COGNITIVE PSYCHOLOGY
WEEK ONE – LECTURE ONE

Lecture Outline
- Define cognition
- Understand the computational metaphor of cognition
- Compare and contrast classical computational models of cognition and alternative models
- Define mental representation
  - Explore examples of different forms of mental representation:
    - Symbolic and analogue representations
      - Propositional representations and mental imagery
- Dynamic, Embodied, and Situated cognition
  - Give examples of all 3
- Understand the argument for **grounding symbolic representations in embodied representations**

What is cognition?
- "To know" → the activity of **acquiring, organising and using information to enable adaptive, goal-directed behaviour**
- The study of information processing
  - includes mental processes such as learning, memory, attention, language, reasoning, decision making
- "The mind is a system that creates ***representations of the world*** so that we can act within it to achieve our goals" – Goldstein
  - **Cognitive abilities = intelligence**

What is a Cogniser?
A cogniser is a **cognitive agent which can:**
- **Sense and act on the environment**
  - Detect and effect changes in the environment
  - Gain information
- **Construct mental models to represent the causal structure of their environment**
- **Adapt their mental models in response to feedback from their behaviour**
- **Use mental models to guide future behaviour**

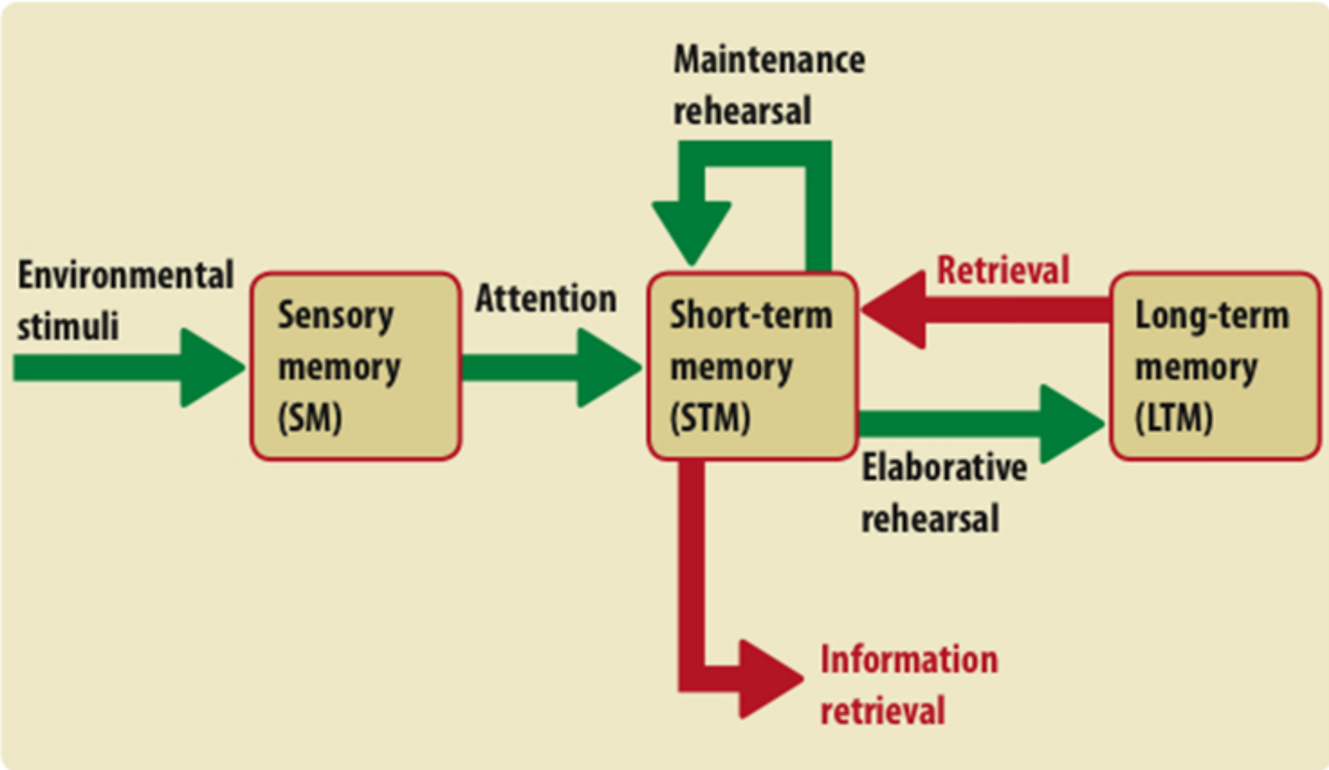
Is a sea-slug a cognitive agent?
- *Aplysia has made it a useful biological model for exploring how learned behaviours are encoded at the level of single cells and defined signalling pathways. While cognitive terms such as "thinking" and "believing" may be somewhat overstated when referring to the mental life of Aplysia, even such a relatively simple animal represents it's experience in the connections of its nervous system, and these representations come to influence it's future behaviour Aplysia's knowledge is represented implicitly (non-declaratively) within its nervous system - it has no explicit (declarative) representation of its knowledge. That is, Aplysia does not 'know what it knows' and cannot consciously consider it's own knowledge in the way that we humans reflect explicitly on our beliefs and desires. Evolutionarily ancient animals like Aplysia provide an insight into the precursors of our own cognitive processes – you will see this approach to cognition in the work of Rodney Brooks discussed later in this lecture.*

Classical Cognition: The computational metaphor of cognition
- Cognition as a flow of information through processing devices that encode, store and retrieve **symbolic representations of knowledge**
  - The brain is the hardware
  - The mind is the software [programme]

- Cognition analogous to the operations of a digital computer

An information-processing model of memory:

- **Sensory signals = provide input to the system**
- Transduction of sensory signals to a mental code for central processing
- Further processing (computation) in STM/Working Memory, informed by LTM



*The figure on the slide represents a typical classical information processing model described in the **three stages shown in the diagram: Environmental input, Short-term memory, and Long-term Memory**.*

This is the kind of memory model that will be familiar to you if you have done introductory psychology (e.g., Atkinson and Shiffrin's, 1968, modal model of memory). According to this classical view, stimuli are first encoded in sensory memory. The aspects of the input that are attended are then transformed into a mental code that is sent on to short term memory (or working memory), which serves as a metaphorical "workbench", where information can be examined, evaluated, and compared to other information from long-term memory.

Short-term/working memory receives input from long-term memory, relating to previous experiences that bring meaning to a stimulus.

Rehearsal increases the chances of storage in long-term memory.

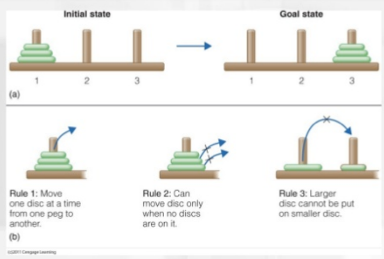
Long-term memory (LTM) is assumed to store large amounts of information for an indefinite amount of time. LTM has a number of different components representing information in a variety of formats including declarative (episodic, semantic, and linguistic knowledge) and non-declarative forms (conditioned learning, procedural skills, priming).

Classical Cognition: thought processes reflect the mental manipulation of symbols according to syntactic rules for combining those symbols

- Symbols represent our knowledge of things and events (concepts) and our knowledge of the way concepts can relate to one another

- Words and numerals are examples of symbols
  - Concepts <dog>
  - Properties and relationships <in> <has> etc.

- Syntactic rules are **the program of the mind expressed in 'mentalese' – the language of thought**
  - Natural languages translate mentalese into a publically-expressible format



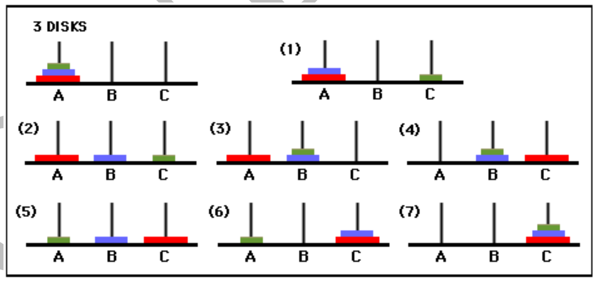
Caption: (a) Initial and goal states for the Tower of Hanoi problem. (b) The operators for the Tower of Hanoi problem.

- Classical cognition can be used to **model intelligent behaviour**
  - Problem solving
  - Reasoning

- **The steps we go through to solve a problem can be represented in an explicit symbolic code**
  - A series of "if…then" commands

- **Good for <u>formal problems and logical reasoning</u>**

- **Bad for <u>perception, action and recognising patterns</u>**



<u>Classical Cognition: Symbolic representations</u>

- **Propositional representations**
  - A symbolic code to express the meaning of a particular relationship among concepts
    - "the cat is under the table"
    - "the table is above the cat"
      - Under [cat, table] → relationship between elements, subject element and object element

*The **propositional representation provides the basic element (building block) for symbolic representations of knowledge and comprehension processes.** The advantage of the propositional approach is that the propositional framework can be used to represent the relationships among semantic elements independently of the specific surface details of a specific utterance, written sentence, or the specific perceptual details of a witnessed event. That is, the propositional framework provides a means to represent the underlying meaning structures, independent of the specific details of the surface structure – and this is said to provide an approximation to the "language of thought" itself.*

- *Propositional representations are covered in your text book over pages 279-281.*

<u>Propositions are:</u>

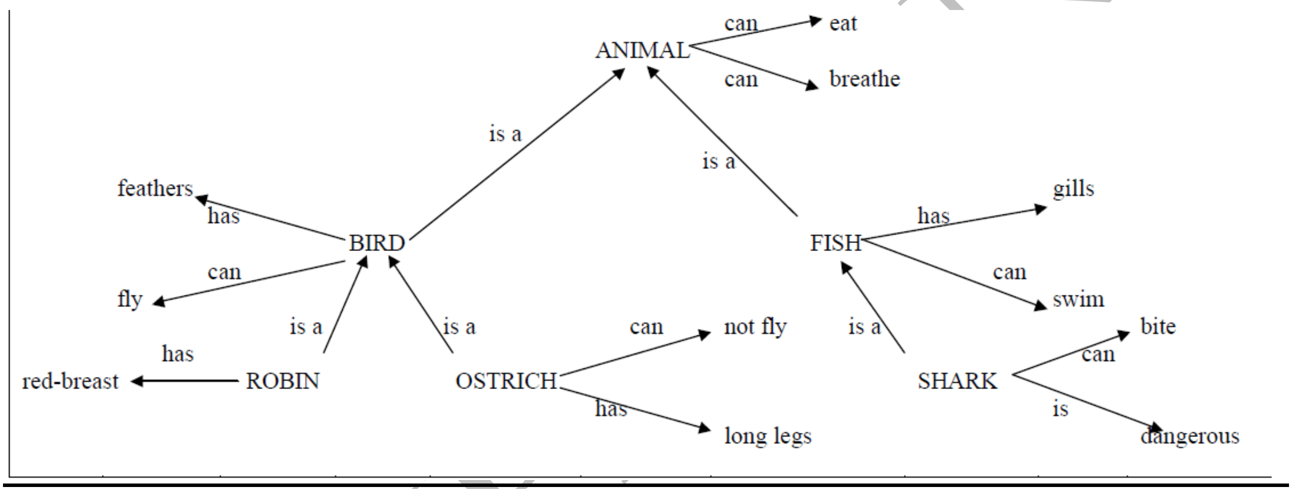
- Derived from propositional logic
- Express underlying meaning, independent of the specific surface details of an utterance, written sentence, image or witnessed object/event
- Abstract, symbolic code like a mathmetical formula
  - Neither words nor images
- **Composed of the <u>predicate</u> and a number of <u>arguments [semantic elements]</u>**
  - <u>Predicate =</u> expresses the **relationship between elements**
  - <u>Argument =</u> expresses the **subject/object elements**
- Propositions take the form of a predicate-argument schema:

- Predicate (argument, argument, argument)
- Relationship/property (subject, object etc.)
- Under (cat, table)
- P (x, y)

Classical Cognition: Symbolic Representations

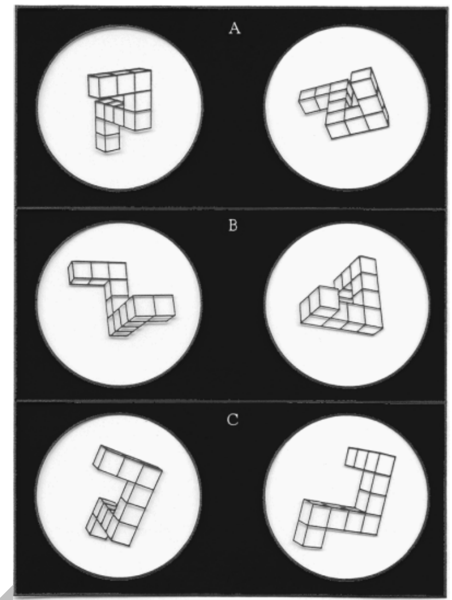
- The same abstract propositional frame/schema can express many different surface forms
- Gave (agent, object, recipient)
  - John gave Mary the book
    - Gave (John, book, Mary)
  - The book was given to him by Mary
    - Gave (John, book, Mary)
  - Kevin gave Julia a kiss
    - Gave (Julia, Kevin, kiss)
- **Propositions can be combined to represent more complex relationships**

Symbolic representations: Semantic Networks



*Collins and Quillian's (1969) model of the organisation of conceptual knowledge in the semantic memory system. According to this classical view of semantic knowledge, **concepts are coded in propositional form expressing relationships** and properties such as "is-a" or "has" or "can" (e.g., a canary "is-a" bird; a canary "has" wings; a canary "can" sing). The model indicates that living things "can breathe" ; that an animal "is a" living thing, that a bird "is a" kind of animal, and that a canary "is a" kind of bird.*
*It follows from the **hierarchical organisation** of the network that that a canary "can" move around. The canary node inherits this property via its connection to the category of animals and to a still higher category of living things. From Figure 1.2 in Rogers & McClelland (2004).*

Analogue Representations: Mental Imagery and Mental Rotation



- Shepard and Metzler's analogue representations in space and rotations study
    - Data provided **compelling evidence** that at least some of our cognitive processes are carried out using **ANALOGUE REPRESENTATIONS, instead of ABSTRACT SYMBOLS**
    - Mental images are analogous to what they represent
    - We manipulate mental images in our minds in a manner analogous to the way in which we might physically manipulate a real object