EVML

MIND AND MACHINE

A COGNITIVE APPROACH

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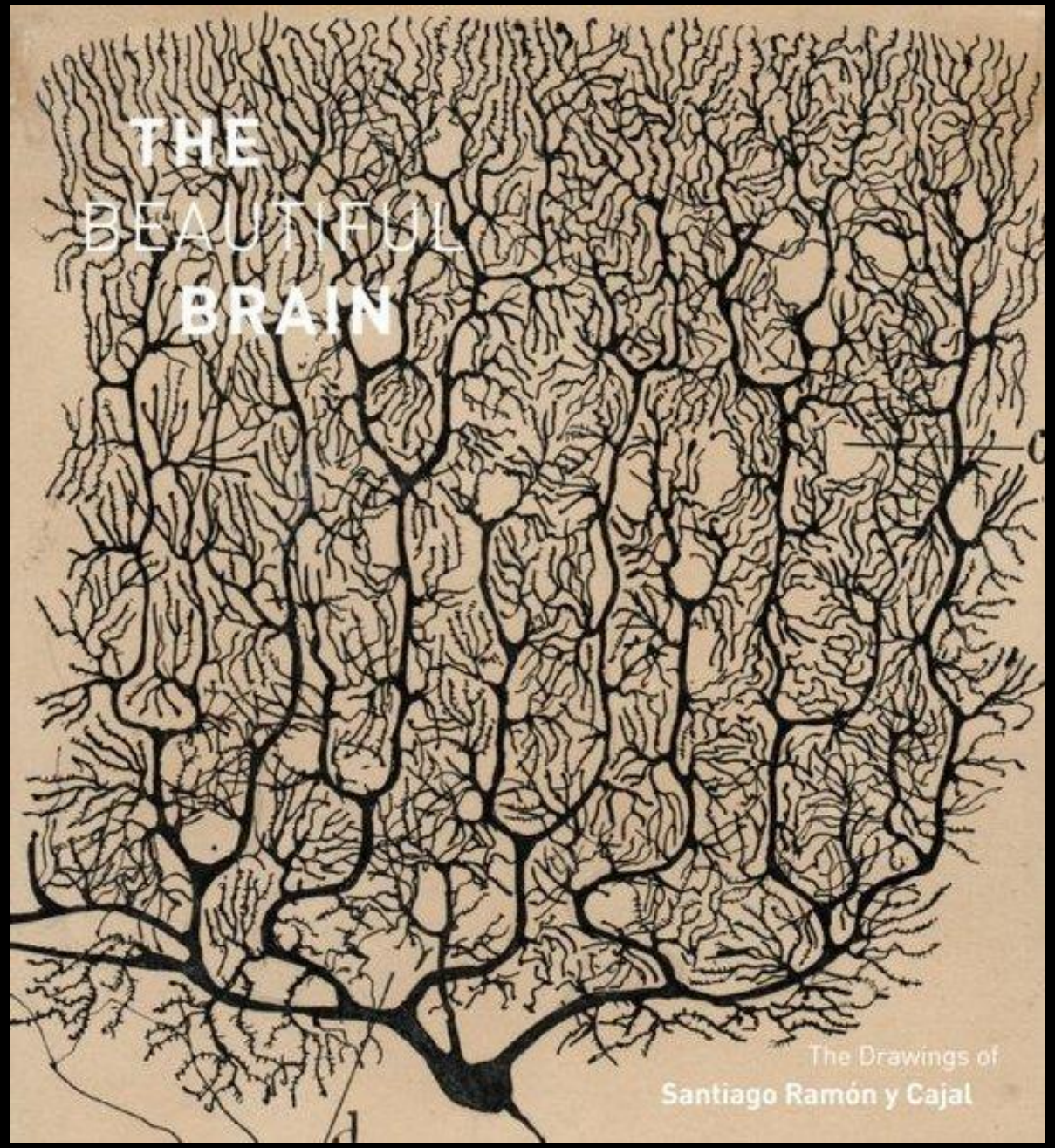
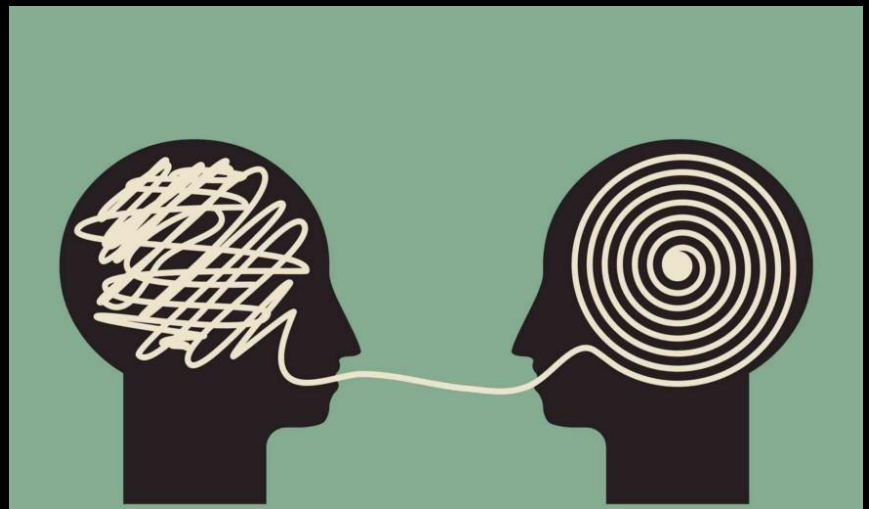

THE
BEAUTIFUL
BRAIN
The Drawings of
Santiago Ramón y Cajal

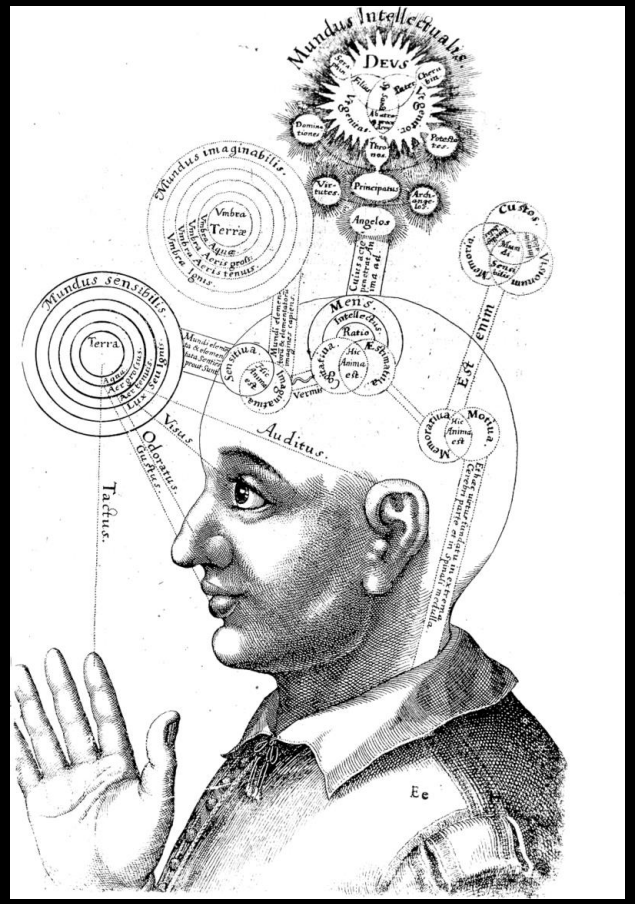
AGENDA

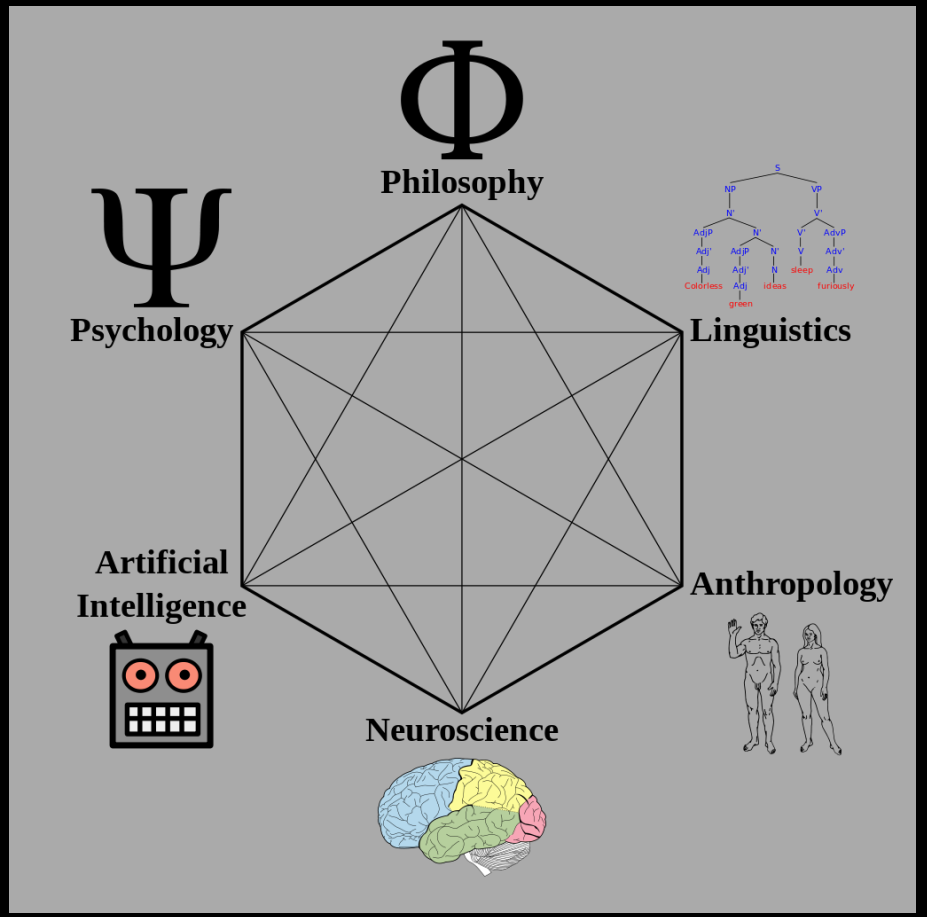
- Mental representations
- Reasoning
- Visual perception
- Cognitive approach
- Mind as a web
- AI
- Reinforcement learning



Source: insideIIM.com

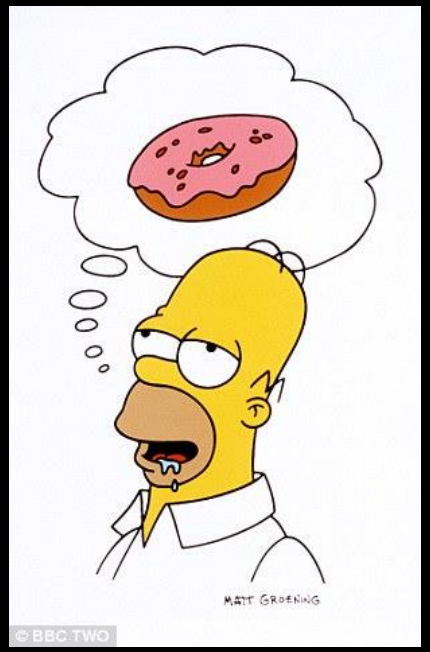
COGNITIVE SCIENCE





MENTAL REPRESENTATIONS

- Computational-representational understanding of mind i.e. mind can be considered an information processor
- Examples of representations are concepts, propositions, rules, and analogies.
- Analogue vs symbolic codes or dual coding?
- Propositions rather than images?

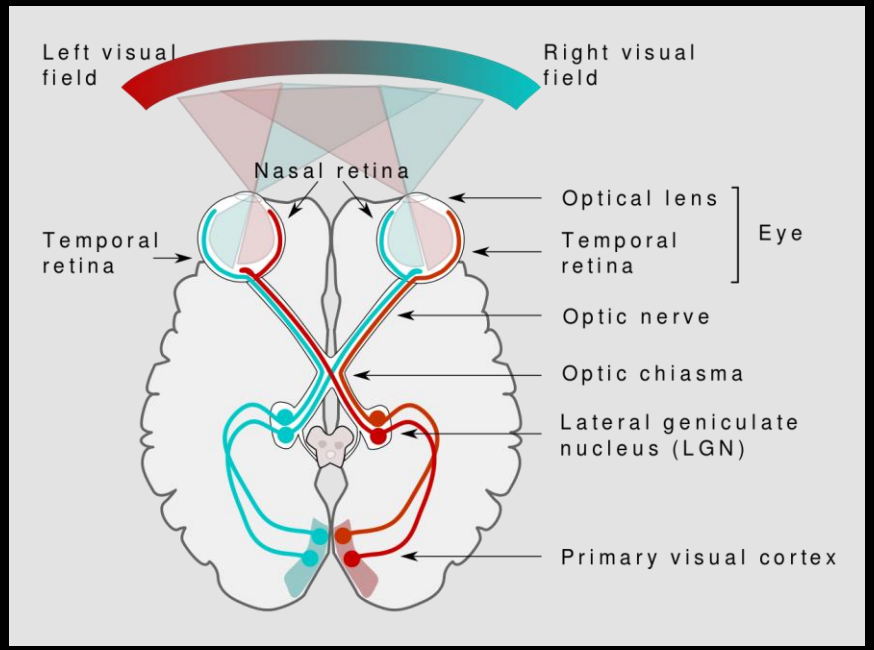


REASONING

- Induction: pattern recognition, seeking causality
- Deduction: from general to specific
- Analogical reasoning: from particular to particular
- Abduction: trained intuition

VISUAL PERCEPTION

- Visual system
- Lateral geniculate nucleus
- Primary visual cortex
- Visual association cortex



Source: https://en.wikipedia.org/wiki/Visual_system#/media/File:Human_visual_pathway.svg

The brain does not need much to see a lot

VISUAL PERCEPTION

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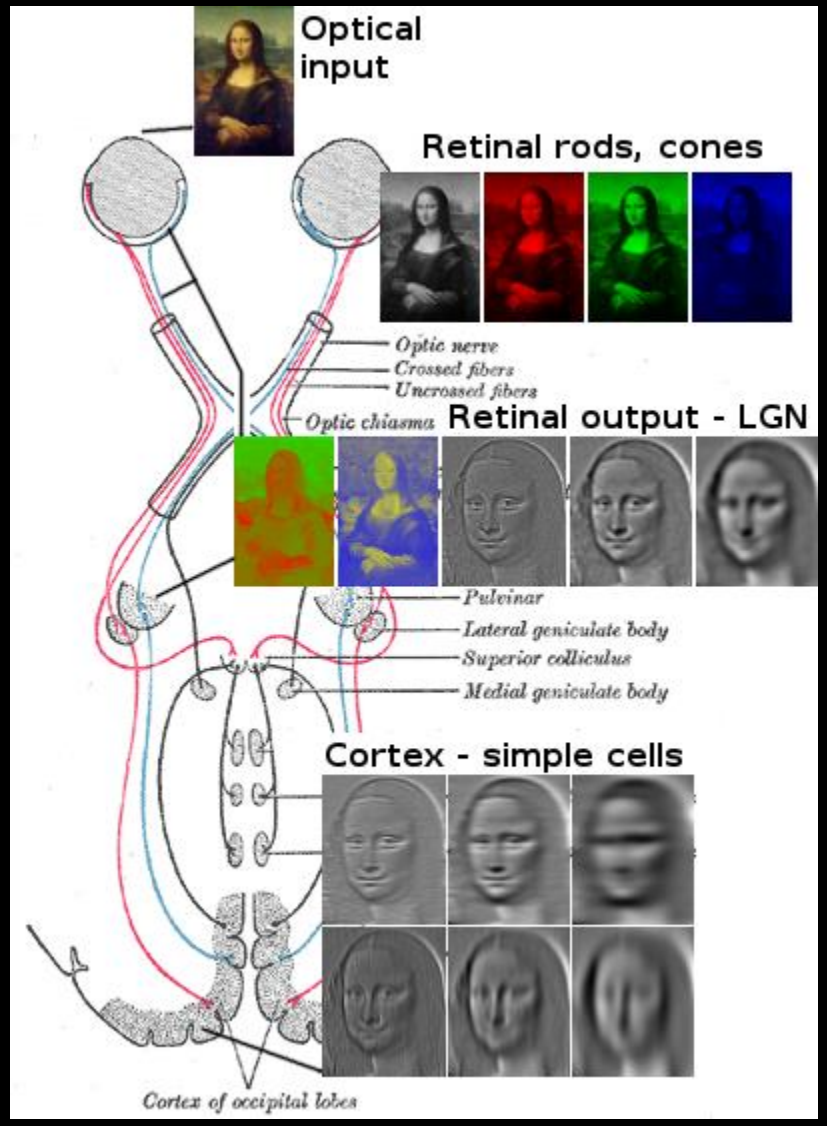

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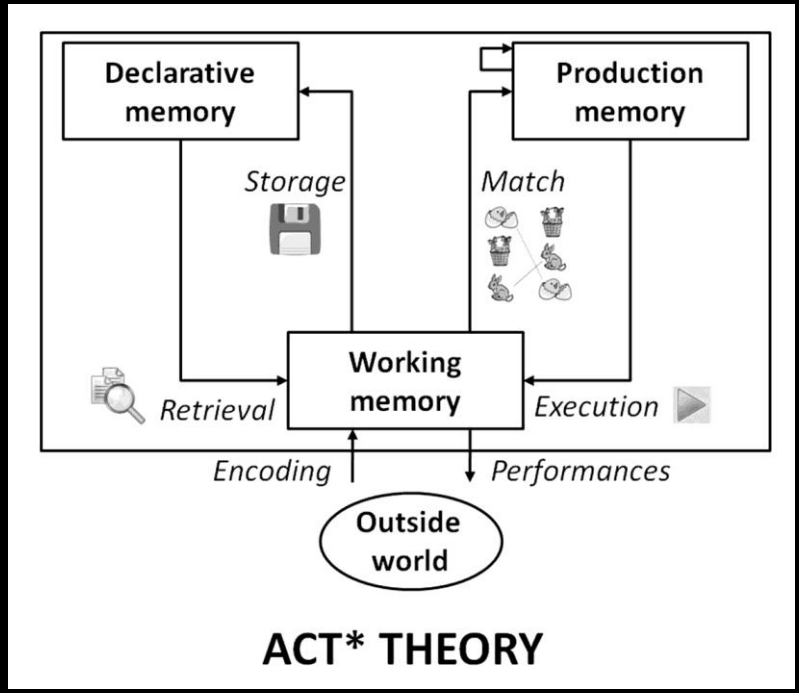
MEMORY

- Sensory memory (iconic in the context of vision)
- Working memory
- Visual short-term memory (VSTM)
- Long-term memory
  - Explicit
  - Implicit
- Visual imagery, how do we imagine?



Anderson's ACT* model

THEORIES OF MIND

- Mind may be an emergent property of a physical brain

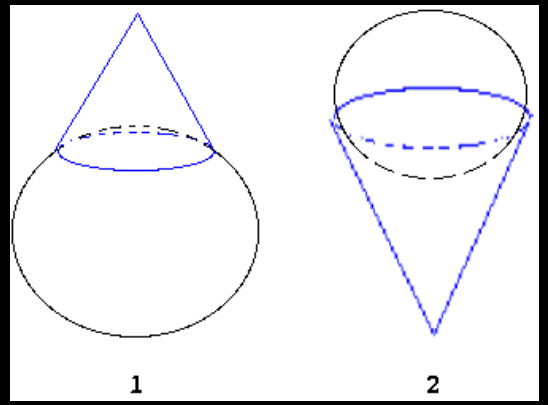
- Mind can be considered an information processor

-> Cognitive approach, network approach, AI

- Alternative perspectives include philosophical, evolutionary, linguistic…

MIND AS A COMPUTER METAPHOR

- Cognitive approach
- Visual pattern recognition theories
  - Template matching
    image is matched to an internally generated representation.
  - Feature detection
    features such as oriented line segments are extracted from the image and used to diagnose object identity
  - Recognition by components (geons)
    image is matched against structural representations of objects
  - Feature integration
    features are extracted pre-attentively and then combined in a focused attention stage.



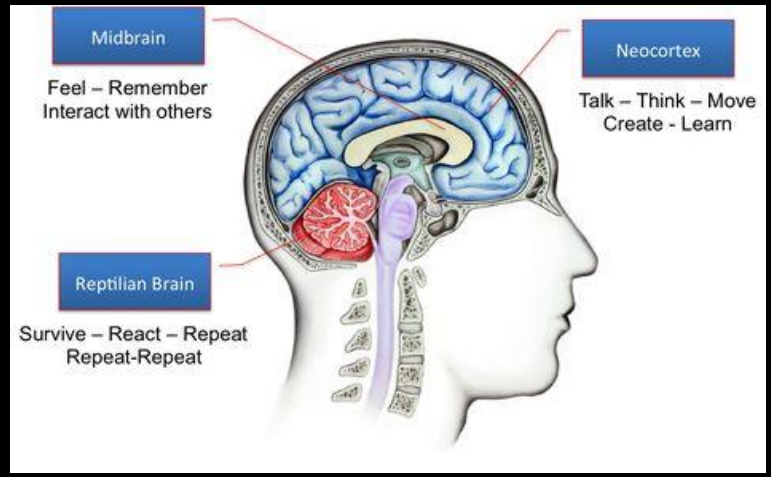
NEUROSCIENCE

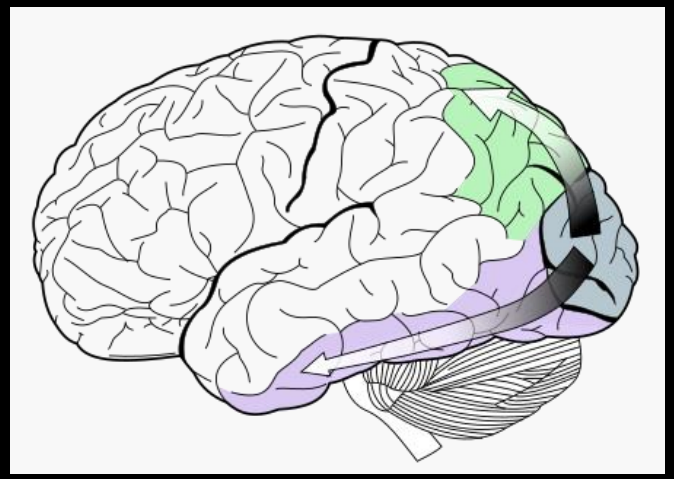
- Neocortex
  - Largest part of the cerebral cortex
  - 2mm thick, 6 layers
  - 40 per cent of the brain's mass.

- Billions of neurons

- Brain imaging

- Two streams-hypothesis



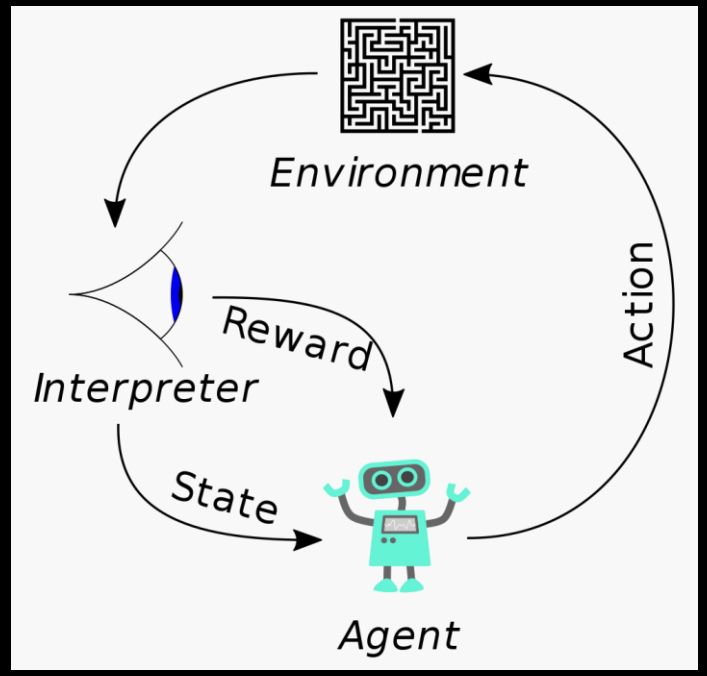


Source: https://en.wikipedia.org/wiki/Two-streams_hypothesis

HOW TO DEFINE AI?

- Mimic the mind
- Intelligent agents
- Strong vs weak
- Machine perception (e.g. vision)

REINFORCEMENT LEARNING



Source: https://en.wikipedia.org/wiki/Reinforcement_learning

- Deep Q learning, https://gym.openai.com/
- Bellman equation

$$Q^{new}(s_t, a_t) \leftarrow \underbrace{Q(s_t, a_t)}_{\text{old value}} + \underbrace{\alpha}_{\text{learning rate}} \cdot \overbrace{\left(\underbrace{r_t}_{\text{reward}} + \underbrace{\gamma}_{\text{discount factor}} \cdot \underbrace{\max_a Q(s_{t+1}, a)}_{\text{estimate of optimal future value}} - \underbrace{Q(s_t, a_t)}_{\text{old value}} \right)}^{\text{temporal difference}}$$

$$\underbrace{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}_{\text{new value (temporal difference target)}}$$

STRONG AI

- Human minds are, in essence, computer programs

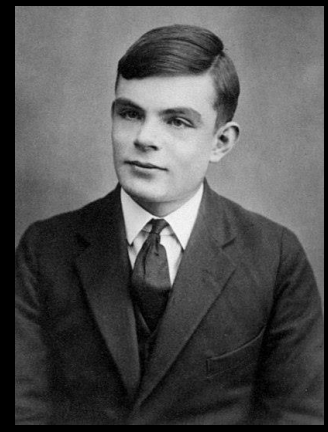
- A hypothetical machine can exist that exhibits behavior at least as skillful and flexible as humans do

- As opposed to weak AI, which is applied only to a narrow task

- Criticism:
  - Human intelligence relies on subconsciousness (Heidegger)
  - Some theories can be neither proved not dis-proved (Gödel)

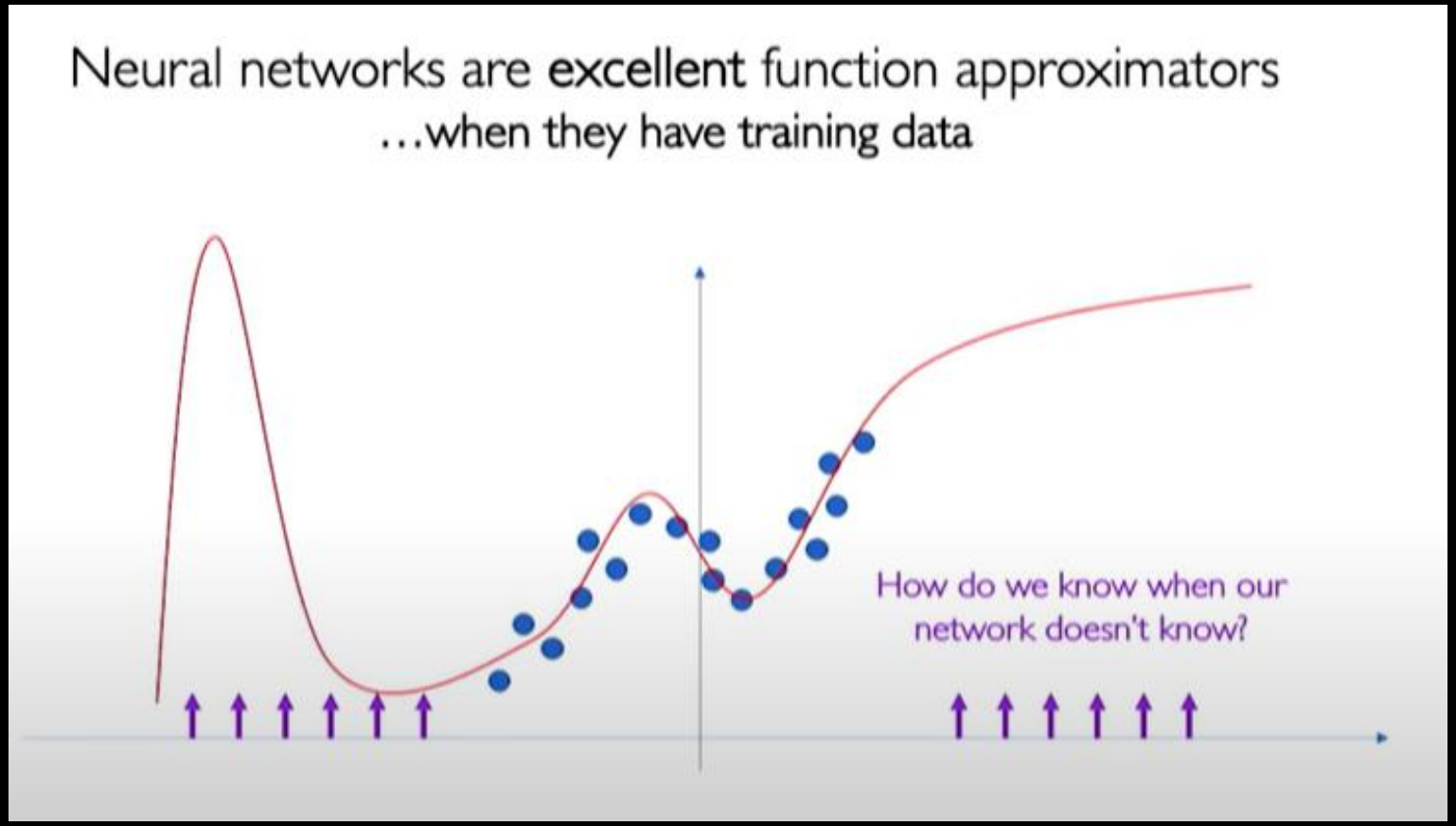
CAN MACHINES THINK?

- Can human intelligence be simulated?
- Turing test
- Zombie consciousness



- https://en.wikipedia.org/wiki/Philosophy_of_artificial_intelligence

LIMITATIONS TO AI



Source: MIT Deep Learning 6.S191 (introtodeeplearning.com)

LITERATURE

- https://open.spotify.com/show/6QefEeY1IKYVn5w6nUV83Y?si=7J8H3Js2RYy3_qur6rPANQ
- Cognitive Science - An Introduction to the Study of Mind, Jay D. Friedenberg, Gordon W. Silverman.