

Fuzzy Classification

Seminar by :

Group No 7

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Agenda

- Fuzzy Classification for Online Customer Database
- Fuzzy Classification Query Language(fCQL)
- Advantages and Limitations
- Hierarchical Fuzzy Classification
- Example from tourism domain
- Conclusions

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An Example to start with

One of the Major areas of application of Fuzzy
Classification
Online Customer Database

Online Shop Example

Consider an online shop. The shop wants increase their customer base by giving discounts to profitable and loyal customers

Why to Classify?

To make intelligent decisions

Target

Building and maintaining customer loyalty

How?

By providing
customer services, sharing cost benefits with
online customers, and rewarding the
most valued customers

How to Identify most valued customers

Lets evaluate the customers on two attributes

Loyalty

Profitability

Loyalty

- **Domain:** {excellent, good, mediocre, bad}

Equivalence classes {excellent, good} for high
and {mediocre, bad} for low loyalty behavior

Profitability

- **Domain** : the attribute domain is defined by $[0, 1, \dots, 1000]$
- **Equivalence Classes** : $[0, 1, \dots, 499]$ for small and $[500, 501, \dots, 1000]$ for large profitability.

Point to note

Who decides these attributes, equivalence classes
etc.





Crisp Classes

		Excellent	Good	Mediocre	Bad	Loyalty
Profitability	1000	C1 Commit Customer		C2 Improve Loyalty		
	500					
	499	C3 Augment Turnover		C4 Don't Invest		
	0					

Problems

⬇ attractive

⬇ non attractive

	Excellent	Good	Mediocre	Bad	Loyalty
1000	 Smith C1		C2		
500	Brown 				
499	C3		 Ford C4		
0			Miller 		
Profitability					

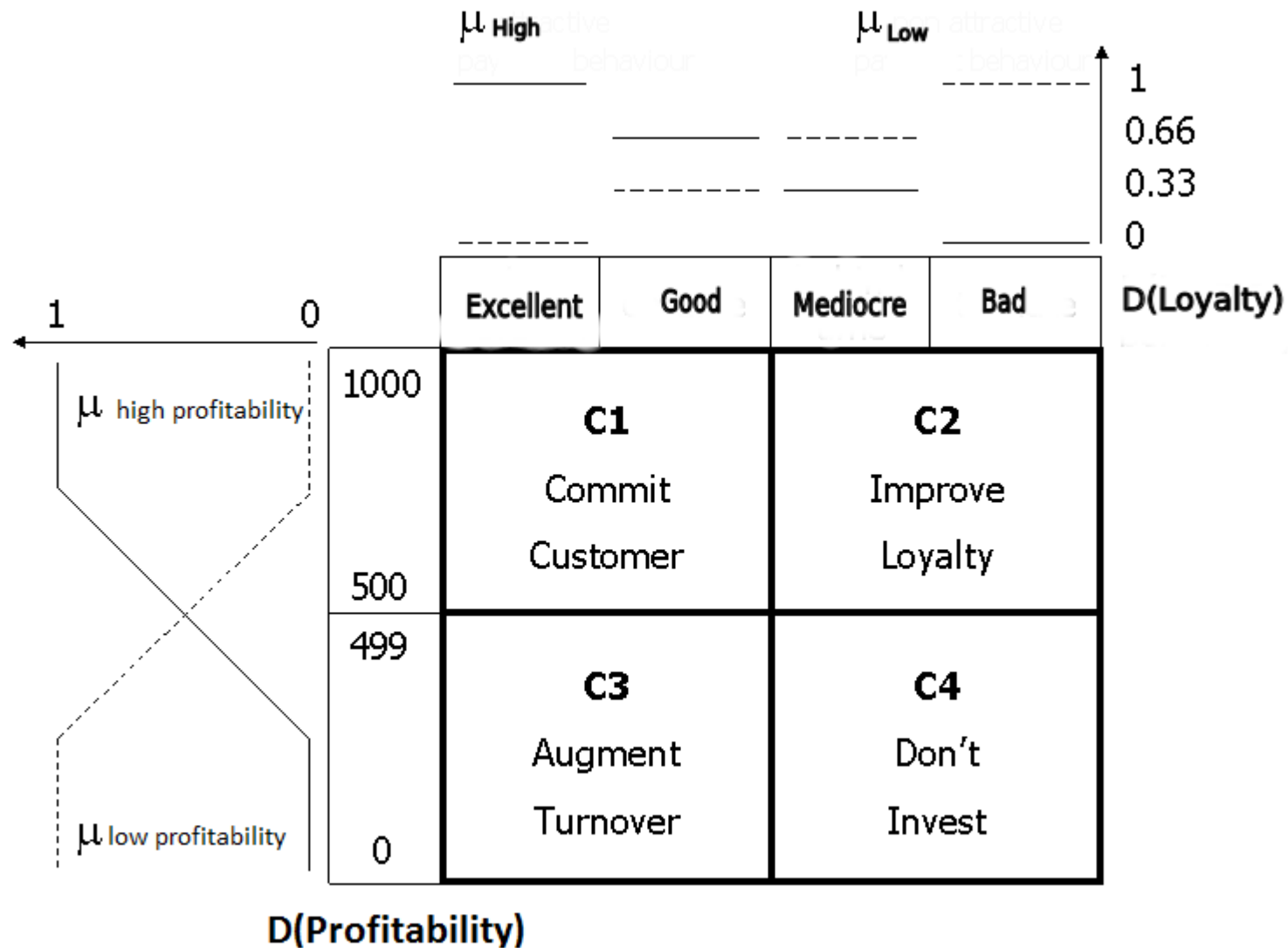
What we need here?

Way to maintain *individuality* of each customer

How?

- Make classes more finegrained
 - This may lead to infinite number of classes.
- Use Fuzzy Classification
 - We can give individual treatment to all points with finite number of rules using this.

Fuzzy Classes



Point to Note

Every object belongs to all equivalence classes
with different degrees of membership

These are *fuzzy objects*

Thinking OO way

- Objects have attributes and behaviour.
- An object is instance of a class. So all objects which belong to a class have same behaviour.

Thinking OO way

- Fuzzy objects belong to more than one class at the same time.
- The behaviour of the object depends on the degree of membership to each of the classes.

In our Example

- Class C1

10% discount

- Class C2

5% discount

- Class C3

3% discount

- Class C4

0% discount

In our Example

- Smith (C1:1.00, C2:0.00, C3:0.00, C4:0.00):
 $1.00 \times 10\% + 0.00 \times 5\% + 0.00 \times 3\% + 0.00 \times 0\% = 10\%$
- Brown (C1:0.28, C2:0.25, C3:0.25, C4:0.22):
 $0.28 \times 10\% + 0.25 \times 5\% + 0.25 \times 3\% + 0.22 \times 0\% = 4.8\%$
- Ford (C1:0.22, C2:0.25, C3:0.25, C4:0.28):
 $0.22 \times 10\% + 0.25 \times 5\% + 0.25 \times 3\% + 0.28 \times 0\% = 4.2\%$
- Miller (C1:0.00, C2:0.00, C3:0.00, C4:1.00):
 $0.00 \times 10\% + 0.00 \times 5\% + 0.00 \times 3\% + 1.00 \times 0\% = 0\%$

What we achieved here?

Fuzzy Classification

- ✓ Smith gets highest
- ✓ Brown does not get same discount as that of Smith
- ✓ Ford gets some discount

Crisp Classification

- Smith gets highest
- Brown gets same discount as that of Smith
- Ford gets no discount

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Fuzzy Classification Query Language

An example in customer relationship management could be given as follows:

classify Customer

from CustomerRelation

with Profit is **large** *and* Loyalty is **high**

This classification query would return the class C1(commit customer) defined as the aggregation of the terms large profit and high loyalty.

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Advantages

- Individual treatment to all objects
- FCQL makes it easy for the decision makers to express their ideas using natural language.

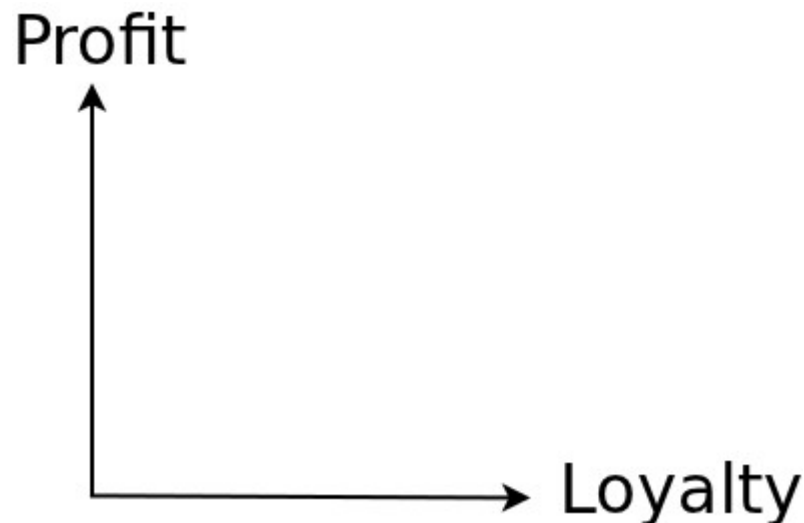
Limitations

- Non-usage of training data for profile generation.
- In other words, domain experts generate the profiles.

Solution – Machine learning techniques can be applied.

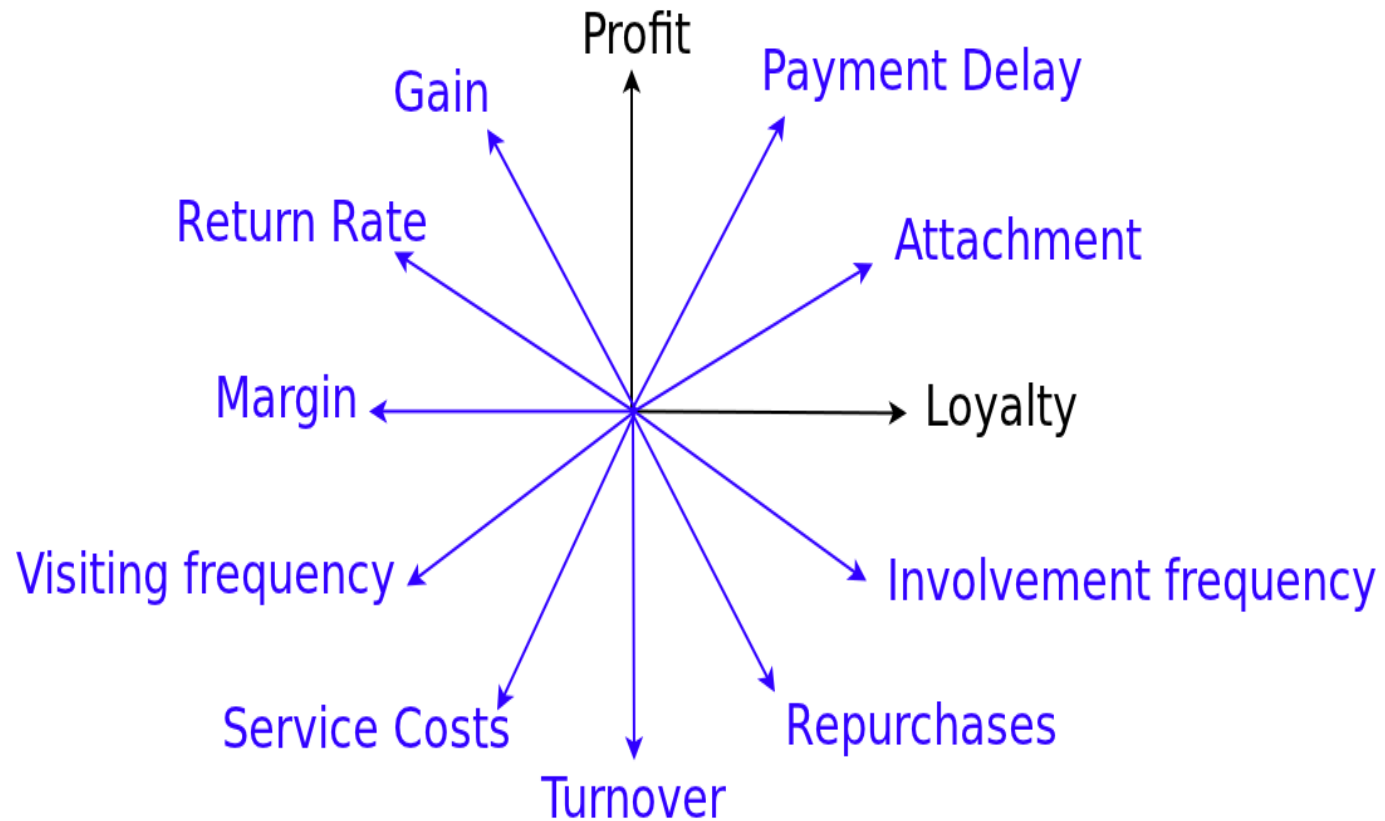
Limitations

- Fuzzy classification becomes **cumbersome** to use when number of linguistic variable are **large**.
- In the previous example, customer was evaluated on two dimensions-



Limitations

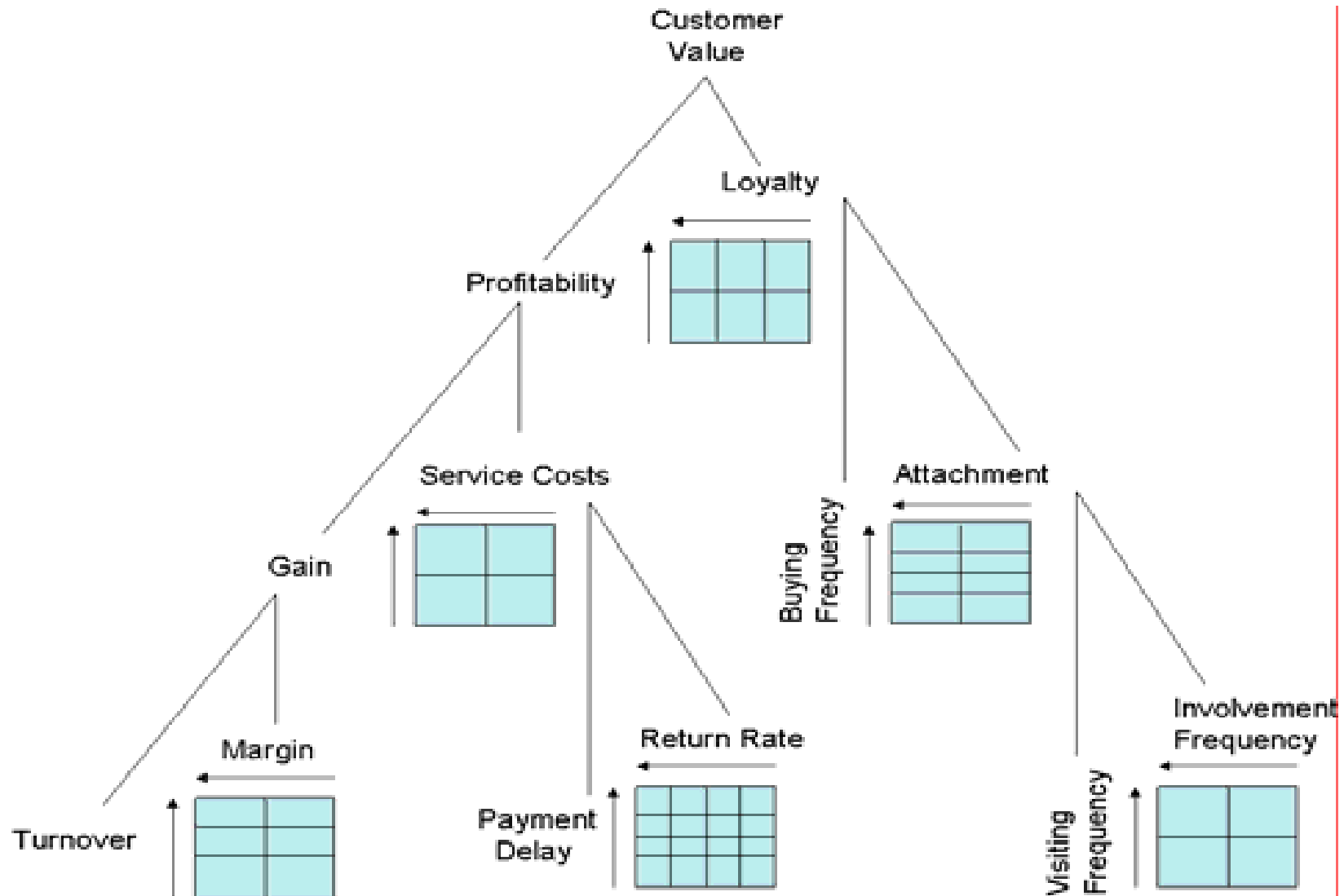
Multiple-dimensions for customer evaluation-



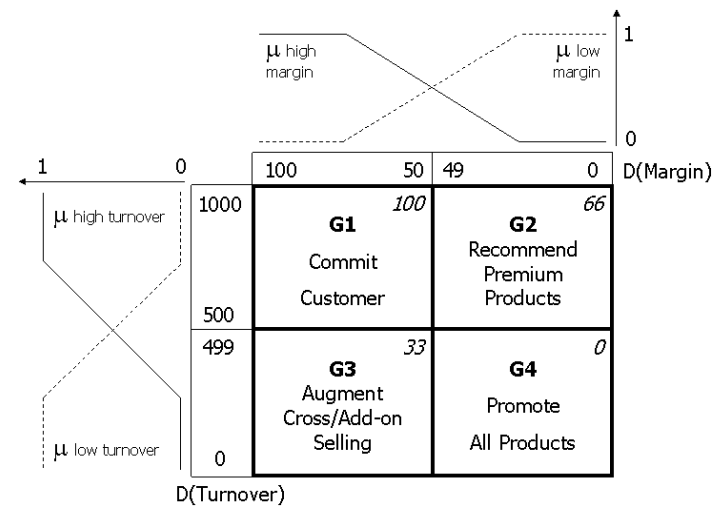
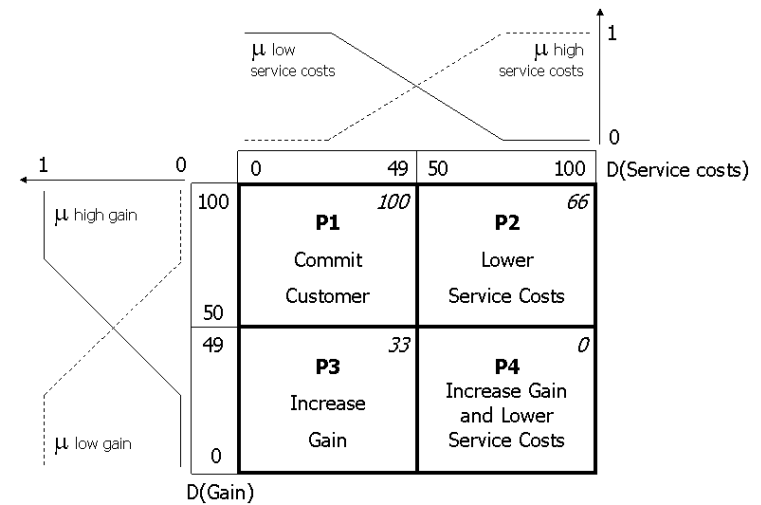
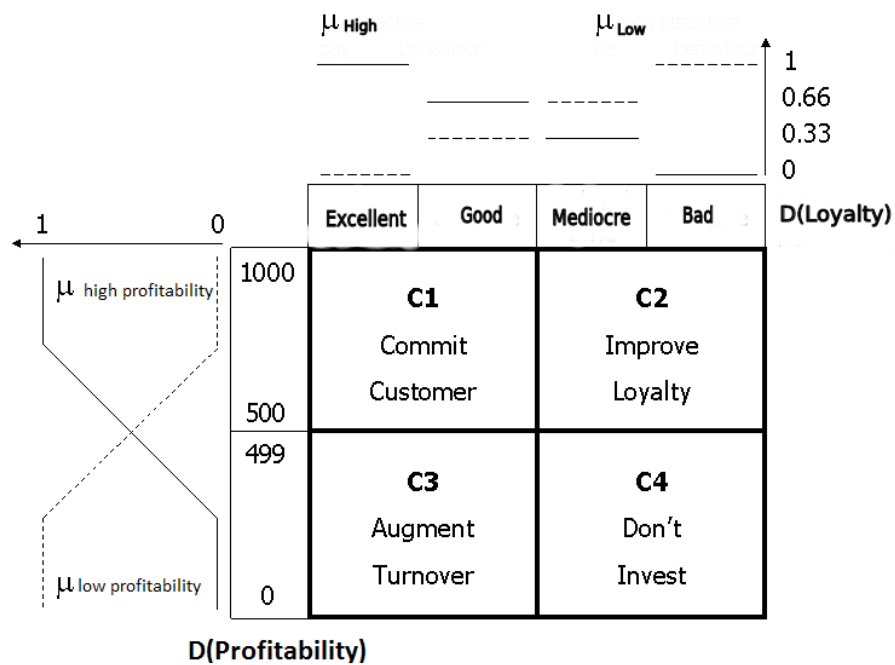
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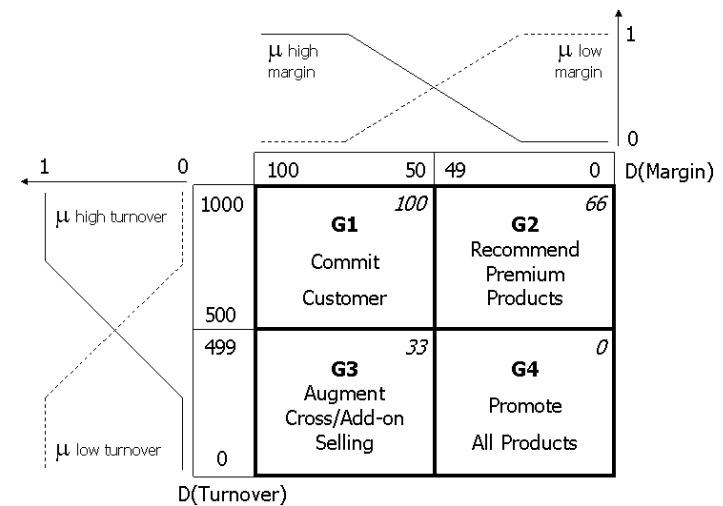
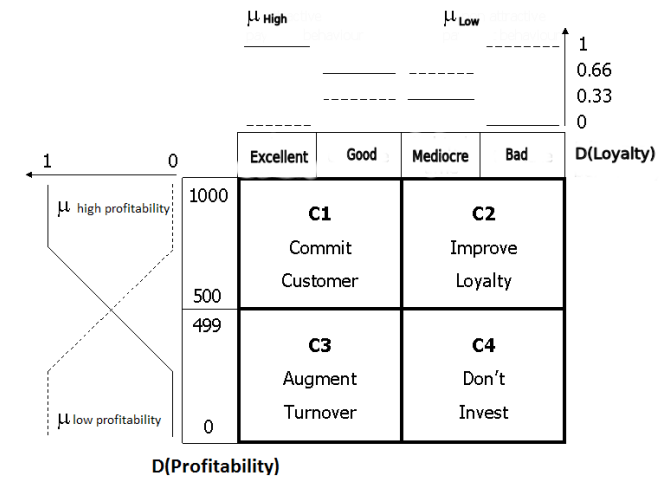
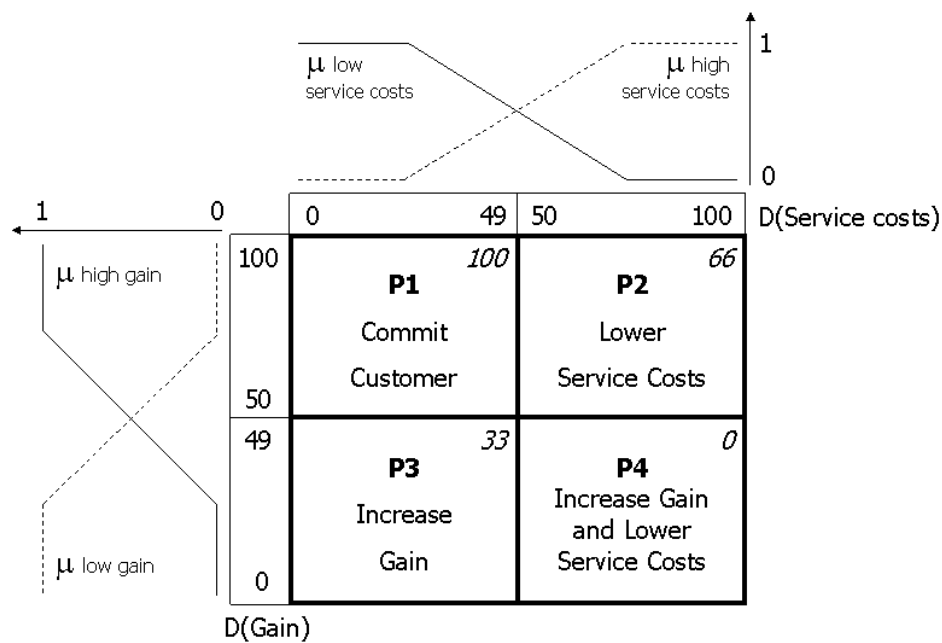
Customer Value as Hierarchical Fuzzy Classification



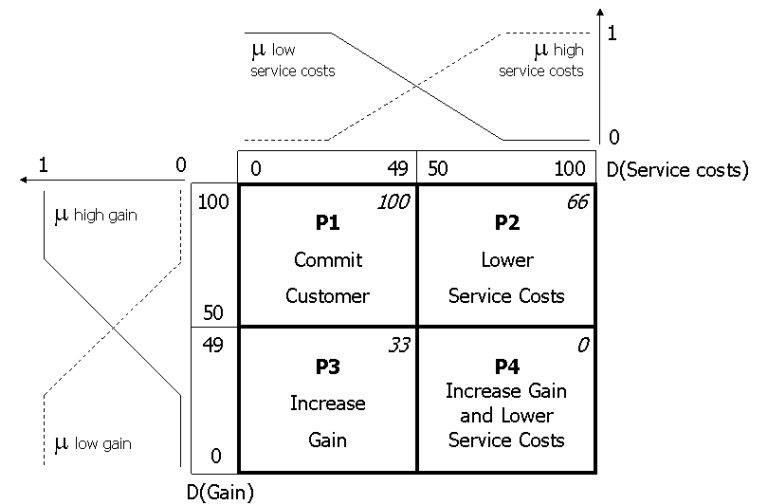
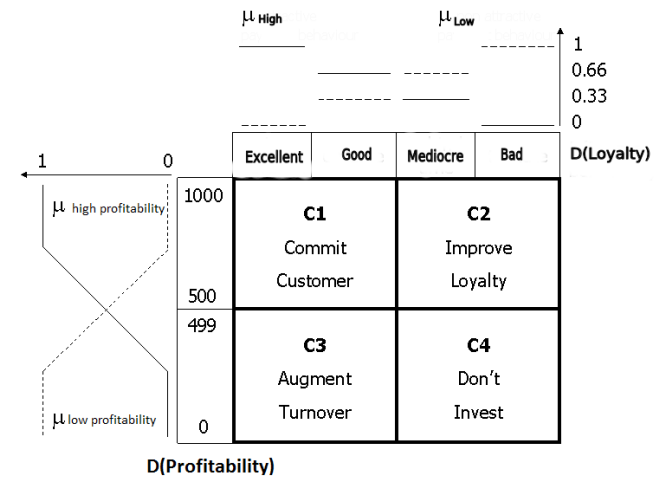
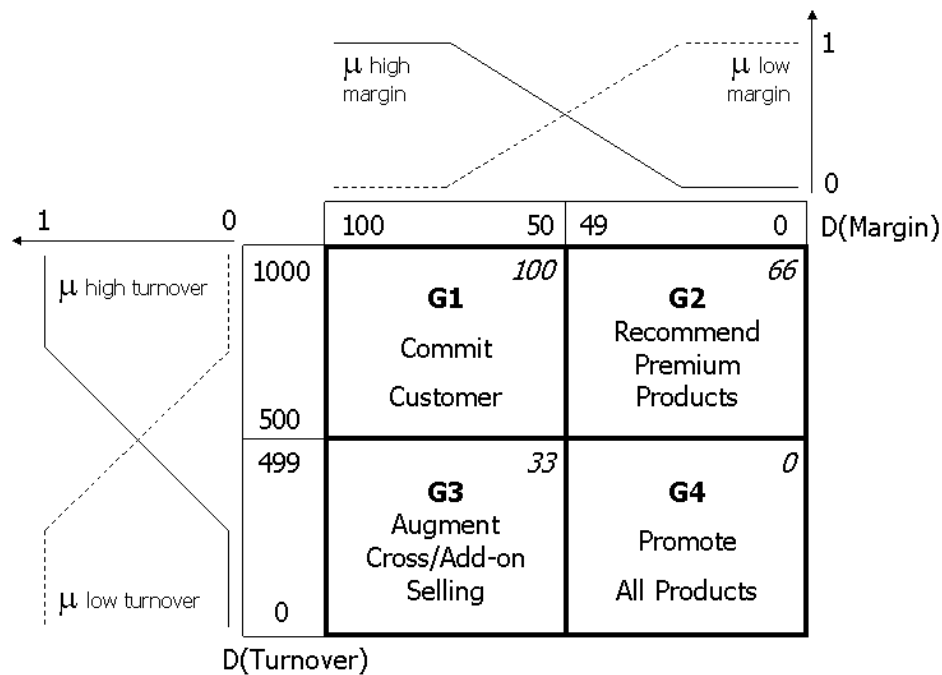
Hierarchical Fuzzy Classification



Hierarchical Fuzzy Classification



Hierarchical Fuzzy Classification



Hierarchical Fuzzy Classification

- Hierarchical Fuzzy Classification decomposes multi-dimensional classification space, and thus reduces complexity.
- By grouping attributes of a given context in sub-classifications, it allows decision makers to focus on area of interest.

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Another Example

A Travel Agent has to suggest spot to the customers that will best suit their **interests**.

Interests?

These are the *attributes* on which a spot will be evaluated. They may be different for every customer.

A Typical Question...

In our group *most* of us are youngsters. We would like a place full of *adventures*. Oh yes...but our parents are also coming along. It will be great if there is *some*thing *less adventures* as well. *Most* of us are *non-vegetarians* but there are a *few* *veggies*.

Translate it to requirements

A place with more adventures and more non-vegetarian food.

Attributes

For this customer the attributes are
Non-veg Food
Adventure

Non-Veg Food

Domain : the attribute domain is defined by $[0, 0.5, 1, 1.5, \dots, 5]$ stars

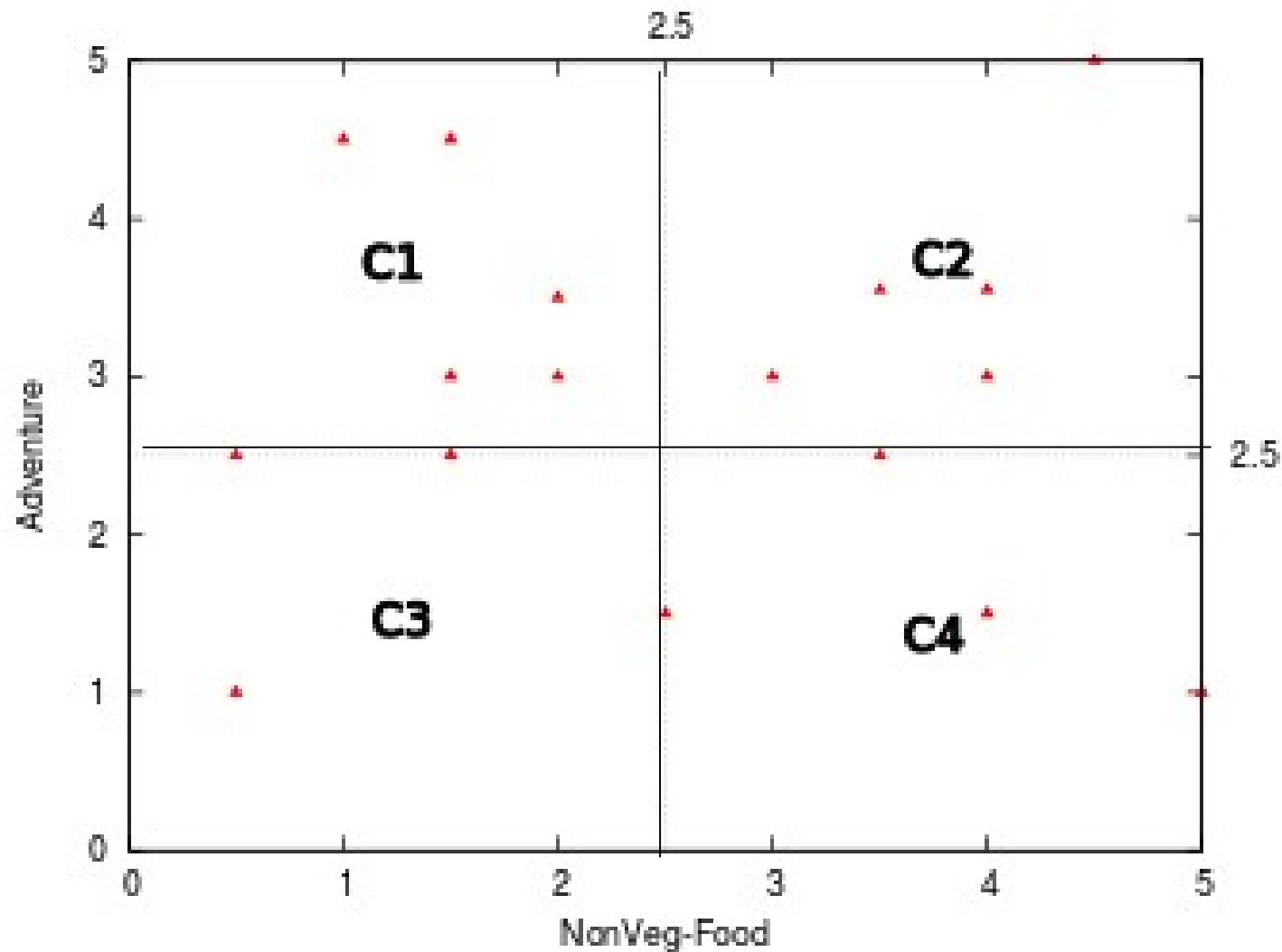
Equivalence Classes : $[0, 0.5, \dots, 2.5]$ for less non-veg food and $[2.5, 3, \dots, 5]$ for more non-veg food.

Adventure

Domain : the attribute domain is defined by $[0, 0.5, 1, 1.5, \dots, 5]$ stars

Equivalence Classes : $[0, 0.5, \dots, 2.5]$ for less adventure and $[2.5, 3, \dots, 5]$ for more adventure.

Crisp Classes



Problem?

Major concerns are very well addressed but minor ones are left out.

Most of the people from group will be Happy but some will be extremely unhappy.

What the company wants?

Maintain the overall Happiness of the all
Customers.

We want everyone to be Happy to some *degree*.

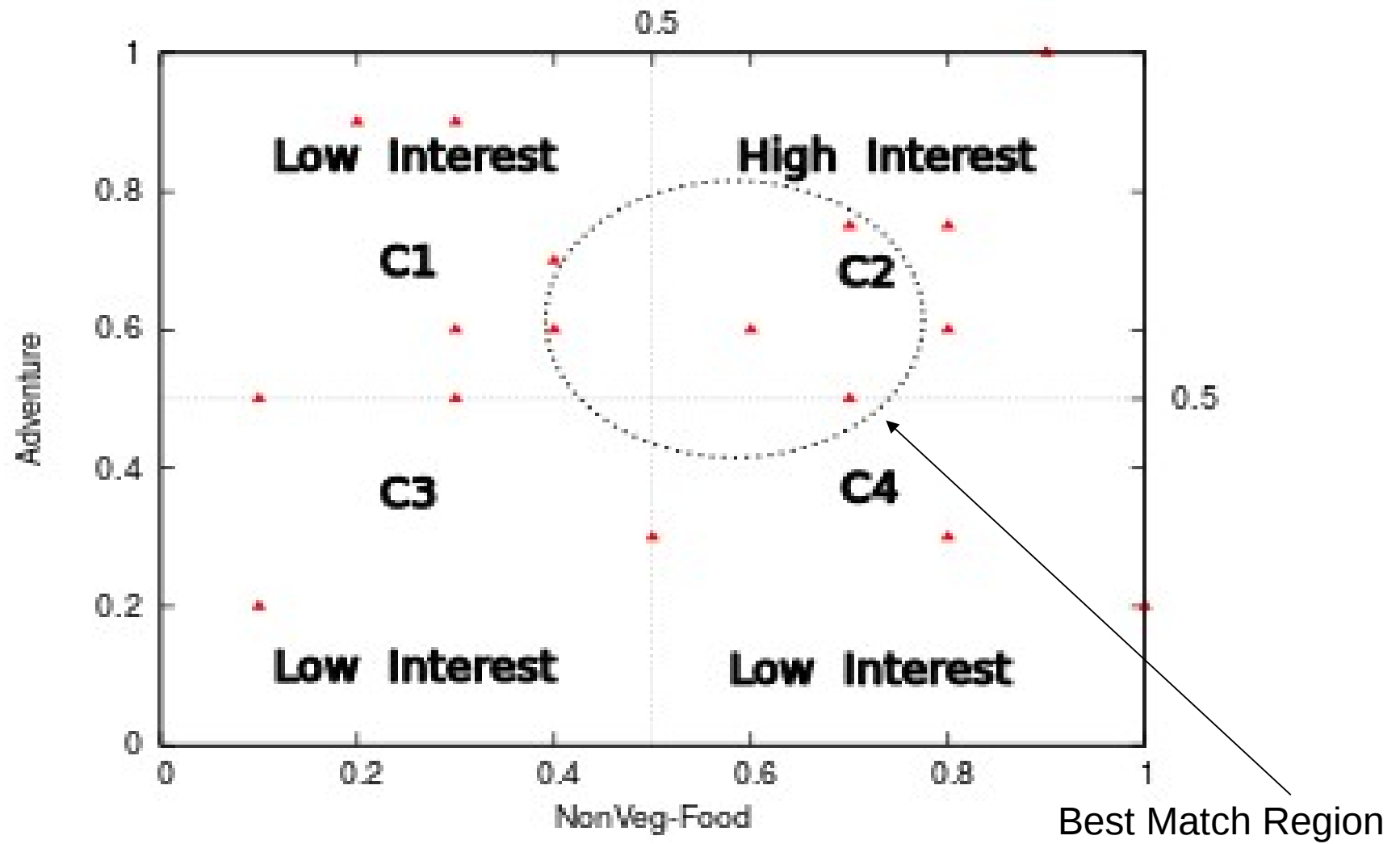
What should we do?

The place should belong to every class with some degree.

But,

While deciding the final place give *more weight* to the class in which *majority* is interested.

Fuzzy Classes



Evaluation

City	c1	c2	c3	c4
Mumbai	0.5	0.9	0.2	0.2
Chennai	0.2	0.1	0.9	0.8
Bangalore	0.5	0.8	0.3	0.4

Evaluation

Mumbai (C1:0.5, C2:0.9, C3:0.2, C4:0.2):

$$0.5*1 + 0.9*2 + 0.2*1 + 0.2*1 = 2.7$$

Chennai (C1:0.2, C2:0.1, C3:0.9, C4:0.8):

$$0.2*1 + 0.1*2 + 0.9*1 + 0.8*1 = 2.0$$

Bangalore (C1:0.5, C2:0.8, C3:0.3, C4:0.2):

$$0.5*1 + 0.8*2 + 0.3*1 + 0.4*1 = 2.8$$

What we achieved?

Fuzzy evaluation helped us chose the better destination from the equivalence class of interest.

Any other way?

Probabilistic

Maximize is the probability that the customer will be happy given the destination

Formulation

$$P(\text{happy}|\text{destination}) = P[\text{happy}|\text{non-veg food}] * P[\text{happy}|\text{adventure}]$$

$\text{argmax}[P(\text{happy}|\text{destination})]$

Gives the most suitable destination

Difference of Approach

Fuzzy Classification

Every Customer will be

definitely

Happy *to a degree*.

Probabilistic Approach

The customers will be

totally happy with
some probability.

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SWOT

Strengths

- ✓ Individuality
- ✓ Use of Natural Language

Opportunities

- ✓ Applying ML techniques can enhance this.

Weaknesses

- × Dependancy on Human experties

Threats

- × Changes in the domain not reflected, compared to incremental learning classifiers.

Questions

- What is fuzzy in Fuzzy classification – attributes or decisions?

Ans: Attributes. Decision is always crisp.

- Can hierarchical fuzzy classification be used for document classification? Ans: Yes. For example, if there are some pages (classes) related to cricket, football, etc then those can grouped under sports superclass.

References

- A. Meier, N. Werro, "A fuzzy classification model for online customers", 2007.
- Nicolas Werro, Henrik Stormer, Andreas Meier, "A Hierarchical Fuzzy Classification of Online Customers," IEEE International Conference on e-Business Engineering (ICEBE'06), 2006.

Thank you!