Is Artificial Neural Network Intelligent?

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Is AI Intelligent?

A history of arguments between pro- & anti-AI parties.

Harsh criticism to AI by Dreyfus

Alchemy and Artificial Intelligence (1965)

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What Computers Can't Do? (1972)

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What Computers Still Can't Do. (1992)

Alchemy and Artificial Intelligence (1965)

The field of AI exhibits a recurrent pattern:

early dramatic success followed by sudden unexpected difficulties.

Rebuff by Papert

“The Artificial Intelligence of Hubert L. Dreyfus: A Budget of Fallacies.”(1965).

Rebuffs by the other big names in AI

Edward Feigenbaum:

"What does he offer us? Phenomenology! That ball of fluff. That cotton candy!"

Marvin Minsky:

"They misunderstand, and should be ignored."

(Actually no responce after the 3rd edition.)

Pamela McCorduck (1992)

Papert:

"For Dreyfus, all social sciences are as wrong-headed as AI. This is not an attitude widely held in universities."

McCorduck:

"If Dreyfus is so wrong-headed, why haven't AI people made more effort to contradict him?"

Rodney Brooks (1991)

"Artificial intelligence started as a field whose goal was to replicate human level intelligence in a machine.

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Early hopes diminished as the magnitude and difficulty of that goal was appreciated.

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No one talks about replicating the full gamut of human intelligence any more."

Can computer play chess?

Dreyfus (1960):

"In fact, in its few recorded games, the Newell, Shaw, Simon program played poor but legal chess, and in its last official bout was beaten in 35 moves by a ten-yea-old novice. "

'The New Yorker' (January 11, 1966)

The Talk of the Town:

Computer was beaten in chess by a ten-yea-old novice.

... We don't care what the machine is going to do.

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includegraphics[width=8cm,height=12cm]newyorkers-2.eps

Also about 'machine translation'

'Time flies like an arrow,' in Russian

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'Time flies enjoy eating arrows,' in English.

A chess match: Dreyfus vs. Computer

Papert:

“I organized the famous chess match. That was beautiful.”

In a bulletin board in SIG AI

Papaert wrote:

'A ten-year-old can beat the machine' – Dreyfus:

But the machine can beat Dreyfus.

Can computer play chess? [II]

Garry Kasparov vs. IBM's Deep Blue.

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(in 6 game match)

1996:	Deep Blue	Kasparov	even	even	Kasparov	Kasparov
1997:	Kasparov	Deep-Blue	even	even	even	Deep Blue


Стр. 1 из 1
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Is Deep Blue intelligent?

Deep Blue's strategy

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A brute force to evaluate billions of future positions.

Dreyfus (1965)

"A little intelligence is not intelligence at all but stupidity.
Any program that does just one thing well is
at best more like an idiot savant than like an intelligent man."

Should intelligence be perfect?

Brook (1991):

"It is unfair to claim that an elephant has no intelligence worth studying just because it does not play chess."

Contradiction & Intelligence?

Frosini (2009):

Contradiction can be seen as a virtue rather than as a defect.

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Constant presence of inconsistencies in our thoughts

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Is contradiction accidental or is it the necessary companion of intelligence?

What about NN in particular?

McClelland, J. L. (2009)

(Author of "Parallel Distributed Processing (1986)"

"Is a machine realization of

truly human-like intelligence

achievable?"

What is human-like intelligence?

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Human-intelligence is spontaneous, flexible, and/or unpredictable,
more or less,

or even erroneous sometimes.

"I beg your pardon?"

Intelligent people try a different explanation for an easier understanding

while

others just repeat the same expression, maybe louder.

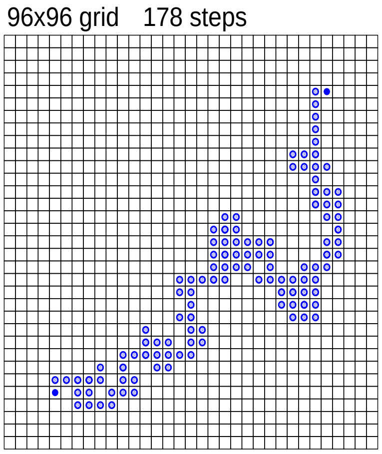
Let's make an agent to be spontaneous!

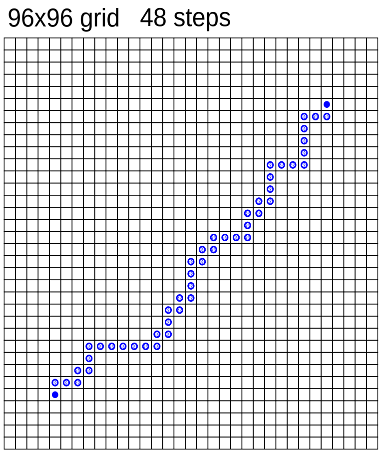
Behaviors might differ even in a similar situations.

Path-planning as a benchmark

An agent plans a shortest route from start to goal.

Examples of path from start to gaol





Which route to be chosen?

The number of shortest paths from (0,0) to (m,n)

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infinitely large.

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$$\sum_{i=0}^{m+n} {}_mC_i \times {}_nC_{m+n-i}.$$

Can an agent take different path from run to run?

What about from (0,0) to (m,0)?

In this case only one unique solution.

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Can an agent still be flexible from run to run?

Goal is

to make an agent behave differently even when it encounters the same situation as before.

NN with fixed weights

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never be intelligent

but repeats exactly the same action in the same situation.

Floreano's approach (2000)

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With McCulloch & Pitts neurons

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Modification of w_{ij} during exploration

with either one of the four Hebbian rule and Hebbian-like rules.

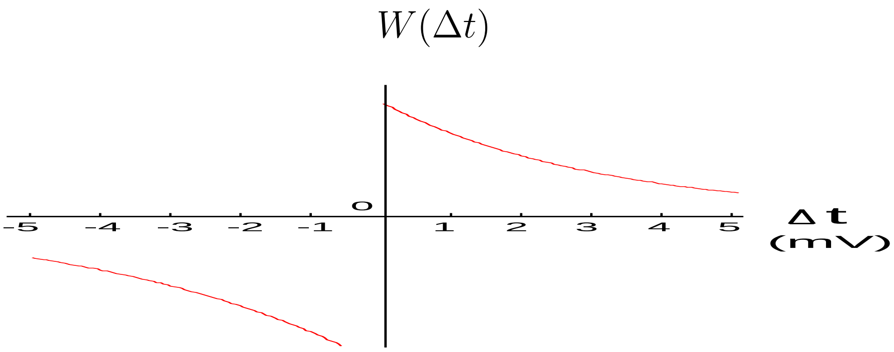
Spike Timing Dependent Plasticity (STDP)

A counter part of Hebbian rule for spiking neurons

What is STDP?

$$W(\Delta t) = \begin{cases} A_+ \exp(-\Delta t/\tau_+) & \text{if} \quad \Delta t \geq 0 \\ -A_- \exp(-\Delta t/\tau_-) & \text{if} \quad \Delta t < 0 \end{cases}$$

where $\Delta t = t_{post} - t_{pre}$



In short

potentiation occurs when a pre-synaptic neuron fires
shortly before a post-synaptic neuron

and

depression occurs when the post-synaptic neuron fires shortly after.

Two implicit implimentations of STDP

- Florian (2005)
  - Feedforward neural network with reward-modulated STDP
  - Stochastic leaky-integrate-and-fire neurons
- Di Paolo (2002)
  - Recurrent neural network with evolved STDP
  - Conductance-based integrate-and-fire model.

Stochastic Leaky Integrate & Fire Model

Membrain voltage of neuron i is

$$u_i(t) = u_r + (u_i(t - \delta t) - u_r)\exp(-\delta t/\tau) + \sum_j w_{ij} f_j(t - \delta t)$$

Reward-modulated STDP Learning

(Florian 2007)

$$w_{ij}(t+\delta t) = w_{ij}(t) + \gamma r(t+\delta t)\zeta_{ij}(t)$$

where

$$\zeta_{ij}(t) = P^{+}_{ij}(t) f_i(t) + P^{-}_{ij}(t) f_i(t)$$

$$P^{+}_{ij}(t) = P^{+}_{ij}(t-\delta t)\exp(-\delta t/\tau_{+}) + A_{+} f_j(t)$$

$$P^{-}_{ij}(t) = P^{-}_{ij}(t-\delta t)\exp(-\delta t/\tau_{-}) + A_{-} f_j(t)$$

Conductance-based I&F model

$$\tau_m \dot{v} = V_{rest} - v + g_{ex}(t)(E_{ex} - v) + g_{in}(t)(E_{in} - v)$$

Di Paolo's implicit STDP

- Every time a spike arrives at the synapse $P^+(t)$ is incremented by A^+
- Every time the post-synaptic neuron fires P^- is decremented by A^-.

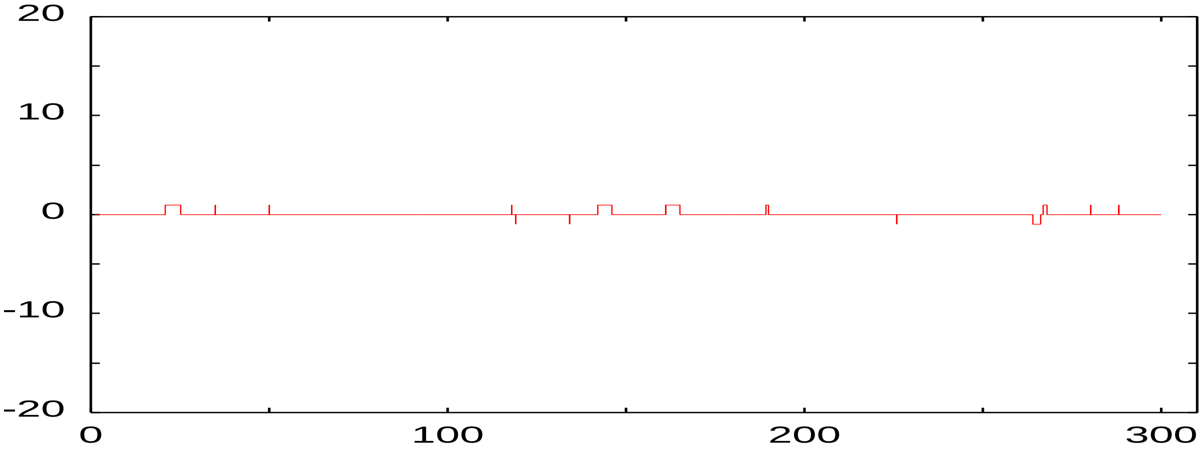
Otherwise, they decay exponentially.

Then

$$w_{ij} \rightarrow w_{ij} - w_{max}P^-(t)$$
$$w_{ij} \rightarrow w_{ij} - w_{max}P^+(t).$$

Are we happy?

Simple heuristics can do it using a dice



Papert (1965)

"A very simple algorithm can sometimes obtain the same results as the holistic, intuitive human mind,"

Not sufficient to be flexible

A different-action-even-in-identical-situation

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just a necessary condition at the best.

What else we need to be intelligent?

spontaneous, flexible, unpredictable behavior should be done consciously

Izhikevich (2006)

defined consciousness as *attention to memory.*

'Science of the conscious mind'

Ascoli et. al (2008)

Cognitive maps index representations by their context, such as spatial location, and are employed by mammals for path-finding and navigation,

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path-finding navigation of rodent using spatial location by hippocampus.

Navigation by hippocampus
muler's experiment

- assume mapping
  points in 2-D field where rat explores $\Rightarrow$ pyramidal cells in a recurrent network of CA3
- Mapping is one-to-one but randomly assigned
- distance realation in 2-D space is stored as weight configulation.
- The shortest path in nural space is also shortest in 2-D space?

Is navigation by hippocampus intelligent?

- Merriam's kangaroo rat can learn the distribution of food patches around its nest in three evenings of foraging;
- Marmoset monkeys reliably relocate food sites and do not revisit a place where food was already eaten on that foraging trip;
- Black-capped chickadees hide insects and seeds in numerous, widely spread caches in trees over its home range.

Elephant cannot play chess, but...

It might not sound like an intelligent behavior, but as already quoted Brooks (1990), an elephant could be intelligent even if it cannot play chess.

Belief, desire and intention

Bratman (1967)
The belief-desire-intention (BDI) model to construct multi agent system
or
Pereira et al. (2005)

a model of emotional BDI agents

these helps us to design ...

Why spontaneous?

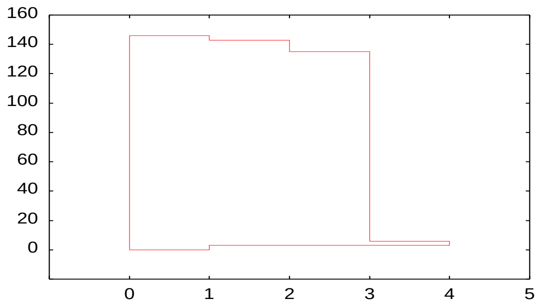
We sometimes need spontaneous and unpredictable intelligence rather than efficiency or effectiveness like in case of SONY's AIBO

I like music but dislike from CD. Why?

McClelland (2009) again

"Over the next decade, the butterfly will finally emerge from the chrysalis, and truly parallel computing will take flight."

Mars Landrover Problem



Can we design a robot such that it navigates flexibly enough to take a different route from run to run, using a memory with some conscious intention, hopefully with belief and some sort of desire?

Behaviors might differ even in a similar situations.
different-action-even-in-identical-situation
repeats exactly the same action in the same situation.
to make an agent behave differently even when it encounters same situation as before.