

# *Interdisciplinary Aspect of Cognition*

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“cognition”  $\Longleftarrow$  Latin “cognoscere”  
= to get to know

# *Philosophical Roots*

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can be seen as the origin of psychology  
(17th century)



# Psychology

study of both mind and behaviour (19th century))

Initially two main schools

- **Structuralism**  
whose object was the study of human mind,  
observed through **introspection**
- **Functionalism**  $\implies$  **Behaviourism**  
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**Cognitivism** based on the **computer analogy** or  
**computer metaphor** (2nd half of the 20th century)

# *Diffusion and Interdisciplinarity*

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Beyond scientific circles through publications by

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## Interdisciplinarity

- Logic  $\implies$  Neuroscience
- Mathematics  $\implies$  Compute Science
- Education

# *Cognition & Logic*

## Mathematical Logic

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- **Inductive Logic**  
from observations to generalisation
- **Abductive Logic**  
from events to causes

# *Logic for Cognition*

**Develop new forms** of logic as the basis of cognitive studies of intelligent interaction

- innovative notations (e.g. icons and diagrams)
- manipulation techniques to express forms of induction and abduction

⇒ **Mathematics**



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⇒ **Mathematics**

**Experimental validation** through EEG and novel brain measurement methods

- fNIRS (functional near infra-red spectroscopy)
- fMRI (functional magnetic resonance imaging)

⇒ **Neuroscience**

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- **brain-computer interfaces** = direct communication pathway between an enhanced or wired brain and an external device
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# Neuroscience

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- **brain-computer interfaces** = direct communication pathway between an enhanced or wired brain and an external device
  - **originally** a communication tool for patients with disabilities (e.g. paraplegia)
  - **novel application** to decode mental states and intentions in
    - gaming
    - biometric
    - workload and fatigue

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# *Cognition emerges from Maths?*

Hofstadter considers the diagonal argument used by Kurt Gödel to prove his two incompleteness theorem: use a property that refers to itself  
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**Hofstadter** considers the **diagonal argument** used by Kurt Gödel to prove his two incompleteness theorem: use a **property that refers to itself**

⇒ **paradox**

Something very strange thus emerges from the Gödelian loop: the revelation of the causal power of meaning in a rule-based but meaning-free universe. [...] When and only when such a loop arises in a brain or in any other substrate, is a *person* — a unique new “I” — brought into being.

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# *Mathematics $\implies$ Meaning*

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Up to the complexity of human reasoning?

- **Penrose**: **human consciousness is non-algorithmic**
- **Hofstadter**: identify what emerges from an **algorithmic process** (i.e. diagonalisation) as **self-awareness**

# *A Compromise?*

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## **Further questions**

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# *A Compromise?*

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## **Further questions**

- Can symbolic manipulation together with the high performance of today's computers effectively be used to emulate human cognition?
- Then, if this is possible, what would be its purpose and the real-life usage?



# *Cognitive Architectures*

comprehensive models of the human mind, with  
a computational power that supports

- the **in silico experiments** carried out in cognitive psychology
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Some forms of emulation of human cognition but **limited real-life usage**

# *Which Real-life Usage*

- **cognitive errors** may emerge in supposedly “correct” **interactive systems**, potentially leading to **catastrophic effects** in safety-critical domains
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- **cognitive errors** may emerge in supposedly “correct” **interactive systems**, potentially leading to **catastrophic effects** in safety-critical domains
- **formal models** are effective in **modelling computer systems**
- **formal models** can be used to **modelling human cognition**
- **formal verification** of **system+human**

# *Cognition & Computer Science*

## Cognition

- can be modelled in a computer science fashion to some extent

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## Cognition

- can be modelled in a computer science fashion to some extent
- is also largely affected by computer ubiquity  
⇒ human living environment is permeated by technology:
  - physical systems
  - computational systems
  - virtual worlds
  - robots

# *Cognition & Education*

## Cognition

- has affected education and its practices
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## Cognition

- has affected **education** and **its practices**
  - **cognitive learning** focusses on the teaching and learning of the cognitive processes and skills connected to reasoning
- has inspired the definition and development of various **educational tools**
  - learning environment
  - cognitive tutors



# *Conclusion*

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# *Question for Discussion*

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- cognition is likely to be formed in relation with the environment with which the human develops.
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## Points for Discussion:

- cognition is likely to be formed in relation with the environment with which the human develops.
- cognition is likely to be influenced by other parts of human body through self-perception and body conditions
- ethical side of research in human cognition and its consequences