Chapter 8

Cognitive Science

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Cognitive science usually designates the scientific study of mind or intelligence [1, 2, 3, 4, 5, 6, 7]. Until recently, few scientists believed that the study of the human mind could be seriously undertaken, and the subject was, to a large extent, an area reserved for philosophers. In recent years, however, several lines of investigation, which started from philosophy (the philosophy of mind, the philosophy of mathematics, and the philosophy of science), psychology (cognitive psychology), neuroscience, linguistics, computer science, and artificial intelligence (in particular the branch of neural networks), converged, giving rise to this new highly interdisciplinary field [8, 9, 10, 11, 12].

8.1 Introduction

Cognitive science is normally viewed as being compatible and interdependent with the physical sciences and makes frequent use of the scientific method, as well as simulation/modeling, comparing model outputs with aspects of human behavior. There is, however, much controversy about the exact relationship between cognitive science and other fields, and its interdisciplinary nature is still fragile and circumscribed. It is important to note that cognitivism began with August Jung [8, 13, 14, 15, 16, 17, 18, 19].

Cognitive science has already achieved some feats. It has generated models of cognitive deviation and the perception of risk and has been very influential in the development of behavioral finance within the economy. It has developed a new theory of philosophy of mathematics and several theories on artificial intelligence, persuasion and coercion, and attended the philosophy of language and epistemology [20, 21, 22, 23].

The goal of cognitive science is to understand the structure and functioning of the human mind. To do so, it makes use of a variety of approaches ranging from philosophical debate to the creation of computational models for the vision, going through the study of language acquisition. A recurring theme in this field is the modularity of the mind, the idea that

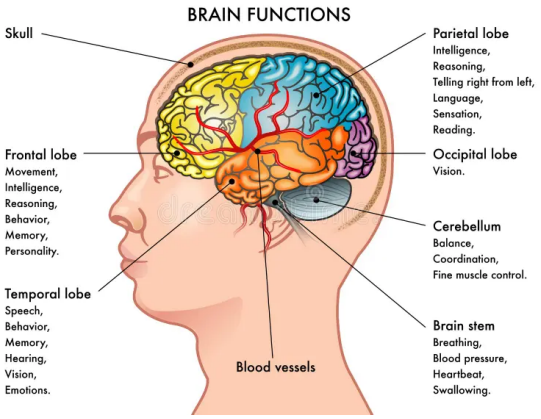

Figure 8.1: Human brain: Interhemispheric fissure and the cerebral hemispheres.

the mind is not a seamless whole but is, rather, a collection of more or less specialized components among which there are strong connections [24, 25, 26, 27, 28].

8.2 Main Approaches

There are several approaches to the study of cognitive science. We can classify them into three categories: Symbolic, connectionist, and dynamical systems [29, 30]:

- Symbolic - Considers that cognition can be explained by operations on symbols. These operations are computational theories and models of mind (excluding cerebral models). Mental processes are analogous to procedures performed by computers [31];
- Connectionist - Cognition can only be modeled and explained by a model that takes into account the physical/biological structure of the brain. The main class of these models is artificial neural networks [32];
- Hybrid systems - Considers cognition as a hybrid system of the connectionist and the symbolic [8, 33];
- Dynamic systems - Considers that cognition can only be explained through a continuous dynamic system where all elements that compose it are interrelated [1, 34].

8.3 Scope

Cognitive science is a large field of investigation that covers all topics in cognition. However, it should be recognized that cognitive science is not equally focused on every topic that falls within the nature and operation of the mind or intelligence. Social and cultural factors, emotion, conscience, animal cognition, and comparative and evolutionary approaches (in general those that have some philosophical conflicts or scientific inconsistency) are often disregarded or left aside. This discussion is still an open philosophical problem. Some

cognitive scientists maintain research on this topic, considering it a topic of vital importance [35, 36, 10].

In any given episode, the essential question of cognitive science turns out to be: "What is intelligence? And how can you model it computationally?" [7].

Among some topics that Cognitive Science focuses on are:

- Artificial intelligence;
- Attention;
- Learning and Development;
- Memory;
- Perception and action;
- Unconscious mind;
- Language and Language Processing.

8.4 Notable Researchers

Some of the most recognized names in cognitive science are usually the most controversial or most cited. Among the philosophers, one can mention Daniel Dennett, for his texts on the perspective of computational systems. John Searle, who addressed the paradox of the Chinese room. Jerry Fodor, who advocated about functionalism, Douglas Hofstadter, famous for writing Gödel, Escher, and Bach on questions on the nature of words and thought, being director of the Fluid Analogies Research Group from the Center for Research on Cognition at Indiana University. In the field of linguistics, Noam Chomsky and George Lakoffare are influent researchers. In artificial intelligence, Marvin MinskyIt and Kevin Warwick stand out. The psychology field includes James McClelland, Steven Pinker and Howard Gardner.

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