered the question of whether or not (fuzzy) points need to be redefined or are, more generally, affected in any way when these approaches are used. This paper attempts to apply crisp approaches to the generalization of points in locales and powerobjects of locales to their fuzzy counterparts. The conclusion reached is that "prototypical" fuzzy points, which are the same as representable sieves of the powerlocale, reflect the nature of the corresponding subobject classifier: if the classifier must be weakened, the fuzzy prototype becomes larger (more inclusive).

216
A Multi-Objective Evolutionary Algorithm for Fuzzy Modeling

Fernando Jimenez, Antonio F. Gomez-Skarmeta, Hans Roubos, Robert Babuska

In this paper a multi-objective evolutionary algorithm with a single run is proposed in order to consider several objectives dealing with transparency and compactness in obtaining a fuzzy model besides the standard accuracy objective. In this way the use of Pareto-optimal solutions within the evolutionary algorithm let us obtain attractive fuzzy models with respect to compactness, transparency and also accuracy. The results of the combination of Pareto-based multi-objective evolutionary algorithms and fuzzy modeling is compared with other approaches in the literature.

217
GA-Based Approaches to Linguistic Modeling of Nonlinear Functions

Hisao Ishibuchi, Daisuke Takeuchi, Tomoharu Nakashima

We show two GA-based approaches to the linguistic modeling of nonlinear functions from numerical input-output data. Our task is to find a small number of linguistic rules for approximately realizing nonlinear functions. In both approaches, the fitness value of each rule set is defined by the weighted sum of three criteria: the total squared error, the number of linguistic rules, and their total length. The length of each rule is defined by the number of antecedent conditions. One approach is rule selection where a small number of linguistic rules are selected from a large number of candidate rules by genetic algorithms. The other approach is fuzzy genetics-based machine learning (GBML) where each linguistic rule is coded as a symbolic substring by its antecedent and consequent linguistic values. A rule set is represented by a concatenated string of variable length. The two approaches are compared with each other through computer simulations on numerical examples.

218
Evaluation of Genetic-Fuzzy Systems in the Configuration Space

Andrea Bonarini, Fabio Fiorellato

We propose an approach to ground the design of learning systems on the analysis of the configuration space of the learning device (e.g., a robot) and on the interpretation of input data. In this paper, we focus on Learning Fuzzy Classifier Systems adopted to evolve behavioral controllers for autonomous robots. We show how it is possible to define some indexes to evaluate objectively both the learning process and the evolved system, thus supporting their designing with engineering principles.

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Ten Years of Genetic Fuzzy Systems: Current Framework and New Trends

O. Cordon, F. Herrera, F. Gomide, F. Hoffman, L. Magdalena

Although fuzzy systems demonstrated their ability to solve different kinds of problems in various applications, there is an increasing interest on augmenting them with learning capabilities. Two of the most successful approaches to hybridise fuzzy systems with adaptation methods have been made in the realm of soft computing: neuro-fuzzy systems and genetic fuzzy systems hybridise the approximate reasoning method of fuzzy systems with the learning capabilities of neural networks and evolutionary algorithms. This contribution focus on genetic fuzzy systems, paying special attention to genetic fuzzy rule based systems, giving a brief overview of the field.

220
Local and Global Estimation of Takagi-Sugeno Consequent Parameters in Genetic Fuzzy Systems

Myriam Regattieri Delgado, Fernando Von Zuben, Fernando Gomide

Automatic design of fuzzy systems constitutes a very promising and challenging research area, where evolutionary computation techniques play a significant role. In evolutionary design of Takagi-Sugeno fuzzy systems, an important issue involves the determination of an effective procedure to optimize rule consequent parameters. All the aspects associated with the antecedent part of each fuzzy rule are evolved through generations, and given a specification of the antecedent part of the rules, that compose a candidate fuzzy system, the best set of consequent parameters should be determined. This paper investigates the use of global and local least squares optimization procedures to perform this task. Function approximation problems are solved to test the performance of the evolutionary process in comparison with alternative solutions.

221
A Multiobjective Genetic Algorithm for Feature Selection and Granularity Learning in Fuzzy-Rule Based Classification Systems

O. Cordon, F. Herrera, M.J. del Jesus, P. Villar

In this contribution, we propose a new method to automatically learn the knowledge base of a Fuzzy Rule-Based Classification System by selecting an adequate set of features and by finding an appropiate granularity for them. This process uses a multiobjective genetic algorithm and considers a simple generation method to derive the fuzzy classification rules.

222
A Design Methodology of Constraint-Based Fuzzy Logic Controller

David Chiang, Robert Lai

Constraint-based fuzzy logic controllers (CFLCs) have been recognized as a unified framework of control system design. Arbitrary types of constraints are allowed in a CFLC to specify the desired states of a plant. The purpose of this paper is to present a design methodology of CFLCs, transforming the intention of a control system into a network of fuzzy constraints. The task of designing a CFLC could be viewed as a process of incremental constraint-based problem-solving, namely a fuzzy constraint refinement problem. Specifically, a schema could be derived for the configuration of a CFLC; after that, constraints can be gradually added (or removed) into the schema until the performance requirements are met. Based on this framework, we have successfully designed a CFLC for modeling a simplified rotary cement kiln that has both nonlinear and time varying characteristics of a plant.

223
Conditions on General Mamdani Fuzzy Controllers as Nonlinear, Variable Gain State Feedback Controllers with Stability Analysis

Hao Ying

Most Mamdani fuzzy controllers must be designed and analyzed individually using the trial-and-error approach coupled with computer simulation. This is due to the lack of knowledge on the structural relationship between the fuzzy controllers and conventional controllers. This paper attempts to partially resolve these issues. The Mamdani fuzzy controllers covered in the paper are general: they use arbitrary continuous input fuzzy sets, arbitrary fuzzy rules, arbitrary inference methods, either Zadeh or the product fuzzy logic AND operator, singleton output fuzzy sets and the centroid defuzzifier. We have established conditions for these fuzzy controllers as nonlinear state feedback controllers with variable gains, which we call fuzzy state feedback controllers for terminological convenience. The necessary and sufficient condition on the fuzzy controllers using Zadeh fuzzy AND operator is that the input fuzzy sets must be linear or piecewise linear (e.g., trapezoidal or triangular). This condition, however, b ecomes only a necessary one for the controllers using the product fuzzy AND operator. These structural conditions enable us to develop a necessary and sufficient local stability condition that can be used not only for stability determination, but also for practically designing stable fuzzy state feedback control systems even when the system models are mathematically unknown.

224
Fuzzy Discrete Event Systems and Their Observability

Feng Lin, Hao Ying

In this paper, we generalize discrete event systems to fuzzy discrete event systems. We introduce fuzzy states and fuzzy events to discrete event systems to describe deterministic uncertainties often existed in some practical applications such as medical applications. This is done by first reformulating crisp discrete event systems in terms of state vectors and transition matrices and then introducing fuzziness in these vectors and matrices. To measure information related to discrete event systems, we modify observability introduced in supervisory control. The modified observability allows us to determine if the output observed is sufficient for decision making. It can be used in both crisp discrete event systems and fuzzy discrete event systems.

225
On the Absolute Stability of the Single-input Fuzzy Logic Controller

Byung-Jae Choi

Many research has been introduced to decrease the number of parameters representing the antecedent part of the fuzzy control rule. In this paper we briefly explain a single-input fuzzy logic controller (SFLC) which uses only a single input variable. And then we analyze it is absolutely stable based on the sector bounded condition. We also show the feasibility of the proposed stability analysis through a numerical example of a mass-damper-spring system.

226
Tractable Neurocontroller Design and Application to Ship Control with Actuator Limits

Wenyuan Feng, Yun Li, Gregory Chong

This paper extends popular PID control structure to a nonlinear format by using a building block based neural network. A GA based-optimisation method is used to optimise the neurocontroller. Special training is employed in the design of a feedforward path neurocontroller, in which the network can be trained from a plant model directly. In order to arrive at the simplest structure of a network, growth training method is developed. Through applications, it is found that if there is a rate limiter in a practical control loop, the automatically designed neurocontroller outperforms an optimised linear controller.

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Tuning of Proportional Plus Derivative Fuzzy Logic Controller for Nonlinear System Control

Dale W. Van Cleave, Kuldip S. Rattan

The transformation of expert's knowledge to control rules in a fuzzy logic controller has not been formalized and arbitrary choices concerning, for example, the shape of membership functions have to be made. The quality of a fuzzy controller can be drastically affected by the choice of membership functions. Thus, methods for tuning fuzzy logic controllers are needed. In this paper, neural networks and fuzzy logic are combined to address the problem of tuning fuzzy logic controllers. The neuro-fuzzy controller uses neural network learning techniques to tune membership functions while keeping the semantics of the fuzzy logic controller intact. Nonlinear systems present a wide spectrum of challenges for control engineers. With neuro-fuzzy techniques, the opportunity exists to control nonlinear systems without the need for a precise mathematical model of the system under control. The architecture and tuning algorithm for a proportional plus derivative neuro-fuzzy logic controller (PDNFLC) is presented in this paper. This step-by-step algorithm for the off-line tuning of a feedforward PDNFLC is demonstrated by a numerical example.

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Maintenance of Generalized Association Rules with Multiple Minimum Supports

Ming-Cheng Tseng, Wen-Yang Lin, Been-Chian Chien

Mining generalized association rules between items in the presence of the taxonomy has been recognized as an important model in data mining. Earlier work on generalized association rules confined the minimum supports to be uniformly specified for all items or items within the same taxonomy level. This constraint would restrain an expert to discover some more interesting but much less supported association rules. In our previous work, we have addressed this problem and proposed two algorithms, MMS_Cumulate and MMS_Stratify. In this paper, we examined the problem of maintaining the discovered multi-support, generalized association rules when new transactions are added into the original database. We proposed an algorithm MMS_UP. Empirical evaluation showed that MMS_UP is 2-6 times faster than running MMS_Cumulate or MMS_Stratify on the updated database afresh.

229
Investigating the Implementation of Production Management to Improve Productivity - A Manufacturing Case in Taiwan

Shu-Yi Liaw

Manufacturing firms performance is significantly important for the development of an industrialized nation, and these firms always seeking ways to assist the management in improving their business performance. Production management (PM) is considered an integration function of all production operations in manufacturing industry, and therefore has a great effect on the performance. To help firms rectify weaknesses of PM, and thus promoting performance, the business performance of 50 large-scale manufacturing firms in Taiwan are measured in terms of their PM achievements. For measurements, total factor productivity and the associated partial productivity indices are used, and four kinds of production planning ranges are defined based on fourteen PM issues. Through a fuzzy clustering approach, the 50 sample large-scale manufacturing firms are grouped into three patterns based on the achievement degrees of production planning, i.e., moderate planning, under-planned and over! -planned types. After analyzing the productivity characteristics of each pattern, the business performance seems to be not completely correlated with the achievements of PM. Since moderate production planning can provide optimal business performance. Referring to the findings in this study, a firm can further investigate its position in the industry to find ways of increasing its competitiveness.

230
An Efficient Clustering Algorithm for Mining Fuzzy Quantitative Association Rules

Been-Chian Chien, Zin-Long Lin, Tzung-Pei Hong

Mining association rules on categorical data has been discussed widely of late years. It is a relatively difficult problem in discovery of association rules from numerical data, since the reasonable intervals for unknown numerical attributes or quantitative data may not be dis-

criminated easily. In this paper, we propose an efficient hierarchical clustering algorithm based on variation of density to solve the problem of interval partition. We define two main characteristics of clustering numerical data: relative inter-connectivity and relative closeness. By giving a proper parameter, to determine the importance between relative closeness and relative inter-connectivity, the proposed approach can generate a reasonable interval automatically for the user. The experimental results show that the proposed clustering algorithm can behave a good performance on both of clustering results and speed.

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Examination of the Influence of Fuzzy Analytic Hierarchy Process in the Development of an Intelligent Location Selection Support System of Convenience Store

Sheng-Chai Chi, Ren-Jien Kuo

The reasons that location selection for a convenience store is so important are the first priority before any other decisions and the unchangeable hardware investment. Thus, it is difficult to compensate by other methods for the negative influence of a worse location decision. Therefore, this research dedicates to apply the fuzzy AHP for the facilitation of capturing the opinions from the experts about the importance of all the feasible factors in the evaluation of the potential locations. In addition, the aim of this research is to examine the usefulness of fuzzy AHP in the evaluation of site selection for convenient stores and its influence to the prediction accuracy of neuro-based location selection system. The output accuracy of neural network using the factors with higher weights is better than using the factors with lower weights. Therefore, it is obvious that fuzzy AHP is practically useful in evaluating decision factors and sieving essential factors for developing! a decision support system for l ocating a convenient store.

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Mining Fuzzy Sequential Patterns from Multiple-Item Transactions

Tzung-Pei Hong, Kuie-Ying Lin, Shyue-Liang Wang

Transaction data in real-world applications usually consist of quantitative values, so designing a sophisticated data-mining algorithm able to deal with various types of data presents a challenge to workers in this research field. Since sequential patterns are also very important for real-world applications, this paper thus focuses on finding fuzzy sequential patterns from quantitative data. A new mining algorithm is proposed, which integrates the fuzzy-set concepts and the AprioriAll algorithm. It first transforms quantitative values in transactions into linguistic terms, then filters them to find sequential patterns by modifying the AprioriAll mining algorithm. Each quantitative item uses only the linguistic term with the maximum cardinality in later mining processes, thus making the number of fuzzy regions to be processed the same as the number of the original items. The patterns mined out thus exhibit the sequential quantitative regularity in databases and can be used to p! rovide some suggestions to appro priate supervisors.

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Incremental Discovery of Functional Dependencies using Partitions

Ju-Wen Shen, Tzung-Pei Hong, Shyue-Liang Wang

The discovery of functional dependencies (FDs) in relational databases is an important data mining problem. Most current work assumes that the database is static, and a database update requires rediscovering all the FDs by scanning the entire old and new database repeatedly. In this work, we present an efficient data mining algorithm to incrementally discover all FDs in the presence of a new set of tuples added to an old database. Based on the concept of tuple partitions and the monotonicity of FDs, we avoid re-scanning of the database and thereby reduce computation time. Computational complexity of the proposed algorithm is analyzed. Comparison with pair-wise comparison based incremental approach is also presented. The results show that improved computation time is achieved while extra space is required for partitions by our approach.

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Normal Forms and Truth Tables for Interval-Valued Fuzzy Logic

Mai Gehrke, Carol Walker, Elbert Walker

In this paper, we provide normal forms and truth tables for interval-valued fuzzy logic which are analogous to those for classical logic, that is, analogous to the disjunctive and conjunctive normal forms and truth tables for Boolean algebras. We give an algorithm for rewriting an expression to obtain its disjunctive normal form. We also give an algorithm for obtaining the disjunctive normal form of an expression from its table of truth values.

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Some Basic Theory of Interval-Valued Fuzzy Sets

Mai Gehrke, Carol Walker, Elbert Walker

Let S be a set. A fuzzy subset of S is a mapping A from S into [0,1]. The value A(s) for a particular s is typically associated with a degree of belief of some expert. There is an extensive theory of fuzzy sets. But there are situations when assigning an exact number to an expert's opinion is too restrictive, and the assignment of an interval of values is more realistic. This paper is concerned with the basics of a theory for such "interval-valued" fuzzy sets, namely, mappings of a set S into the set of subintervals of [0,1].

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Application of Functional Intervals to the Stability Analysis of Fuzzy Linear Systems

J. Bondia, J. Pico

A coefficientwise stability margin for fuzzy linear systems is derived. It is based on the functional interval representation of fuzzy numbers and the well-known Argoun's stability test for interval systems. Consideration of independent confidence levels for every coefficient allows a clear understanding on how each coefficient affects stability

and thus an analysis on how much precise one should be on some coefficients to allow more uncertainty on others can be carried out.

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Optimal Choice of Granularity in Commonsense Estimation: Why Half-Orders of Magnitude

Jerry R. Hobbs, Vladik Kreinovich

It has been observed that when people make crude estimates, they feel comfortable choosing between alternatives which differ by a half-order of magnitude (e.g., were there 100, 300, or 1,000 people in the crowd), and less comfortable making a choice on a more detailed scale, with finer granules, or on a coarser scale (like 100 or 1,000). In this paper, we describe two models of choosing granularity in commonsense estimates, and we show that for both models, in the optimal granularity, the next estimate is 3-4 times larger than the previous one. Thus, these two optimization results explain the commonsense granularity.

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Granular Computing: An Introduction

Witold Pedrycz

The study is concerned with the fundamentals of granular computing. Granular computing, as the name itself stipulates, deals with representing information in the form of some aggregates (that embrace a number of individual entitites) and their ensuing processing. We elaborate on the rationale behind granular computing. Next, a number of formal frameworks of information granulation are discussed including several alternatives such as fuzzy sets, interval analysis, rough sets, and probability. The notion of granularity itself is defined and quantified. A design agenda of granular computing is formulated and the key design problems are raised. A number of granular architectures are also discussed with an objective of dealinating the fundamental algorithmic and conceptual challenges. It is shown that the use of information granules of different size (granularity) lends itself to general pyramid architectures of information processing. The role of encoding and decoding mechanisms visible in this setting is also discussed in detail along with some particular solutions. We raise an issue of interoperability of granular environments. The intent of this paper is to elaborate on the fundamentals and put the entire area in a certain perspective while not moving into specific algorithmic details.

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Information Granules in Spatial Reasoning

James Peters, Andrzej Skowron, Jaroslaw Stepaniuk

Information processing in intelligent systems requires new computing paradigms in response. Intelligent systems require a high-level of sensitivity to nuances in the information sources coming from changing environments. Information sources provide us with an approximate picture of portions of the world. The information sources or sensors of an intelligent system, provide us with granules of information that must be transformed, analyzed and built into structures that support problem-solving. To build adequate adaptivity and responsiveness to information sources, an approximate reasoning approach based on rough set theory and rough mereology has proven fruitful. In this paper, schemes of approximate reasoning approaches to transforming of information granules from different information sources are considered. Such schemes are obtained by approximate reasoning rules and methods for their composition relative to available data and background k! nowledge. By tuning the paramet ers of schemes, the information granules representing patterns relevant to given tasks can be generated. The contribution of this article is the presentation of examples of decomposition problems for information granules useful in quantitative spatial reasoning. These problems are strongly related to algorithmic methods of approximate reasoning schemes extracting from data and are crucial for solving problems in many areas such as autonomous systems.

241
The Hybrid Multi-Layer Inference Architecture and Algorithm of FPNN Based on FNN and PNN

Byoung-Jun Park, Sung-Kwun Oh, Witold Pedrycz

The study is concerned with an approach to the design of a new category of fuzzy neural networks. The proposed Fuzzy Polynomial Neural Networks (FPNN) with hybrid multi-layer inference architecture is based on fuzzy neural networks (FNN) and polynomial neural networks (PNN) for model identification of complex and nonlinear systems. The one and the other are considered as premise and consequence part of FPNN respectively. Therefore the proposed FPNN is available effectively for multi-input variables and high-order polynomial according to the combination of FNN and PNN. We introduce two kinds of FPNN architectures, namely the basic and modified architectures depending on the connection points (nodes) of the layer of FNN. Owing to the specific features of two combined architectures, it is possible to consider the nonlinear characteristics of process and to get output performance with superb predictive ability. The availability and feasibility of the FPNN is discussed and illustra! ted with the aid of two represen tative numerical examples. The results show that the proposed FPNN can produce the model with higher accuracy and predictive ability than any other method presented previously.

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Sensor Fusion: A Rough Granular Approach

J.F. Peters, S. Ramanna, M. Borkowski, Andrzej Skowron, Jaroslaw Stepaniuk, Zbigniew Suraj

This paper introduced an application of a particular form of rough granular computing in fusing(combining) sensor readings. The intent of this paper is to describe a system that engages in a form of knowledge discovery based on sensor fusion. Such a system responds to sensor outputs in a manner that is selective, determines the relevance of each sensor in a classification effort, and constructs information granules computationally useful in arriving at a decision in a problesolving system. A sensor id a device that responds to each stimulus by converting its measured input to some form of usable output. Relevance of a sensor is computed with a rough integral that computes a form of ordered weighted average of sensor values. The construction of an information granule depends on the selection of a threshold for sensor values. Only those sensors with rough integral

values approaching a selected threshold are fused (i.e., used to construct a granule). The contribution of this ! paper is the introduction of a s ensor fusion method based on rough integration. By way of practical application, an approach to fusion of homogeneous sensors deemed relevant in a classification effort is considered.

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A Compensatory Wavelet Neuron Model

M. Sinha, M.M. Gupta, P.N. Nikiforuk

This paper proposes a compensatory wavelet neural model, which is based on a wavelet activation function. This is obtained by replacing the sigmoid type nonlinearity by the wavelet function in the compensatory neuron model. The compensatory neuron model is obtained by replacing the linear basis, a summation function, by a combination of linear and nonlinear bases.

Here, the nonlinear basis consists of a multiplicative function. It is reported that for a spectrum of functional mapping and classification problems, the compensatory neuron based neural network model performs better than the ordinary neuron based neural network, in terms of accuracy of prediction and computational time involved. On the other hand, the wavelet neuron is obtained by modifying an ordinary neuron with a non-orthogonal wavelet bases.

Therefore, it is imperative to analyze the performances of a compensatory neuron, a compensatory wavelet neuron, a wavelet neuron and an ordinary neuron based neural networks for some of the functional mapping and the classification benchmark problems. The performances of different neuron based neural networks, as discussed above, are also analyzed in this paper. It is also shown that an ordinary neural network can well predict the behavior of a chaotic nonlinear dynamical system contrary to the conclusions drawn by Yamakawa et al, that an ordinary neural network cannot predict the behavior of a chaotic nonlinear dynamical system.

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Interdependent Multiobjective Control Using Biased Neural Network (Biased-NN)

Hwan-Chun Myung, Z. Zenn Bien

A Biased Neural Network (Biased-NN) is proposed to solve an interdependent multiobjective control problem. The main idea of the Biased-NN stems from a decoupled fuzzy sliding mode control scheme that provides the simple way to achieve asymptotic stability for a class of decoupled systems. Each neuron in the Biased-NN is used to approximate a sign function in order to replace the sliding mode control structure with the Biased-NN. Such a feature is useful for handling the interdependent multiobjective control problem based upon the proposed supporting strategy. While the previous works require a priori knowledge for all the objectives, the proposed method uses only expert knowledge of the objective that is considered main concern. Simulations are conducted to show the effectiveness of the Biased-NN.

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A Neuro-Fuzzy Combiner for Multiobjective Control

I-Fang Chung, Chin-Teng Lin

This paper proposes a neuro-fuzzy combiner (NFC) with supervised learning capability for solving multiobjective control problems. The proposed NFC can combine n existing low-level controllers in a hierarchical way to form a multiobjective fuzzy controller. It is assumed that each low-level (fuzzy or nonfuzzy) controller has been well designed to serve a particular objective. The role of the NFC is to fuse the n actions decided by the n low-level controllers and determine a proper action acting on the environment (plant) at each time step. Hence, the NFC can combine low-level controllers and achieve multiple objectives (goals) at once. Here a NFC can be designed by proposed architecture and supervised learning scheme. Computer simulations have been conducted to illustrate the performance and applicability of the proposed architecture and learning scheme.

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Model-Based Multiobjective Fuzzy Control using a New Multiobjective Dynamic Programming Approach

Dong-Oh Kang, Zeungnam Bien

In this paper, we propose a model-based multi-objective fuzzy control method which is optimized on-line via a new multiobjective dynamic programming. The new multiobjective dynamic programming is guaranteed to derive a Pareto optimal solution. To estimate the effect of each candidate for control input in the dynamic programming procedure, we use state-value predictors of multiple objectives based on the plant model. Temporal difference learning and supervised learning are used for update of the predictors and the plant model. As the learning proceeds, the proposed method derives the compromised solution among multiple objectives. To show the effectiveness of the proposed method, some simulation results are given.

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Investment Decision Making with Minimum Fluctuations Based on Two Objective Criterions

Junzo Watada, Teruyuki Watanabe

In this paper, we will discuss the investment problem based on minimum variance and maxmum expected return based on minimum fluctuation from the previous investment pattern. A conventional portfolio selection problem, which is based on a mean-variance model, is not solved under the consideration of its preceding investment. In a real market, considering influence of investing on a market, a large trade should not be a good strategy.

We propose a method to take the investing pattern of a preceding term under the consideration. In this model, the distance of portfolio that is investing patterns is evaluated between this term and its preceding term and the portfolio is selected so as to minimize the total value of both the risk and the dist.

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Dual Learning for Perception and Behavior of Mobile Robots

Naoyuki Kubota, Yusuke Nojima, Fumio Kojima, Toshio Fukuda

This paper deals with a learning method for perception and behavior of mobile robots. An intelligent robot should acquire its behaviors based on the embodiment of the robot itself. The robot cannot understand the meaning of the perceptual information until acquiring behaviors, in other words, the robot does not know which information in the facing environment is important for the target behavior beforehand. This indicates that the robot should reconfigure the perceptual mechanism after acquiring behaviors. Therefore, this paper proposes a coupled learning mechanism of the perception and the behavior. Furthermore, we discuss a reconfiguring method of the perceptual mechanism to enable the coherent relationship with the facing environment. We show the effectiveness through computer simulation results.

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A Hierarchical Recurrent Neuro-Fuzzy System

Andreas Nuernberger

Fuzzy systems, neural networks and its combination in neuro-fuzzy systems are already well established in data analysis and system control. Especially, neuro-fuzzy systems are well suited for the development of interactive data analysis tools, which enable the creation of rule-based knowledge from data and the introduction of a-priori knowledge into the process of data analysis. However, its recurrent variants - especially recurrent neuro-fuzzy models - are still rarely used. In this article a (hybrid) recurrent neuro-fuzzy model is presented which is designed for application in time series prediction and identification of dynamic systems. It has been implemented in a tool for the interactive design of hierarchical recurrent fuzzy systems.

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Fuzzy Data Analyis with NEFCLASS

Detlef D. Nauck

Nowadays fuzzy systems are frequently applied in data analysis problems like classification, function approximation or time series prediction. Here we interpret fuzzy data analysis as the application of fuzzy systems to the analysis of crisp data. The goal is to obtain simple intuitive models for interpretation and prediction. We interpret data analysis as a process that is exploratory to some extent. In order for neuro-fuzzy learning to support this aspect we require fast and simple learning algorihtms that result in small rule bases. In this paper we present the current version of the NEFCLASS structure learning algorithms that support those requirements.

251
A New Approach to Fuzzy Partitioning

Frank Hoppner, Frank Klawonn

Fuzzy clustering algorithms like the popular fuzzy c-means algorithm (FCM) are frequently used to automatically divide up the data space into fuzzy granules (fuzzy vector quantization). In the context of fuzzy systems, in order to be intuitive and meaningful to the user, the fuzzy membership functions of the used linguistic terms have to fulfill some requirements like boundedness of support or unimodality. By rewarding crisp membership degrees, we modify FCM and obtain different membership functions that better suit these purposes. We show that the modification can be interpreted as standard FCM using distances to the Voronoi cell of the cluster rather than using distances to the cluster prototypes. In consequence, the resulting partitions of the modified algorithm are much closer to those of the crisp original methods. The membership functions can be generalized to a fuzzified minimum function. We give some bounds on the approximation quality of this fuzzification.

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Semi-Supervised Induction of Fuzzy Rules Applied to Image Segmentation

Aljoscha Klose, Jochen Schneider

In many applications huge amounts of data are available. However, these are often unlabeled and the user must manually assign labels. The idea of semi-supervised learning is to use as much labeled data as available and try to additionally exploit the structure in the unlabeled data. In this paper we describe an approach to semi-supervised learning of fuzzy systems. Our work is targeted at supporting object tracking in images.

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Fuzzy Cluster Analysis of Classified Data

Heiko Timm

Fuzzy cluster analysis is a method for unsupervised clustering. However sometimes class information is available for the given dataset, i.e., only the number of clusters per class is unknown. In this paper it is discussed how class information can be exploited. Some common approaches are reviewed and a new approach is suggested, which integrates class information into fuzzy cluster analysis.

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Classification of Internet Newsgroup Articles using RACE

Thomas A. Runkler, James C. Bezdek

Conventional point prototype clustering like fuzzy c-means is used to extract prototypes and partitions from numerical data. Clustering is often done by an alternating cluster estimation (ACE) algorithm that may either be specified by an objective function or by user-defined membership and prototype functions. Also non-numerical data like text data can often be represented numerically by (pairwise) relation

matrices. Clusters in these relational data can be found by relational alternating cluster estimation (RACE). For text data with Levenshtein distances the RACE cluster centers can be used as keywords.

We apply RACE to extract keywords from the articles of internet newgroups. For example, for the newsgroup sci.electronics we automatically extract the following 20 prototypes: gaithersburg, f, cyanoacrylate, simulatenously, compatability, semiconductor, electrically, potentiometers, massachusetts, multivibrators, intelligence, revolutionized, asynchronously, joseph, subdirectories, birlinghoven, transportation, microcontroller, administration, reprogramming.

We use these keywords to build a classifier that automatically assigns (previously unknown) articles to the most appropriate newgroup. Depending on the article size, we obtain classification rates between 60 and 100%. These are very good classification rates for a text classification algorithm that does not use any semantic information. Our method is easily extended to classification of world wide web documents and automated e-mail filtering.

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Thermal Control with Image Processing and Fuzzy Controllers

L.X. Kong, F.H. She, S. Nahavandi, L.H. Wang

The image processing is used to correlate the area of different temperatures in the die thermal images of high pressure die casting for thermal control as thermal balance is the most important aspect in this process. The areas of higher and lower temperature ranges than the optimum empirical/experimental range can therefore, be identified. Using the heat index developed, the heat stored on the die surface can be quantitatively calculated and consequently, controlled using fuzzy neural networks. This fuzzy neural network control system makes the decision what action has to be taken ie whether to take away a certain amount of heat (H-) or take less heat away (H+) from a specific area..

256
Implementing the Color Conspicuity Model for Visualization

Eric Cooper, Katsuari Kamei

We are developing systems for color selection and placement support, especially for desktop visualization software. One essential part of this system is the conspicuity model, which infers relative, subjective conspicuity between colors. In addition to visibility and discriminability, relative visual weight is an important aspect of any visual design. Previously, we implemented a linear rule-based system for prototype implementation. Recent changes in the prototype allowed us to incorporate simple a neural network, which inferred conspicuity much more effectively than the previous model. Testing on actual visualizations showed that the network also predicts ease-of-use for color selection support.

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Neuro-Fuzzy Modelling and Control of Cooperative Manipulators Handling a Common Object

S. Rajasekharan, C. Kambhampati

This paper presents a novel approach to controlling multiple manipulators handling a common object using a decomposed architecture that is composed of linguistic rules. A method is proposed here that separates the interconnections so that the resulting model of a link is decomposed into fuzzy IF-THEN rules. This model is then used to design a Lyapunov based fuzzy logic controller for the system by solving Linear Matrix Equalities.

258
Quantisation Error Reduction for Reducing Q-Factor JPEG Recompression

C.M. Ng, Vincent Ng, P.L. Poon

This paper studies the mechanism of recompression using the reduced Q-factor JPEG compression and highlights the areas which contribute to image distortion during recompression. A quantisation error reduction algorithm with the aim to preserve the originality of the image against recompression was presented. Statistical information from a typical image was collected which was then used as the threshold in the run time criteria of the algorithm. The algorithm works with the approach of adjusting the DCT coefficients to correct the quantisation errors. The algorithm was found work well for both images consisting of low frequency and high frequency components.

259
Fuzzy System Representation of Digitized Patterns and an Edge Tracking Thinning Algorithm

B.S. Moon, D.Y. Lee, H.C. Lee

In this paper, we describe how to build a fuzzy system z=S(x,y) to represent digitized patterns consisting of black pixels with value 1's and white pixels with value 0's. The numerical representation of digitized images is used as the fuzzy rule table needed to combine input variables x and y. We use the cubic B-splines as the input fuzzy sets and triangular functions as the output fuzzy sets, while center area method is used as the defuzzification method. The resulting function z=S(x,y) is a continuous function whose values at grid points are approximately the same as the original. A pair of fuzzy systems are derived based on this representation to evaluate the x and y components of the curl vector \nabla \times \bf{r} where \bf{r}=(x,y,S(x,y)). These fuzzy systems are used to compute the curl vector \nabla \times \bf{r}\rm in an edge tracking algorithm, and they are found to provide a very simple and efficient means for thinning digitized patterns. A few examples are included to verify our algorithm.

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Vehicle Fuzzy Driving Based on DGPS and Vision

Miguel Angel Sotelo, Sergio Alcalde, Jesus Reviejo, J. Eugenio Naranjo, Ricardo Garcia, Teresa de Pedro, Carlos Gonzalez

This document presents a fuzzy control application in the unmanned driving field. Two electric cars have been conveniently instrumented in order to transform them in platforms for automatic driving experiments. Onboard speed and steering fuzzy controllers are the core of the guiding system. Navigation is essentially DGPS-based providing obstacles and avoidance by means of vision in a reactive manner.

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Operators of Contrast Modification of Fuzzy Sets

Slavka Bodjanova

When a vague value is expressed by a fuzzy set, its fuzziness (vagueness) is measured with respect to the threshold 0.5. This point is the equilibrium of the standard fuzzy complement. It also separates ``large" and ``small" membership coefficients of a fuzzy set when the operator of contrast intensification (diminishment) is used to decrease (increase) the amount of fuzziness of a fuzzy set. For a threshold alpha from interval (0,1) more general operators of alpha-contrast intensification and alpha-contrast diminishment based on fuzzy complement with equilibrium equal to alpha will be introduced, discussed and illustrated with examples.

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A Study of Applying Fuzzy Analytic Hierarchy Process on Management Talent Evaluation Model (in IC Packaging in Taiwan)

Liang-Chih Huang, Peitsang Wu, Bih-Shiaw Jaw, Yen-Hui Wu

This study is to construct a new managerial talent evaluation model for the assessors in IC packaging industry in Taiwan. The Fuzzy Analytic Hierarchy Process (FAHP) method involved in evaluation to be able to obtain the information with more systematic ways and more efficient to assist the related managerial competency activities. Techniques of the Borda function, FAHP method, fuzzy Delphi method and questionnaire survey were used in the study. Finally, an empirical study was conducted to examine the FAHP of management talent evaluation model effectively to promote quality of decision making and can be referenced for further managerial talent related activities.

263
A Fuzzy Fault Diagnosis Scheme with Application

Xiaochun George Wang, Wei Liu

Fault detection and diagnosis has been an important research filed in control engineering. In this paper, a new fuzzy logic diagnosis strategy is developed. The advantages of the proposed fuzzy logic fault diagnosis include the integration of human expertise, experience and knowledge into the rule base which has qualitative, descriptive and linguistic quantities. Fuzzy numbers and numeration are applied to modeling the uncertain fault-symptom relations, as well as to the fault analysis and recognition, so that imprecise and incomplete information can be well represented and processed. The simulation results demonstrate that the proposed strategy provides a feasible way with less time and higher accuracy. It especially suits for industrial large-scale systems.

264
Using Fuzzy Petri Nets to Coordinate Collaborative Activities

Alberto B. Raposo, Andre L.V. Coelho, Leo P. Magalhaes, Ivan L.M. Ricarte

This paper presents a fuzzy Petri net based approach suitable for the modeling of flexible coordination mechanisms to deal with temporal interdependencies between collaborative tasks. Such approach is based on an extension of the Generalized Fuzzy Petri Net model, including the notion of time for the execution and synchronization of these tasks. A scenario of study is described, indicating the suitability of the proposal.

265
Engineering a Front-End Prototype using Computing with Words in Generic BK-Product Fuzzy Relational Architectures

Ladislav L. Kohout, Bobby C. Granville

When employing fuzzy relational structures in the development of intelligent systems, a unified generic tool is needed to assist designers, knowledge experts, and users in constructing the application's data dictionary and relational structures for the observed environment being modeled. Such a tool must apply some form of "computing with words" to help users conceptualize the semantics of the fuzzy relations themselves. Everyday terms and those used in special environments form a natural means of conceptualizing the reasoning process of fuzzy analysis on fuzzy relations using words rather than numbers. The recognized words and terms allow the potential users of fuzzy systems the opportunity to step back and see the big-picture of a typical application's overall relational structures and compositions. A front-end English Query Language (EQL) tool is specified along with the supporting grammar to view the emerging technologies employed in representing fuzzy relational struc! tures and how the relational app roach can be used for "computing with words" systems. Therefore, the desired logical analysis can be expressed using natural language queries as opposed to the mathematical products forms of the multi-valued logics used. Such a tool enables future researchers to facilitate rapid construction of new applications of fuzzy relational systems with ease.

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Fuzzy Intrusion Detection

John E. Dickerson, Jukka Juslin, Ourania Koukousoula, Julie A. Dickerson

The Fuzzy Intrusion Recognition Engine (FIRE) is a network intrusion detection system that uses fuzzy systems to assess malicious activity against computer networks. The system uses an agent-based approach to separate monitoring tasks. Individual agents perform their own fuzzification of input data sources. All agents communicate with a fuzzy evaluation engine that combines the results of individual agents using fuzzy rules to produce alerts that are true to a degree. Several intrusion scenarios are presented along with the fuzzy systems for detecting the intrusions. The fuzzy systems are tested using data obtained from networks under simulated attacks. The results show that fuzzy systems can easily identify port scanning and denial of service attacks. The system can be effective at detecting some types of backdoor and Trojan horse attacks.

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Fuzzy Decision Modeling for Manufacturability Evaluation Under the Concurrent Engineering Environment

B.C. Jiang, Chi-Hsing Hsu

A manufacturability evaluation decision model is formulated and analyzed based on fuzzy logic and multiple attribute decision-makings under the concurrent engineering envirnment. Multiple criteria such as the goal space, the decision space, the function space, the developmennt (i.e., product & process design) space, are then applied under different analysis of decision-making methods. The fuzzy multiple attribute decision-making (FMADM) combined with activity-based costing (ABC) can be used in the activity decision space. And the fuzzy logic decision model can be applied in the goal decision space. The results of this study point out the importance of early decision making capability. An example of a high-pressure vessel is provided to demonstrate the proposed model for evaluating the manufacturability.

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Modeling Uncertain Reasoning with Possibilistic Petri Nets

Jonathan Lee, Kevin F.R. Liu, Weiling Chiang

A possibilistic Petri nets model (PPN) is proposed to imitate possibilistic reasoning. A possibilistic token carries information to describe an object and its corresponding possibility and necessity measures. Possibilistic transitions are classified into four types: inference transitions perform possibilistic reasoning; duplication transitions duplicate a possibilistic token to several tokens representing the same proposition and possibility and necessity measures; aggregation transitions combine several possibilistic tokens with the same classical proposition; and aggregation-duplication transitions combine aggregation transitions and duplication transitions.

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Hybrid Logic for Possibilistic Reasoning

Churn-Jung Liau

Hybrid logic is an extension of modal logic with nominals for referring to the possible worlds. A nominal is an atomic formula which is true at exactly one point in any model. By using hybrid logic, the labelled deduction mechanism can be internalized to the object language, so the proof methods for the logic can be developed without resort to meta-linguistic devices. In this paper, we present two hybrid logics for possibilistic reasoning. The first is based on the graded modal formulation of possibilistic logic, so its proof method is essentially a modification of the tableau system for hybrid multimodal logic. The second is a kind of fuzzy modal logic and has a many-valued semantics. We present its proof method by using a tableau system for annotated formulas.

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Implementation of an Extended Possibilistic Logic in an Annotated Logic Theorem Prover

Peter Kullmann, Sandra Sandri

We present here a theorem prover for possibilistic logic extended with fuzzy constants and fuzzy quantifiers (PLFC), using system KOMET, a general theorem-prover system based on generalized annotated logic (GAL). In a previous work, we verified the formal transformation of PLFC with Horn clauses into GAL. In the present work, we discuss some implementation issues and present some examples.

271
Adding Similarity to Possibilistic Logic with Fuzzy Constants

Teresa Alsinet, Lluis Godo

In this paper we propose an extension of a Horn-rule sublogic of PLFC (a first-order Possibilistic logic programming language dealing with fuzzy constants and fuzzily restricted quantifiers) with similarity-based unification of object constants. At the semantic level, we equip each sort with a fuzzy similarity relation, and at the syntactic level, we replace each precise object constant in the antecedent of a Horn-rule by a variable weight fuzzily ``enlarged'' by means of a fuzzy similarity relation.

272
Different Models of Fuzzy Logic Programming with Fuzzy Unification (Towards a Revision of Fuzzy Databases)

Peter Vojtas, Teresa Alsinet, Lluis Godo

The aim if this paper is to show relationships between different formalism for handling uncertainty in logic programming, knowledge based systems and deductive databases. Namely we show that our model of fuzzy logic programming has same expressive power as annotated logic programs with restricted continuous semantics. Features of fuzzy unification are achieved by extending the rule base

by axioms of equality with fuzzy similarities. This induces a new fuzzy relational algebra. Our procedural semantics enables to estimate truth values of the answers during the computation.Using this we introduce a model with threshold computation and an another for finding the best answer with prescribed precision tolerance.

273
Life Long Learning and Adaptation for Embedded Agents Operating in Unstructured Environments

Hani Hagras, Martin Colley, Victor Callaghan

In this paper we introduce a novel technique for life-long learning and adaptation of mobile robotic agents operating in unstructured environments based on our patented fuzzy-genetic system (British patent 99-10539.7). The life long learning strategy tunes the controllers learnt in our previous work by a process of gradual improvement and adaptation to the surrounding environment. We have applied this work to two different unstructured environments, the agricultural environment and the intelligent buildings environment.

274
A Neuro-Fuzzy-Genetic System for Automatic Setting of Control Strategies

J.F.M. Amaral, M.M. Vellasco, R. Tanscheit, M.A.C. Pacheco

This work deals with the design of control systems based on hybrid techniques of computational intelligence. Initially a neuro-fuzzy system is employed in the control of several plants. The neuro-fuzzy system used here is the NEFCON model, which is capable of learning and optimizing online the rule-base of a Mamdani-type fuzzy controller. The algorithm is based on reinforcement learning that uses a fuzzy measure for the error. Its performances in the control of linear plants of diverse complexity and also of a nonlinear one are evaluated. Results are compared to those obtained through conventional techniques. The main focus of this work is on the development of a new Neuro-Fuzzy-Genetic System, which makes use of Genetic Algorithms for rule base optimization. The satisfactory results obtained with the two more complex plants show the potential of this hybrid model in the design of control systems.

275
A Fast Genetic Method for Inducting Linguistically Understandable Fuzzy Models

Luciano Sanchez

Fuzzy Rule bases can be regarded as mixture of experts, and boosting techniques can be applied to learn them from data. In particular, provided that adequate reasoning methods are used, fuzzy models are extended additive models, thus backfitting can be applied to them. We propose to use an implementation of backfitting that uses a genetic algorithm for fitting submodels to residuals and we also show that it is both more accurate and faster than fuzzy rule learning methods.

276
Boosting a Genetic Fuzzy Classifier

Frank Hoffmann

This paper presents a new boosting algorithm for genetic learning of fuzzy classification rules. The method is based on the iterative rule learning approach to fuzzy rule base system design. The fuzzy rule base is built in an incremental fashion, in that the evolutionary algorithm extracts one fuzzy classifier rule at a time. The boosting mechanism reduces the weight of those training instances that are classified correctly by the new rule, such that the next iteration of the evolutionary algorithm focuses the search on those fuzzy rules that capture the currently uncovered or misclassified instances. The weight of a fuzzy rule reflects the relative strength the boosting algorithm assigns to the rule class when it aggregates the casted votes. The method is applied to the Wisconsin breast cancer diagnosis data set.

277
Genetic Tuning of Fuzzy Rule-Based Systems Integrating Linguistic Hedges

J. Casillas, O. Cordon, F. Herrera, M.J. Del Jesus

Tuning fuzzy rule-based systems for linguistic modeling is an interesting and widely developed task. It involves adjusting the membership functions composing the knowledge base. To do that, as changing the parameters defining each membership function as using linguistic hedges to slightly modify them may be considered.

This contribution introduces a genetic tuning process for jointly making these two tuning approaches. The experimental results show that our method obtain accurate linguistic models in both approximation and generalization aspects.

278
Evolutionary Algorithm Based Fuzzy Modeling Using Conciseness Measure

T. Suzuki, T. Furuhashi, H. Tsutsui

In this paper, a fuzzy modeling method using a new conciseness measure is presented. Conciseness of fuzzy models is defined by the shape and allocation of membership functions and the conciseness is quantified by introducing fuzzy entropy. This paper proposes a new measure which evaluates the deviation of a membership function from symmetry. The measure has a different aspect from De Luca and Termini's fuzzy entropy measure, which could only evaluate the shape of a membership function. By combining these two measures, a new measure is derived for evaluation of the shape and allocation of membership functions of a fuzzy model. Numerical results show that the new conciseness measure is effective for fuzzy modeling formulated as a multi-optimization problem.

279
Detection of Pneumoconiosis Rounded Opacities using Neural Network

Hiroshi Kondo, Takaharu Kouda

Fast detection of pneumoconiosis diseased part using Neural Network is presented. The rounded opacities on the pneumoconiosis X-ray photo are picked up quickly through a back propagation (BP) neural network with several typical training patterns. The training patterns from 0.6 mmØ to 4.0 mmØ are made as simple circles. The neck problem for an automatic pneumoconiosis diagnosis has been to reject the unnecessary part like ribs and vessel's shades. In this paper such unnecessary parts are rejected well by adding several output neurons for detecting these shades. The input of the neural network is 30x30 pixel image which is quarried succeedingly from the bi-level ROI(region of interest) image with the size 500x500 pixel. The new technique called moving normalization is developed here in order to made an appropriate bi-level ROI image. The total evaluation is done from the size and figure categorization. Mary simulation examples show that the proposed method gives much reliable result than traditional ones .

280
An Even More Realistic (Non-Associative) Logic and its Relation to Psychology of Human Reasoning

I.R. Goodman, Vladik Kreinovich, Raul Trejo, Jesus Martinez, Reginaldo Gonzalez

If we know the degrees of certainty p(S1) and p(S2) in two statements S1 and S2, then possible values of p(S1&S2) form an interval p=[max(p1+p2-1,0),min(p1,p2)]. As a numerical estimate, it is natural to use a midpoint of p of this interval; this midpoint is a mathematical expectation of p(S1&S2) over a uniform (second order) distribution on all possible probability distributions.

This midpoint operation & is not associative. We show that the upper bound on the difference a&(b&c)-(a&b)&c is 1/9, so if the size of the corresponding granules is >=1/9, we will not notice this associativity. This may explain the famous 7+-2 law, according to which we use no more than 9 granules.

281
Toward the Representation of Implication-Based Fuzzy Rules in Terms of Crisp Rules

Didier Dubois, Eyke Huellermeier, Henri Prade

The paper studies the representation of implication-based fuzzy rules in terms of a convex combination of gradual rules, a special type of (implication-based) fuzzy rule inducing a crisp relation. This representation, which can be interpreted in a probabilistic way, is shown to be unique on the assumption that the implication operator used for modeling the fuzzy rule does not have some strict monotonicity property. In this case, the crisp relations induced by the involved gradual rules correspond to level-cuts of the fuzzy relation associated with the fuzzy rule. However, other representations might exist if the aforementioned property is satisfied. Under a slightly stronger (strict) monotonicity condition, the existence of further (non-consonant) representations is even guaranteed. The usefulness of the proposed interpretation of fuzzy rules is expemplified in connection with the evaluation of rules in data mining.

282
On Syntactical and Semantical Approaches to Similarity-Based Approximate Reasoning

Francesc Esteva, Pere Garcia-Calves, Lluis Godo

In this paper we survey and compare two different logical approaches to similarity-based approximate reasoning that have been proposed recently in the literature. A first one, that may be named syntactical, is based on attaching similarity degrees directly to pairs of propositions. Such an approach has been followed mainly by Ying, Gerla and colleagues . A second approach, that may be named semantical, proposes to attach a similarity relation on a set of possible worlds rather than on propositions. This approach has its roots in works on approximate truth, or truthlikeness, by Niiniluoto, Weston and others in the eighties, and more recently by Ruspini.

283
A Relational Framework for Approximate Reasoning in Truth Space

Fernando Gomide, Witold Pedrycz

The paper consider a fuzzy inference scheme in the truth space that assumes the i-th rule linguistically qualified, that is, it comes with a truth value of the implication. In contrast to the standard version of modus ponens, the entire inference process is completed at the higher conceptual level formed by the mechanisms of fuzzy logic. The reasoning process invokes three phases: inverse linguistic truth qualification; inference based on fuzzy truth values exploiting the notion of fuzzy implication and the solution of an inverse relational equation; inverse linguistic truth qualification. An immediate application of the approach concerns fuzzy logic control.

284
The Representation of Linguistic Hedges Using Fuzzy Relational Calculus

Martine De Cock, Etienne Kerre

Traditionally in fuzzy set theoretical frameworks linguistic hedges are modelled by technical operators lacking inherent meaning. In this paper we elaborate on a recently developed representation of modified linguistic expressions that takes into account mutual relationships between objects of the universe. Formally this is accomplished by modelling hedges by means of taking images under fuzzy relations: for ordering-based hedges orderings and strict orderings are used, while for weakening and intensifying hedges we propose to use fuzzy relations modelling approximate equality. Since fuzzy T-equivalence relations prove to be unsuitable for this purpose, resemblance relations are chosen instead.

The resulting framework not only allows for a unified approach to the modelling of hedges but also endows them with an inherent semantics, thereby overcoming important shortcomings of the traditional

approaches, as we will illustrate by means of several examples in numerical as well as non-numerical universes.

285
A Qualitative Diagnostic Method Based on Structural Analysis for a Circulatory System Model

Ken'ichi Asami, Tadashi Kitamura

The purpose of this study is to develop a diagnosis and simulation tool for a circulatory system model. We use Coleman's dynamic model Human, which consists of 25 modules including equations of about 1000 lines, over 200 variables, and over 100 static parameters. In this paper, we propose a qualitative method for understanding causal propagation of variables in the model structure. The proposed method 1) generates cause and effect relations between variables, 2) visualizes hierarchical directed graph of variables, and 3) enables to trace the hierarchy of the circulatory model.

286
Automated Extraction of the Endorrhachis from MR Lumbar Images by Fuzzy Inference Techniques

Michiharu Terao, Syoji Kobashi, Yutaka Hata, Masamichi Tanaka, Yasuhiro Tokimito, Osamu Ishikawa, Makoto Ishikawa

Surface rendering of the endorrhachis is one of the effective techniques to diagnose diseases of the endorrhachis caused by spine malformations. It requires a procedure for segmenting the 3D endorrhachis from many MR images, however few automated extraction methods have been developed before. In this paper, we propose a fuzzy rule-based approach for extracting the endorrhachis from MR lumbar images. Our target portion, the endorrhachis, consists of the spinal cord and the nerve roots. This method is based on knowledge of location and knowledge of intensity. They are expressed by fuzzy if-then rules and compiled to a total degree as the measure of extraction. Our extraction method can be divided into two steps. Firstly, the method extracts the spinal cord by using thresholding and labeling. Secondly, our method extracts the nerve roots with the knowledge derived from anatomical information. The experimental results showed that our method successfully extracted the targ! et portion, and that the results were useful to diagnose the compression of the endorrhachis.

287
A Disease Evolution Model with Uncertain Parameters

L.C. Barros, R.C. Bassanezi, R.Z.G. Oliveira, M.B.F. Leite

The simplest model to describe the dynamics of directly transmited diseases with interaction among susceptible and infected individuals, which does not confer immunity, is the SIS model without vital dynamics. The concepts of susceptibility as well as infectivity are uncertain in the sense that they occur in different degrees. These uncertainties will be treated using Fuzzy Theory. For that, we will suppose that the infectivity of each individual depends on its amount of virus(v). Moreover, the higher the amount of virus, the higher will be the chance of diasease transmission and lower will be the chance of recuperation of the infectious individuals. That is, the transmission coefficient of the disease and the recuperation coefficient will be considered as fuzzy sets. For epidemiological models, an essential parameter concerned with the diasease evolution, is the Basic Reprodution Value(R0), which gives the number of secondary cases caused by an infected individual introduced in a whole susceptible population. From our assumptions, it is an increasing function of v. For the whole population, we define the Fuzzy Basic Reproduction Value(R0F) and we proved that the possible value for R0 is lower than R0F, which we believe as being more appropriate than R0.

288
Enhanced Parameter Identification for Complex Biomedical Models on the Basis of Fuzzy Arithmetic

Michael Hanss, Oliver Nehls

With the objective of future improvement of medical therapy, a method for the improvement of parameter identification for complex biomedical models on the basis of fuzzy arithmetic is presented. The model parameters to be identified are considered as uncertain, and are represented by fuzzy numbers with their membership functions quantifying an initial guess for the actual value of the model parameter. Using the transformation method as a special implementation of fuzzy arithmetic, the model can be analyzed with the intention of determining the influence of each parameter on the variation of the overall model output. Finally, the parameter identification can be improved by reducing the high-dimensional identification procedure to a number of lower-dimensional optimization problems with measurement data taken from those time intervals only where the parameters show significant influence. The enhanced performance of the model with the newly identified parameters is proved by a higher conformity of its predictions with reality.

289
Modelling Temporal Distribution of Symptoms and Diseases with Fuzzy Logic

Tatiana Kiseliova, Claudio Moraga

Although the importance of a time-factor in medical diagnoses leaves no doubts, a formalisation of time-varying situations (in particular, using fuzzy set theory and fuzzy logic methods) for computer-assisted diagnosis systems presents a lot of open problems for investigators. While each time-varying situation conditionally can be separated into non temporal and temporal components, both expressed with fuzzy sets, for example, ``high temperature early in the morning'' the question is how to formalise these kind of situations and use them in the inference mechanism of the medical expert systems, in particular in the inference mechanism based on Generalised Modus Ponens (GMP).

290
Design of Complex-Valued CNN Filters for Medical Image Enhancement

Katsuya Kondo, Masayoshi Iguchi, Hiroyuki Ishigaki, Yasuo Konishi, Kunihiko Mabuchi

In this paper, we present a new enhancement technique using cellular neural network(CNN) filters with complex weighting factors, applicable to medical images. Since the CNN-type filters have only spatially local interconnections and the number of connections between neurons is relatively few, the required computation in the learning phase is a reasonable amount. Instead, the output/input behavior is restrictive. The proposed CNN filters are designed as complex coefficient filters which can improve the output S/N ratio, and process the 2D analytic signals of input images. The filter parameters are determined by applying complex domain backpropagation algorithm. Through several simulations, it is shown that the proposed filters are robust and noise tolerant for medical images.

291
On the Importance of Interval Sets in Type-2 Fuzzy Logic Systems

Jerry M. Mendel

Type-2 fuzzy logic systems (FLSs) let uncertainties that occur in rule-based FLSs be modeled using the new third dimension of type-2 fuzzy sets. Although a complete theory of type-2 FLSs exists for general type-2 fuzzy sets, it is only for interval type-2 fuzzy sets that type-2 FLSs are practical. This paper explains why this is so.

292
How to Make Sure that 'Approximately 100' + 1 is Approximately 100 in Fuzzy Arithmetic: Solution and its (Inevitable) Drawbacks

Vladik Kreinovich, Hung T. Nguyen, Witold Pedrycz

>From the commonsense viewpoint, if a person who weighs around 100 kilograms gains one more kilogram, his weight is still around 100 kilograms. Alas, not so in traditional fuzzy arithmetic. In this paper, we propose a modification of fuzzy arithmetic which does have this property. We gain the desired property, but there is no free lunch, we have to lose two important properties of the traditional fuzzy arithmetic: first, addition is no longer always associative; second, addition is no longer always easily computable.

293
Classivalent and Difunctional Relations in the Interval Calculus of Fuzzy BK-Products

Ladislav J. Kohout

The paper presents theorems characterizing classivalent relations based on t-norm residuated fuzzy logics. The classivalency conditions are characterised by various relational inequalities containing the BK-products of relations. This generalizes to the realm of t-norm resuduated fuzzy logics the characterization of classivalency by means of square products of relations previously given by Bandler and Kohout in 1977.

The proofs of the most important theorems are conducted rigorously in the first order predicate fuzzy logic BL that was developed by Petr Hajek. The paper concludes with the extensions of characterisation of classivalency to the relations based on the checklist paradigm based fuzzy interval logics of Bandler and Kohout. There are five families of such logics, but the paper restricts the discussion to the systems generated by measure m1.

It should be noted that difunctional relations are a special case of classivalent relation, namely total classivalent relations. So classivalency could also be called partial difunctionality. The paper is concluded with references to applications of classivalent relations in knowledge engineering and elsewhere.

294
The Extension of Interval Validation Methods to Fuzzy Set Theory

Weldon A. Lodwick, K. David Jamison, Francis Newman

The idea of validation arises naturally within the context of interval analysis where the theory and methods are well-developed. Approaching fuzzy set theory through fuzzying interval analysis, we develop a validation theory for fuzzy sets. An example is given to illustrate the ideas.

295
Optimization under Uncertainty using Possibility and Necessity Distributions Consistent with Probability Distributions

K. David Jamison, Weldon A. Lodwick, Francis R. Newman

A standard formulation of a constrained optimization problem is examined where it is assumed that several parameters of the functions involved are uncertain. It is assumed that each such parameter can be represented by a probability distribution and the problem restated as a stochastic programming problem. This research examines the reformulation of the stochastic programming problem when the uncertain parameters are replaced with possibility and necessity distributions that are consistent with the probability distributions. It is shown that the reformulated problem optimizes an estimate of the expected value of the origanl problem.

296
Interval + Communications = Walsh: For Signal Multiplexing Under Interval Uncertainty, Walsh Functions are Optimal

Rami Al-Jamal, Samir Manoli, Alejandro E. Brito, Olga Kosheleva

In communications, often, statistical characteristics of the noise vary so much that, in essence, we can only have interval estimates for this noise.

We show that under this interval uncertainty, the optimal multiplexing technique consists of using Walsh functions. This result provides a new theoretical explanation for the success of Walsh-based multiplexing techniques which are actively used in cellular phones and in other types of wireless communication.

297
Granular Structures: The Perspective of Knowledge Representation

Wladyslaw Homenda

The paper deals with granularity of knowledge representation. The subject is studied on the basis of representation of music notation. Music notation is a language allowing for communication in music, one of the most sophisticated field of human activity, and has high level of complexity itself. On one hand, music notation symbols vary in size and have complex shapes; they often touch and overlap each other. On the other hand, music notation is a two dimensional language in which importance of geometrical and logical relations between its symbols may be compared to the importance of the symbols alone. Thus, computer representation of music is the first and perhaps most important issue in music processing computer systems. Music data representation is highly structured and perfectly fits paradigm of granular knowledge structuring. Granularity of music data representation is especially emphasised in the paper.

298
Some Approximations of Trapezoidal Fuzzy Sets

Eugene Roventa, Tiberiu Spircu

In this paper we study different approximations of fuzzy sets. In the multi-dimensional case we obtain the crisp approximation of a fuzzy set. In the one-dimensional case we define tame fuzzy sets and approximate them with combinations of trapezoidal ones. Keywords: fuzzy sets, approximation of fuzzy sets.

299
A Study on the Self-Organizing Polynomial Neural Networks

Sung-Kwun Oh, Tae-Chon Ahn, Witold Pedrycz

In this study, we introduce and investigate a class of neural architectures of polynomial neural networks (PNNs), discuss a comprehensive design methodology and carry out a series of numeric experiments. PNN is a flexible neural architecture whose topology is developed through learning. In particular, the number of layers of the PNN is not fixed in advance but is generated on the fly. In this sense, PNN is a self-organizing network. PNN has two kinds of networks, Polynomial Neuron(PN)-based and Fuzzy Polynomial Neuron(FPN)-based networks, according to a polynomial structure. The essence of the design procedure of PN-based Self-organizing Polynomial Neural Networks(SOPNN) dwells on the Group Method of Data Handling (GMDH). Each node of the SOPNN exhibits a high level of flexibility and realizes a polynomial type of mapping (linear, quadratic, and cubic) between input and output variables. FPN-based SOPNN dwells on the ideas of fuzzy rule-based computing and neural networks. Simulations involve a series of synthetic as well as experimental data used across various neurofuzzy systems. A detailed comparative analysis is included as well.

300
Classification and Clustering of Granular Data

Andrzej Bargiela, Witold Pedrycz

Information granules are formed to reduce the complexity of the description of real-world systems. The improved generality of information granules is attained by sacrificing some of the numerical precision of point-data. In this study we consider a hyperbox-based clustering and classification of granular data and discuss detailed criteria for the assessment of the quality of the combined classification and clustering. The robustness of the criteria is assessed on both synthetic data and real-life data from the domain of urban traffic control.

301
Discrimination of Software Quality in a Biomedical Data Analysis System

Nicolino J. Pizzi, Aleksander Demko, Rodrigo Vivanco

Object-oriented visualization-based software systems for biomedical data analysis must deal with complex and voluminous datasets within a flexible yet intuitive graphical user interface. In a research environment, the development of such systems are difficult to manage due to rapidly changing requirements, incorporation of newly developed algorithms, and the needs imposed by a diverse user base. One issue that research supervisors must contend with is an assessment of the quality of the system's software objects with respect to their extensibility, reusability, clarity, and efficiency. Objects from a biomedical data analysis system were independently analyzed by two software architects and ranked according to their quality. Quantitative software features were also compiled at varying levels of granularity. The discriminatory power of these software metrics is discussed and their effectiveness in assessing and predicting software object quality is described.

302
Granular Weights in a Neural Network

Scott Dick, Abraham Kandel

In this paper, we investigate a mechanism for storing granular information in a neural network. The classic Backpropagation network, which uses numeric weights, is known to be a universal approximator. However, training times for a Backpropagation network can be very long, and the knowledge stored in these networks is exceptionally difficult to understand. Using granular weights can speed up network training and increase clarity, at the cost of some loss in accuracy. We describe our network architecture, called the Granular Neural Network (GNN), which uses linguistic weights, as well as the rules of linguistic arithmetic that we have developed for this network. In an initial experiment, we found that the GNN completed training in an average of less than one tenth the number of epochs required by a Backpropagation network on the Iris data set, when using a coarse granulation.

303
Uncertainty Theory Influences Classical Mathematics

Arthur Ramer

Success of a new theory can be measured by the extent of its impact in other, already well established fields. We report how such influence of possibility theory is now becoming to emerge in one of the very classical fields of mathematics - theory of inequalities.

Until now, perusing citations or surveying the references in fuzzy theory papers, one would discover that almost all the influence has been one-way: from classical mathematics to fuzzy systems. The `external' references to fuzzy works would be either on negative side, or attempting to reinterpret fuzzy theory in some more classical framework.

The author had a good fortune to be involved in analysis of uncertainty measures for a range of nonprobabilistic theories. Several properties of these measures were established in answer to questions about Generalized Information. The results combined both epistemic aspects, specific to a given theory, and strictly mathematical ones. The latter could often be transformed into new results in the theory of inequalities.

We present a new class of inequalities for rearragements of sequences and functions, discuss some extremal problems in fuzzy optimization, and close with geometric inequalities related to evidence theory.

304
Measuring the Information and Character of a Fuzzy Measure

Ronald R. Yager

We discuss the use of the fuzzy measure for representing information about uncertain variables. We describe the relationship between the fuzzy measure and the Dempster-Shafer belief structure. A method for generating the fuzzy measures associated with a D–S belief structure is described. We discuss the use of the Shapley index as a means for providing an entropy for fuzzy measures. We introduce the cardinality index of a fuzzy measure and use it to define the attitudinal character of a fuzzy measure.

305
Tests and Entity in Evidence Theory and Quantum Mechanics

Germano Resconi, B.A. Nikolov

Starting from the verification that syntactic and semantic structure of theory of evidence is not sufficient to understand the meaning of quantum phenomena and in general physical phenomena, in this paper we propose a new interpretation of Dempster-Shafer theory of evidence based on a stochastic model for a quantum system developed in terms of amplitude on entities. An entity provides an axiomatic description for the set of tests and states of a physical system and an amplitude density gives a mean for computing probability and pseudo-probability (non additive measure) within this framework. The interference and independence of tests relative to an amplitude density are formulated. Various ways of combining entities and amplitudes are presented as superpositions of amplitude Interference, superpositions , entity, states, and tests are not considered in the evidence theory but only in quantum theory and in physical observable experiment.. We propose to extend the theory of evidence also to the physical observable experiment in quantum mechanics. So we can use, for quantum mechanics, all the knowledge in the evidence theory. On the contrary the knowledge in the evidence theory can give new insight in the quantum mechanics uncertainty. Modal logic interpretation of uncertainty is presented

306
Measuring Uncertainty and Uncertainty-Based Information for Imprecise Probabilities

George J. Klir

After a brief overview of the various theories of imprecise probabilities, the paper focuses on the issue of measuring uncertainty and uncertainty-based information in the individual theories. This issue is covered in three parts. First, essential requirements that must be satisfied by any measure of uncerainty are discussed in generic terms. Second, an overview of established uncertainty measures for the various types of imprecise probabilities is presented. Third, open problems in this area of research are briefly surveyed.

307
Measures of Distortion in Possibilistic Approximations of Consistent Random Sets and Intervals

Cliff Joslyn

The available of probability or possibility measures for random set (Dempster-Shafer evidence theoretical) structures are highly desirable. Probabilistic conditions involve disjointness or specificity, while possibilistic conditions involve consonance of the underlying focal elements. Consistency results in possibilistic distributions, but not measures, but then a unique approximation is available. Especially in random interval measurement situations, this condition is common. In this paper we develop some of the mathematical ideas necessary to develop a measure of the distortion introduced by this consonant approximation of a consistent random sets.

308
Measuring Conflict in Evidence Theory

Mark J. Wierman

The Shannon entropy measures conflict in probabilistic evidence. Evidence Theory also presents information that is inherently conflicting. Uncertainty measures for conflict in Evidence Theory include aggregate uncertainty, dissonance, confusion, discord, granularity and strife. This paper compares and critiques the properties of these measures.

309
Robust Control Configured Design Method for Systems with Multi-Objective Specifications

Susumu Yoshizawa, Tohru Kawabe, Sadaaki Miyamoto

In this paper we propose a new design method for robust control configured systems with multiple design specifications. This design method is based on the input deviation, the minimax design approach and pareto-partitioning GA (Genetil Algorithm). The input deviation is the criterion to estimate the structure of systems from the viewpoint of the control designing. The minimax design approach is one of the worst case design methods, namely, parameters of controller are adjusted so as to minimize the performance measure maximized by parameters representing uncertainties of the structure. In this design method, to prevent a partial convergence of non-dominated solutions in the trade-off surface on the multi-objective minimax optimization problem, the pareto partitioning GA which uniformly controls a distribution of non-dominated solutions is developed. We apply proposed method to design of 4WS (4 wheeled steering) car.

310
Fuzzy Control Algorithm for Multi-Objective Problems by using Orthogonal Array and its application to an AMB System

Choo-Ho Kim, Chong-Won Lee

A new fuzzy logic control design algorithm suitable for multi-objective control problems is proposed based on the orthogonal array that is widely used for design of experiments in statistics and industrial engineering. The essence of the algorithm is to introduce an N-th order certainty factor for each rule defined from its F-value, in order to effectively exclude the less confident rules and rate the rules. The proposed algorithm with multi-objective decision table (MODT) is found to be capable of detection of inconsistency and the rule classification, reduction and modification. It is also shown that the algorithm can be successfully applied to the fuzzy controller design of a rigid rotor-active magnetic bearing system with model uncertainties.

311
Multiobjective Optimization of Fuzzy Logic Scheduled Controllers for Missile Autopilot Design

Anna Blumel, Brian White

This paper describes the design of a Fuzzy Logic Scheduled Controllers used for side-slip velocity control of a missile autopilot design. A multiobjective evolutionary algorithm is used to determine the membership function distribution of the fuzzy trajectory controller within an outer loop control system. Scaling factors of the FLC inputs and outputs for each required demand are obtained by using a polynomial fit for a large range of multiple velocity demands (1g,5g,10g,15g-lateral acceleration equivalent). The design meets multiple objectives related to closed loop performance such as: steady state error, overshoot, settling and rise time. Multiple solutions are obtained simultaneously by using nondominated sorting for forming the Pareto front, combined with a reference point approach to incorporate preference information into the GA to direct the search towards feasible desirable areas which satisfy specific values of the objectives. Simulationn results are presented showing the fuzzy gain surface and extreme models in the multiple model population.

312
Active Control of Flexible Structures Using Adaptive Fuzzy Controllers and Piezoelectric Patches

G.L.C.M. Abreu, J.F. Ribeiro

This paper presents a design of adaptive fuzzy controllers applied to the control of vibrations in flexible structures containing distributed piezoelectric actuator patches. The adaptive fuzzy controller is constructed from a set of fuzzy IF-THEN rules whose parameters are adjusted on-line according to some adaptation law. The adaptive law is derived based on the Lyapunov's stability theory. This control methodology is experimentally verified in a steel cantilever test beam and a set of experimental tests are made in the system to verify the efficiency of the adaptive fuzzy controller proposed.

313
Construction of a Multilayer Perceptron for a Piecewise Linearly Separable Classification Problem

Birka von Schmidt, Frank Klawonn

The principle behind fuzzy control is rule-based function approximation. Fuzzy rules can also be used to design classification systems. However, the common max-min inference leads to quite restricted classification systems that decide locally on the basis of only two variables. In order to build more flexible systems, it is recommendable to use other operators, for instance the Lukasiewicz t-norm instead of the minimum. It can be shown that such a fuzzy classifier basically constructs a set of (hyper-)planes to separate the classes. Since multilayer perceptrons rely in principle on the same strategy, our idea is to construct a fuzzy classifier on the basis of expert knowledge and then to transform it into a multilayer perceptrons in order to apply learning techniques to further reduce the classification error. The paper concentrates on the construction of a multilayer perceptron, based on a classification that uses hyperplanes for class separation.

314
Preprocessing for Informative, Efficient and Small Networks

Patrik Eklund, Lena Kallin Westin

In this paper we will demonstrate how sigmoidal fuzzification effects discriminance capacities. In particular, we study the preprocessing perceptron and compare it with the multilayer perceptron. Case studies are selected from the medical domain, where output performance needs to be related to requirements for high sensitivities. These smaller and more informative networks tend also to be more robust with respect to accuracy with various requirements on sensitivities.

315
Data Mining Using Synergies Between Self-Organizing Maps and Inductive Learning of Fuzzy Rules

Mario Drobics, Ulrich Bodenhofer, Werner Winiwarter, Erich Peter Klement

Identifying structures in large data sets raises a number of problems. On the one hand, many methods cannot be applied to larger data sets, while, on the other hand, the results are often hard to interpret. We address these problems by a novel three-stage approach. First, we compute a small representation of the input data using a self-organizing map. This reduces the amount of data and allows us to create two-dimensional plots of the data. Then we use this preprocessed information to identify clusters of similarity. Finally, inductive learning methods are applied to generate sets of fuzzy descriptions of these clusters. This approach is applied to three case studies, including image data and real-world data sets. The results illustrate the generality and intuitiveness of the proposed method.

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Enhanced Topology Preservation of Dynamic Self-Organising Maps for Data Visualization

Arthur L. Hsu, Saman K. Halgamuge

Unsupervised knowledge discovery using Self Organising Maps (SOM) has been successfully used in obtaining unbiased and visualisable results. A Growing (or Dynamic) Self Organising Maps (GSOM) is an extended version of the original SOM with adaptive map size and controllable spread. In experiments a GSOM usually has considerably higher topographic error than SOM with similar quantisation error. This can be undesirable in cases where topology preservation is important, therefore in this paper the authors proposed an algorithm to assist the growing of the dynamic self-organising map in achieving better topographic quality whilst maintaining or even improving level of quantisation error. Results shown improvement of topographic error when comparing to GSOM, and have better topology preservation than non-topologically optimised SOM with similar map size.

317
Modular Preference Moore Machines in News Mining Agents

Stefan Wermter, Garen Arevian

This paper focuses on Hybrid Symbolic Neural Architectures that support the task of classifying textual information in learning agents. We give an outline of these symbolic and neural preference Moore machines. Furthermore, we demonstrate how they can be used in the context of information mining and news classification. Using the Reuters newswire text data, we demonstrate how hybrid symbolic and neural machines can provide an effective foundation for learning news agents.

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Fuzzy Rules Extraction by a Hybrid Method for Pattern Classification

Ching-Chang Wong, Bo-Chen Lin, Chia-Chong Chan

A method based on the concepts of Genetic Algorithm (GA) and SVD-QR method is proposed to construct an appropriate fuzzy system for pattern classification. In this method, an individual of the population in the GA is used to determine a fuzzy partition such that some rough fuzzy sets of each input variable are obtained. The SVD-QR method is used to extract significant fuzzy rules from the rule base of the defined fuzzy system. Furthermore, a fitness function in the GA is considered to guide the search procedure to select an appropriate fuzzy system such that the number of incorrectly classified patterns and the number of fuzzy rules are minimized. Finally, a classification problem is considered to illustrate the effectiveness of the proposed method.

319
A Supervised Fuzzy Clustering for Radial Basis Function Neural Networks Training

R. Tagliaferri, A. Staiano, D. Scala

In this paper we present a new learning algorithm for Radial Basis Function Neural Networks (RBFNN's) based on a supervised fuzzy clustering technique. Our methodology follows the conditional fuzzy clustering presented by Pedrycz and permits to obtain a completely automatic clustering, where data agglomeration is based on both input and output pattern values. Objective function-based clustering methods are regarded as usual algorithmic vehicles used in the determination of the prototypes of the radial basis functions. One drawback that is commonly encountered among the variety of clustering methods for RBFNN's is that all of them are regarded as completely unsupervised. In this context, instead, the clustering mechanism needs to determine groups within the data assuring that these are homogeneous also with regard to the output variable. The key characteristic of the supervised clustering algorithm is the insertion of the output values in the objective function of the classical fuzzy c-means. The experimental results show that the performances of the RBFNN's trained with our algorithm are comparable to those obtained by Pedrycz.

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Simultaneous Approach to Principal Component Analysis and Fuzzy Clustering with Missing Values

Katsuhiro Honda, Nobukaza Sugiura, Hidetomo Ichihashi

The simultaneous approaches to multivariate data analysis and fuzzy clustering have been proposed since Fuzzy c-Varieties (FCV) clustering was proposed by Bezdek et al., which can be regarded as a simultaneous approach to principal component analysis and fuzzy clustering. In spite of the usefulness of fuzzy clustering, it often suffers from the presence of missing values in real applications. In this paper, we propose a method for partitioning incomplete data including missing values into several fuzzy clusters using local principal components. In the novel approach, we extract local principal components by using the lower rank approximation of data matrix. The

objective function is based on the least square criterion that is used in principal component analysis. Because the least square criterion is similar to the objective function of FCV, it can be said that our novel technique is an extension of FCV into incomplete data sets. Numerical example shows that the method provides a tool for interpretation on local structures of a database.

321
A Linguistic Clustering Algorithm for Fuzzy Prototype Induction

I. Gonzalez Rodriguez, J. Lawry, J.F. Baldwin

A clustering algorithm is described which learns fuzzy prototypes to represent data sets and decides the number of prototypes needed using a new measure of prototype quality. This algorithm is based on ideas taken from mass assignment theory. It is illustrated with a model classification problem and its potential is shown by its application to a benchmark problem for glass identification.

322
Self-Organizing Map (SOM) Model for Mental Workload Classification

Natalia Mazaeva, Celestine Ntuen, Gary Lebby

Development of reliable mental workload measurement and classification techniques have been an area of concern in human factors engineering. Artificial Neural Networks (ANN) have been used to model workload by performing EEG data classification. In the present study, a Self-Organizing Map (SOM) neural network was used to simulate workload metrics. SOM is an unsupervised algorithm that clusters similar input vectors to allow its output neurons to compete among themselves to become activated. For purposes of this study, EEG data was preprocessed via Fast Fourier analysis, temporally segmented and reduced by Principal Component Analysis (PCA) prior to inputting it to the network. The network was trained using 2/3 of available data and tested with remaining 1/3 of the data to classify workload into six categories ranging from very low to overload. The SOM was able to cluster the training data into 6 output categories and differentiate between workload classes when presented with the test data set. The results in dicated that implementation of Self-Organizing Map networks offers a robust method for analyzing electrophysiological data signals related to work performance and could potentially be used as a tool for extraction of workload correlates from EEG data.

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The Unsupervised Niche Clustering Algorithm: Extension to Multivariate Clusters and Application to Color Image Segmentation

Olfa Nasraoui, Raghu Krishnapuram

The Unsupervised Niche Clustering (UNC) is a new robust clustering algorithm that can successfully find dense areas (clusters) in feature space and determine the number of clusters automatically. The clustering problem is converted to a multimodal function optimization problem within the context of Genetic Niching. However, UNC was only formulated for using the Euclidean distance and for 2-dimensionbal data sets, which means that it could only be tested on spherically distributed 2-D data. In this paper, we extend UNC to the case of general multivariate distributions in n-D space by modifying our definition of scale and adapting the mating restriction rules and extraction procedure accordingly. Genetic Optimization makes our approach less prone to suboptimal solutions and the use of robust weights makes it less sensitive to noise. Most importantly, Genetic optimization frees our approach from the necessity of deriving prototype equations when such derivations are impossible. Thus our approach can handle data with both numeric and qualitative attributes, and general subjective, non-differentiable, and non-metric dissimilarity measures. The effectiveness of the extended UNC is compared with the K-Means and the Possibilistic C-Means using several examples with clusters of various size, density, orientation, and noise contamination rates.

324
A Possibilistic Exclusion Principle for Tracking Multiple Objects

Mourad Oussalah, Joris De Schutter

Tracking multiple targets in a dense environment where there is a high density of false alarms has received recently a wide interest in the literature due to its important repercussions in many radar and military type applications. The challenge arises from how to determine the evidence with which a given measurement is associated to a given track. Typically, the class of algorithms based on Joint Probabilistic Data Association Filter JPDAF investigated by Bar-Shalom and his team is widely explored. In an attempt to use some possibilistic tools for determining the evidence of measurement-track association, we have recently proposed a hybrid approach that keeps track of the structure of JPDAF while one makes use of fuzzy clustering methodology. In this paper, we extend the proposal to the case where the track itself may not be observable, or does not exist. This refers in the literature to track initiation problem. In probability theory, such purpose is handled, for instance, using Integrated Probabilistic Data Association Filter IPDAF proposed by Musicki. Two proposals are put forward, the first one makes use of multiple model approach while the second one is based on adding a second class of noise prototype which captures the lack of perceivability of the target. Some simulation results are performed to prove the feasibility of the proposals.

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An LMI Approach to H-Infinity Fuzzy Output Feedback Control for Nonlinear Systems

Cheng-Liang Chen, Tzxy-Chyi Wang, Shuo-Huan Hsu

An LMI approach for designing an H-infnity fuzzy controller for nonlinear dynamic systems is presented. The entire operating range for a nonlinear system is partitioned into several regimes. A local linear model with parameter uncertainties is identified for each region. These local models are integrated as the norm-bounded Tagaki-Sugeno fuzzy model. The output feedback H-infty fuzzy controller design procedures are investigated based on the TS model, theirin the standard H-infty design problem is formulated as Linear Matrix Inequalities (LMIs). The necessary and sufficient conditions for the

existence of the controller is derived. One numerical example is supplied, demonstrating the effectiveness of the proposed design procedure.

326
Query Evaluation Based on Domain-Specific Ontologies

Troels Andreasen

We describe here a query evaluation principle that is based on compound or hierarchical aggregation, where an aggregate may be an argument to another aggregate. A query is assumed to consist of or be decomposed into a set of query attributes that are divided into groups. During query evaluation, groups are treated for individual aggregation and group aggregates are in turn aggregated, leading to a query aggregate. The evaluation principle is considered in the context of an approach to ontology-based querying, where domain knowledge in the form of a dictionary and an ontology is utilized in the computation of groups of attributes and aggregation parameters. While the user may pose a query in a simple form as a list of words or in natural language, queries are evaluated as compound expressions. The groupings and operators applied are the results of a knowledge-based manipulation of the initial query.

327
Towards Learning Default Rules by Identifying Big-Stepped Probabilities

Salem Benferhat, Didier Dubois, Sylvain Lagrue, Henri Prade

This paper deals with the extraction of default rules from a database of examples. The proposed approach is based on a special kind of probability distributions, called ``big-stepped probabilities''.

It has been shown that these distributions provide a semantics for the System P developed by Kraus, Lehmann et Magidor for representing non-monotonic consequence relations. Thus the rules which are learnt are genuine default rules, which could be used (under some conditions) in a non-monotonic reasoning system, which can be encoded in possibilistic logic.

328
Development of Model-Referenced Fuzzy Adaptive Control

Poi Loon Tang, Clarence W. de Silva, Aun-Neow Poo

This paper outlines the development of three different types of model-referenced adaptive control and then evaluates their performance through computer simulation. Specifically, conventional model-referenced adaptive control is used as the basis of comparison of the performance of two knowledge-based techniques. Fuzzy logic is used in the development of the knowledge base and for decision making, in the two techniques. In one knowledge-based technique, the parameters of a low-level direct digital controller are adapted so that the system tracks a reference model. In the other knowledge-based technique, the reference input to the system is adapted. Simulation studies are carried out for the three techniques, as applied to a simple nonlinear servomotor and load system. Results indicate that the knowledge-based adaptive techniques can out perform the conventional technique in specific situations.

329
On Playing Games Without Knowing the Rules

Denis V. Batalov, B. John Oommen

One of the most interesting areas in Artificial Intelligence (AI) is the area in which a machine is taught to play a game against an educated opponent. The basic premise in all of the reported techniques is that the machine is informed of the rules of the game, which are encoded efficiently. In this paper, we consider the scenario in which a Learning Mechanism (LM) is given the task of playing a game without being aware of the rules of the game. It is neither aware of what constitutes a valid or invalid move. The LM learns the rules of the game and the strategies with which it should play as it makes the moves. It accomplishes this by processing the responses it gets from the game Environment - which serves as an informed teacher. The entire game is modeled in a novel setting where the salient differences between the Agents and Environments are erased, but in which the players and the game board are considered as abstract entities interacting with each other. In this regard, we believe that our paper presen ts pioneering work.

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A Multi-Agent Approach to Immediate View Maintenance for an Operational Data Store

Gary C.H. Yeung, William A. Gruver, Dilip B. Kotak

An operational data store provides current, consolidated data derived from autonomous, distributed data sources. A data store combined with OLAP applications can provide a decision support or operation-monitoring tool for advanced Enterprise Resource Planning and Supply Chain Management systems. In order to keep the data store up-to-date, changes at the sources must be correctly propagated to the data store. Commercial systems typically designate a maintenance time when the data store is disabled for data updates. The maintenance time window could range from several hours to several days, depending on the size of the data sources.

In this research, we apply a multi-agent approach to enable updating of a data store as changes are made at the sources. This approach reduces down time for the data store - a crucial requirement for Internet-based application. A fuzzy priority scheduling system is applied to prioritize tasks. Results from this research showed that the proposed multi-agent system drastically increases the availability of the data store while preserving a high level of data consistency.

331
Towards Inductive Support Logic Programming

J.F. Baldwin, T.P. Martin

Support logic programming and its practical implementation (Fril) integrates probabilistic and fuzzy uncertainty into logic programming using mass assignments. This paper presents a snapshot of current

research, aimed at combining the best aspects of inductive logic programming with the uncertainty representation of Fril to create a sophisticated and novel approach to knowledge discovery. An example is given showing how a supported Fril rule can be extracted from uncertain Fril relations.

332
Unification as Negotiation: A Context-Based Approach

Francesca Arcelli Fontana, Ferrante Formato

In this paper we start from a notion of similarity-based unification, as defined by the authors in previous works, and we introduce a more structured process that can be seen more adequately as a form of unification as negotiation between agents. Of course, our negotiation process is a particular kind of communication between two agents performing a structured task and as such it depends on the context. The agents should act in a manner depending on the "state of the world", i.e. each of them should have the own notion of context in mind. We start by modeling a context through a particular t-norm, i.e. a way of interpreting the conjunction according to capture the features of the given context and we show some methods to adapt a t-norm to a suitable context. We assume that each agent is situated in a particular context or, more precisely, that he believes to be in a particular context and chooses a t-norm accordingly. Then we introduce a process of negotiation among the agents, each of them equipped with a notion of similarity associated to the context; for this purpose we attempt to formulate a theory of negotiation as a fragment of modal logic and, in particular, we show that similarity-based unification can be expressed in terms of modal logic, by means of an "acceptance" operator.

333
Algebraic-Geometric Structures for Uncertainty

Claudio Sossai

A simple observation is presented, although the mathematical method used is not elementary, about the fact that some key concepts in uncertainty such as dependent/independent events or conditional events, can be represented using the local concept of truth. Intuitively the shift from global to local truth can be represented as the shift from the question if the proposition p is true to the question where the proposition p is true. A method is presented to give a formal definition of local truth for an uncertainty-based universe of sets. To this aim, a universe of generalized sets is defined as the topos of presheaves on a suitable topological space, that formalizes the idea of where. As it is known, sets in such a universe are variable objects, governed by a local idea of truth. Some interesting aspects of uncertainty are described in this formalism.

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Fuzzy Sets as Conditional Probabilities: Which Meaningful Operations can be Defined?

Giulianella Coletti, Romano Scozzafava

Conditional events and coherent conditional probability theory can be a proper framework for dealing with fuzzy theory, both from a semantic and a syntactic point of view: the former aspect has been emphasized in a previous NAFIPS conference, while here we discuss the latter by embedding our approach in a formal logic framework. We introduce suitable operations between fuzzy sets, looked on as corresponding operations between conditional events endowed with the relevant conditional probability.

335
A Fundamental Decomposition of Type-2 Fuzzy Sets

Jerry M. Mendel, Robert I. John

Type-2 fuzzy sets let us model and minimize the effects of uncertainties in rule-base fuzzy logic systems; however, they are difficult to understand for a variety of reasons which we enunciate. In this paper we strive to overcome the difficulties by: (1) establishing a small set of terms that let us easily communicate about type-2 fuzzy sets and also let us define such sets very precisely, and (2) presenting a new representation for type-2 fuzzy sets. This new representation can be used to derive formulas for union, intersection and complement of type-2 fuzzy sets without having to use the Extension Principle.

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Type 2 Fuzzy Representations of Lung Scans to Predict Pulmonary Emboli

P.R. Innocent, R.I. John, I. Belton, D. Finlay

In this paper we describe the exploratory use of Type 2 fuzzy sets to represent the perceptions of lung scan images by experts in order to predict pulmonary emboli using Type 2 fuzzy relations. We used a GA to find suitable parameters for the fuzzy sets so that good classification was achieved. We present preliminary results with a limited data set demonstrating the potential power of the approach.

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1st Order, 2nd Order, What Next? We Do Not Really Need Third-Order Descriptions: A View from a Realistic (Granular) Viewpoint

Vladik Kreinovich, Hung T. Nguyen

To describe experts' uncertainty in a knowledge-based system, we usually use numbers from the interval [0,1] (subjective probabilities, degrees of certainty, etc.). The most direct way to get these numbers is to ask an expert; however, the expert may not be 100% certain what exactly number describes his uncertainty; so, we end up with a second-order uncertainty - a degree of certainty describing to what extent a given number d adequately describes the expert's uncertainty about a given statement A.

At first glance, it looks like we should not stop at this second order: the expert is probably as uncertain about his second-order degree as about his first-order one, so we need third order, fourth order descriptions, etc. In this paper, we show that from a realistic (granular) viewpoint, taking into consideration that in reality, an expert would best describe his degrees of certainty by a word from a finite set of words, it is sufficient to have a second-order description; from this

viewpoint, higher order descriptions can be uniquely reconstructed from the second-order one, and in this sense, the second-order description is sufficient.

338
Type 2 Uncertainty in Knowledge Representation and Reasoning

I. Burhan Turksen

Type 2 fuzziness exists both in knowledge representation and approximate reasoning. First, it has been shown that acquisition of membership functions, whether (1) they are obtained by subjective measurement experiments, such as direct or reverse rating procedures or else (2) they are obtained with the application of fuzzy clustering methods, we can capture Type 2 membership functions. Type 2 fuzziness can be represented either with interval-valued Type 2 or with full Type 2 membership functions, which specify gradations between the upper and lower bounds of the interval of its variation. Secondly, it has been shown that the combination of linguistic values with linguistic operators, AND, OR, IMP, etc., as opposed to crisp connectives that are known as t-norms and t-conorms and standard negation, lead to the generation of Fuzzy Disjunctive and Conjunctive Canonical Forms, FDCF and FCCF, respectively. In this paper, we di! scuss how one captures Type 2 re presentation and how one executes Type 2 reasoning that rests on Type 1 representation. This entails interval-valued Type 2 consequences. Furthermore we demonstrate some of its consequences.

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Type-2 Fuzzy Sets for Modelling Nursing Intuition

Robert John, Sarah Lake

Expert nurses concurrently assess the patient need for nursing care in several domains of concern to nursing. It is suggested that the process takes into account the overall context of patient need in relation to at least five domains. The degree of need within each domain is prioritised, reflecting the need for nursing intervention. This is an intuitive process in that the expert nurse uses inexact or imprecise information to make judgements based on nursing knowledge and practice wisdom. This paper presents the argument that type-2 fuzzy logic is able to model the perceptions present in the patient assessment. The problem of nursing assessment is discussed and the role of type-2 fuzzy sets in modelling nursing perceptions described. Some results are presented that indicate type-2 fuzzy logic has much to offer for modelling nursing intuition.

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A Type-2 Fuzzy C-Means Clustering Algorithm

Frank Chung-Hoon Rhee, Cheul Hwang

This paper presents a type-2 fuzzy C-means (FCM) algorithm that is an extension of the conventional fuzzy C-means algorithm. In our proposed method, the membership values for each pattern are extended as type-2 fuzzy memberships by assigning membership grades to the type-1 memberships. In doing so, cluster centers that are estimated by type-2 memberships may converge to a more desirable location than cluster centers obtained by a type-1 FCM method in the presence of noise. Several examples are given.

341
On Modal Fuzzy Approximate Reasoning

Bernd Reusch, Helmut Thiele

The starting point of the paper presented is the concept of context dependent fuzzy set based on the ideas of Kripke semantics. This concept was introduced to make more precise the notion of qualitative fuzzy set. In a following paper approximate reasoning with context dependent fuzzy sets was defined by generalizing the “classical” fuzzy approximate reasoning based on the compositional rule of inference. The paper presented is a combination (synthesis) of “classical” modal reasoning with approximate reasoning using context dependent fuzzy sets to a “modal fuzzy approximate reasoning”.

342
Controlled Clustering, Uni-Norm Operators and OWA Operators

Alexander Rybalov, Ronald R. Yager

Clustering processes now widespread applications, their purpose being to separate data into groups of similar characteristics. Usually these processes are data driven, and, thus, we don’t have effective mechanism to control them. The standard procedure is to set the number of clusters. But generally we don’t have any control on the number of points in each cluster. In some applications, especially those in which we are using clustering to partition objects into different classes we may be interested in controlling the number of elements falling into each class. Our concern here is on the problem of how to manage distribution of points into the different clusters. The distribution of points in clusters reflects the level of concentration: if almost all points are in one cluster then level of concentration is very high; if points are equally distributed across clusters then level of concentration is low. Therefore, the first problem is to find the way to measure level of concentration. After this we proceed to describe clustering process that permits us to control concentration. We then apply uninorm operators and OWA operators to managing of clustering process.

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Necessity Measures and Fuzzy Rough Sets Defined by Certainty Qualifications

Masahiro Inuiguchi, Tetsuzo Tanino

In this paper, we describe a necessity measure specification method and its application to fuzzy rough sets. We show that a necessity measure can be specified by two modifer functions. Many famous implication functions can be specified by this approach. A novel class of necessity measures is designed by the specification method. Six necessity measures in this class are obtained by linear modifier functions. We apply those necessity measures to fuzzy rough sets defined by certainty qualifications. We demonstrate one of novel necessity

measures is most suitable in application to fuzzy rough sets in the sense that it gives better lower and upper approximations.

344
Fuzzy Transformation

Elena Haldeeva, Irina Perfilieva

The technique of approximate representation of continuous functions is presented. It is based on two transformations (direct and inverse) applied step by step. Both transformations use fuzzy representations of local areas by their membership functions in the same way as basic functions are used in the construction of generalized functions. Besides the satisfactory approximation, the presented technique can be successfully applied to the computing of the approximate derivatives of the initial function as well as to the computing of definite integrals.

345
Gradual Rules and Extended Functional Dependencies - A Discussion

Laurent Ughetto, Noureddine Mouaddib

This paper discusses the interest of gradual rules for the representation of extended functional dependencies, in classical relational databases, in the particular case of continuous domains for some attributes. First, it shows that classical rules can represent imprecise functional dependencies, but that they are not adapted to the case of a large amount of noisy or uncertain data. Then, the case of pure gradual rules is considered, in order to relax the constraints imposed by the classical rules. In this case, it is shown that the functional dependency can be more restrictive than the imprecise one it is supposed to relax. Thus, the use of special kinds of partitions, or the use of fuzzy gradual rules are studied.

346
Soft-Computing-Considerations on Diagnostic Accuracy of Multiple Tests

Sadayasu Shibata

In order to find the optimum combination of multiple tests, it was considered how the diagnostic accuracy changes with the number of tests and five kinds of combination methods: A) Sequential tests, B) Sequential tests after changing the order in A, C) Simultaneous tests using the Believe-the-Negative Rule, D) Simultaneous tests using the Believe-the-Positive Rule, and E) Simultaneous tests using the Believe-all-Positive-all-Negative Rule. The diagnostic accuracy is defined by sensitivity and specificity. An over-all two-by-two table for multiple tests was inducted from the two-by-two tables for each test. An over-all diagnostic accuracy was calculated from the over-all two-by-two table, and was expressed by a generalized formula. As it was proved that combination methods A, B and C are equivalent, the five methods could be summarized into three methods. For A, B and C: increased but decreased with increasing n. For D: increased but decreased with n . For E: and increased with n, although problem exists concerning how to judge the remaining subjects who are between positive in all tests and negative in all tests. Soft-computing-considerations ware adopted for this problem.

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Automated Segmentation of the Cerebrospinal Fluid and the Lateral Ventricles from Human Brain MR Images

Syoji Kobashi, Tomokazu Takae, Yutaka Hata, Yuri T. Kitamura, Toshio Yanagida, Osamu Ishikawa, Makoto Ishikawa

This paper presents a computer-aided diagnosis (CAD) system, which be able to segment the whole brain, the brain portions, the cerebrospinal fluid (CSF) and the lateral ventricles from human brain MR images, and then to give the volumes and the 3-D volume renderings. In the system, the whole brain and the brain portions are automatically segmented by using previously developed software (Hata et al., IEEE SMC-C, 2000). In this paper, we introduce a new concept of a representative line to segment the CSF and the lateral ventricles. The representative line is automatically detected by inferring its direction with evaluating the location in the head, the position in the CSF, and the shape of the line. The inference is preformed with fuzzy inference technique. The developed system was applied to MR volumes of 20 normal subjects, 20 Alzheimer disease and 20 hydrocephalus patients. The segmentation error ratio was 1.98% in comparison with the volumes of manually delineated region. This allows us to experimen tally characterize modes of variation that are indicative of disease processes.

348
Hemodynamic Alarm System for Pulmonary Artery Catheters in an Intensive Care Unit

William Siler, Janis Martens

A pulmonary artery catheter (PAC) is placed in a large vein through the right side of the heart. The PAC measures blood pressure in the pulmonary artery directly and indirectly in the left atrium through a procedure called “wedging”. Since the PAC is in a dynamic environment, inaccurate measurements can result for various reasons (events), some of which can cause harm to the patient. Detection of such events can be difficult; many nurses are inadequately trained to interpret pressure waveforms, and it is not feasible for nurses to watch a cardiac monitor continuously.

We constructed an online fuzzy expert system to monitor cardiac data continuously and alarm when an untoward event was detected. Of 13 patients monitored while developing the prototype system, only 2 failed to exhibit alarm events. A 200-patient clinical trial confirmed that the system reduced the number and duration of alarm events.

The original program used our fuzzy expert system shell “FLOPS”. The rule syntax is quite different from fuzzy control systems, using approximate numerical comparisons with moving averages and categorical outputs. Input is from the cardiac monitor units via RS-232 or Ethernet and output is voice alarm messages, such as “Bed 4 - extended damp”.

349
Temporal Knowledge Discovery in Time-Series Medical Databases based on Fuzzy-Rough Reasoning

Shusaku Tsumoto

Since hospital information systems have been introduced in large hospitals, a large amount of data, including laboratory examinations, have been stored as temporal databases. The characteristics of these temporal databases are: (1) Each record are inhomogeneous with respect to time-series, including short-term effects and long-term effects. (2) Each record has more than 1000 attributes when a patient is followed for more than one year. (3) When a patient is admitted for a long time, a large amount of data is stored in a very short term. Even medical experts cannot deal with these large databases, the interest in mining some useful information from the data are growing. In this paper, we introduce a combination of extended moving average method and rule induction method, called CEARI to discover new knowledge in temporal databases. Extended moving average method are used for preprocessing, to deal with irregularity of each temporal data. Using several parameters for time-scaling, given by users, this moving average method generates a new database for each time scale with summarized attributes. Then, rule induction method is applied to each new database with summarized attributes. This CEARI is applied to three medical datasets, the results of which show that interesting knowledge is discovered from each database.

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Teaching Soft Computing in Medicine: An Interdisciplinary Experiment

Mariagrazia Dotoli, Hubertus Axer, Georg Berks, Dagmar Suedfeld, Andreas Prescher, Diedrich Graf v. Keyserlin, Gabriel A. Krombach, George Dounias, George M. Panagi, George Tselentis, Jan Jantzen

The objective of this study was to test the feasibility of teaching some of the many engineering applications within medicine to medical students together with engineering students. A summer school was created in a block-course design that lasted one week. Different teaching modules were divided into lecture and exercise sessions. Several engineering topics combined with medical examples were presented. Half of the students were engineering or computer science students and the other half medical students. The staff of lecturers was also mixed. At the end of the course the students had to pass a web-based examination and fill out an online evaluation-sheet. Most of the students regarded the co-operation between physicians and engineers as very important. The major challenge of the course was the interdisciplinary aspect of teaching: medical students had to learn about methods of information technology and engineering students were exposed to medical information analysis. Teaching both groups of students toget her resulted in a close collaboration between both groups. The paper highlights some pitfalls and gives recommendations for a similar type of course. In particular, the main recommendation for the future, given the technological advances in medicine, is a closer cooperation with disciplines such as information technology.

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Regional Rates of Brain Atrophy - Can They be Used as a Reliable Tool for Early Diagnosis of Alzheimer's Disease?

Deming Wang, Steve Rose, Gary Cowin, Donna Spooner, Daniel Barnes, Graham Galloway, David M. Doddrell, Jonathan B. Chalk, James Semple

We present global and regional rates of brain atrophy measured on serial structural magnetic resonance (MR) images for a group of Alzheimer's patients and age-matched normal elderly control subjects. Specifically, three rates of brain atrophy: the rate of atrophy in the entire cerebral volume, the rate of lateral ventricular enlargement and the rate of atrophy in the temporal lobe region were evaluated for 14 Alzheimer's patients and 14 age-matched control subjects. The rates of brain atrophy were measured with an automated procedure that includes image segmentation and a fuzziness measure for voxels with partial volume effect. All three rates demonstrated great discriminant power in separating the two groups. However, the most discriminant power was found when the regional rates were combined. Using the lateral ventricular enlargement rate and the rate of brain atrophy in the temporal lobe region, the two groups could be completely separated. We conclude that regional rates of brain atrophy measured on structural MR images have a potential for early diagnosis of Alzheimer's disease.

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Why Unary and Binary Operations in Logic: General Result Motivated by Interval-Valued Logics

Hung T. Nguyen, Vladik Kreinovich, I.R. Goodman

Traditionally, in logic, only unary and binary operations are used as basic ones - e.g., "not", "and", "or" - while the only ternary (and higher order) operations are the operations which come from a combination of unary and binary ones. For the classical logic, with the binary set of truth values {0,1}, the possibility to express an arbitrary operation in terms of unary and binary ones is well known: it follows, e.g., from the well known possibility to express an arbitrary operation in DNF form. A similar representation result for [0,1]-based logic was proven in our previous paper. In this paper, we expand this result to finite logics (more general than classical logic) and to multi-D analogues of the fuzzy logic - both motivated by interval-valued fuzzy logics.

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Interval and Fuzzy Techniques for Plan Checking Under Uncertainty

Raul A. Trejo

The problem of planning is that of finding a sequence of actions that an agent must perform to achieve a given objective. An important part of planning is to check whether a given plan achieves the desired objective. In AI, the planning and plan checking problems were mainly formulated and solved in a deterministic environment, where the initial state is known precisely and the results of each action in each state is known (and uniquely determined). In this deterministic

case, planning is difficult (the simplest planning problem is NP-hard), but plan checking is straightforward. In many real-life situations, however, we only know the probabilities of different fluents; in such situations, even plan checking becomes computationally difficult. In this paper, we describe how methods of interval computations can be used to get a feasible approximation to plan checking under probabilistic uncertainty. The resulting method is a natural generalization of the 0-approximation proposed in by Baral and Son to describe planning in the case of partial knowledge. It turns out that some of the resulting probabilistic techniques coincide with heuristically proposed fuzz methods. Thus, we justify these fuzzy heuristics as a reasonable feasible approximation to the (NP-hard) probabilistic problem.

354
Use of Intervals for Soft Classification in Fuzzy Neural Networks

Patricia A. Nava

Neural networks can be used to classify input data into one of a given set of categories. With limited training sets, crisp neural network results are predictably poor. Incorporation of fuzzy techniques improves performance in these cases. Even though fuzzy neural networks classify imprecise data quite well, the incorporation of a soft decision classification lowers the error rate substantially. This paper discusses methods for soft decision making, including a method that uses intervals. A neuro-fuzzy system that classifies input vectors is examined. This neuro-fuzzy system not only uses intervals in a fuzzy neural network, but also employs a method of utilizing intervals in a soft decision for classification. This neuro-fuzzy system's performance in computer simulations is examined and compared with crisp neural networks' performance.

355
Assessing the Predictive Accuracy of Complex Simulation Models

Timothy Ross, Vladik Kreinovich, Cliff Joslyn

Predictive accuracy is the sum of two kinds of uncertainty–natural variability and modeling uncertainty. This paper addresses the quantification of predictive accuracy of complex simulation models from two perspectives. First, it recognizes that there is a difference between variability and modeling uncertainty; the former can not be reduced with more test information, while the latter can. We suggest that variability is a natural form of uncertainty that can be quantified with probability theory, but that modeling uncertainty is a form that is better addressed by a theoretical foundation that is not based on random variables, but rather random intervals. We suggest possibility theory as the formalism to address modeling uncertainty. The paper discusses the two different methods, and illustrates the power of their integration to address predictive accuracy with a recent case study involving the crushing load of axially loaded metallic spheres.

356
A Family of Similarity and Star Products: New Additions to Fuzzy Relational Products

Pratit Santiprabhob

In this paper, a family of new fuzzy relational products is presented. This new family of products is based on the Similarity product and the Star product previously defined by the author and his colleagues. The products have been developed from practical viewpoints arisen in certain applications for which the semantics of the classical fuzzy relational products has proven somewhat inadequate. These two products are further extended here. The definitions and semantics of the two products together with those of their respective variations are elaborated. Suggestions on the products' potential application are also discussed. These new additions together with the classical fuzzy relational products would certainly contribute greatly to our ability to manipulate and process information with uncertainty by means of fuzzy relations.

357
Interval and Fuzzy Methods in Remote Sensing and Satellite Image Processing

Scott A. Starks

Remote sensing conducted from satellites can be very useful for the purpose of extracting geophysical, environmental, and other earth-related information. A central problem in remote sensing is the enormous amount of data that is typically available for processing. In many cases, traditional data processing methods, that work well for data sets of smaller size, often require too much computational time and storage when applied to satellite images. In order to combat the data explosion problem encountered in remote sensing applications, interval and fuzzy methods may be employed. This paper presents several applications that have been addressed using these approaches.

358
Application of Genetically-Generated Fuzzy Knowledge Bases in Manufacturing

Marek Balazinski, Sofiane Achiche, Luc Baron

The need of an expert to build the knowledge base (KB) of fuzzy decision support systems (FDSS) is a strong limitation to the expansion of their use in the industry. However, this paper proposes a genetic algorithm (GA) capable to automatically build KBs from a set of sampled data. This paper presents the GA used to automatically constructs the KBs. The GA produces a KB allowing an optimal approximation of a set of sampled data from a low amount of input information. The GA is validated with a theoretical surface and applied to a tool wear monitoring problem.

359
Fuzzy Quantifiers for Data Summarization and their Role in Granular Computing

Ingo Glockner, Alois Knoll

Data summarization is an enabling technique of Granular Computing, because of its promise to abstract from individual observations and to view a phenomenon as a whole. The linguistic summaries are built around a fuzzy quantifier which functions as the `summarizer'. Linguistic data summarization therefore presupposes an underlying model of fuzzy quantifiers, which is of crucial importance to the adequacy of the generated summaries. In the paper, we present an axiomatic theory of fuzzy quantification. It attempts to formalize the notion of `linguistic adequacy', in order to eliminate the implausible results observed with existing approaches. We provide evidence that the models of the theory are plausible from linguistic considerations. Finally we present three practical models and discuss some of their properties. These models are computational, and systems for data summarization can directly profit from our improvements by plugging in the new algorithms.

360
Evolutionary Optimization of Information Granules

Marek Reformat, Witold Pedrycz

Granulation involves decomposition of whole object into a collection of parts called granules. The granules are formed based on the notions of indistinguishability, similarity, proximity or functionality. Building information granules, especially for highly dimensional data is a demanding task. In this study, we propose a genetic-based development of information granules. The approach is concerned with structural and parametric aspects of the information granulation that involves the number of information granules and their parameters. It is shown how information granulation supports a descriptive data analysis, namely a comprehensive process of revealing essential structures in data sets.

361
Feature Subset Selection using Granular Information

Shounak Roychowdhury

Studies in machine learning, data mining, and pattern classification often use a technique to select relevant features from a large data set. This technique is known as Feature subset selection. This feature selection technique is performed in order to reduce hypothesis search space, to reduce storage, and enhance the performance of the data mining, or machine learning algorithms. In recent years researchers have been actively involved and are focusing on this particular problem from the perspective of machine learning.

This paper will briefly study the existing approaches to select features. Also, we will study the effectiveness of granular information to feature selection. We will also propose a simple feature elimination based algorithm that uses granular information.

362
Fuzzy Sets and Decision Making System for Thyroid Hormone Profile

Jose Gilberto H. Vieira, Maria Ghiringhello, Paulo Garcia, Roque Barros, Fernando Gomide

Automation of the analytical specimen processing tasks in clinical laboratories is provided by the laboratory information and automation systems. Integration of these systems increase throughput, lower cost, improve and ensure quality standards, and store and keep data for knowledge maintenance and mining. Among several important tasks, a key one concerns data acquisition from analyzers and their processing and interpretation as well. Data interpretation and decision making is an especially complex task mostly performed by experts, and represent a major bottleneck in highly automated laboratories. This paper introduces a real-time knowledge based system whose purpose is to select analytical test results that must be audited by an expert from those results which are considered as coherent. The system, developed at Laboratorio Fleury, comprises a rule based fuzzy classifier and a learning module. The emphasis here is on the fuzzy classification and selection system as a means to increase decision making capabilities in advanced laboratory information and automation systems. Actual experiments with thyroid hormone profile tests reveals that the approach has succeed in screening a significant amount of coherent results, therefore increasing system efficiency and throughput with the same quality standard obtained by expert reviewing.

363
Nonlinear Rule Reduction and Robust Control

Tadanari Taniguchi, Kazuo Tanaka

We propose modeling and model reduction using generalized form of Takagi-Sugeno fuzzy systems. First, we define a generalized form of Takagi-Sugeno fuzzy systems. The structure of these fuzzy systems has some advantages. One is that this fuzzy systems accord with dynamics of the original model. The other is that it is suitable for reducing the number of rules. Thus, these fuzzy systems are constructed by many if-then rules. Secondly, we derive the conditions to reduce the number of rules are represented in terms of LMIs. The main idea is to find a structure of if-then rules of the reduced model that agrees well with dynamics of the original model. Furthermore, we estimate the lower bound of the norm of model uncertainty of the Takagi-Sugeno fuzzy system that can cover the reduction error. Finally, we illustrate an example of model reduction and robust control for a nonlinear system.

364
Stable Control for R/C Helicopter

Kazuo Tanaka, Hiroshi Ohtake, Tsuyoshi Hori

This paper presents stable control for an R/C helicopter whose degree of freedom is reduced by fixing at a (joint) point. The nonlinear model of the R/C helicopter is constructed. After simplifying the nonlinear dynamics, we replace the simplified nonlinear dynamics with a Takagi-Sugeno fuzzy model. The control purpose is to realize good speed of response as well as stabilization with small control effort

from practical control points of view. We present a decay rate condition and an input constraint condition that realize good speed of response and avoidance of actuator saturations, respectively. Both of them are represented in terms of linear matrix inequalities (LMIs). By simultaneously solving them, we design a stable fuzzy controller that achieves good speed of response with small control effort.

365
A Design Method of Stable Fuzzy Controller on Symbolic Level for Dynamical Systems

Hidehiro Yamamoto, Takeshi Furuhashi

Fuzzy inference has a multi-granular architecture consisting of symbols and continuous values, and this architecture has worked well to incorporate experts' know-how into fuzzy controls. Symbolic stability analysis of fuzzy control system has been developed. However, this conventional analysis has not been applied to dynamic systems with state variables. This paper presents a design method of stable fuzzy controller using symbols applicable to dynamic systems.

366
A Study on Coincidence of Symbolic and Continuous Behavior for Symbolic Stability Analysis

Hidehiro Yamamoto, Takeshi Furuhashi

Fuzzy inference has a multigranular architecture consisting of symbols and continuous values, and this architecture has worked well to incorporate experts' know-how into fuzzy controls. Stability analysis is one of the main topics of fuzzy control. A stability analysis based on symbolic expression of fuzzy control system has been proposed. This method is a good tool for design of stable fuzzy controller using symbols. This paper introduces a "chain of rules" to clarify the description of the behavior of fuzzy control system. A coincidence of the symbolic and continuous behavior is defined. A sufficient condition together with a new inference method that guarantees the coincidence of symbolic and continuous behavior of fuzzy control systems is revisited.

367
Identification and Control of Dynamical Systems Based on Cause-Effect Fuzzy Models

Gancho Vachkov, Toshio Fukuda

In this paper an incremental type of dynamical system model, based on cause-effect relationships is proposed. It is a fuzzy-like model where the relationships between the change-of-past-inputs and change-of-the-output is represented by a single fuzzy membership function. The shape of this membership function directly affects the type of the modeled dynamics and the gain of the dynamical system is represented as summation of all the strength levels of the membership function. Three identification schemes using the Least Mean Squares algorithm and its modifications are discussed and analyzed, as follows: direct identification, reduced size indirect identification and the newly proposed soft-guided identification. The direct identification, determines all the points of the cause-effect memberhip function, based on experimental data. The indirect identification reduces the size of the original problem by tuning the consequent parameters of a simple one-dimensional Takagi-Sugeno Fuzzy model that represents in an indirect way the cause-effect relations in the dynamical system. The soft guided identification uses a human specified reference (preferable) model and makes a kind of compromise solution betwen pure data fitting and pure model fitting.

368
Evolutionary Control Method and Swing Up and Stabilization Control of Inverted Pendulum

Seiji Yasunobu, Hiroaki Yamasaki

The control of a nonlinear system which the characteristics are changing is difficult. In order to control the system, it is needed to study the model during the execution and control by using its model.In this paper, it is proposed the new evolutionary control method that combines the evolutionary modeling by on-line GA and predictive fuzzy control. This control method is applied to the control of inverted pendulum which characteristic are modified actively to the external factor. The effectiveness of this control method has been confirmed.

369
Computational Intelligence - Fuzzy, Neural, and Evolutionary Computing

Toshio Fukuda, Naoyuki Kubota

This paper introduces the recent topics of computational intelligence. First, elemental techniques of fuzzy, neural, and evolutionary computing are described, and next, their emerging synthetic methodology for robotics is introduced. Furthermore, this paper proposes the total architecture of the structured intelligence for robotic systems. Finally, simulation results show the flexible behavior acquisition can be done according to the behavioral knowledge and evaluation functions.

370
Modular Neural Network-Type CANFIS Neuro-Fuzzy Modeling for Multi-Illumination Color Device Characterization

Eiji Mizutani, Kenichi Nishio

This paper describes adaptive-network modeling for color correction and compensation through multi-illuminant color device characterization of an electronic video camera. In particular, we shall emphasize a great potential for practical use of modular neural network-type CANFIS neuro-fuzzy models in this application, and discuss their strengths and weaknesses compared with other adaptive-network approaches as well as conventional lookup-table-based (TRC-matrix) methods.

In our experiments, a wide variety of illumination conditions (180 illuminants) were considered: Our neuro-fuzzy CANFIS with MLP local experts was proved to have a remarkable generalization/approximation capacity, even under a restricted condition where only four-illuminant data were allowed us to use for optimization purpose due to efficient practical implementation in an industrial setting.

371
Acquisition of Sensor Fusion Rule Based on Environmental Condition in Sensor Fusion System

Futoshi Kobayashi, Yosuke Tanabe, Toshio Fukuda, Fumio Kojima

The manufacturing system has become more and more complex for adapting to various process conditions. Recently, various and numerous sensors are equipped in the system for measuring various states in process. For efficient manufacturing, a sensor fusion method is needed for inferring state which cannot be measured by conventional sensors. So, many sensor fusion methods have been proposed so far. We also have been proposed a sensor fusion method with sensor selection based on the reliability of sensor value. However, conventional sensor fusion methods cannot infer states accurately under various environmental conditions. In this paper, we propose a sensor fusion system with a knowledge database for fusing under various environmental conditions. The sensor fusion rules under each environmental condition are stored in the knowledge database. Then, the system selects sensors according to an appropriate sensor fusion rule in the knowledge database and fuses selected sensor values by a recurrent neural network. Ad ditionally, the system generates a new sensor fusion rule for an unknown environmental condition by the genetic algorithm. For showing the effectiveness, we apply the proposed method to inference of the surface roughness in the grinding process.

372
Learning of Neural Networks with GA-based Instance Selection

Hisao Ishibuchi, Tomoharu Nakashima, Manabu Nii

We examine the effect of instance and feature selection on the generalization ability of trained neural networks for pattern classification problems. Before the learning of neural networks, a genetic-algorithm-based instance and feature selection method is applied for reducing the size of training data. Nearest neighbor classification is used for evaluating the classification ability of subsets of training data in instance and feature selection. Neural networks are trained by the selected subset (i.e., reduced training data). In this paper, we first explain our GA-based instance and feature selection method. Then we examine the effect of instance and feature selection on the generalization ability of trained neural networks through computer simulations on various artificial and real-world pattern classification problems.

373
Exact Inversion of Takagi-Sugeno Fuzzy Models

Reda Boukezzoula, Sylvie Galichet, Laurent Foulloy

In this paper, an exact inversion of Takagi-Sugeno fuzzy models based on manipulation and interpretation of fuzzy rules is proposed. First, the considered fuzzy model is decomposed into MISO elementary subsystems. Then, the inversion of each subsystem is studied. In this framework, the original MISO subsystems are transformed into SISO ones, whose rule conclusions are determined according to the suppressed input variables at each sampling time. The objective of the proposed transformation is simply to make easier the inversion mechanism. Finally, in order to demonstrate the feasibility of the proposed methodology, two simulation examples are given.

374
At the Crossroads of Database Systems and Fuzzy Sets

Patrick Bosc, Olivier Pivert

Research activities on fuzzy sets and databases began more or less at the same time, about thirty years ago. Outstanding results have been reached in each of these areas, among which numerous systems and products used in practical applications. However, one can notice that the interaction level between the two domains remains low despite i) the potential complementarity of the topics dealt with in each area and ii) the research activity deployed by some groups along the theme usually called “fuzzy databases”. This track offers a good opportunity to point out important lines of research investigated by the fuzzy database community during the past years and to focus on some current trends through a collection of presentations made by invited speakers.

375
Indexing Fuzzy Data

Sven Helmer

Providing efficient query processing in database systems is one step in gaining acceptance of such systems by end users. We propose several techniques for indexing fuzzy sets in databases to improve the query evaluation performance. Three of the presented access methods are based on superimposed coding, while the fourth relies on inverted files. The efficiency of these techniques was evaluated experimentally. We present results from these experiments, which clearly show the superiority of the inverted files.

376
Representation of Semi-Structured Imprecise Data for Fuzzy Querying

Patrice Buche, Ollivier Haemmerle, Rallou Thomopoulos

This work is part of a national project which aims at building a tool for the analysis of microbial risks in food products. As a first step, we propose a unified querying system which simultaneously scans two complementary bases, containing microbiological information : a relational database containing structured information and a conceptual graph knowledge base containing semi-structured information. The unified querying system sends the user’s query to both of them. Fuzzy queries and imprecise information are handled in both bases. To achieve this goal, we propose a way of representing fuzzy values, including numerical values, in conceptual graphs.

377
Problems of Fuzzy Queries Involving Aggregation Functions: The "Select Count" Case

N. Marin, D. Sanchez, J.M. Serrano, M.A. Vila

This paper deals with the problem of solving flexible queries made to relational databases, where the target of a query is not a list of attributes but any kind of summary function which is applied either to one attribute or to the whole table. In particular, we will attempt to solve questions which imply a generalization of the "SELECT COUNT" sentence. We will consider as general a context as possible, by assuming: the involved table includes fuzzy attributes, and the property which makes the selection, generates a fuzzy set of tuples.

We have proposed a solution for this problem, by means of a linguistic version for the cardinal of a fuzzy set and by defining a not-null accomplishment degree. This linguistic fuzzy cardinal is established, based on previous definitions of the cardinal of a fuzzy set and the accomplishment degree of linguistic properties, imprecision measures of fuzzy sets are also used.

378
An Algebra for Querying a Constraint Defined Fuzzy and Uncertain Object-Oriented Database Model

G. De Tre

A formal framework for a generalized object-oriented database model (OODB) is presented, which can be used to model fuzzy and uncertain information. This model is built upon a generalized algebraic type system and a generalized constraint system, which are both used for the definition of so-called generalized object schemes and generalized database schemes. In this paper, both the data definition and the data manipulation aspects of the database model are introduced, together with the definition of an &object algebra.

379
On the Combination of Fuzzy Logic and Kohonen Nets

Andreas Tenhagen, Ulrich Sprekelmeyer, Wolfram-M. Lippe

Several ways of combining concepts of fuzzy set theory with connectionist methods are known. We focus on the use of fuzzy numbers in neural networks. Our goal is to create a fully fuzzified Self-Organizing-Map, which receives fuzzy numbers as inputs and computes its output employing fuzzy weights. We want to extend results about goodness prediction, that exist for fuzzified multilayer perceptrons (MLP).

The main problem is the determination of the winning neuron by the exclusive used of special, "monotonic" fuzzy operations, which guarantee a certain "goodness" of the input/output behaviour. A selection-function is introduced, solving this problem.

Furtheron we formulate a fuzzified version of the standard learning rule, that can be applied on the fuzzified Kohonen neurons.

380
Musical Symbol Recognition using SOM-based Fuzzy Systems

Mu-Chun Su, Chee-Yuen Tew, Hsin-Hua Chen

Over the last two decades a large number of research activities have been undertaken to investigate into Optical Music Recognition (OMR). OMR involves identifying musical symbols on a scanned sheet of music and transforming them into a computer readable format. In this paper we propose an efficient method based on SOM-based fuzzy systems to recognize musical symbols. A database consisting of 9 kinds of musical symbols were used to test the performance of the SOM-based fuzzy systems.

381
Fuzzy Clustering for Categorical Multivariate Data

Chi-Hyon Oh, Katsuhiro Honda, Hidetomo Ichihashi

This paper proposes a new fuzzy clustering algorithm for categorical multivariate data. The conventional fuzzy clustering algorithms form fuzzy clusters so as to minimize the total distance from cluster centers to data points. However, they cannot be applied to the case where only cooccurrence relations among individuals and categories are given and the criterion to obtain clusters is not available. The proposed method enables us to handle that kind of data set by maximizing the degree of aggregation among clusters. The clustering results by the proposed method show similarity to those of Correspondence Analysis or Hayashi's Quantification Method Type III. Numerical examples show the usefulness of our method.

382
Discovering Similar Time-Series Patterns with Fuzzy Clustering and DTW Methods

Guoqing Chen, Qiang Wei, Hong Zhang

Data mining, as one of active fields nowadays, is to discover useful knowledge from large data sets. This paper focuses on continuous time-series data that have often been encountered in real applications (e.g., sales records, economic data, and stock transactions), and discusses how to discover the hidden relationship among time-series patterns in terms of their similarities. Fuzzy clustering and Dynamic Time Warping (DTW) methods are used to deal with fuzzy groupings of data attributes as well as with degrees of distance between time-series patterned attributes, respectively. Concretely, the distance between time-series is not matched in a fixed fashion, while the shortest distance can be dirived with DTW method. At the end of the paper, an economic time series example is provided to help illustrate the ideas.

383
Fuzzy Cognitive Maps for Decision Support in an Intelligent Intrusion Detection System

Ambareen Siraj, Susan M. Bridges, Rayford B. Vaughn

The "health" of a computer network needs to be assessed and protected in much the same manner as the health of a person. The task of an intrusion detection system is to protect a computer system by detecting and diagnosing attempted breaches of the integrity of the system. A robust intrusion detection system for a computer network will necessarily use multiple sensors, each providing different types information about some aspect of the monitored system. In addition, the sensor data will often be analyzed in several different ways. We describe a decision engine for an intelligent intrusion detection system that fuses information from different intrusion detection modules using a causal knowledge based inference technique. Fuzzy Cognitive Maps (FCMs) and fuzzy rule-bases are used for the causal knowledge acquisition and to support the causal knowledge reasoning process.

384
Creating Metabolic and Regulatory Network Models using Fuzzy Cognitive Maps

J.A. Dickerson, Z. Cox, E.S. Wurtele, A.W. Fulmer

This paper describes a model of metabolic networks that uses fuzzy cognitive maps. Nodes of the map represent specific biochemicals such as proteins, RNA, and small molecules, or stimuli, such as light, heat, or nutrients. Edges of the map capture regulatory and metabolic relationships found in biological systems. These relationships are established by a domain expert, the biological literature, and extracted from RNA microarray data. This work is part of the development of a software tool, FCModeler, which models and visualizes metabolic networks. A model of the metabolism of the plant hormone gibberellin in Arabidopsis is used to show the capabilities of the fuzzy model.

385
Latent Class DEDICOM

Yoshio Takane, Henk A.L. Kiers

A probabilistic DEDICOM model was proposed for mobility tables. The model A probabilistic DEDICOM model was proposed for mobilityattempts to explain observed transition probabilities by a latent mobility table and a set of transition probabilities from latent classes to observed classes. The model captures asymmetry in observed mobility tables by asymmetric latent mobility tables. It may be viewed as a special case of both the latent class model and DEDICOM with special constraints. A maximum penalized likelihood (MPL) method was developed for parameter estimation. The EM algorithm was adapted for the MPL estimation. An example was given to illustrate the proposed method.

386
Kansei-Mining: Identifying Visual Impressions as Patterns in Images

Nadia Bianchi-Berthouze

Kansei engineering is a quite recent discipline aimed at understanding and modeling how subjective information is processed. In this paper, we address a particular aspect of kansei engineering, which is visual impression, i.e. impressions experienced when observing images. They are highly subjective and difficult to explicit. We address the issue of how to reduce the complexity and uncertainty of the mapping between visual impressions and impression words used to convey them. In this paper we argue that the co-operation of the user is crucial in order to direct the system's modeling activity of this mapping. The role of the user takes the form of an externalization process aimed at transforming the user tacit knowledge into modeling hypotheses. We propose a conceptual space that supports the translation of these hypotheses into a formal specification to be then implemented in the computer. Cognitive maps are proposed as a tool to trigger externalization process in the user and to support objective reasoning upon subjective beliefs.

387
Fuzzy Data Analysis for Three-Way Data

Y. Nakamori, M. Ryoke

In this paper, fuzzy data analysis for three-way data is discussed. This paper proposes a modeling technique to deal with complex perceptions or evaluations. It provides the tendency of people's opinions, and at the same time, their diversity. This modeling technique is useful for analyzing subjective feeling of people in, for instance, product planning, city planning, or any social decision-makings.

In this paper, the regression analysis for three way data, which is either quantitative or qualitative, is considered. An average regression model is identified, then by a data mapping technique, the personal data is mapped into the parameter space of the regression model. This mapping preserves, in some sense, the relative positions of personal perceptions of people. After data mapping, membership functions are determined in the parameter space to develop a fuzzy regression model which is a new type of fuzzy linear model for the case when plural different outputs exist for the same input.

388
Linguistic Modifiers and Measures of Similarity or Resemblances

Bernadette Bouchon-Meunier, Christophe Marsala

On the one hand, linguistic modifiers can be used to express imprecise values of variables which are described around a given fuzzy set. On the other hand, measures of comparison of fuzzy sets, such as measures of satisfiability or resemblance for instance, enable to establish the proximity between two imprecise values of variables. In this paper, a formal connection between modifiers and measures of comparison is presented, starting from studies about similarity-based systems, on the basis of simple types of modifiers and measures of comparison.

389
Satisfaction Measure for Result in Fuzzy Reasoning and Retrieval - An Attempt towards the Application of Fuzzy Logic as the 'Brainwave' of the Internet

Liya Ding, Masao Mukaidono

Reasoning and retrieval based on uncertain information and imprecise knowledge is often requested in designing and developing intelligent inforamtion systems. As a recent trend, the ideas of fuzzy logic have also been widely used in search of the Internet. An important issue for these applications is to equip the reasoning and retrieval with the capability of transmitting uncertainty from imprecise requirement to a conclusion at a reasoniable level of belief and satisfaction. Similarity measure has been widely used in fuzzy reasoning and retrieval. However, using similarity between two objects overlooks the fact that obtaining A with requesting B, or obtaining B with requesting A does not always lead to the same satisfaction. In other words, the use of similarity measure may not sufficiently meet our need when our concern is not only about how similar the result is to our target, but also at which level our desire is satisfied. In this paper, the satisfaction measure is first defined based on fuzzy truth values and then extended to fuzzy sets. Properties of the satisfaction measure are also discussed.

390
Fuzzy Controlled Resonant DC-DC Converters

Istvan Denes

The main purpose of this paper to give a comparison between two different control techniques, applied at a dual channel resonant DC-DC converter. As a first alternative a regular PI control was built and tested, and as a second solution a fuzzy control was introduced.

391
From Fuzzy Control to Fuzzy Multimedia Information Technology

Kaoru Hirota

In the middle of 1980's in Japan the fuzzy technology became a central issue for mainly process control and the year 1990 became a so called "fuzzy-home-electronics year." Then the neural network technology was merged in fuzzy technology in 1991 and again many consumer products were sent to the real market in Japan. In 1993 chaos technologies were also taken part in research and development of such high-tech issues. Other technologies, e.g., chaos, genetic algorithms, and artificial life, are also studied by company engineers. These kinds of practical, technological aspects mainly in Japan are discussed first. Then the concept of Fuzzy Multimedia Intelligent Communication System (FuMICS) is proposed. It is a human friendly communication interface and is able to handle fuzzy information in the fuzzy knowledge base where the multimedia information is integrated.

392
Evolving Multiple Sensory-Motor Controllers based on Cellular Neural Network

Sung-Bae Cho

There has been extensive work to construct an optimal neural network for controlling a mobile robot by evolutionary approaches such as genetic algorithm, genetic programming, and so on. However, evolutionary approaches have a difficulty to obtain the controller that conducts complex and general behaviors. In order to overcome this shortcoming, we propose a method of combining several evolved modules by a rule-based approach. The multi-modules integration method can make complex and general behaviors by combining several modules evolved or programmed to do simple behavior. Experimental results show the potential of the multi-modules integration method as a sophisticated technique to make the evolved neural network to do complex and general behaviors.

393
Maneuvering Target Tracking by Using Particle Filter

Norikazu Ikoma, Naoyuki Ichimura, Tomoyuki Higuchi, Hiroshi Maeda

The aim of this research is to track a maneuvering target, e.g. ship, aircraft, and so on. We use a state space representation to model this situation. Dynamics of the target is represented by system model, firstly in continuous time. Discretized system model is actually used. Position of the target is measured by radar, and this process is described by nonlinear observation model in polar coordinate. To follow abrupt changes of the target's motion due to sudden operation of acceleration pedal, break, and steering, we propose a use of heavy-tailed non-Gaussian distribution for the system noise. Consequently, the model we use here is a nonlinear non-Gaussian state space model. Particle filter is used to estimate the target's state of the nonlinear non-Gaussian model. Usefulness of the method is shown by simulation.

394
Stabilization Control of Ball and Beam Systems

Jianqiang Yi, Naoyoshi Yubazaki, Kaoru Hirota

Nonlinear ball and beam system has four state variables. The conventional fuzzy inference model, which puts all the input items into the antecedent of each fuzzy rule, is difficult to handle this system. In this paper, a new fuzzy controller for stabilization control of the ball and beam systems is proposed based on the SIRMs (Single Input Rule Modules) dynamically connected fuzzy inference model. The ball position, ball velocity, beam angle, and beam angular velocity are selected as the input items. Each input item has a SIRM and a dynamic importance degree. Each SIRM is set up from the relation of the input item with control performance. The two dynamic importance degrees of the ball use both the ball position and the beam angle as the antecedent variables, while the two dynamic importance degrees of the beam takes the beam angle as the only antecedent variable. By using the SIRMs and the dynamic importance degrees, the fuzzy controller can smoothly realize the ball position! control and the beam angular co ntrol according to control situations. The fuzzy

controller has a simple and intuitive structure. Control simulations demonstrate the effectiveness of the fuzzy controller.

395
Modified Genetic Algorithms Based on Disparity Theory of Evolution

Yoichiro Maeda

Generally, it has a problem that searching performance in the initial stage and the final stage of GA search is not always good because genetic parameters are normally constant. We apply the disparity theory of evolution proposed by Dr. Furusawa to GA search. In this research, we propose parity and disparity model of GA which has the mutation algorithm of this theory. We also report some simulation results by using knapsack problem.

396
A Technique on Adjusting the System's Knowledge of Linguistic Hedges to Human Naïve Thinking

Haruhiko Takeuchi

The concept of a linguistic hedge has been successfully formalized in the field of fuzzy set theory. The meaning of linguistic expressions such as "very tall" have been well expressed by using membership functions. Although various methods for measuring the membership functions have been proposed, the change of the meaning in the real world is not treated well. In this paper, we introduce the concept of population type for the perceived data set, and conduct psychological experiments to determine the membership functions for the linguistic expressions, changing the stimulus population type. Then, by using the concept of population type, we propose a technique for adjusting the system's knowledge of linguistic hedges to new perceived data, and discuss the usefulness of the method.

397
Model Construction for Expression of Color Impressions - Considering Reduction of Human Load

Makoto Kawamura, Takehisa Onisawa

This paper proposes a method to construct a subjective model for color impressions considering the reduction of human load. A model is constructed using the fuzzy rules expression in which the premise part shows color information and the consequent part shows emotional effects of color. Two kinds of questionnaires, absolute and comparative judgments, are carried out in order to obtain subjective information and a subjective model is constructed using them. The effectiveness of constructed subjective models is verified by the comparison with the objective model constructed by experts, and by the comparison between subjective models.

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Human Color Impression Model for Well-Ordered Color Signal Sequence with Minimum Distance

Naotoshi Sugano, Youichi Matsushita

We examine how a seven-color cyclic sequence affects human color impressions. In order to investigate different effects of two sequences, we consider hexagonal diagram that is a projection of RGB color space from white to black. The hexagonal diagram is roughly corresponding to the hue circle indicated by both hue and saturation in HLS system. It is assumed that if i) the projected route is nearly the minimum, ii) each saturation is large, and iii) neighboring colors are not too close each other, the projected route area is large. Namely the route area indicates the magnitude of naturalness (as a rainbow feeling) for color sequences. The minimum sequence is similar to the order of rainbow colors. On the other hand, the non-minimum sequence is completely different from the order of rainbow colors. Although seven colors in this study are not distributed as rainbow colors, and the seven-color cyclic sequences are also not continuous sequences with gradation, we can propose a huma! n color impression model using t he route area indicated by both hue and saturation. In this model, the subject has natural impressions when the route area is large, but the subject has unnatural impressions when the route area is small.

399
Generation of Japanese Puns Based on Similarity of Articulation

Toshihiko Yokogawa

Generating puns is a language play by generating expressions with similar sounds. In this paper, similarity of sounds is hypothesized by the similarity of articulations. The similarity is calculated by the indices from how and where a sound is articulated. Its validity is checked by existent puns. Japanese pun generating system based on similarity of articulations is also proposed. It selects a pun base expression from a word in a sentence, and changes the word into various similar expressions using the similarity of articulations. The system finds out grammatically correct word sequences from the expressions; then adds default expressions to generate a complete sentence with puns. An experiment shows the system can make various pun sentences from a base sentence.

400
User Authentication with Facial Images: Human-friendly Identification in the Internet

Hiroaki Kikuchi, Tatsuya Hattori, Shohachiro Nakanishi

With conveying an unlimited and uncertain information, human face can be an expressive media for human communication and human computer interface. We study the short-term capacity of human brain for faces. A testee has a period of time to remember a set of face pictures, which will be replaced with a newly chosen face pictures except one, he tries to identify the picture which remains in the new set. As many pictures are given, the chance to answer correctly decreases. The simple test has shown that the observed results are as confident as an unlikely happening event with probability of 10^{-6} would not

happen. With 91\% confidence, a human remembers faces easier than numerical data. A formulation of capacity in terms of faces is left as a future study.

401
A Web-Based Retrieval System for 3D Polygonal Models

Motofumi T. Suzuki

This paper describes a web-based retrieval system for 3D polygonal models. Feature descriptors of 3D polygonal model are reduced by feature descriptor grouping techniques. This enables fast queries of 3D polygonal models from the databases. Also, the system can retrieve colors from material color databases for 3D polygonal models reflecting users' preferences. The system can display 3D models queried to standard web browsers interactively. Our preliminary experimental result showed good recall and precision for the retrieval test.

402
Cliques and Fuzzy Cliques in Fuzzy Graphs

P.S. Nair, S-C Cheng

In this paper we define the concept of a fuzzy clique. In the case of a fuzzy graph the concept of a cycle and a fuzzy cycle has been studied. Aim of this paper is to present the concept of a clique and a fuzzy clique in fuzzy graphs consistent with the definition of cycles and fuzzy cycles in fuzzy graphs. Various interesting properties of fuzzy cliques are presented. A complete characterization of the structure of the fuzzy clique is also presented.

403
Lattice Type Fuzzy Order and Closure Operators in Fuzzy Ordered Sets

Radim Belohlavek

The aim of the present paper is to study fuzzy ordered sets and (fuzzy) closure operators in fuzzy ordered sets. Special attention is paid to fuzzy ordered sets that form a complete lattice (in a many-valued sense), so-called complete lattice fuzzy ordered sets. The presented results generalize the so far established results on general fuzzy closure operators and provide thus a unifying look at fuzzy closure-like structures from the point of view of fuzzy ordered sets. Presented are examples and general results on fuzzy closure operators and related structures.

404
A Fuzzy Epidemic Model Based on Gradual Rules and Extension Principle

Neli Regina S. Ortega, Laecio C. de Barros, Eduardo Massad

Modelling epidemiological systems is a difficult task. This is particularly true for fuzzy epidemics models which usually rely heavily on experts knowledge. In this work we applied the Extension Principle in order to build the consequents of the rules of a fuzzy epidemic model. The main idea is to use a function of a classical model an epidemic system, and with the extension principle to find a fuzzy function which operates on the fuzzy epidemic sets. In this sense, the modelling become less dependent on the experts opinions, which is an advantage, in particular when the original system is a complex one. Our fuzzy rules are so called gradual rules and the method described above was originally proposed by Dubois et al. We applied this method to a fuzzy dynamical model of the simplest epidemics problem: the so called Susceptible-Infected-Susceptible model, as applied in a real case. We used both the inference method of Mamdani and of Dubois. The results were compared with the ex! perimental data set and with ano ther MISO Model, which is entirely based on expert knowledge and presented in a previous work.

405
Data Summarization Using Extended Concept Hierarchies

Guillaume Raschia, Laurent Ughetto, Noureddine Mouaddib

This paper introduces an original approach to data summarization, using concept hierarchies and fuzzy techniques. Only the summarization of precise data obtained from a classical relational database is considered here. The proposed method aims at producing summaries which are directely understandable, and therefore described by means of words, or linguistic labels, taken from extended concept hierarchies built on each attribute. The summaries are produces at different levels of granularity, according to the concept hierarchies. This kind of summaries can be usefull to answer flexible queries, when only a global view of the information stored in the database is needed. Indeed, querying the base of summaries, with the generalization level used in the query, is faster than querying the whole database, and it gives an answer using the same level of vocabulary, i.e., the same imprecision than the query.

406
Multiobjective Fuzzy Random Linear Programming Using E-Model and Possibility Measure

Hideki Katagiri, Masatoshi Sakawa, Hiroaki Ishii

In this research, we consider a multiobjective linear programming problems with fuzzy random variable coefficients. A fuzzy random variable is a useful concept to deal with an element involving both fuzziness and randomness or to represent fuzzy stochastic environment. Since the mathematical programming problems involving fuzzy random variables are ill-defined problems due to both fuzziness and randomness, we propose a decision making model based on an expectation model called E-model and possibility measure in a possibility theory. The formulated problem is to maximize the expected value of possibility measure with respect to fuzzy goal given by a decision maker. At first, we show that the problem is reduced to a multiobjective linear fractional programming problem. After defining a Pareto optimal solution based on expected value of possibility measure, we construct an algorithm for solving the problem that is to maximize the minimum value of objective functions. Further we c! onsider an interactive decision making using reference points and give numerical

examples. Finally, we conclude this research and discuss other decision making models in a fuzzy random programming.

407
On the Solutions of Lattice-Valued Matrix Game with Fuzziness

Yang Xu, Jun Liu, Jun Ma

Game theory is a very important branch of applied mathematics. There have been a lot of excellent results within eighty years of its history. Many research areas have been developed, but most of them are limited to the real domain. A great amount of non-real practical game problems, especially the lattice-valued game, remains unexplored. This paper focus on the lattice-valued matrix game. Firstly, we propose the concept of lattice-valued matrix game with pure strategy and discuss the sufficient and necessary conditions for the existence of the solution of the lattice-valued matrix game with pure strategy. Then considering the real situation that the strategy set of the players are often fuzzy set and the matrix are often described by fuzzy sets, we investigate the lattice-valued matrix game with fuzziness. Especially, we investigate the determination of solutions of a lattice-valued matrix game with pure strategy and fuzzy value matrix, with fuzzy strategy and classical game m! atrix, as well as with fuzzy str ategy and the function value game matrix.

408
Current Approaches to Extending Fuzzy Logic to Object-Oriented Modeling

Jonathan Lee, Jong-Yih Kuo, Nien-Lin Xue

In this study, we have attempted a survey of current approaches carried out in the confluence of the two technologies: fuzzy set theory and object-oriented technology, that could provide a powerful tool for enhancing database management systems, software modeling, and knowledge representation in AI systems. Possible types of fuzziness are discussed and key features related to different kinds of fuzzy software systems are also pinpointed out. In a nutshell, fuzzy theory, as a modeling mechanism, is especially useful in tackle real world applications whose complexity demands are growing intensively.

409
A Fuzzy Database and Knowledge Base Environment for Intelligent Retrieval

Murat Koyuncu, Adnan Yazici

We discuss an environment that permits flexible modeling and fuzzy querying of complex data and knowledge including uncertainty. With such an environment, one can have intelligent retrieval of information from knowledge-intensive applications. In this study, we specifically describe the details (the model, inference mechanism, etc.) of the fuzzy knowledge base system (coupled with a fuzzy object-oriented database system, namely FOOD) of this environment.

410
Inheritance and Recognition in Uncertain and Fuzzy Object-Oriented Models

T.H. Cao, J.M. Rossiter, T.P. Martin, J.F. Baldwin

This paper proposes probabilistic default reasoning as a suitable approach to inheritance and recognition in uncertain and fuzzy object-oriented models. Firstly, we introduce an uncertain and fuzzy object-oriented model where a class property (i.e., an attribute or a method) can contain fuzzy sets interpreted as families of probability distributions, and uncertain class membership and property applicability are measured by lower and upper bounds on probability. Each uncertainly applicable property is interpreted as a default probabilistic logic rule, which is defeasible. In order to reduce the computational complexity of general probabilistic default reasoning, we propose to use Jeffrey's rule for a weaker notion of consistency and for local inference, then apply them to uncertain inheritance of properties. Using the same approach but with inverse Jeffrey's rule, uncertain recognition as probabilistic default reasoning is also presented. The approach is illustrated by an example in Fril++, the uncertain and fuzzy object-oriented logic programming language that we have been developing.

411
Softening the Object-Oriented Database Model: Imprecision, Uncertainty, and Fuzzy Types

I.J. Blanco, N. Marin, O. Pons, M.A. Vila

Object-oriented databases have proved to be a good alternative to the relational ones of Codd when dealing with applications characterized by their complexity and dynamism. In the last few years, a big part of the effort of researchers in the field of object-oriented databases (OODB) has been focused on the study of the addition of vagueness to this database model. There are different levels where vagueness can arise: uncertain and imprecise attribute values, fuzzy extents in classes, vague relationships between classes (including inheritance), and soft type definitions. In this paper, we summarize our proposal in this area, showing how these different sources of vagueness can be managed over a traditional OODB system. We explain the new structures to be considered in order to incorporate vagueness and we use the Unified Modeling Language (UML) to make the conceptual representation of this structures clear because of its direct translation to an object-oriented model.

412
The Application of Level-2 Fuzzy Sets in Fuzzy and Uncertain Data Modeling

G. De Tre, R. De Caluwe, A. Verkeyn

A formal framework for the uniform representation and manipulation of fuzzy and/or uncertain data is presented. This framework can be used within the context of (the formal definition of) e.g. fuzzy and uncertain databases and knowledge bases. The presented framework is based on the definition of a generalized type system, which is a generalization of a crisp type system and establishes the definition of so-called generalized types. Each generalized type is characterized by a generalized domain -which contains the valid values for the type-

and by an implicitly defined behavior. Each generalized domain is a generalization of a crisp domain, as it is defined as a set of level-2 fuzzy sets, which on their turn are all defined over the elements of the crisp domain. This approach allows to represent fuzzy data, uncertain data and uncertainty about fuzzy data in a uniform and advantageous way. The behavior of a generalized type is defined by means of a set of operators -which are a! ll defined over the generalized domain of the generalized type- and by a set of axioms. It is shown how these sets can be obtained as generalizations of their crisp counterparts.

413
Fuzzy Extensions for Relationships in a Generalized Object Model

Valerie V. Cross

To better model the dynamic and uncertain real world, many researchers have proposed approaches for integrating fuzzy set theory into the knowledge representation methods used in data modeling. This paper presents an initial recommendation for the primary relationships of a generalized object model that would incorporate fuzzy set theory as a tool to use in the task of object modeling.

414
Construction of Dynamic Fuzzy If-Then Rules Through Genetic Reinforcement Learning for Temporal Problems Solving

Chia-Feng Juang

In this paper, a genetic algorithm (GA) based dynamic fuzzy network design approach is proposed. First, a Dynamic Fuzzy Network (DyFN) constituted from a series of dynamic fuzzy if-then rules is introduced. One characteristic of DyFN is its ability to deal with temporal problems. Then, GA is adopted into the design process as a means of allowing the application of DyFN in situations where only reinforcement signal is available. To promote the design performance, a mofification to traditional GA, the Relative-based Mutated Reproduction GA (RMRGA), is proposed. To show the efficiency of DyFN designed by GAs, including both traditional GA and RMRGA, two temporal problems, the dynamic plant control and adaptive noise cancellation, are simulated. The simulated results have verified the efficiency of DyFN designed by GA.

415
Rough Sets and Interval Fuzzy Sets

Y.Y. Yao

Semantical interpretation of the degrees of membership values is one of the fundamental issues in the theory of fuzzy sets. This study addresses such an issue in the light of the newly developed rough set theory. The connections between theories of fuzzy sets and rough sets are established, and the notion of interval fuzzy sets is studied. A salient feature of the rough set based interpretation of fuzzy sets is that the relationship between elements of the universe is considered. More specifically, the membership values of related elements are related in the proposed framework.

The significance of the study can be stated as follows. The formulation and interpretation of rough membership functions are inseparable parts of the theory of rough sets. Each rough membership function has a well defined semantical interpretation. The source of uncertainty modeled by rough membership functions is the indiscernibility or similarity of elements. Constraints are therefore imposed on rough membership functions by the similarity of elements. Rough set based interpretation thus provides a more restrictive, but more concrete, view of fuzzy sets. Such more concrete views of fuzzy sets, with explicitly stated semantics of membership values, may be more informative and useful for the applications of the theory.

416
Fuzzy Disjunctive and Conjunctive Canonical Forms: A Foundation for Interval-Valued Fuzzy Techniques

I. Burhan Turksen

Fuzzy Disjunctive and Conjunctive Canonical Forms, FDCF, and FCCF, respectively, should be used as a foundation for Interval-valued approximate reasoning. It has been shown that in the combination of linguistic concepts, membership values generated by linguistic operators, AND, OR, IMP, etc., as opposed to crisp connectives that are known as t-norms and t-conorms and standard negation, are computed with Fuzzy Disjunctive and Conjunctive Canonical Forms, FDCF and FCCF, respectively. Approximate reasoning computed with these forms reveal the information content available in information granules, as well as expose the uncertainty and risk represented with the gradation between the lower and the upper membership degrees.

417
Qualitative Fuzzy Sets: A Comparison of Three Approaches

T.Y. Lin

A real world fuzzy set should be able to tolerate “small amounts” of perturbations. There are three approaches. Thiele’s approach, observing some weak points of Lin’s earlier versions, proposed a refined approach based on Kripke style semantics; his results, but independently, are essentially applying Lin’s 1996’s view using Lin’s 1998’s new notion of neighborhood systems. A type II fuzzy set realizes the idea by representing each grade by a fuzzy number. Lin’s has approach represents a fuzzy set by a “fuzzy set” of membership functions. Lin did in two ways; one by granulation and another by “physical” perturbation. In summary, Thiele’s approach has a good Kripke style semantics. Type II fuzzifies the grade; its advantage is simplicity. Lin’s approach fuzzifies the membership function; its advantage is formalize the intuitive “physical” perturbation. The three approaches are not equivalent, but do have common intersection. three results are discussed in different universes (categories).

418
Rule Induction System based on Characterization of Medical Diagnosis using Rough Sets

Shusaku Tsumoto

In this paper, a rule-induction system, called PRIMEROSE3 (Probabilistic Rule Induction Method based on Rough Sets version 3.0), is introduced. This program first analyzes the statistical characteristics of attribute-value pairs from training samples, then determines what kind of diagnosing model can be applied to the training samples. Then, it extracts not only classification rules for differential diagnosis, but also other medical knowledge needed for other diagnostic procedures in a selected diagnosing model. PRIMEROSE3 was evaluated on three kinds of clinical databases and the induced results are compared with domain knowledge acquired from medical experts, including classification rules. The experimental results show that our proposed method correctly not only selects a diagnosing model, but also extracts domain knowledge.

419
Investigating the Role of Fuzzy Sets in a Spatial Modeling Framework

Phil A. Graniero, Vincent B. Robinson

This paper outlines a method of constructing a spatial data collection agent that is capable of adopting a spatial sampling strategy along a transect network in real-time, based on minimal prior knowledge of the measured surface and a concept of spatial heterogeneity. The agent uses fuzzy reasoning to decide upon the appropriate distance to travel along the current transect before making a new measurement. Fuzzy functions for the sets “widely spaced” and “immediate neighbourhood” are constructed “on the fly” based on the deviation of the most recent measurement from the value anticipated from the original crude surface. The two functions are combined to produce a pi curve, and the minimum distance between samples that produces a maximum fuzzy membership, i.e. that balances sample sparseness and sample density, is used to determine the next sample point along the transect. The exact form of the fuzzy functions and their parameterization will be designed using a spatially explicit simulation modeling framework to produce experimental performance measures. It is anticipated that the resulting agent will be sufficiently elegant to be easily incorporated into semi-autonomous field acquisition systems, and ultimately contribute to autonomous acquisition systems.

420
Fuzzy Techniques for Multiple Criteria Decision Making in GIS

Ashley Morris, Piotr Jankowski

Spatial decision making is a fundamental function of contemporary Geographic Information Systems (GIS). One of the most fertile GIS development areas is integrating multiple criteria decision models (MCDM) into GIS querying mechanisms. The classic approach for this integration has been to use Boolean techniques of MCDM with crisp representations of spatial objects (features) to produce static maps as query answers. This paper examines a prototype system, FOOSBALL, which addresses many of the inherent weaknesses of these systems by implementing: 1) fuzzy set membership as a method for representing the performance o f decision alternatives on evaluation criteria, 2) fuzzy methods for both criteria weighting and capturing geographic preferences, and 3) a fuzzy object oriented spatial database for feature storage. This makes it possible to both store and visually represent query results more precisely. The end result of all of these enhancements is to provide spatial decision mak! ers with more information so tha t their decisions will be more informed, and thus, more correct.

421
Representing Continuous Spatial Variation of Geographic Phenomena Using Fuzzy Logic

A-Xing Zhu

Variation of geographical phenomena is often gradual and continuous over space. A discreet model based on Boolean logic has been used to portray (map) this gradual and continuous spatial variation. Due to the limitation of this discreet model spatial variation of geographic phenomena is portrayed by discreet and distinct units, and changes only occur at the boundaries of these units. As a result, the gradual and continuous nature of geographical phenomena is not retained in this discreet model. This paper presents a fuzzy logic based model (referred to as a similarity model). The model consists of two components: a fuzzy representation of geographic phenomena in the attribute domain and a raster representation in the spatial domain. With the use of fuzzy logic and raster representation a given geographic phenomenon is perceived as a continuum in both the attribute and spatial domains. Case studies conducted in the area of soil survey have shown that spatial variation of soils was better represented under the similarity model than under the Boolean model. It was found that information retained under the similarity model allows the quantification of uncertainty when one chooses to harden the similarity information into the conventional Boolean model.

422
A Clips-Based Implementation for Querying Binary Spatial Relationships

Huiqing Yang, Maria A. Cobb, Kevin B. Shaw

Geographic Information Systems (GIS) is an integrated technology that incorporates concepts from computer graphics, spatial modeling and database management. The ability to perform queries on spatial data is essential to GIS and related systems. The power of spatial queries for analysis and planning purposes in many different application fields has drawn significant attention within the GIS research field.

The extraction of meaningful information from spatial data requires specialized data structures, query languages and query processing strategies. This paper is primarily concerned with the binary data structures that support the fuzzy queries of spatial relationships in two dimensions. For implementation purpose, the topological relations in this model are refined from a previously defined model. This modified binary spatial model will reduce the burden of geometric computation.

Based on the modified binary spatial model, a CLIPS implementation for querying binary spatial relationships is investigated. Details about the query processing strategies are also provided. The query results show the capabilities of the binary spatial data model and a CLIPS tool to support fuzzy topological and directional queries.

423
Modifications of Fuzzy Directional Queries for Spatial Databases

Maria Cobb, Frederick E. Petry, Lixong Wen

A previously developed approach for determining directional and spatial relationships has been based on the partitioning of the Minimum Bounding Rectangel that represents the underlying actual spatial object. This development took an approach which allowed a very computationally efficient determination of directions. However the simplifications caused some anomalous cases to possilby occur. This paper will provide some modifications of the reference area and axis weight used ot compute directions. This permits a better representation of the intuition of certain directional cases without being computationally inefficient.

424
Parsing 'Grammatically Incomplete' Natural Language Queries to Spatial Databases

Fangju Wang

Of the applications of information system technology, geographic information management and processing can be categorized into the group that has both the most diversified users and the largest number of imprecise concepts. Formal query languages have limitations when applied to these fields. A natural language user interface may be more expressive in dealing with geographic information and can improve accessibility of geographic information systems (GIS's). A challenge in creating a natural language user interface is that user queries in a natural language may be grammatically incomplete. That is, some grammatical constituents may be missing. In this paper, we report a technique we developed for parsing such queries. This technique is based on the fuzzy set possibility theory, which is used to handle the uncertainty caused by missing constituents and ambiguity.

425
Perception-Action Rule Acquisition by Coevolutionary Fuzzy Classifier System

Hisashi Handa, Takashi Noda, Tadataka Konishi, Mitsuru Baba, Osamu Katai

Recently, many researchers have studied for applying Fuzzy Classifier System (FCS) to control mobile robots, since the FCS can easily treat continuous inputs, such like sensors and images by using fuzzy number. By using the FCS, however, only reflective rules are acquired. Thus, in proposed approach, an additional Genetic Algorithm in order to search for strategic knowledge, i.e., the sequence of effective activated rules in the FCS, is incorporated. That is, proposed method consists of two modules: an ordinal FCS and the Genetic Algorithm. Computational experiments based on WEBOTS, one of Khepera robots' simulators, are confirmed us the effectiveness of the proposed method.

426
Continuous Locomotion of Brachiation Robot by Behavior Phase Shift

Yasuhisa Hasegawa, Hiroaki Tanahashi, Toshio Fukuda

In this paper, we propose an extension of a hierarchical behavior controller which achieve dynamically dexterous behavior by shifting behavior phase. A controller for a dynamically dexterous behavior is hard to be designed by using any unsupervised leaning methods, because of enormous searching space. In order to reduce the searching space and its complexity, a hierarchical behavior structure is effective. We have previously proposed a hierarchical behavior controller, which consists of two kinds of modules: behavior coordinator and behavior controller and adaptation algorithm for scaling of behavior outputs. It is applied to the control problem of a seven-link brachiation robot, which moves dynamically from branch to branch like gibbon swinging its body. The robot however does not locomote from branch to branch stably, by adjusting amplitude of two behavior controllers. A hybrid adjusting algorithm with amplitude scaling and phase shifting of behavior outputs is proposed in this paper. Numerical simulations demonstrate that the obtained controller can successfully generate the stably continuous locomotion.

427
Rule Conversion in Knowledge Acquisition for Flowshop Scheduling Problems

Tadahiko Murata, Takashi Sugimoto, Yashuhiro Tsujimura, Mitsuo Gen, Hisao Ishibuchi

In this paper, we examine the performance of an inductive decision tree learning system to acquire important knowledge for flowshop scheduling problems, and propose a rule conversion method from acquired rules by the system. We employ an inductive learning process for producing decision trees like the C4.5 proposed by Quinlan. Several rules for job assignment are obtained from decision trees those are constructed by training cases. In the case generation method employed in the previous system, there seems to be a problem, that is, several obtained rules are not available for assigning jobs since there are no job combinations that satisfy antecedent conditions of the rules. We modify the case generation method to obtain more available rules. Computer simulations show that the modified method is effective in problems with one of the following objectives: minimizing the makespan, minimizing the total flowtime, and minimizing the total tardiness. In the previous decision tree learning system, only typical rules with good consequent parts had been used for job assignment. In order to utilize rules with typical bad consequent, we transform the antecedent parts of bad rules to get good rules. Computer simulations show that some bad rules can be converted to good rules.

428
Genetic Programming for Life-Time Learning of a Mobile Robot

Naoyuki Kubota, Setsuo Hashimoto, Fumio Kojima

This paper deals with a mobile robot with structured intelligence. The robot interacts with a dynamic environment. The evaluation criteria or functions are the strategy for the behavior acquisition. Generally, it is difficult for human operators to describe internal models of the robot because the organization of the robot is quite different from that of a human. In the optimization , the evaluation function is generally given by human operators beforehand. It is easy to give the evaluation functions if the environmental condition is easy and fixed. But the robot must interact with dynamic, uncertain and unknown environments or human operators. Therefore, the robot should generate the evaluation criteria by itself based on its embodiment. A human improves its behavior by using and changing its evaluation criteria as adaptive processes. The robot also has to acquire their evaluation criteria through life-time learning. Therefore, we apply genetic programming (GP) for generating! evaluation functions. The resul t of computer simulation shows that GP can generate the evaluation function suitable to the facing environments, the given tasks, and the robot.

429
Application of Genetic Algorithms to Hypersonic Flight Control

K.J. Austin, P.A. Jacobs

This paper presents an application of genetic algorithms to the design of a longitudinal flight controller for a hypersonic accelerator vehicle which is to be used to launch small satellites. A feature of hypersonic air-breathing flight vehicles is the high level of engine integration with the airframe. As a result, maintenance of vehicle attitude is not simply an issue of stability, but also one of propulsive effectiveness, which itself varies with flight conditions and the vehicle attitude. There is therefore, limited scope for departure from optimum operating conditions. This, together with the extreme flight conditions, performance uncertainty, and the inherent instability of the vehicle, contributes to a demanding control task. We examine the capacity of a genetic algorithm in designing a fuzzy logic controller for the task of closed loop flight control. With a fixed, preset control structure the design task is to configure the control surface through selection of the rule consequents and input scaling. The genetic algorithm uses a collection of simulated flight response in its formulation of the objective function. This allows the generation of a controller design without linearization of the vehicle model and dynamics. Stability augmentation is shown through flight simulation at the low-speed end of the hypersonic trajectory and also at a higher speed.

430
A Multidimensional Index Structure for Fuzzy Spatial Databases

Kemal Akkaya, Adnan Yazici

The current index structures are not appropriate for representing and efficiently accessing fuzzy data, especially for fuzzy spatial data existing in many complex applications such as Geographic Information Systems (GISs), Multimedia Database Systems, Decision Support Systems, etc. For the effectiveness of fuzzy databases non-fuzzy and fuzzy data should be indexed together. Therefore, a multidimensional access structure should be used for efficiently accessing fuzzy databases. In this study we describe a multi-dimensional access structure, namely Spatial Multi Level Grid File (MLGF), as an indexing technique for effeciently retrieving both crisp and fuzzy spatial data from fuzzy databases. In addition to the design of the access structure, we focus on the issue of partitioning, representation and organisation of spatial data at physical database level. We also discuss how this fuzzy spatial indexing technique can be utilized for complex and spatial data in a database application, e.g., geographic information systems (GIS).

431
On the Use of Fuzzy Numbers in Flexible Querying

Daniel Rocacher

An issue in extending database management functionalities is to increase the expressiveness of query languages. Flexible querying enables users to express preferences inside requirements and priorities inside compound queries. The answers are then qualified and sorted out. The fuzzy sets theory offers a general framework for dealing with flexible queries. Moreover the bag structure plays an important role in databases. Systems taking into account both flexible queries and bags introduce a new concept: fuzzy bags. A new approach of this concept, based on the notion of fuzzy cardinality, is presented in this paper. The use of fuzzy bags and fuzzy cardinalities in flexible querying is also introduced.

432
Why Spatial Databases Need Fuzziness

Ashley Morris

Geographic Information Systems (GIS) and spatial databases are inherently suited for fuzziness. Because the only accurate storage and representation of a spatial object can be on a one-to-one scale, there must be a level of uncertainty and/or fuzziness introduced into the model. Also, the result of a query must eventually be represented to the user. This may be done in the form of textual retrieval, chart, or graph, but the usual way is by presentation of a map. When the map is presented to the user, additional uncertainty may be introduced as well. Because of the uncertainty inherent in the assimilation, storage, and representation of spatial data, spatial databases need some mechanism to support uncertainty, and the obvious choice is fuzziness.

433
A First Approach to Possibilistic Queries Addressed to Possibilistic Databases

Patrick Bosc, Laurence Duval, Olivier Pivert

It is now recognized that querying databases containing imprecise information raises several problems, including that of complexity. In this paper, we consider a new kind of queries, called possibilistic queries, of the form “to what extent is it possible that a given tuple t belongs to the answer of Q (a regular relational query)”. This paper is

a first attempt to show that a resonable complexity can be expected for a specified subset of possibilistic queries.

434
At the Crossroads of Fuzzy Galois Lattice and Information Retrieval

Sadok Ben Yahia, Ali Jaoua

In this paper, we propose a new algorithm for generating a fuzzy Galois lattice from a fuzzy binary relation. As a practical application of the fuzzy Galois lattice, we show that it can be used as an underlying basic structure access, for providing relevant additional information, to user asking queries to an indexed documentary database. Keywords: Fuzzy sets, Fuzzy Galois lattice, Information retrieval, Documentary database.

435
SQLf and FQUERY for Access

Janusz Kacprzyk, Slawomir Zadrozny

The FQUERY for Access add-on to Miscrosoft Access, designed and implemented in its pilot version by the present authors, provides for the processing of fuzzy queries in the framework of the popular Microsoft Access database management system. In the paper we discuss some enhancement to the package that are inspired by the concepts elaborated by Bosc and his collaborators in a series of papers on the SQLf language. These enhancements consist in the extension to the FQUERY's for Access underlying querying language as well as in increasing the efficiency of the fuzzy querying engine.

436
Fuzzy Rule Interpolation for Multidimensional Input Space with Petroleum Engineering Application

Kok Wai Wong, Tamas D. Gedeon

Fuzzy rule based systems have been very popular in many engineering applications. In petroleum engineering, fuzzy rules are normally constructed using some fuzzy rule extraction techniques to establish the petrophysical properties prediction model. However, when generating fuzzy rules from the available information, it may result in a sparse fuzzy rule base. The use of more than one input variable is also common in petroleum engineering. This paper examines the application of fuzzy interpolation to resolve the problems using sparse fuzzy rule bases, and perform analysis of fuzzy interpolation in multidimensional input space.

437
Interpolative Reasoning with Multi-Variable Rules

Christophe Marsala, Bernadette Bouchon-Meunier

The classical interpolative reasoning has been previously extended to handle an incomplete rule base with imprecise descriptions of variables. This extension has been done thanks to the assumption of graduality in variations of the variables, by using an analogical fuzzy approach. In this paper, we propose an extension of this fuzzy interpolative reasoning when several variables appear as premises in the given rules.

438
HOSVD based Computational Complexity Reduction of TS Fuzzy Models

Peter Baranyi, Annamaria R. Varkonyi-Koczy, Yeung Yam, Pal Michelberger

One of the usual important criteria to be considered in real time control applications is the computational complexity of the controllers, observers and models applied. In this paper a higher order singular value decomposition (HOSVD) based complexity reduction technique is proposed to Takagi Sugeno (TS) fuzzy models, which is capable of defining the contribution of each local linear model included in the TS fuzzy model. This helps us with discarding the weakly contributing ones according to a given threshold. Reducing the number of models leads directly to the computational complexity reduction.

439
An Adaption Technique to SVD Reduced Rule Bases

Peter Baranyi, Annamaria R. Varkonyi-Koczy, Yeung Yam, Peter Varlaki, Pal Michelberger

The practically non-universal approximation property, shown by Tikk at al. and the exponential complexity problem of widely adopted fuzzy logic techniques, shown by Kóczy and Hirota, reveal the contradictious features of fuzzy rule bases in pursuing of good approximation. As a result complexity reduction topic emerged in fuzzy theory. One of the natural disadvantages of using complexity reduction is that the adaptivity property of the reduced approximation becomes strictly restricted. This paper proposes a technique, to singular value decomposition (SVD) based reduction may alleviate the adaptivity restriction. A high order tensor projection is proposed here as key idea.

440
Fuzzy systems with interpolation. An overview

Laszlo T. Koczy, Domonkos Tikk, Leila Muresan

One of the main questions related to fuzzy systems regards the execution time of the algorithms used. This paper presents some efficient methods in this respect. Another characteristic of the algorithms discussed in the paper is that they can deal also with gaps of information, situation which generally is not handled by the so-called "classical" methods. A summary of the most important reasons that lead to the apparition of sparse rule bases is given and the first interpolation method - the KH interpolation based on the Fundamental Equation of Rule Interpolation - is thoroughly discussed. Afterwards the most recent improvement of it, the MACI algorithm, which avoids the abnormality of the conclusion, is also described. Some other, conceptually different methods conclude the survey.

441
A Comparative View of Interpolation Methods Between Sparse Fuzzy Rules

B. Bouchon-Meunier, D. Dubois, C. Marsala, H. Prade, L. Ughetto

Several approaches have been proposed in the last past years for interpolating between sparse fuzzy rules. These proposed methods yield very different results in some cases. This is due to different views on the basic principles underlying the interpolation process. Especially, the problem can be viewed as the one of completing a partially known mapping associating fuzzy sets to fuzzy sets, or the one of extending the interpolation mechanism applicable to classical functions to fuzzily specified ones. This paper intends to clarify the differences between the various methods.

442
On Clustering Based on Homogeneity

Mika Sato-Ilic

The clustering technique in data analysis has had two main problems. One of them is how to determine the number of clusters and the other is concerned with the interpretation of the clustering result, that is, what the obtained clusters mean. Fuzzy clustering has also had these problems. In this paper we focus on the latter one, as it relates to fuzzy clustering. The merit of fuzzy clustering is that we can consider not only the belonging status to the clusters, but also how much the objects belong to the clusters. So, we can get the clustering result as the degree of belongingness of objects to the clusters and these values usually will not be discrete values. Using this feature and the idea of homogeneity of the homogeneity analysis, we propose a model to get the interpretation of the fuzzy clusters.

300
Classification and Clustering of Granular Data

Andrzej Bargiela, Witold Pedrycz

Information granules are formed to reduce the complexity of the description of real-world systems. The improved generality of information granules is attained by sacrificing some of the numerical precision of point-data. In this study we consider a hyperbox-based clustering and classification of granular data and discuss detailed criteria for the assessment of the quality of the combined classification and clustering. The robustness of the criteria is assessed on both synthetic data and real-life data from the domain of urban traffic control.

444
Linear Fuzzy Clustering Using Eigenvalues for Optimization of Dimensional Coefficients

Kazutaka Umayahara, Sadaaki Miyamoto, Yoshiteru Nakamori

This paper considers the problem of detecting local linear substructures of a system in a high-dimensional data space by applying a fuzzy clustering technique. The origin of the fuzzy clustering method is the fuzzy c-means (FCM) algorithm developed by Bezdek. One of the recent interests in the field of fuzzy clustering is the simultaneous determination of a fuzzy partition of a given data set and parameters of assumed models of different shapes. In this paper, we propose the linear fuzzy clustering method using eigenvalues of the fuzzy scatter matrix in the objective function for optimizing dimensional coefficients. The objective function proposed in this paper combines the advantages in the two methods called adaptive method and fuzzification method. Namely, it includes eigenvalues used in the adaptive methods, and fuzzifies the dimensional coefficients. The fuzzification method has the monotone decreasing property of the objective function. The adaptive method has a property of clear geometrical interpretation with the use of the eigenvalues. These two advantageous features are combined into the present objective function that uses the eigenvalues and the fuzzification simultaneously.

445
Complexity Reduction to Non-singleton Fuzzy-Neural Network

Annamaria R. Varkonyi-Koczy, Kin-fong Lei, Masaharu Sugiyama, Hirotsugu Asai

Singular value based reduction technique has been proposed for a singleton based fuzzy-neural network. In fuzzy theory the use of non-singleton consequent based Takagi-Sugeno model is also adopted. Applying non-singleton based fuzzy model in fuzzy-neural networks the non-singleton based network is obtained. The main objective of this work is to extend the SVD based reduction technique proposed for fuzzy-neural network to non-singleton based fuzzy-neural network.

446
Virtual Training of Potential Function based Guiding Stiles

Peter Korondi, Annamaria R. Varkonyi-Koczy, Szilveszter Kovacs, Peter Baranyi, M. Sugiyama

The main goal of this paper is twofold. One goal is to adapt the advantages of using immersive virtual environment for teaching robots. The subsequent aim is to define a suitable model for robot guiding-style description, which can serve as an easily adaptable and implementable general guiding stile description of various mobile robots. The guidelines of virtual training and the proposed general neural network based guiding-style description model are also introduced in this paper.

447
Theory of Classification using the Object-Predicate Table for our Better Understanding of Intergroup Relationship

Hiroshi Watanabe

In the Zadehian formalization a grade function is defined with respect to a single object, and not to a group of objects, while in such fields as pattern recognition and clustering, analysis of the relationship among groups of objects is a problem of interest. The present paper propose a formal framework which enable us to examine a compli-

cated relationship among groups of objects, and to deal with loosely defined concepts in the non-quantitative level. Assuming that each object is characterized by a set of predicates as a binary vector, whose components are 1 or 0 according as the object affirms a predicate or not, we first examine the relationship among objects in reference to the choice of predicates, or classifier, and formulate a formal theory of classification of objects by predicates. The formalization is perfectly symmetrical between the objects and the predicates, and allows us to consider a classification of predicates by objects. Based on this reciprocal view of classification we clarify a formal basis of equality between two groups of objects, propose a new approach to clustering, and discuss its merits by showing examples.

448
Learning Fuzzy Control Rules by Vector Simplex Method

Setsuko Sakai, Tetsuyuki Takahama

Learning of fuzzy control rules can be considered as a nonlinear optimization problem, in which the objective function isn't differentiable. Also, the problem is usually defined as multiobjective optimization problem (MOP) because of plural control targets. Since the objective function in MOP is vector-valued, their set is a partially ordered set. Thus, in MOP's, a complete optimal solution, which minimizes all objective simultaneously, does not necessarily exist. Pareto optimality is the representative concept of optimality in MOP's. In the case of using Pareto optimal solutions, it is very important for the decision maker (DM) to obtain the set of all Pareto optimal solutions and select one solution based on his global preference information. In this paper, we propose a multiobjective optimization method, Vector Simplex method, which can obtain the approximate set of Pareto optimal solutions directly and quickly. Also, we learn fuzzy control rules for an inverted pendulum by using the Vector Simplex method. And we show that this method is effective enough to learn fuzzy control rules in comparison with other optimization method.

449
Application of Fuzzy Concept in the Apparel Industry

W.K. Wong, C.K. Chan, W.H. Ip

In the fabric-cutting department of apparel manufacturing process, the production supervisors must make appropriate decisions at any time to transfer the operatives between spreading and cutting operations in order to maintain the line-balance of computerized fabric-cutting system. Theoretically, the adjustment of spreading capacity at determined time should be executed by exact mathematical programming. A Fuzzy Line-Balancing (FLB) model is proposed in which this function can be approximated on the basis of production expert experience. The FLB model can handle five levels of work-in-progress to determine the five levels of spreading resource adjustment. The level of WIP on each spreading table is reviewed with planned level of WIP at predefined time which will give fuzzy input variables to the fuzzy model. The schedule of generated by spreading and cutting sequencing model using genetic algorithm of Wong et al. (2000) was compared with that of FLB model under the dynamic m! anufacturing environment. The r esults indicated that the proposed model could solve the line-balancing problem in the dynamic manufacturing environment of the apparel industry.

450
Composite Fuzzy Measure and its Application to Decision Making

Toshihiro Kaino, Kaoru Hirota

A Composite fuzzy measure space built up from two fuzzy measure spaces is proposed. It is applied to the automobile factory capital investment decision making problem. Firstly, in the application using fuzzy measure on a real number, it is a problem how to evaluate the inbetween intervals each of which is given by a fuzzy measure. So, a composite fuzzy measure built up from two fuzzy measures defined on two fuzzy measurable spaces is proposed using composite fuzzy weights. Here, the measurable space of this composite fuzzy measure is the direct sum of two measurable spaces. It is proved that a composite measure built up from two fuzzy measures using composite fuzzy weights will be a fuzzy measure. It is recursively extended to a composite fuzzy measure built up from plural measurable spaces. And, the associative, composite fuzzy measure built up from three fuzzy measures is introduced. Then, it is applied to the automobile factory capital investment decision making problem. ! It is assumed that an automobile company has a sales plan of a new car. The current factory line has a capacity to manufacture 3,200 new cars, additional to the current car lines. Then, by the use of this composite fuzzy measure, the differentiation of the Choquet integral becomes the important index for decision making, and it is confirmed to be a useful tool for this decision making.

451
Fuzzy Regression Models to Represent Electricity Market Data in Deregulated Power Industry

Tak Niimura, Maninder Dhaliwal, Kazuhiro Ozawa

In this paper the authors present a flexible model that represents the relation of electricity price and demand in a deregulated power market. Power market data are first analyzed by regression analysis. The price data show upward trend as the demand volume increases. We have therefore divided the regression models into two regions: low demand and high demand. Low demand data is represented by a linear regression model, and high demand data by quadratic model. Two curves are then smoothly connected by a TSK-fuzzy model noting the fact that the "low" demand and "high" demand regions are not distinct but overlapping. The fuzzy model is further extended to encompass the data region indicating the degree of possibility. The parameters of fuzzy regression model are found by minimizaing the area between the possible highest and lowest prices for a demand. California Power Exchange data are analyzed as an example.

452
Car Image Recognition with Lacked Input Data

Yoshinori Arai, Kaoru Hirota

It is difficult that all features are extracted completely in general using image processing methods. And for the system used the fuzzy infer-

ence, if input datum is lacked, the system does not work well. In this paper, a frame work of a modified fuzzy inference method with lacked input data is introduced. And experimental results are provided. In the proposed method that is modified from the Mamdani's fuzzy inference, a result of each rule is the adjustment for the purpose of protection from influence of lacked input data. The adjustment of result fuzzy labels at each rule is used the degree of importance which is set up in the rules by human. In the results of experiment, the system can infer well with lacked input data used this method. In results of experiments used a set of eight fuzzy rules (five input and eight output), when all combination of all input data are lacked, the system infers so correctly.

453
A Designing Method for Type-2 Fuzzy Logic Systems Using Genetic Algorithms

Seihwan Park, H. Lee-Kwang

Fuzzy logic systems(FLSs) have been successfully used in widely various applications. The membership functions(MFs) and the rules of a FLS are designed using the linguistic information or numeric data. However, there is uncertainty associated with the information or data. A type-2 fuzzy set can represent and handle uncertain information effectively. Recently, type-2 fuzzy sets are used to incorporate uncertainty in type-2 FLSs. To design a type-2 FLS, the optimization of both the MFs and the rules is required. Genetic algorithms(GAs) are known to have a strong optimizing capability as searching the solution space in parallel. GAs have been used to design the type-1 FLSs. In this paper, we propose a designing method for a type-2 FLS using GAs. The proposed method determines the positions and the shapes of the MFs and the rules of a type-2 FLS. We encode type-2 fuzzy sets as feature parameters. The proposed method is applied to the chaotic time-series prediction and the result o! f the experiment is shown to dem onstrate the performance.

454
Building Exterior Design System by Hierarchical Combination Fuzzy Model

Norikazu Ikoma, Hiroshi Maeda, Yukihiro Kobayashi, Tomomi Tabira, Daisuke Yamamoto

A new "Kansei" design method for building exterior by using decomposed fuzzy model and its inverse problem solution is proposed. Kansei of Human to CG image of building exterior is measured by SD technique. Decomposed fuzzy model is used to perform the human reactions. The model is divided into sub-models with single output variable. Input variables are common in these sub-models. each input variable of a sub-model is fed into fuzzy inference unit separately, and the output signals of these fuzzy inference units are combined two by two, by combination unit. Parameters of the model are tuned by error back propagation algorithm. To design of building exterior to satisfy a customer's Kansei request, inverse problem of the model is solved. Inverse problems for all sub-models are solved separately under a constraint of noninferior property to the solution, and these solutions are unifyed by taking intersection for all sub-models. Unique solution is required to draw a CG image of building exterior, and is obtained by numerical optimization method to satisfy the customer's requests as much as possible. Experimental result is resported, and the method is implemented into a WWW system using JAVA and CGI.

455
Towards Flexible Modeling of Collective Human Behavior with Cognitive Process

Kazuo Nakamura

Recently industrial products and systems are coming to involve machine intelligence. As such products and systems have to work like friendly partners in collective human behavior, their designs are to match with human cognitive characteristics. Thus, this study focuses on modeling for collective human behavior with cognitive process. To develop such models the crucial issues are treatments of 1) physical, physiological, psychological and informational interactions among persons, 2) vagueness, ambiguity, uncertainty of human inner states and knowledge, 3) flexible information processing in human cognitive processes. To cope with these issues soft computing approaches are investigated. First modeling framework of collective human behavior is introduced on the basis of Rasmussen's concepts of decision ladder, and then the feasibility of soft computing approaches is shown through some trials of flexible modeling.

456
Soft Computing Agents

Dimitar Lakov

The paper introduces a new paradigm in broad family of Software Agents. It is called Soft Computing Agents (SCA) that combines advantages of Soft Computing Technology with Software Agents paradigm as universal optimal resource allocation techniques. SCA are oriented to improve Quality of Services QoS and endows Intelligent Agents with ability to perceive, be aware, and perform sensitive to customers' claims optimal actions. A primary definitions and axiomatic of SCA are introduced. The strategy of Mobile SCAs creation dedicated to routing task has been developed. It comprises three types of SCAs: information, optimal routing, and inter-nodes interactive. These three types of SCA have been created for solution of optimal routing tasks into Internet applications. The first, information SCA, is responsible for providing necessary information in all the nodes under some horizon under consideration. The second type performs optimization based on such gathered information. The! proposed paradigm reflects a co mbined criterion that comprises five sub-criteria, namely: price, priority, security, time delay, and length of queue. These five sub-criteria are contradictory in their influence into desired quality. The third type, inter-node interactive SCA, is responsible for timely recover of the current states to every node into horizon after every successive routing implementation.

457
Expanding the Definitions of Linguistic Hedges

Hongjian Shi, Rabab Ward, Nawwaf Kharma

The subject of this paper is fuzzy linguistic hedging, used to modify membership functions. Our investigation will exceed the traditional

definition given by Zadeh (and others), upon which our research is based. We will present new and more general definitions for four of the most commonly used linguistic hedges. These hedges are very, more or less, positively and negatively. The effect of applying each hedge to a membership function will be described both qualitatively and quantitatively in this summary. We will also describe conditions under which a specific hedge is valid, chart the examples, and finally explore the properties of the hedge operations.

458
A Fuzzy Approach to Evaluate Quality Awards Process

Edson Pacheco Paladini

Abstract This paper describes a fuzzy process to evaluate the performance of different companies in terms of quality management (Quality Award Processes). The model considers several elements but highlight seven of them: the company clients' satisfaction; the organized system to the improvements management; clear objectives of The Quality Program (known by everyone), the participating management in the Company; the structure of Quality Program; the training process; the performance indicators and the main company executive of the company (if he is compromised with Quality). The fuzzy set theory is used in the evaluation model, which deals with the application of concepts, policies, strategies and techniques from total quality management. The parameters from the Quality Brazilian Award are used as a reference.

459
New Learning Scheme for Skill Growing and Structure Expansion

Chien-Kuo Li, Chian-Son Yu

One desirable feature of an intelligent system is the capability of expansion of the system structure as well as the learned techniques. In this study, we investigated the development of such capability. The learning structure consists of a pool of neurons. For learning a primary skill, a genetic algorithm is adopted to search for weights for performing the skill. To develop more advanced techniques, a number of neurons are added. The genetic algorithm (GA) is then used to search for weights within the new set of neurons and between the newly added neurons and the old ones. The original structure is not altered. This preserves the previously learned skills and the new skill can be established based on existent ones. Although the purpose of this study is to resolve the problem of skill expansion upon completing design, it is noted that the scheme can also be applied to relax learning difficulty by decomposing a difficult skill. Attractive features of the new approach include module structure, system expansibility, requirement of less hardware resources, and potential faster learning.

460
An Application of Fuzzy Rule-Based System: To the Economic Equilibrium Considering the Shift in Demand Curve

Chao-Chih Tsai, Ke-Chih Chen

The application of fuzzy rule-based system is discussed. The example is the equilibrium problem in economics. In this case we have two curve, one between price and supply and the other between price and demand. The demand curve will shift due to the change in average income. We apply the fuzzy rule-based system to calculate the amount of shift in demand curve. Finally, the equilibrium price can be found.

461
Assigning Local Weights within Fuzzy Production Rules for Improving Reasoning Accuracy

X.Z. Wang, D.S. Yeung

When a set of fuzzy production rules which are acquired by learning from training examples have poor reasoning accuracy with respect to the training examples, one may use a refining method to improve the reasoning accuracy. This paper proposes a new approach to refine the fuzzy production rules, which assigns local weights to propositions of fuzzy production rules by using a linear programming procedure. In addition to the reasoning accuracy improvement, this approach has a number of advantages such as intuitive background of local weights, non-increasing of number of rules, and less computational effort for obtaining local weights.

462
Weighted Fuzzy Production Rule Reasoning with Interactive Propositions

D.S. Yeung, M.H. Ha, X.Z. Wang

Weighted fuzzy production rule reasoning is a kind of similarity-based reasoning. One frequently used model for weighted fuzzy production rule reasoning is to consider the weighted average of proposition-similarities as an overall similarity. Due to some inherent interaction among diverse propositions, the weighted average model does not work well in many real-world problems. The main purpose of this paper is to handle this kind of interaction by introducing a non-linear integral tool in fuzzy production rule reasoning. Several non-linear integrals with respect to a fuzzy measure or a non-additive set function are outlined in this paper. The interaction among the propositions is considered to be reflected in the non-additive set function, and the overall similarity is computed by using the integral model instead of using the weighted average model. Because the weighted average can be regarded as a special case of nonlinear integral, this paper to some extent generalizes the application scope of similarity-ba sed reasoning. Illustrative examples show that the inclusion of an expert measure enhances the representative and interpretive power of fuzzy production rules. Particularly, while interaction exists among the propositions, the inclusion of an expert measure can reduce the likely occurrence of undesirable consequent.

463
Commensurability of Fuzzy Membership Values in Fuzzy Rules

John W.T. Lee

Fuzzy rules are often expressed in the form: IF (X is AX) AND (Y=BY) AND … THEN (Z is CZ), where X, Y, Z,… are attribute variables, and AX, BY, CZ… are fuzzy sets in the corresponding attribute value domains. When fuzzy sets corresponding to different linguistic terms are combined in the antecedent using fuzzy operators, we are implicitly assuming that these membership functions are commensurate in accordance with their membership values. In most situations this assumption may not be justified. In this paper we describe an interpretation of fuzzy rules which would suggest a commensurability mapping among the membership functions and the underlying attribute values. This approach will provide us an insight into the possible equivalence between different attribute values relating to the rule antecedent. Furthermore, the commensurability mapping can help us refine fuzzy rules in a production system by suggesting a realignment of interacting membership functions that can improve t! he performance of the fuzzy prod uction rules.

464
Construction of Fuzzy Basis Function Networks Using Adaptive Least-Squares Method

Cheol W. Lee, Yung C. Shin

The fuzzy basis function network (FBFN) which was proposed by Wang and Mendel (1992b) provides a way of representing fuzzy inference systems in a simple structure similar to those of radial basis function networks (RBFN). In this paper, a new algorithm based on the least-squares (LS) method and genetic algorithm (GA) is proposed for autonomous learning and construction of FBFN's when training data are available. The proposed algorithms add significant fuzzy basis functions (FBF) at each iteration during training, based on error reduction measures. The adaptive least-squares (ALS) algorithm based on the combined LS and GA, realizes hybrid structure-parameter learning without any human intervention. Simulation studies are performed with numerical examples for comparison with conventional algorithms. The ALS algorithm is applied to the construction of a fuzzy basis function network model for surface roughness in a grinding process using experimental data. In both cases, the proposed algorithm provides autonomous construction of parsimonious FBFN's with good approximation and generalization capabilities.

465
Web-Based Scheduling Agent for a Practical Product Line

Hironori Hiraishi, Ryo Katsuta, Fumio Mizoguchi

This paper describes a web-based scheduling agent for a product line. We design our agent for a practical product line of Machinery and Tooling Division in one real company. In general, schedule computation for a product line is executed within just only a high performance machine. But, our agent realizes the remote management of schedule. So, we can access our agent using a web browser and make a schedule at a remote site. This allows us to show the accurate time of delivery for a customer order in real-time. However, it is problem that everyone can reference and execute scheduling. So, our agent has the access control function that right to access to the scheduling engine is set up for every user and the agent restricts the command that users can execute.

466
Log Summarizing Agent for Web Access Data using Data Mining Techniques

Hisayoshi Kato, Hironori Hiraishi, Fumio Mizoguchi

We can get useful information from the WWW (World Wide Web) and the users increase every year. The available data is growing explosively, so, the techniques for analysis and discovery of useful information are important. The information providers and web manager make an effort to construct the effective web site. If providers and administrators can determine users' browsing patterns from web access logs, they could use the patterns as one index to construct an effective site. However, it is difficult to extract users' browsing patterns manually because the web access log is huge. Therefore we adopt data mining technique to this problem and design the log summarizing agent. This agent can automatically get profitable information from large amounts of web access logs.

467
Collaboration of Networked Home Electronics using Multi-agent Technology

Yukinobu Mine, Hinori Hiraishi, Fumio Mizoguchi

In this paper, we indicate advantage of multi-agent technology that as a control method of Home Electronics such as TV, lightings, cellular phones, PDAs and robots. And we propose a collaboration method for multi-agent control method of Home Electronics. Developer must abstract functions of a device, and provide it as a software component. And developer must provide agents that execute a request from users. An agent realizes it using abstract functions of components and/or other agents. Users set up the precondition of activation of agents using a user interface device such as PDA.

468
Design of Entrance System Using Robotic Agents in Smart Office

Masaaki Ohgishi, Fumio Mizoguchi

In recent years, there has been much research on smart offices in which various information appliances, sensors, cameras and robots collaborate to support human office activities. The goal of this paper is to make the smart office more intelligent by recognizing humans and detecting their whereabouts from many camera agents and sensor agents. We also present a practical example called Entrance System that uses some agents in a smart office. This system monitors visitors and if it judges the visitor to be a guest, informs Entrance managers that a guest is in the Entrance. We implemented this system in our office environments.

469
KAGAMI: Web Rating Agent Based on Hyperlink Structure

Naonori Otsuka, Hironori Hiraishi, Fumio Mizoguchi

In recent years, Internet users have been able to benefit from the increased amount of information in the World Wide Web (WWW) space. However, information retrieval efficiency has decreased because of the increasingly complicated WWW. A fundamental solution has not been achieved, though the information retrieval efficiency has been improved by browsing support tools such as the Web Information Access System (WIAS). Web sites must be improved to achieve a fundamental solution.

In this paper, we rate Web sites and clarify the problems using Web site rating agent KAGAMI (Japanese for mirror) and present an index for Web site improvement. This system autonomously collects data using a Web robot and rates sites using the site structure based on the WIAS framework. Additionally, this system generates a report by various visualization and supports for improving the Web site rating by this system.

470
Development of Web Based Educational Toy

Tomotaka Isogai, Hironori Hiraishi, Fumio Mizoguchi

There are many educational web sites and toys for children. They are researched as Edutainment (Education + Entertainment). Web sites can change the contents of the learning tool easily but the toys one can't be changed. However educational toys are suitable for children because of attractiveness to children in that fun, familiar, and operation. In this research project, we suggest the "Web-Toy System" that integrates with advantages of web sites and toys. Our "Web-Toy System" has two aspects. One is that user can manipulate real objects, and output from system is represented as action of the toy. The other aspect is virtual world. If user studies with PC or hand-held devices, we can get various information. PC is a powerful media in point of Animation, Sound, and so on. PC and hand-held devices can connect with Web, so they are very useful for study. In traditional educational toy, ability of teach is limited. But our system allows us to study new teaching material with advantages of PC or hand-held device. The purpose of this research is design of Web-Toy System, that user can study using various teaching materials on the web.

471
Identification of Dynamic Systems Using Recurrent Fuzzy Neural Network

Chih-Min Lin, Chun-Fei Hsu

This study proposes a recurrent fuzzy neural network (RFNN) structure, which is a modified version of a fuzzy neural network (FNN). The proposed RFNN is a recurrent multilayered connective network for realizing the fuzzy inference and can be constructed from a set of fuzzy rules. Adding feedback connections in the second layer of the FNN develops the temporal relations embedded in the RFNN. This modification provides the memory elements of the RFNN and expands the basic ability of the FNN to include temporal problems. Since a recurrent neuron has an internal feedback loop, it captures the dynamic response of a system, thus the network model can be simplified. Finally, the proposed RFNN is applied to identify some nonlinear dynamic systems. Simulation results confirm the effectiveness of the RFNN.

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Recurrent Algebraic Fuzzy Neural Networks Based on Fuzzy Numbers

Dragos Arotaritei

A hybrid structure, Recurrent Algebraic Fuzzy Neural Networks (RAFNN) using fully connected recurrent neural network architecture is proposed. The hybrid structure is based on neural network topology and fuzzy algebraic systems. The inputs, the outputs and the weight are triangular fuzzy numbers (usually non-symmetric). All the operations are defined in the frame of fuzzy arithmetic. The input-output relations in this fuzzy neural network, using max/min operators, defined by the extension principle of Zadeh are used here, also. All the nodes have a semilinear (sigmoidal) transfer function. A cost function, based on recurrent architecture, is defined. The cost takes into account the Left, the Central and the Right values at the output of the nodes, during dynamic evolution of the learning process. Based on previously work, an dynamic adapted gradient algorithm is developed. The experiments refer to the fuzzy sine wave oscillations, using a pair of units, fully connected and a bias for each unit. The results demonstrate the capability of algorithm and the possibility to use successfully fuzzy numbers in recurrent architecture in order to acquire a dynamic behavior.

473
Fuzzy Regression Analysis by a Fuzzy Neural Network and its Application to Dual Response Optimization

Chi-Bin Cheng

Fuzzy regression analysis achieved by a fuzzy radial basis function neural network is discussed in this paper. A fuzzy regression model constructed in such a manner is then applied to a dual response optimization problem. Fuzzy regression models are ideally suited for dual response optimization with two advantages: 1) many systems encountered in practice are fuzzy, and 2) fuzzy regression models have dual responses in nature. The dual response optimization problem is formulated as a multiple objective decision making programming, and an algorithm based on the duality theory is developed to solve this problem. A numerical example is also provided for illustration.

474
On Equalization with Complex MLP Network in the GSM Environment

A. Kantsila, T. Haverinen, M. Lehtokangas, J. Saarinen

Neural networks have been studied for channel equalization purposes with quite promising results. However, not a lot of published results are available for their performance in realistic mobile systems, such

as GSM (Global System for Mobile communications). Therefore, we have studied in this paper the use of complex-valued multilayer perceptron (MLP) network, trained with complex backpropagation (BP) algorithm, for equalization purposes in the GSM environment. Performance comparisons are made to a conventional decision- feedback equalizer (DFE) in terms of bit error rates and computational complexity.

475
Neural Approach to Linguistic Approximation of Fuzzy Sets

Sorina Zahan

In many practical implementations involving fuzzy systems, a numerical value is delivered to the user as the output of the system. Nevertheless, there are applications where such a numeric value is of little interest for the user, which, in turn, demands a linguistic output. In these cases, the linguistic approximation of the output has to be performed. This is not a simple problem, since often the application of approximate reasoning leads to very irregular, non-normal, possibly non-convex output fuzzy sets. The paper shows that linguistic approximation can be approached in a more traditional way as a problem of compatibility between fuzzy sets, but also as a pattern classification problem. Several possible solutions are presented and discussed. Emphasis is put on neural-based pattern classification approach. In order to comparatively evaluate the performances of all considered solutions, each one was integrated within an expert system dedicated to coronary heart disease diagnosis. The performances of the whole system were then evaluated using clinical data from 152 patients, by comparing the linguistic output of the expert system to the results of the gold standard that is coronary angiography.

476
Tuning of a PID Controller Using a Artificial Immune Network Model and Local Fuzzy Set

Dong Hwa Kim

Abstract This paper suggests that the immune algorithms can be used effectively on tuning of a PID control structures for nonlinear process. The controller's attribute behavior mechanism in plant and the artificial immune system have certain similarities since both systems deal with various attribute inputs (antigens: plant input and noise) and output through interactions among multiple attribute modules (lymphocytes and/or antibodies: control function or information-processing). Since antibodies communicate to each other among different species of antibodies/B-cells through the stimulation and suppression chains among antibodies that form a large-scaled network, the artificial immune network system always has a new parallel decentralized processing mechanism for various situations. In addition to that, the structure of the network is not fixed, but varies continuously. That is, the artificial immune network flexibly self-organizes according to dynamic changes of external environment (meta-dynamics function). On the other hand, a number of tuning method on the PID controller have been considered but with the only P, I, D parameters, it is very difficult to control a plant with complex dynamics, such as large dead time, inverse response, and highly nonlinear characteristics. A applied possibility of the flexible arbitration abilities of artificial immune network has been suggested for the PID controller tuning. Simulation results reveal that immune network algorithms are effective use to search for optimal control against disturbance.

477
Solving Fuzzy Problems in Operations Research: Inventory Control

James J. Buckley, Thomas Feuring, Yoichi Hayashi

In this paper we are interested in generating good approximate solutions to single item, N-period, fuzzy inventory control problems. It is a fuzzy inventory control problem since some of the parameters (ordering cost, holding cost, penalty cost) can be fuzzy numbers. We consider three cases: (1) demand is known each period; (2) demand is unknown and fuzzy each period; and (3) demand is fuzzy and backordering is allowed. We employ an evolutionary algorithm to search out good approximate solutions.

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Fuzzy Markov Chains

James J. Buckley, Thomas Feuring, Yoichi Hayashi

We first review some of the basic results of finite Markov chains based on probability theory, then we present fuzzy finite Markov chains based on possibility theory, and compare the results of the two theories. Then we introduce finite horizon Markovian decision processes based on fuzzy Markov chains and study an example in detail showing our solution procedure.

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Group Decision Making for TOPSIS

Hsu-Shih Shih, Wen-Yuan Lin, E. Stanley Lee

This study aims at improving TOPSIS, a technique of multi-attribute decision making, through nominal group technique, a process of group decision making, and other related tools. The decision quality will be secured after an integrated procedure is introduced, and the level of the group consensus can be measured and increased through some consensus indicators with referenced values. Finally, the proposed integrated procedure is implemented on a networked-based PC's system as a decision aid in practice.

480
Estimation in DEA by Possibility Regression with the Upper and Lower Approximations

Tomoe Entani, Hidetomo Ichihashi, Hideo Tanaka

The exponential possibility regression is applied to estimate interval efficiency values. Interval efficiency value is obtained by interval DEA. It shows the possible efficiency and its upper and lower limits are obtained from the opimistic and pessimistic viewpoints for an object to be analyzed. The interval efficiency value for the object is calculated relatively by using all given inputs and outputs without assuming an identical single model for all DMUs. We analyze the

interval efficiency values by regression analysis so that the identical model can be obtained. The obtained linear model in regression analysis can represent the relation between the given inputs and outputs and the obtained interval efficiency values in interval DEA. When new objects are added, we can estimate their interval efficiency values using the models obtained by regression analysis.

481
Optimization Approaches to Possibilistic Linear Programming Problems

Masahiro Inuiguchi, Tetsuzo Tanino, Hideo Tanaka

In this paper, we describe optimization approaches to possibilistic linear programming problems. After exemplifying a drawback of satisficing approaches, we define possibly and necessarily optimal solution sets. A necessarily optimal solution is the most rational solution but it does not always exist. As a weaker solution concept, the necessarily soft optimal solution set is defined. In order to obtain a solution with the maximum membership degree to the necessarily soft optimal solution set, we propose a solution algorithm based on a relaxation procedure and a bisection method. Moreover, a solution algorithm based on a relaxation procedure is proposed to obtain a solution with minimum tolerance under a given necessity level. A simple numerical example is given to illustrate the solution procedure.

482
Fuzzy AHP with Incomplete Information

Kazutomi Sugihara, Hiroaki Ishii, Hideo Tanaka

In this paper, we deal with fuzzy comparison ratios which are more comfortabe than crisp ones for expressing human's intuition. The proposed method is the fuzzy extension of Interval AHP which estimate the interval weights. It reflects human's fuzzy judgments on the interval priority weights. Based on the given fuzzy pairwise comparisons, we can obtain the intervals with h-level sets. The fuzzy intervals are analyzed from two concepts called least upper and greatest lower bounds, respectively. In this sense, two models are similar to upper and lower approximations of rough sets. Since the proposed method resorts to LP, it can be applied to a matrix with some unknown elements. It can be said that the lower h-level value is, the wider the obtained interval width is.

483
Soft Computing Based Networking Technique and Its Application to Control System Design and Identification

Yun Li, Gregory Chong

Modelling and designing a controller of a nonlinear plant is particularly difficult when the plant to be controlled is significantly nonlinear. Forming a nonlinear model from fundamental equation may not be possible in some cases and design of the controller become difficult. To address this problem and eases the difficulties in modelling and designing of industrial controllers, this paper proposes a trajectory controller network (TCN) technique and linear approximation model (LAM) technique. TCN and LAM proposes here are form by multiple linear block and both can be obtain directly from plant step response data and can also be designed by evolutionary computation where it offers a powerful and practical alternative to a wide variety of traditional engineering, mathematical and statistical problem-solving techniques.

484
Applying Fuzzy Logic Systems in the Estimation of Crossflow Filtration Processes

Ivan Nunes da Silva, Paulo Cezar Razuk, Rogerio Andrade Flauzino

The crossflow filtration process differs of the conventional filtration by presenting the circulation flow tangentially to the filtration surface. The conventional mathematical models used to estimate the parameters of crossflow filtration have presented certain limitations. The use of linear models has not offered a good representation for the process because its dynamics is typically nonlinear. On the other hand, more complex nonlinear models need various experiments to estimate properly their fixed parameters. The accomplishment of several experiments can be unviable due to the operational costs involved to implement such purpose. In this paper, a system based on fuzzy logic systems is developed to overcome the problems usually found in the conventional mathematical models. Imprecisions and uncertainties associated with the measurements made on the system are automatically incorporated in the fuzzy approach. This approach showed efficient to estimate the filtration flow of the crossflow filtration proces s. The input variables of the fuzzy logic system are the time, the transmembrane pressure, the initial concentration of the fluid, and the density of the particles to be filtered. The output variable of the fuzzy system is the filtrated flow or filtration rate.

485
Fuzzy Modeling of Nonlinear Stochastic Systems by Learning from Examples

A.H. Meghdadi, M-R. Akbarzadeh-T

The conventional fuzzy logic techniques have been extensively used in modeling nonlinear and complex systems. Such techniques, however, generally ignore the statistical nature that many complex systems may exhibit. When the system's behavior is significantly influenced by stochastic parameters, it is reasonable to expect that the modeling performance would be improved if the effect of such parameters is taken into account. In this paper, a novel modification to table look-up scheme is proposed. A new stochastic chaotic time series is also introduced. It is demonstrated that the modified method improves learning accuracy by considering the system's stochastic nature. Moreover, examining the results at different noise levels reveals that this improvement is indeed due to the stochastic nature of the system.

486
Soft Computing Applications in Equipment Maintenance and Service

Piero P. Bonissone, Kai Goebel

We present methods and tools from the Soft Computing domain, which are used within the diagnostics and prognostics framework to accommodate imprecision of real systems. Soft Computing (SC) is an association of computing methodologies that includes as its principal members fuzzy, neural, evolutionary, and probabilistic computing. These methodologies enable us to deal with imprecise, uncertain data and incomplete domain knowledge typically encountered in real-world applications. We outline the advantages and disadvantages of these methodologies and show how they can be combined to create synergistic hybrid SC systems. We conclude the paper with a description of three successful SC case study applications to equipment diagnostics: 1) Prediction of Paper Web Breakage in Paper Mill Using Neural Nets and Induction Trees; 2) Method for automated tuning of a raw mix proportioning controller in cement plants; 3) Adaptive Classification for Gas Turbines Anomalies.

487
Knowledge-Based Interpretation of Toxoplasmosis Serology Test Results Including Fuzzy Temporal Concepts

D. Kopecky, A. Rappelsberger, M. Hayde, A.-R. Prusa, K.-P. Adlassnig

Transplacental transmission of Toxoplasma gondii from an infected pregnant woman to the unborn occurs with a probability of about 60 percent and results in fetal damage to a degree depending on gestational age. The computer system ToxoNet processes the results of serological antibody tests performed during pregnancy by means of a knowledge base containing medical knowledge concerning the interpretation of toxoplasmosis serology test results. The interpretation algorithm infers the stage of maternal infection to determine the degree of imminent fetal damage. For this purpose, it matches the results of all serological investigations of maternal blood with the content of the knowledge base and generates interpretive reports consisting of a diagnostic interpretation and recommendations for therapy and further testing. In order to take the varying immune responses of individual patients into account, certain intervals between two consecutive tests have to be maintained; this ensure! s correct interpretation of test results. These time intervals are modelled as fuzzy sets, since they allow the formal description of temporal uncertainty. ToxoNet comprises the knowledge base, an interpretation system, and a knowledge acquisition and modification program. It is available from the World Wide Web by starting it from a standard browser.

488
Approximate Reasoning in Logistics

H.-J. Zimmermann

Fuzzy Technology has been used in logistics primarily in traffic management and based either on fuzzy control or on fuzzy cluster algorithms. In the recent pastapproximate reasoning has alsobeen used to handle very complex logistic assignment-type systems. Examples will be described below and in the presentation.

489
Generation of Evaluation Function for Robot Force Control Using Genetic Programming

Kazuo Kiguchi, Keigo Watanabe, Kiyotaka Izumi, Toshio Fukuda

Force control is one of the most important and fundamental tasks of robot manipulators. It is known that a neuro-fuzzy control method is one of the best control methods for robot force control. Usually, the neuro-fuzzy controller is trained to minimize the error function. However, unexpected response such as overshooting or oscillation might occur as far as only the control error is evaluated, since the dynamics of the robot and the environment is not reflected in the evaluation function. In this paper, we propose an effective evaluation function generation method using genetic programming. The effectiveness of the proposed method was evaluated by simulation.

490
Further Investigations on Friction Compensation Using a Neuro-Genetic Based Hybrid Framework

N. Chaiyaratana, K. Boonlong

This paper presents further investigations into the use of a neuro-genetic based hybrid framework within a model-based friction compensation scheme in a closed-loop robotic system. The hybrid framework is composed of a number of neural network modules and a genetic algorithm module. The neural networks are used to perform a function approximation task while the role of the genetic algorithm is to search for an optimal combination between different neural structures during the generalisation process. In the previous work, the genetic algorithm has successfully located an optimal combination between radial-basis function networks and multilayer perceptrons and that between radial-basis function networks and modular networks. The extension presented in this paper covers the modification on the genetic algorithm to include two additional genetic operators: fitness scaling and diversity control operators. In addition, the search for an optimal combination between different neural s! tructures is also extended to the case of the combination between radial-basis function networks, multilayer perceptrons and modular networks. The simulation results indicate that the friction compensation performance is further improved after the genetic algorithm and the search space has been modified. This helps to reveal the full potential of the hybrid framework in the friction compensation task.

491
Fuzzy Adaptive Q-Learning Method with Dynamic Learning Parameters

Yoichiro Maeda

An active search in the reinforcement learning disturbs the learning process when learning proceeds and converges to a partial search area. Therefore, it is important to balance between searching behavior of the unknown knowledge and using behavior of the obtained knowledge. In this research, we propose an adaptive Q-learning method

tuning learning parameters of the reinforcement learning by fuzzy rules. We also report some results of artificial ants simulation using this method.

492
Application of Evolutionary Artificial Potential Field in Robot Soccer System

Prahlad Vadakkepat, Tong Heng Lee, Xin Liu

Evolutionary Artificial Potential Field (EAPF) functions are utilized for mobile robot navigation in a micro-robot soccer (MiroSot) environment. In a micro-robot soccer system the robots are monitored using an overhead CCD Camera, making it suitable for real time application of the EAPF functions. The effectiveness of the EAPF functions in real time mobile robot navigation are verified through experimentation. The EAPF functions proposed are tested in different scenarios related to ball tracking and ball kicking, while facing competition from other robots.

493
Self-Consciousness and Emotion for a Pet Robot with Structured Intelligence

Naoyuki Kubota, Fumio Kojima, Toshio Fukuda

This paper deals with a pet robot with structured intelligence. The pet robots require several capabilities such as perceiving, acting, surviving, and communicating with human. The communication is very important in order that an owner grows the friendlyship with a pet robot. Furthermore, an internal model independent of environmental states is also important, because the pet robot should be seen to be alive. Therefore, this paper discusses emotions and self-consciousness for a pet robot. We consider two assumptions about self-consciousness. First, the self-consciousness is activated when temporal change of perceptual information is relatively big. Second, the self-consciousness is activated when the predicting perceptual information is different from the actual perceptual information. Furthermore, we discuss the unit of the behavior using a modular neural network for robotic systems. We conduct several computer simulations and experiments based on these assumption.

494
Environmental Valuation by Using Fuzzy-Neural System Realizing the Method II of Fuzzy Quantification

K. Okuhara, H. Fujita, T. Tanaka

This paper propose a system evaluating environments by using a method II of fuzzy quantification. We first give outlines of method II of fuzzy quantification. It is known, however, that a usual canonical correlation analysis including the method II of fuzzy quantification can not be applied when Cholesky decomposition can not be calculated. In order to correspond to such case, we derive a fuzzy neural network which can execute the method II of fuzzy quantification, and we incorporate the fuzzy neural network into the proposed system.

495
Fuzzy Control of an Autonomous Helicopter

B. Kadmiry, D. Driankov

This work aims at designing a velocity controller for the unmanned helicopter APID MK-III by Scandicraft AB in Sweden. The controller regulates high horizontal velocities via stabilization of the attitude angles. We use a novel approach consisting of two steps: (i) a Mamdani-type of fuzzy rules are used to compute desired values for the attitude angles and the main rotor collective pitch; (ii) a Takagi-Sugeno controller regulates the attitude angles so that the helicopter achieves its desired horizontal velocities at a desired altitude. The performance of the combined linguistic/model-based controllers is evaluated in simulation and shows that the proposed design method achieves its intended purpose.

496
A New Fuzzy Reaching Law for Discrete-Time Variable Structure Control Systems

Yi-Ming Lai, Rey-Chue Hwang, Chun-Jung Chen, Chin-Wen Chuang, Gwo-Ruey Yu

In this paper, a new fuzzy reaching law for discrete-time variable structure control systems is developed. Based on this law, a discrete controller and its control algorithm that satisfies the Lyapunov stability can be easily derived and developed. Compare with the traditional reaching law, the new fuzzy reaching law we proposed has much better performance. The steady state error caused by delay of sampling of discrete system could be greatly reduced.

497
A Fuzzy Radial Basis Function Neural Network for Predicting Multiple Quality Characteristics of Plasma Arc Welding

Sheng-Chai Chi, Li-Chang Hsu

This research attempts to develop an intelligent decision support system for plasma arc welding based on fuzzy Radial Basis Function (RBF) neural network. This approach may solve the following problems: (1) time-consuming of learning in back-propagation neural network, (2) fluctuation of the values of parameters during welding, and (3) fuzzy linguistic-term judgment for welding quality. Based on the results obtained from the Taguchi experiments, the developed fuzzy neural network can be trained to establish a quality prediction system for plasma arc welding. The developed system can also be applied to predict the welding quality for the different designs of welding parameters, which are not trained. In addition, the system may support for plotting the diagrams of three-dimensional suitability region of the three parameters when one parameter is fixed.

498
On the Development of an Optimal Parametric Fuzzy Controller by Genetic Algorithms

Chih-Hsun Chou

One way of systematic approach for fuzzy controller design is the applying of genetic algorithms (Gas). The Gas, however, are much applicable to a numerical type optimization problem. A traditional fuzzy controller contains both linguistic type rules and numeric type reasoning, hence transforming a fuzzy controller design into a Gas-applicable optimization problem becomes the first subject in the design approach. So, in this paper, we present an index function to represent the linguistic control rules in terms of numeric indices. By this way, GAs-design approach becomes feasible. The index function has a tunable parameter, which is adaptive to the controlled system and is novel to the fuzzy rule in a TSK type fuzzy controller. Simulation results with a second order damping system are presented to show the performance of the proposed fuzzy controller.

499
Fuzzy Control of Brushless DC Motors by Gray Prediction

Gwo-Ruey Yu, Chin-Wen Chuang, Rey-Chue Hwang

A novel control technique of brushless dc motors is proposed in this paper. The design of the fuzzy controller combined with a gray predictor is used to improve the response of a brushless dc motor. Using a gray predictor to predict the speed errors of the motor and then a compensated energy will be generated which can be used in adjustment of the control energy of the system. Simulation results show that the performance of the control energy and the motor speed is ameliorated.

500
Spatial Interpolation Using Conservative Fuzzy Reasoning

Kok Wai Wong, Tamas D. Gedeon, Patrick M. Wong

Spatial interpolation is an important feature of a Geographic Information System, which is the procedure used to estimate values at unknown locations within the area covered by existing observations. In this paper, we propose a conservative spatial interpolation technique that incorporates the advantages of local interpolation, Euclidean interpolation, and conservative fuzzy reasoning. The main objective of this paper is to formulate a computationally efficient spatial interpolation technique similar to the IDWA technique that can be used in real time application. The main feature of our spatial interpolation technique is inherited from the concept used in conservative fuzzy interpolation reasoning for interpolating fuzzy rules in sparse fuzzy rule bases. Illustration examples from a rainfall spatial interpolation problem are also used to illustrate the applicability of the proposed technique.

501
Supervised Training Algorithm for B-Spline Neural Networks and Fuzzy Systems

Antonio E. Ruano, Critiano Cabrita, Jose V. Oliveira, Domonkos Tikk, Laszlo T. Koczy

Complete supervised training algorithms for B-spline neural networks and fuzzy rule-based systems are discussed. By introducing the relationships between B-spline neural networks and Mamdani (satisfying certain assumptions) fuzzy model, training algorithms developed initially for neural networks can be adapted to fuzzy systems. The standard training criterion is reformulated, by separating the linear and nonlinear parameters. By employing this reformulated criterion with the Levenberg-Marquardt algorithm, a new training method, offering a fast rate of convergence is obtained. It is also shown that the standard Error-Back Propagation algorithm, the most common training method for this class of systems, exhibits a very poor performance

502
Notes on Sugeno and Yasukawa's Fuzzy Modelling Approach

Domonkos Tikk, Gyorgy Biro, Laszlo T. Koczy, Tamas D. Gedeon, Kok Wai Wong

This paper deals with Sugeno and Yasukawa's qualitative fuzzy modelling. This method creates a fuzzy rule base (a set of fuzzy if-then rules) from sample input-output data, and assigns meaningful linguistic labels to the fuzzy sets in the rule base. This assignment is very important in fuzzy systems, because it makes the behaviour of system, which is modelled by the rule base, easily interpretable and transparent. In the original paper there are some details which are not quite clear, thus, require clarification or leave room for improvement. These problems concern the determination of trapeze membership function, the rule projection from sample data, the selection of important variables, and the parameter identification.

503
Fuzzy Signatures in Data Mining

Tibor Vamos, Laszlo T. Koczy, Gyorgy Biro

Fuzzy signature has a special role in data mining, concerning data mixed with human estimates. The semantics of the fuzzy concept is a relevant is- sue of data interpretation. A software system was developed to implement these ideas and works on a rather extensive database of a two-decade neurodev- elopmental project. Another project initiated in the subjects of transition economy and society is ongoing. Delicate problems of sensitivity and the re- thinking of principal component and factor analysis for fuzzy data are current research issues.

504
Fuzzy Modelling in Energetic

Antal Penninger, Tibor Tari, Sandor Konczol, Laszlo T. Koczy, Peter Varlaki

Abstract - Application of fuzzy control in consumer electronics is a daily practice. In energetic there are also promising areas, especially in power industry, air conditioning and heating technology. We attempt to apply fuzzy control technique to small household boilers. A demonstration of this application is presented in this paper. The goal was to keep the outcome temperature of the domestic hot water at a given constant value; meanwhile the temperature of the incoming water was changed. We also examined the effects of the regular and random perturbation in the input mass flow. At last we pointed out some potential possibilities of this development in the increase of the energetic and environmental effectiveness. In the first step, the control algorithm is based on the well-known classic Mamdani approach, because in this system the number of variables is small. However, in further prospective systems we will integrate several components and our intention is to use various complexity reduction approaches e specially fuzzy rule interpolation techniques. At these complex systems the hierarchical interpolative fuzzy control will be reasonable and applicable.

505
Fuzzy Interpolation with Cartesian Representation and Extensibility Functions

Yeung Yam, Laszlo T. Koczy

This paper summaries the application of the recently proposed Cartesian representation of membership functions to the problem of fuzzy interpolation. It is shown that under this formulation the problem can be separated as whether the observation lies within or outside the antecedent spanning set. For the former, the observation contains the same geometric properties as the given antecedents, and interpolation can be conducted based on the given rules using the extensibility function concept. On the other hand, observation lying outside the antecedent spanning set contains new geometric properties beyond those of the given rules, and heuristic reasoning must therefore be applied. A two step approach with flexibility to accommodate additional criteria and design objectives is presented for this case.

506
A Fuzzy Petri Net Approach to Decision-Making in Case of Railway Track Closures

Alexander Fay

Modern train traffic systems have to fulfill high requirements on service reliability and availability. This becomes especially important with competitive transport markets. Train operators can only meet with these requirements by quickly developing an efficient action in case of traffic disturbances. This paper describes a dispatching support system which is employs fuzzy expert knowledge. The approach is based on a Fuzzy Petri Net notion that combines the graphical power of Petri Nets and the capabilities of Fuzzy Sets to model rule-based expert knowledge in a decision support system. An assistant system for train traffic control is presented, and the advantages of this Fuzzy Petri Net notion are shown in the context of a complex railway on-line control problem.

507
Applying Fuzzy Set Theory to Measuring Air Transportation Service Quality

Tsuen-Ho Hsu

This paper describes the development of fuzzy measuring process for assessing customer perceptions of service quality in airlines. After a discussion about the conceptualization of the service quality and PZB model for measuring consumer perceptions of quality, we describe the procedures used in constructing a fuzzy evaluation model that uses fuzzy number to present the fuzzy rating, and Hamming distance method to measure the service quality. In the end, we use Taiwan domestic airlines as an example to describe the evaluation process, to analysis the service quality improvement strategy and to compare our model with PZB model.

508
Fuzzy Adaptive Traffic Signal Control - Principles and Results

Jarkko Niittymaki, Riku Nevala

Abstract Traffic engineering handles complex problems that include several objects, some of which are conflicting. Subjective and illogical behavior of traffic users still increase the vagueness of the transportation planning and study. Fuzzy logic and its capability to imitate human decision-making provide systematic approach to the multi-objective problem solving, which makes it competitive method also in traffic signal controlling.

Results of several studies indicate good performance of fuzzy traffic signal control compared to traditional vehicle actuated signal control. In general, fuzzy control has been proved to be an effective in minimizing delays, maximizing traffic safety, and minimizing fuel consumption. In addition to the simplest and most studied fuzzy signal control of isolated intersections, the performance of fuzzy logic in more complicated traffic systems, such as coordination and areal signal control, has been promising.

509
Hierarchical High Level Fuzzy Petri Nets - An Enhancement through Place Substitution

Heloisa Camargo

This work presents an additional type of hierarchical construct in the Hierarchical High Level Fuzzy Petri Net, namely the substitution of places. The Hierarchical High Level Fuzzy Petri Net was introduced before as a tool suited to compositional modeling of fuzzy knowledge, using the substitution of transition. A Hierarchical HLFPN is a set of ordinary HLFPN that we call pages, each one describing a Knowledge Base is a different level of abstraction. The modeling tool capabilities are now augmented through the proposal of using substitution of places as a different focus on the application of the hierarchical con-

cept on the topic of fuzzy knowledge bases development. Both substitution transition and substitution place allow the replacement of a node in a net by a subnet, comprising a more precise and detailed descriptions of the knowledge base portion represented by the correspondent node. The Hierarchical HLFPN is briefly reviewed, together with the definition of substitution transition. The substitution of places is then described as an alternative modeling construct, that allow to hide or show different types of transitions. The use of both abstraction process - substitution transition and substitution places - is discussed based on the representation of parallel rules.

510
Sensor Fusion: A Rough Petri Net Model

J.F. Peters, S. Ramanna, M. Borkowski, Andrzej Skowron, Zbigniew Suraj

This paper introduces the use of Rough Petri Nets to model sensor fusion. Considerable work has already been carried out in modeling various forms of systems with Petri Nets. The aim of the earlier as well the current research has been to provide a complete framework for approximate reasoning. This paper returns to the idea of Rough Petri Nets to model sensor fusion. Guarded transitions based on multivalued logic and rough sets are used to design Petri Net models of sensors and filters. Dill Receptor processes are used to define input places that model sensors. Rough Integrals are used to design particular forms of Lukasiwewicz guards. The contribution of this paper is the modeling of fusion of sensors considered relevant in a problem-solving system. An application of this approach is given in fusing homogenous sensors.

511
A Method to Adjust Observed Transportation Data: Application to Passenger Counts on a Transit Line

Shinya Kikuchi, Dragana Mijkovic

Traffic volume is a critical information in transportation planning. The observed values usually do not satisfy various physical relationships, e.g. in-flow = out-flow. We propose a procedure that adjusts the observed values so that they meet the basic physical principle and usable for analysis, given the subjective information about the characters of the observed values. Adjustment is based on fuzzy optimization in which the observed values and basic knowledge about the relationship among the observed volumes are considered fuzzy. The method is applied to estimate transit ridership at individual stops.

512
Subjective Explanations of Pictures Considering Consistency between Pictures

Shigeru Kato, Takehisa Onisawa

This paper describes the system that outputs linguistic expressions of pictures considering consistency of their contents and connections, where pictures are given in any order. Picture information obtained from given pictures is inputted into the system. The system gets descriptions of basic contents of each picture using neural network models, fuzzy reasoning and case-based reasoning. The connective relationships between pictures are also explained using case-based reasoning. If the contradictory relationships between pictures are obtained, they are eliminated from linguistic expressions. The system outputs linguistic expressions including basic contents of pictures and relationships between pictures. Finally, simulation experiments show that the presented system is useful.

513
Kansei-Keyword Extraction from Japanese Film Scenario Using Sensitivity Information

Yasufumi Takama, Misako Kawabe, Kaoru Hirota

A method of extracting kansei-keyword from Japanese film scenarios based on their sensitivity information is proposed. The kansei-keyrword extracted from each scene in a film is useful as the index to retrieve scenes in the film. In addition to the relations between kansei-keywords (usually paired with the antonymous keyword) and sensitivity expressions, which has been used in former studies, the relations among sensitivity expressions within the same sentence are also considered to extract kansei-keywords from scenarios. The 20 pairs of kansei-keywords are selected based on the questionnaire to 50 people, who frequently watch the movies, while the relations between selected kansei-keywords and 1171 sensitivity expressions are determined based on another questionnaire to 27 people. The kansei-keywords of a scene are determined based on the impressive information of all sentences in it, which are calculated from the relation between sensitivity expressions. Experiments are done! with Japanese film scenario, Shall we dance?, and it is confirmed that both of the recall rate and the precision are 70%, which is sufficient for the applications such as a scene retrieval systems.

514
A Negotiation Support Tool Using Emotional Factors

Masahide Yuasa, Yoshiaki Yasumura, Katsumi Nitta

In this paper, We introduce a new support tool for participants of negotiation through a computer network using emotional factors. The emotional factors are important in negotiation, since the participant's decision is affected by emotional factors such as their emotional disturbances, the impression of opponent's attitude and so on. In order to consider a negotiation strategy using emotional factors, we constructed a new state graph model. This model describes how participants' emotional status is affected by the opponent's proposal and the opponent's attitude. Based on this model, we made the negotiation support tool by which users exchange their proposal and their emotion by facial expression of an interface agent. This tool shows the user the proper action to take next by considering the opponent's proposal and the facial expression. We showed the availability of negotiation strategy using the state transition model by a computer simulation.

515
Decision Trees as a Model of Chance Perception

Yukio Ohsawa, Yumiko Nara

The results of interviews to refugees of south-Hyogo earthquake (1995, M7.2) meant that the human process into the awareness of rare hazards is composed of context-shifting of people. Supported by studies in cognitive science relevant to risk management, this paper models context-shifting by means of decision trees, with nodes describing human-concerned contexts and situations. The optimal explanation, i.e., the most useful statement for navigating people to the understanding of the meaning of a certain event or situation, is formalized as the shortest path on the set of decision trees connected by loose bridges, from his/her initial concern to the understanding of the situation/event in question. This framework is devoted especially to aiding people in dealing with rarely significant situations, i.e. fatal risks or beneficial opportunities, which we call chances here.

516
Affective and Social Behavior in Animated Agents

Helmut Prendinger, Mitsuru Ishizuka

This paper introduces a model of interaction between users and animated agents as well as inter-agent interaction that supports basic features of affective conversation and social interaction. As essential requirements for animated agents' capability to engage in and exhibit affective and social communication we motivate reasoning about emotions and emotion expression, personality, and social role awareness. The main contribution of our paper is the incorporation of `social filter programs' to mental models of animated agents. Those programs may qualify an agent's expression of its emotional state by the social context, thereby enhancing the agent's believability as a conversational partner. Our implemented system is entirely web-based and demonstrates animated agents with affective and social behavior in a virtual coffee shop environment.

517
Information Presentation Based on Estimation of Human Multimodal Cognitive Load

Fumio Wada, Mitsuru Iwata, Shun'ichi Tano

Our goal is an implementation of an adaptive system for presenting information in high-cognitive load environment. Users in such environments include car drivers, aircraft pilots and plant operators. We have examined models to estimate user's cognitive load for planning and creating a great variety of information presentation formats, and set up three hypotheses. This paper describes an experiment to measure subjects' response to various combinations of information presentation formats in order to verify these hypotheses. The results suggest that various combination of information presentation formats influence the ability that subjects recognize them and there is some possibility that these hypotheses are valid.

518
Counterfactuals and Other Philosophical Challenges to Machine Intelligence: A Fuzzy View

Timo Airaksinen

My plan in this paper is to map out some of the remaining challenges to artificial intelligence from the point of view of the philosophy of fuzzy logic. I try to show that human reasoning is an extremely complex procedure which is able to handle such problems as counterfactual truth, which are difficult to explain in terms of logical theory. If we want to achive this, we need to understand them in a more natural manner than the standard positivistic logic is able to do. Counterfactual reasoning employs notions like the distance between possible worlds and the mental costs of reasoning. Also the whole notion of truth becomes a problematic explanandum, instead of being an explanans. Certain key ideas of L. Zadeh are used as points of reference.

519
Information Granulation Modelling in the Human Sciences

Vesa A. Niskanen

The aim of soft computing is to mimic human reasoning. This is carried out well by using Zadeh's theories such as the theory of the information granulation. This aim also presupposes that the methods of the human sciences, both quantitative and qualitative approaches, should be applied. These methods are briefly described, and a soft computing modelling example concerning the hypothesis assessment simulation in the conduct of inquiry is pre-sented.

520
Extension Structures and Compactifications

Werner Gaehler, Patrik Eklund

In this paper basic results on compactifications are presented applying the notion of extension structure. Each extension structure has a canonical completion. The related completion constructions can be applied for instance for generating completion theorems in algebra, lattice theory and general topology, in particular they lead to a universal completion for Cauchy-spaces in the fuzzy filter case.

Since compactifications can be identified with special Cauchy-completions, even different types of compactifications can be generated. Among others, we present in this paper new results on the Richardson compactification in the fuzzy filter case applying new results on fuzzy filters.

521
Diagonal Method for Modifying Fuzzy Numbers

Jorma K. Mattila

Basing on diagonals of square matrices, the diagonal method is created for modifying triangle-shaped fuzzy sets. The method can be used as both fuzzification and defuzzification procedures. The method

is connected to a so-called standard system of fuzzy numbers. A standard fuzzy n umber is a fuzzy set of the set of real numbers having triangle-shaped symmetric membership function such that the area of the triangle is one. Using diagonal method we can modify a standard fuzzy number into a form of any triangle-shaped fuzzy set, and vice versa. There are also connections to arithmetic operations in the set of standard triangle-shaped fuzzy numbers (the first idea about standard fuzzy numbers is due to the author). Some examples are given concerning standard fuzzy integers.

522
On Coarsenings of L-Sets

Jari Kortelainen

Usually, L-sets are understood to be functions on the universe U, where L is a complete lattice satisfying, perhaps, some additional properties. However, knowledge about the universe, e.g., topologies, may restrict us to determine level sets of L-sets. L-sets are defined on a topological space and in this case some level sets may not be closed in that topology. Then, Representation Theorems, presented by Negoita and Ralescu, can be applied to determine a class of coarsenings of an L-set by means of a topology on the universe. An operation for computing a specific coarsening of an L-set is proposed and some properties of this operation is studied.

523
The Thought and Model of Linguistic Regression

Junzo Watada

Generally it is important for human experts to express their ideas and thoughts. Human words are basically employed in these expressions. So we employ fuzzy regression analysis to handle human words and find the latent structures under these human words and build a linguistic regression model. As Professor L. A. Zadeh has placed the stress on the importance of the computation of words, it is a central role in handling words to treat fuzzy sets. Fuzzy logic is offen thought as the main tools to deal with human words. In this paper we intend to present another approach to handle human words instead of fuzzy logic. That is, fuzzy regression analysis enables us deal with the computation of words.

We intend to abstract the latent structure under the relations between words. Human words can be translated into fuzzy sets such as fuzzy numbers. If it is possible such as fuzzy control, we can build the relations under the data in terms of fuzzy regression analysis.

Consequently, only experts with much professional experiences are capable of making assessment using their intuition and experiences. The measurements and interpretation of these characteristics are taken with uncertainty, because most measured characteristics, analytical result, and field data can be interpreted only intuitively by experts. In such cases, judgments may be expressed by experts with linguistic terms. The difficulty in the direct measurement of certain characteristics makes the estimation of these characteristics imprecise. Such measurements may be dealt with the use of fuzzy set theory. Watada, Fu and Yao proposed in 1984 a model of damage assessment by using the information given by experts through fuzzy multivariant analysis.

In order to process linguistic variables, we define the vocabulary translation and vocabulary matching which convert linguistic expression into membership functions on the interval [0-1] on the basis of a linguistic dictionary, and vice versa. We employ Fuzzy Regression Analysis modeled by H. Tanaka, J. Watada et al in order to deal with the assessment process of experts' from linguistic variables of features and characteristics of an objective into the linguistic expression of the total assessment.

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A Data Mining Approach for Fuzzy Classification Rule Generation

Dianhui Wang, Tharam S. Dillon, Elizabeth J. Chang

This paper aims at developing a data mining approach for fuzzy classification rule generation. A regularization theory based theoretical framework for refining fuzzy classification rules is proposed. Our fuzzy rule induction methodology has four phases, namely: (1) ellipsoidal crisp rule generation with membership function assignment, (2) generic hyperbox fuzzy rule (GHR) derivation,(3) refinement of the GHR using a regularization model, and (4) simplification of the GHR by selecting an informative subset of premises out of the initial set.

525
Case-Base Reduction Using Learned Local Feature Weights

Eric C.C. Tsang, Simon C.K. Shiu, X.Z. Wang, Keith Ho

Case-base reasoning (CBR) systems using previous cases to solve new, unseen and different problems have drawn great attention recently. It is true that the number of cases stored in the case library of a CBR system is directly related to the retrieval efficiency. Although more cases in the library can improve the coverage of the problem space, the system performance will be downgraded if the size of the library grows to an unacceptable level. This paper addresses the problem of case base maintenance by developing a new method to reduce the size of large case libraries so as to improve the efficiency while maintaining the accuracy of the CBR System. To achieve this, we adopt the local feature weights approach. This approach consists of three phases. The first phase involves partitioning the case-base into different clusters. The second phase involves learning the optimal local feature weights for each case and the final phase involves reducing the case-base based on the optimal local weights. This paper focus es on the last two phases. To justify the usefulness of the method, we perform an experiment which uses efficiency, competence, and ability to solve new problems as the benchmark to verify our design.

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Clustering and Classification of Cases Using Learned Global Feature Weights

Eric C.C. Tsang, Simon C.K. Shiu, X.Z. Wang, Martin Lam

Case-base Reasoning (CBR) systems have attracted great attention in recent years. It is a system that allows user to store, share and reuse what has been stored inside the system. It is similar to the way we solve unknown problems by using our experience and knowledge. When the case-base size increases, it is very difficulty to maintain the case-base, for example when similar cases have accumulated, anomalies such as redundant cases, conflicting cases, ambiguous cases, subsumed cases and unreachable cases may exist in the case-base. This is the so called case-base maintenance (CBM) problem. This paper proposes a method to improve the performance of clustering and classification of cases in a large-scale case-base by using a learned global feature weight methodology which is based on the idea that we could use similarity measure to find several concepts (clusters) in the problem-domain such that those cases in a cluster are closely related among themselves while among different clusters those cases are farther apart. An experiment demonstrates that the performance of clustering with learned global feature weights is much better than the performance without global feature weights in terms of the retrieval efficiency and accuracy of solution provided by the system.

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Mining Generalized Fuzzy Quantitative Assocation Rule with Fuzzy Generalization Hierarchies

Keon-Myung Lee

Association rule mining is an exploratory task to discover some hidden dependency relationships among items in transaction data. Quantitative association rules denote association rules with both categorical and quantitative attributes. There have been several works on quantitative association rule mining such as the application of fuzzy techniques to quantitative association rule mining, the generalized association rule mining for quantitative association rules, and importance weight incorporation into association rule mining for taking into account the user's interest. This paper introduces a new mining method for generalized fuzzy quantitative association rule mining with importance weights. The method uses fuzzy concept hierarchies for categorical attributes and generalization hierarchies of fuzzy linguistic terms for quantitative attributes. It enables the users to flexibly perform the association rule mining by controlling the generalization levels for attributes and the importance weights for attributes.

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Intelligent Scheduling Management for QoS-Enabled Wireless Ad Hoc Network with Fuzzy Rule-Based System

Kevin Thankakan, Thanachai Thumthawatworn, Pratit Santiprabhob

In this paper, we consider a large group of mobile stations that are interconnected by a multihop network, namely ad hoc network. This network has an ability to operate without any existing wired or wireless infrastructure. The essential characteristics of this kind of network are a large number of nodes (also referred to as mobile users), node's mobility, and a need to support various kinds of services. To guarantee the quality-of-service (QoS) in an ad hoc network is quite challenging because the network's topology can change at anytime. In order to tackle the problem, we introduce an innovative scheduling management scheme utilizing a fuzzy rule-based system. This scheme takes in to account queue length, link stability, link utilization, and packet's deadline. Experimental results reveal that the purposed scheme offers a promising performance in maintaining the network's QoS.

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Query Fuzzy Association Rules in Relational Database

Joyce Y. Shu, Eric C.C. Tsang, Daniel S. Yeung

An important issue to extend database management systems functionality is to allow the expression of imprecise queries to make these systems able to satisfy user needs more closely. In the last few years, some authors have dealt with the problem of relaxing the relational model in order to admit some imprecision. Two significant data mining problems have been addressed recently, namely, the mining fuzzy association rules, and set-oriented mining for association rules in relational database (SETM algorithms). At present, the problem how to express the mining fuzzy association rules algorithm as SQL queries have not been proposed. In this paper, we attempted to develop a fuzzy version of SETM algorithms that can be expressed as SQL queries in relational databases and discuss optimization of the algorithm.

530
Modeling of a Drying Process using Subtractive Clustering Based System Identification

Radu Platon, Mouloud Amazouz

This paper describes the modeling of an industrial drying process into a three-input one-output first order Sugeno system. An objective system model is identified from input-output data of the system by applying the subtractive clustering algorithm. The input-output data represents process parameters measured during the drying of starch in a jet spouted dryer. Minimum error models are obtained through enumerative search of clustering parameters. A set of checking data is used to verify the model output. The optimal model, as well as its output, is presented. The step size used in the clustering parameter search is varied and its influence on the modeling performance is presented. Models obtained by setting the same cluster radius for all data dimensions and models obtained by setting a cluster radius for each data dimension are computed and their performance is compared.

531
Fuzzy Perturbation of Vector Fields

Laecio C. Barros, Pedro A. Tonelli

We start a study of additive fuzzy perturbation to a deterministic vector field. This is done using similar procedures from random

dynamical systems and affine control theory, and an effort is made to identify the which kind of flow is involved in this theory. The perturbated vector field is the sum of fuzzy map to a drift field in Euclidean space. This gives rise to a fuzzy differential equation which can by interpreted in two ways. We make the comparisons of Kaleva solutions and Huellermeier solutions. Then in both case we prove that the deterministic trajectory remains in the levels of both solutions and that a trajectory in the sense of Huellermeier is also a trajectory in the sense of Kaleva.

532
Integrating Rules and Neural Nets for Carcinogenicity Prediction

Giuseppina Gini, Marco Lorenzini, Emilio Benfenati, Raffaella Brambilla, Luca Malve

One approach to deal with real complex systems is to use more techniques in order to combine their different strengths and overcome each other's weakness to generate hybrid solutions. In this project we pointed out the needs of an improved system in toxicology prediction. An architecture able to satisfy these needs has been developed. The main tools we integrated are rules and ANN. We defined chemical structures of fragments responsible for carcinogenicity according to human experts, developing a module able to recognize these fragments into a chemical. Furthermore, we developed an ANN, using molecular descriptors as inputs to predict carcinogenicity as a numerical value. Finally, we developed an automatic learning program to combine the results into a classifications of carcinogenicity to man.

533
Fuzzy Modeling of Hysteresis from Input-Output Data

Mak Tafazoli, Kudret Demirli

This paper summarizes work undertaken on the area of modeling of non-linearities such as hysteresis using the subtractive clustering procedure based on Takagi-Sugeno fuzzy systems. Multi-valued functions such as hysteresis are considered hard non-linearities since they are complex to model and are considered failure to linear analysis. As an application, we have chosen the airfoil hysterisis which is essentially a set of input-output data that represents a two-valued curve. The output (Normal Force Coefficient) depends on whether the input (angle of attack) is increasing or decreasing. In order to introduce the problem, the paper starts with an overview of the physics of airfoil and their basic concepts. Then, a brief description of fuzzy modeling is presented. We particularly focus on the Sugeno-type modeling as one of the popular fuzzy modeling approaches and further explain its application to hysterisis. Finally, we illustrate how the model reduction takes place and we review two (2) different approaches. The main idea here is to find a structure of if-then rules of the reduced model that agrees well with the dynamics of the original model. Finally some conclusions are drawn with respect to the merits of these fuzzy models.

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Fuzzy Control and Gain Scheduling-Case Study: Robust Stabilization of an Inverted Pendulum

M. Alata, K. Demirli

An interactive procedure is presented for controller design of nonlinear systems by integrating available classical as well as modern tools such as fuzzy logic, and neural networks. The proposed approach is based on quasi-linear dynamic models of the plant. Classical optimal controllers for each set of operating conditions were developed. These controllers are used to construct a single fuzzy-logic gain scheduling-like controller. Adaptive-neuro-fuzzy inference system was used to construct the rules for the fuzzy gain schedule. This will guarantee the continuous change in the gains as the system parameters change in time or space. The proposed approach is applied on a well known bench mark system which is the inverted pendulum.

535
A Technique for Fuzzy Logic Modeling of Machining Process

H. Al-Wedyan, K. Demirli, R. Bhat

Machinability is one of the important properties of a material. It is about cutting the material with maximum metal removal, in shortest time, with best surface finish while having maximum tool life. The high quality of surface finish is very important in order to face the required accuracy and marketing needs. In this paper we present a technique for modeling a machining process of Alumic-79 with 2 and 4-flutes cutting head. In this paper, optimum parameters, which are feed rate, spindle speed and depth of cut, are found for 2-flutes and 4-flutes cutting head to obtain a high quality surface finish.

536
A Fuzzy Guidance Law for Modeling Offensive Air-to-Air Combat Maneuver

Shahab Akbari, Mohammad B. Menhaj

In this paper we propose a new guidance law based on fuzzy logic that can be successfully used for modeling offensive maneuver in an special case of air-to-air combat encounters. Based on the fighter's pilot decision process, a two-phase pursuit law represented as fuzzy "if ... then ..." rules is introduced. The inputs to rule bases are x and y distance and heading angle and the output is the desired heading angle.Simulation results show that the proposed guidance law can produce satisfactory maneuvers against both non-maneuvering and maneuvering targets.

537
Choice of the Radial Basis Function Approximation in Neural Networks Used for Fuzzy System Implementation

Anthony Little, Leonid Reznik

The paper continues an investigation of the method proposing a fuzzy system implementation through its approximation with neural net-

works. This method allows an easy and cheap realisation on simple general purpose microprocessors popular with the industry. This paper concentrates on further simplification of realisation by the replacement of Gaussian radius basis function in neural networks with its linear and piecewise linear approximation. Different approximating possibilities are tested on four controllers chosen as benchmarks. The analysis has identified that the Gaussian basis function can be approximated without a significant change of error if the number of neurons is not too small.

538
Design of Neuro-Fuzzy Controller on DSP for Real-Time Control of Induction Motors

Tae-Chon Ahn, Yang-Won Kwon, Hyung-Soo Hwang, Witold Pedrycz

This paper deals with the DSP implementation of the high performance induction motor drive that presented on the viewpoint of the design and experiment. The speed control system for the induction motor drive is based on the ANFIS (Adaptive Network-Based Fuzzy Inference System) controller, that is, a sophisticated neuro-fuzzy controller. This ANFIS controller acts as a feed forward controller that provides the plant with the proper control input and accomplish error back- propagation algorithm through the network. In this paper, the DSP (TMS320F240) has been used to perform the high-speed calculation of the space vector PWM and to build the ANFIS control algorithm. It is confirmed that proposed algorithm provides the more improved control performance for the conventional V/F controller and Vector controller. The proposed ANFIS algorithm and DSP technique can be applied to the precise speed control of the induction motor drive system or the field of power electronics.

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Modeling the Real World for Data Mining: Granular Computing Approach

T.Y. Lin, Eric Louie

In logic, a "real world" is modeled by a Cantor set with relational structure. In this paper, the relational structure is confined to the simples kind, namely, binary relations.

From different consideration, in granular computing, such a binary relational structure has been called a crisp/fuzzy binary granulation, or binary neighborhood system (BNS/FBNS). Intuitively, the set has been granulated into binary neighborhoods (generalized equivalence classes). Combining the two views, the simplest kind of "real world" model is BNS-space.

From this view, the classical relational theory is the knowledge representation of the universe whose structure is a finite set of equivalence relations; in a "real world" relational theory, a finite set of crisp/fuzzy binary relations. Here knowledge representation is assigning meaningful names to binary neighborhoods (or equivalence classes in relational theory).

Depending on the structures, the model can be useful in fuzzy logic or data mining. The focus of this paper is on data mining using granular computing. Experiments show that the computing is extremely fast and the cost of computing extra semantics is very small.

540
Educational Evaluation Applying Approximate Reasoning

Jiro Inaida, Ei Tsuda, Akihiko Yanai, Hajime Yamashita

The monotonicity is the important point for applying fuzzy reasoning to "educational evaluation", "clinical decision making", etc. It is well-known that Mamdani's method doesn't always hold the monotonicity condition. Then, by defining some fuzzy mathematical concepts, "Normal Convex Fuzzy Set", "Fuzzy Partitioned Space", etc. we can mathematically introduce a new fuzzy reasoning method "Product-Sum-Gravity Method" that could make it clear the above point.

541
A Method to Induce Fuzzy Automata using Neural Networks

A. Blanco, M. Delgado, M.C. Pegalajar

It has been shown that neural networks are able to infer regular crisp grammars from positive and negative examples. The fuzzy grammatical inference problem however has received less considerably attention. In this paper we show that a suitable two-layer neural network model is able to infer fuzzy regular grammars from a set of fuzzy examples belonging to a fuzzy language. Once the network has been trained, we develop methods to extract a Deterministic representation of the fuzzy automaton encoded in the network that recognizes the training set.

542
Information Granulation via Neural Network-based Learning

G. Castellano, A.M. Fanelli

This paper concerns with an information granulation approach that is based on neural network learning. The approach involves three key phases. First, information granules are induced in the space of numerical data via a soft competitive learning algorithm with the ability to automatically determine the granularity level needed to properly model the data. Then, information granules are fuzzified, i.e. quantified in terms of fuzzy sets and used as building blocks of a fuzzy rule-based model. Finally, a supervised learning phase is applied to adjust the shape and the distribution of fuzzy granules. The approach is illustrated with the aid of a numerical example that provides insight into the validity of the induced granules and their effect on the results of computing.

543
Fuzzy Control of a Benchmark Problem: A Computing with Words Approach

Michael Margaliot, Gideon Langholz

The rotational/translational proof-mass actuator (RTAC)system was developed as a simplified model of a dual-spin spacecraft. It consists of two subsystems, a translational one and a rotational one, with a strong nonlinear coupling between them.

Later on, Dennis Bernstein and his colleagues at the University of Michigan posed it as a benchmark problem in nonlinear control: How to stabilize the entire system using the rotational actuator? Design approaches from classical linear control theory are not applicable because of the strong nonlinearity of the system.

A special issue of the "International Journal of Robust and Nonlinear Control" was devoted to describing the control problem and presenting several control design methods including optimal control theory, passivity theory, and more.

In this paper we systematically design a fuzzy controller for the system using fuzzy Lyapunov synthesis, which is a computing with words version of classical Lyapunov synthesis. The fact that linguistic, rather than exact, equations are used allows us to design a controller based on linguistic, rather than exact, description of the plant.

We prove that the resulting fuzzy controller stabilizes the system and describe its advantages with respect to conventional controllers: (1) The design of the fuzzy controller requires only linguistic information (that can be derived from physical intuition)regarding the system, whereas conventional design approaches require a mathematical model of the system. (2) The fuzzy controller is bounded whereas conventional controllers are not. This property can be very important in applications where physical limitations always pose bounds on the possible control actions. (3) There is reason to believe that the fuzzy controller is more robust than conventional controllers.

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Automatic Training of Generalized Min-Max Classifiers

A. Rizzi, M. Panella, F.M. Frattale Mascioli, G. Martinelli

Among fuzzy classifiers, Min-Max networks have the advantage to be trained in a constructive way, by a simple learning procedure. The classification strategy of Simpson's Min-Max classifier consists in covering the training data with hyperboxes constrained to have their boundary surfaces parallel to the coordinate axes of the chosen reference system. In order to obtain a more accurate data coverage, it is possible to adopt a new classification model which allows to arrange the hyperboxes orientation along any direction of the data space. The training algorithm is based on the ARC/PARC technique, which already yields better performances with respect to the original Simpson's algorithm. Although the most important feature of a classifier is its generalization capability, the effectiveness of a training procedure is strictly related to its automation degree. A low automation degree can be a serious drawback for a classification system, since it can prevent an unskilled user from successfully generate an acceptable model. From this point of view, a learning procedure should not depend on any critical parameter. The automation degree of the new classification system is evaluated in the paper.

545
A Term-Based Algorithm for Hierarchical Clustering of Web Documents

Adam Schenker, Mark Last, Abraham Kandel

In this paper we introduce the novel Class Hierarchy Construction Algorithm (CHCA) in order to create hierarchical clusterings of web documents. Unlike most clustering methods, CHCA operates on nominal data (the words occurring in each document) and it differs from other hierarchical clustering techniques in that it uses the object-oriented concept of inheritance to create the parent/child relationship between clusters.

A prototype system has been developed using CHCA to create cluster hierarchies from web search results returned by conventional search engines. CHCA, without any guidance, creates term-based clusters from the contents of the retrieved pages and assigns each page to a cluster; the clusters correspond to topics and sub-topics in the investigated domain. The performance of our system is compared with a similar web search clustering system (Vivisimo).

546
Label Prototypes for Modelling with Words

Jonathan Lawry

This paper suggests a framework for modelling with words using label prototypes. The underlying methods are based on a random set label semantics together with the voting model interpretation of fuzzy sets. An algorithm is introduced for learning tuples of mass assignments on words. These can be viewed as label prototypes describing, for example, a certain class of objects. A method is then presented for estimating classification probabilities from these mass assignments. These are incorporated into both a naive bayes and fully composed classification algorithm. The potential of this methodology is illustrated by its application to a number of benchmark classification problems.

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Computing with Words in Information Retreival

Fernando Berzal, Maria J. Martin-Bautista, Maria-Amparo Vila, Henrik L. Larsen

A study of the use of computing with words in the Information Retrieval Processes is presented in this paper. The lack of friendly interfaces of communication between the user and the system in traditional retrieval approaches is supplied with the use of Fuzzy Logic in the different levels of the retrieval process. The arising of the fuzzy Information Retrieval systems allows a linguistic representation, providing the user with a tool of understandable language based in words. Besides the outline of the fuzzy linguistic model in the processes of querying and evaluation, some reflections and future trends about the

linguistic modeling in the processes of user feedback and user profile construction are outlined.

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Optimization of Multi-pass Turning Operations Using Genetic Algorithms for the Selection of Cutting Conditions and Cutting Tools with Tool-wear Effect

X. Wang, I.S. Jawahir

In this paper, a new genetic algorithm-based method is formulated and applied for the optimization of cutting conditions and selection of cutting tools in multi-pass turning operations. A comprehensive optimization criterion for multi-pass turning operations is developed and used as the objective function integrating the contributing effects of major machining performance measures (cutting forces, tool-wear/tool-life, surface roughness, chip-form/chip breakability, etc.) in all passes. A new methodology for the allocation of total depth of cut in multi-pass turning operations is also developed. The effect of progressive tool-wear in optimization processes for multi-pass turning operations is included in the current work. Presented case studies demonstrate the application of the new methodology for optimal allocation of total depth of cut as well as optimization of cutting conditions and the selection of cutting tool inserts. This paper also gives a comparison of the results obtained for the optimization processes with and without the effect of tool-wear in all passes.

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Notes