Cognitive Architectures: SOAR

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1 The Soar Processing Cycle

Explain the following phases:

1.1 Input Phase

The input phase is the first phase in the decision cycle. This is where working memory elements are created to reflect the changes in the perception.

1.2 Operator selection

This is the phase after the phase which introduces preferences to our working memory. These are now evaluated by a fixed architectural decision procedure. This results in the selection of a "correct" operator.

1.3 Operator application

In the operator application phase, the chosen operator by the previous phase is applied.

2 Memory in Soar

2.1 Describe the memory structure in Soar

The memory structure is split into the LTM, WM and the decision procedure. The WM is the one which receives perceptional and sends out actional output. It gets additional knowledge from the LTM and its three structure types. The WM uses the decision procedure to choose which operator to apply to its situation. If the decision and application results in a motor command the WM passes it on to the output onto the action.

2.2 Describe the three types of long term memory (LTM) structures in Soar and their roles in problem solving

In the LTM we have three types of structures. The procedural knowledge is based on how and when to do things e.g. how to shuffle a deck of cards. The semantic knowledge is the knowledge of facts which we believe to be true in general, such as that a square has four sides. The episodic structure contains the knowledge of experiences, such as breaking your ankle by jumping off a high roof.

2.3 Describe the working memory (WM) in Soar and it's three components

Soar's WM holds the knowledge most relevant to the current situation. This knowledge is mostly specified to the given situation and is true for the given situation and time. It may also contain general information which is relevant to the given situation.The working memory can extract knowledge from the LTM structures. The three components of the WM is the objects, the preferences and the conflict stack which is connected to the decision procedure.

2.4 How does the WM and LTM communicate/cooperate?

For the knowledge in the LTM to be usable it must be retrieved by knowledge and firings in the WM. The WM and LTM cooperate by LTM working as a external memory which is accessed if the WM needs the knowledge held there or the WM is insufficient.

3 Miscellaneous

3.1 Explain the notion of problem space in Soar.

The problem space is a set of states and the possibilities represented by a triangle. The problem state shows the initial state and the operators which changes our current state, along the triangle. The problem space represents all facets of our agent.

3.2 Explain the principle of rationality and its role in Soar

The principle of rationality says that if an agent has knowledge that an operator application will lead to one of its goals, then the agent will select that operator.

3.3 What is an "impasse", and how does Soar handle the situation?

An impasse is when the decision structure cannot decide between operators because of a lack of preference. Soar handles impasses by creating a substate. A state with the sole goal of choosing between the operators.

3.4 Describe the different ways Soar can learn from its problem solving experience?

3.4.1 Chunking

The architecture automatically forms new rules to reflect the outcome of the impasse. This allows the model to immediately make a preferential decision based on the outcome of our last last impasse should the situation arise again under the same circumstances, avoiding a new impasse.

3.4.2 Reinforcement Learning

Reinforcement learning creates new operator selection rules based on the statistical regularity in reward of a given action. The change of the expected reward may alter the selection of operator next time as it follows its ever-lasting pursuit in maximizing reward.

3.4.3 Using its Episodic Memory

Soar may use its episodic memory of how its actions fared in the past to predict the outcome of its operators. By replaying the memories from previous experiences it can create a connection between these and use the knowledge of the outcome to avoid a negative outcome and pursue a positive one.

3.4.4 Semantic Memory

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4 How do you think emergence could be integrated into Soar?

Emergence could be integrated in Soar where several of these systems together have more properties and functions than each of them by themselves. An example of this is that several soccer players interconnected can play together with a specific tactic of setting a high press. By each of them planning out to take an opposition player each, they can set enough pressure on the ball-carrier to force a clearance.