Is Artificial Neural Network Intelligent?

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Is 'Artificial Intelligence' 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)

What Computers Still Can't Do. (1992)

Rebuff by Papert

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

Rebuff by other big name 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 respance after 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?"

Machines Who Think (1992)

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.

Also int the article ...

Machine translated:

'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 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 Kasp even even Kasp Kasp

1997: Kasp Deep even even even Deep

Is Deep Blue intelligent?

Deep Blue's strategy

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A brute force to evaluate billions of future positions.

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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Intelligence should be 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 with a louder voice.

Let’s make an agent to be spontaneous!

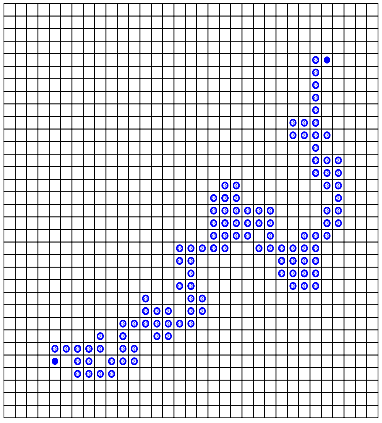
Behaviors might differ even in a similar situations.

Path-planning as a benchmark

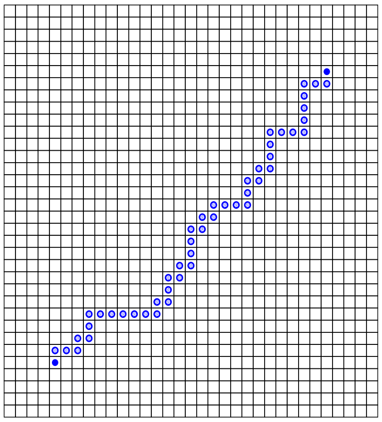
An agent plans a shortest route from start to goal.

Examples of path from start to gaol

96x96 grid 178 steps



96x96 grid 48 steps



Which route to be choosed?

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 agent take different path from run to run =¿ (0,0) to (M,0) only unique route can ... ?

Goal is

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

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 four Hebbian and Hebbian-like rules

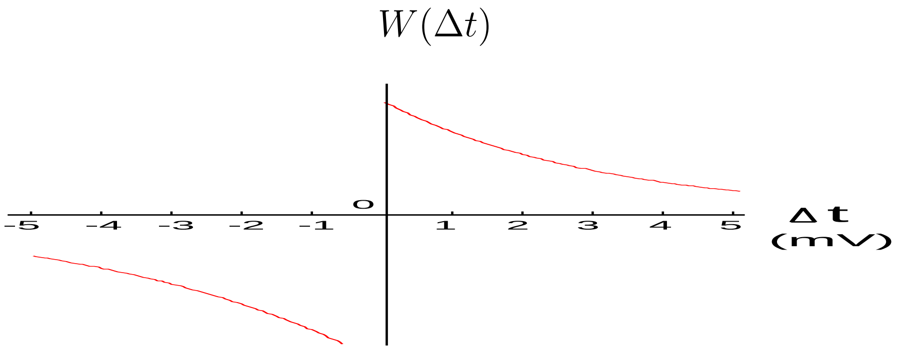
Spike Timing Dependent Plasticity

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 of spiking neurons

Stochastic Leaky Integrate & Fire Model

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

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 integrate-and-fire 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

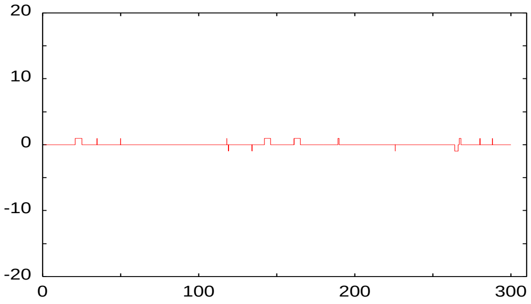
Every time a spike arrives at the synapse $P^+(t)$ is incremented by A^+
Every time the post-synaptic neuron fires P^- is decremented by A^-.
Otherwise, decay exponentially with time constant τ^- and τ^+ respectively.

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

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

Are we happy?

Simple heuristics can do it using a dice



Not sufficient to be flexible

different-action-even-in-identical-situation

$\Downarrow$

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

recurrent neural space and 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

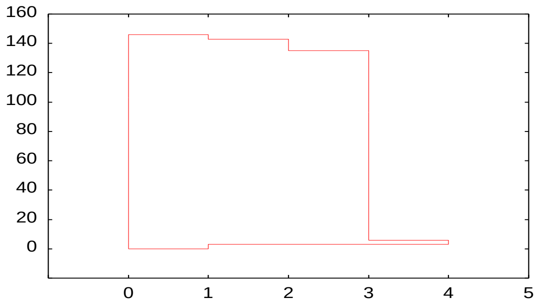
Why spontaneous?

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

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?