Cognitive Architectures: Miscellaneous

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1 Part 1 – Icarus and Clarion

1.1 Briefly describe the main modules in the cognitive architectures ICARUS and CLARION

ICARUS:

- Conceptual Inference: The primitive beliefs are inferred from a combination of one or more percepts. Higher level beliefs are inferred from only beliefs, either primitive or higher-order.

- Goal Generation and Selection: ICARUS selects the highest priority goal from the agents top level goals.ICARUS can be built with modules allowing generation and alteration of goals and their priority.

- Teleoreactive Skill Execution: Skills are executed either by execution of an action or by adopting the defined subgoal.

- Problem solving and skill learning: When Icarus encounters previously unseen concepts and situations, ICARUS chains backward through skills it has, and creates new subgoals. When it has completed the problem-solving, it creates a new skill for the situation of in which is contained the skills it uses to reduce the problem to a primitive one and then uses the primitive skills to cap off the problem.

CLARION:

- Keeps an updated encoded hierarchy of concepts relating to both simple and complex objects. It also classifies new entities as instances of already known concepts and objects.

- Keeps a taxonomy of motor skills and their experienced outcomes, and revises its knowledge of its motor skills based on these experiences.

- Stores a hierarchy of plan elements in memory to select operatorrs and updates based on experiences.

1.2 Compare the two architectures in terms of:

1.2.1 Underlying philosophy and motivation

ICARUS is based on the philosophy that one should maintain focus on physical agents in their environment.

CLARION is based on the philosophy that robots are inherently social and must be able to cooperate with and adapt to other agents in its environment.

1.2.2 Memory structures - types of memory and how the content is represented

Both CLARION and ICARUS use symbolic representation, however CLARION uses subsymbolic as well.

CLARION uses the working memory as a temporary information storage whilst ICARUS uses it for the production rules, input and states relevant to the current situation.

CLARION uses the long term storage to keep procedural memory on the bottom level, and declarative memory on top level. ICARUS also keeps procedural and declarative memory as long term memory, but also episodic memory.

1.2.3 Cognitive cycle - from input to action

The cognitive cycle of ICARUS:

1. Inference

2. Goal processing

3. Skill retrieval and selection

4. Problem solving and skill learning

The cognitive cycle of ICARUS:
in ICARUS we have way more minor parts which make up the cognitive cycle, because of the almost overly specialized small mechanisms within it. However, this is a slightly more broad description:

1. Goal setting by MCS based on context by MS.

2. Action selection by ACS based on Goal, reinforcement, sensory input and the WM action network updated by the NACS.

3. Learning done by MS, ACS and NCS based on sensory input from outcome of said cycle.

2 Part 2 – Analogy reasoning

2.1 Explain the following key terms from analogy reasoning:

2.1.1 Analogy

An analogy is an assertion that a relational architecture can be applied in a domain other than the one which it is normally applied.

2.1.2 Base

The base is the domain which serves as a source of knowledge.

2.1.3 Literal similarity

A literal similarity is a comparison in which a large portion of the both object-attributes and relational predicates is mapped from base to target.

2.1.4 Relational similarity

A relational similarity is a comparison in which a large portion of relational predicates is mapped from base to target. However, there are few object-attributes mapped.

2.2 Fill in the following table?

Mapping	#attributes mapped	# relations	Example
Literal similarity	Many	Many	The K5 solar system is like our solar system
Relational similarity	Few	Many	The atom is like our solar system
Abstraction	Few	Many	The atom is a central force system
Anomaly	Few	Few	Coffee is like the solar system

2.3 Explain the Systematicity Principle

Systematicity principle tells us we should prefer connected knowledge over independent facts, meaning we believe a predicate which is interconnected is more likely to be imported than isolated predicates.

2.4 The analogy "a T is (like) a B" defines a mapping from the base B to the target T. What mapping rules are proposed by Gentner (Gentner 1983) in his framework for analogy?

- Discarding attributes of objects

- Try to preserve relations between objects

- Systematicity principle

2.5 The figure below shows an architecture for analogy reasoning. Briefly explain the MAC/FAC-principle, and how it works. In what way is MAC/FAC connected to the Retriever and Analogy Engine-modules?

The MAC/FAC-principle is based on "Many are called but few are chosen". MAC calls many candidate bases, and FAC selects the base. In this case the retreiver and the analogy engine are subsumed by MAC/FMC

3 Case-based reasoning

3.1 What is the main principle of Case-based reasoning (CBR)?

The main principle of case-based reasoning is to apply knowledge from past experiences to new situations.

3.2 How does CBR relate to human cognition? Give a few examples

CBR is closely related to human cognition as a large part of the reasoning a human does is based on applying learnt solution of previous cases to new cases and situations.

A mechanic might not know the exact way to fix every car, but rather has knowledge of fixes for similar cars and applies this to the new case.

If one meets a dog one has never seen before one can use knowledge of how to approach a dog from a previous encounter with another dog.

3.3 What is a MOP in the Dynamic Memory model?

A MOP in the Dynamic Memory model is a memory organization packet. These hold general knowledge and organize specific experiences of that general knowledge.

3.4 What are the key principles for indexing a new case, according to the Dynamic Memory model?

- Indexes should have discriminatory power

- They should capture unusual aspects of a situation

- They are indexed under norms based on if they either violate, specialize or generalize it.