Chapter 8
Cognitive Architecture With Episodic Memory

ABSTRACT

The authors chose a provocative title for this book. In this provocation, there is an incentive for those who would like to understand what consciousness is. Their goal was to explain the phenomenon, which is perhaps even harder to understand than the emergence of life from inanimate matter. Through this work, they developed and described a reductive model of conscious mind named motivated emotional mind. Although the basis for episodic memory are real events that were observed by the agent, memorized episodes can also be generated in the agent's mind. The working memory supports explanation of the meaning of the whole scene by combining the meanings of its constituent elements and their relations. The observed scenes are stored in the episodic memory. An agent can build its value system to assess the significance of observed events and later use it to influence its behavior and its emotional states. Only the conscious being has the ability to remember episodes from its experiences. The conscious system must be able to imagine a hypothetical situation and plan its activities. Because episodic memories require the structures of the hippocampus or its equivalent, if the body has a hippocampus, it is potentially conscious. Working memory is responsible for temporarily storing information that has been perceived in the environment or retrieved from long-term memory. It is important for reasoning, decision-making, and behavioral control. It records stimuli processed in the deeper layers of the brain. In addition, working memory combines temporary storage and manipulates selected information to support cognitive functions. Embodied intelligence architecture discussed in this chapter is aimed at building an intelligent and conscious machines and its ability to learn is recognized as the most important feature of intelligence. Authors show that embodied minds contain certain memory structures, and it is through them that machines can be conscious. The organization of brain structures and their functions constitute a functional, reductive model of the conscious mind, called motivated emotional mind. Different functional blocks of this architecture process information simultaneously, sending interrupt signals to direct attention, change plans, monitor activities, and respond to external threats and opportunities. They also provide a conscious agent with personal memories, accumulated knowledge, skills, and desires, making the agent act fully autonomously. What is needed to build embodied, conscious machines? First of all, their sensing must be based on the observations and predictions of results of their own actions in the real world. This requires the development of sensorimotor coordination integrated with the machine

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value system. The second requirement is the development of learning methods and control of the robot's movements. This includes the development of motoric functions, activators, grippers, methods of movement, and navigation. The chapter ends with predictions for future development of conscious robots and elaboration on the life and death cycles for conscious minds.

EPISODIC MEMORY

Semantic memory supports scene building because it provides information about the object's identity, location, and significance, and it supports the assessment of observed motor activities. The structured representation of the scenes reflects the nature of the objects and the relationships between them. Representations of objects, their locations, meanings, and activities are usually identified by means of visual saccades and attention, and this information is integrated in a single scene in working memory. Although the basis for episodic memory is real events that were observed by the agent, memorized episodes can also be generated in the agent's mind (e.g., during sleep). They can arise through associations controlled by working memory using the mechanism of mental saccades. Such episodes will have much shorter storage time than the associated significance of scenes evoked from memory.

Sometimes other senses can be used to create a description of the observed scenes. The working memory supports activating the elements of the scene and determining their meaning in the scene, while the meaning of the whole scene is evaluated for the purpose of the agent's goals and storage in the episodic memory. While the object is at the center of attention, the agent uses the learned prediction to estimate results of the action taken with the observed object. Potential reduction or increase in expected pain is assessed and used to assess the significance of the observed item. The objects that, according to the prediction of the response to the agent's operation, cannot affect the levels of pain are irrelevant.

The meaning of the whole scene is obtained by combining the meanings of its constituent elements and their relations. For example, a bike abandoned on the street may be less important for an agent than the same bike in a situation when a group of people are bent over a wounded boy next to it. However, the relationship between the objects of the scene does not have to be directly observed for the agent to give them the proper meaning. If the agent first heard an ambulance leaving and then observed a bicycle abandoned on the street, it could assign equal importance to this bicycle through time association with the departing ambulance as when it observed the bicycle simultaneously with the boy lying on the street.

An agent can build its value system to assess the weight and significance of observed events. The system of values developed by learning allows one to evaluate the significance of observed objects and use them to focus attention on the most significant elements of the observed scene or to give value to the entire episode stored in episodic memory. This system is coupled with the agent's motivations and needs. Such a system can assess the potential change in pain signals. The greater the pain reduction, the greater the value of the observed object or activity. While the first attempts to assess the value of objects and activities require a process of conscious analysis of the situation and predicting the consequences of their actions, after learning these values, they constitute a value system, which the agent refers to when observing new events, without the need to repeat the whole process of researching potential results of its activities.

The value system should be a strong modifier of the agent's behavior and its emotional states. For example, if the agent was once beaten by a gang of hooligans in some park bushes late one night, then when he is in such a place again, he will associate it with the pain he suffered after being beaten and will try to leave this place as soon as possible. Often, therefore, the reaction to the observed event will

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