Informatics One: Cognitive Science

Generated by LectureMate

February 21, 2025

1 Introduction

Today's lecture provides an introduction to cognitive science, focusing on two key concepts: cognitive modeling and language acquisition. The readings for this lecture include a paper by Aston Martin on computational modeling and a summary by Haz on cognitive gadgets, which will be discussed in detail.

2 Cognitive Science Overview

Cognitive science studies mental representations and processes. Representations store information in structured formats, while processes are algorithms that operate on these representations. These processes can transform sensory information into representations or actions.

2.1 Pizza Example

To illustrate decision-making, consider the choice between two 12-inch pizzas and one 18-inch pizza. Many people intuitively prefer the two smaller pizzas, but calculating the area reveals that the single larger pizza offers more food. This example highlights the importance of cognitive modeling in understanding decision-making.

2.2 Cognitive Modeling

Cognitive modeling formalizes verbal descriptions into implementable theories. For instance, the area of a pizza can be calculated using the formula for the area of a circle. By implementing a decision function in Python, we can clarify assumptions about how decisions are made based on area.

3 Cognitive Modeling Process

According to Aston Martin, cognitive modeling is a multi-step process:

1. Start with a framework (meta-theory).
2. Formulate a specific theory (e.g., pizza selection).
3. Specify the theory formally (mathematical description).

4. Implement the theory (e.g., software code).
5. Generate hypotheses based on the implementation.
6. Test hypotheses and gather data.
7. Revise the theory based on data.

3.1 Frameworks and Theories

A framework is a conceptual system for generating models. For example, neural networks serve as a framework for modeling cognitive processes. Theories are specific instantiations of frameworks, while specifications formalize the theories.

3.2 Hypothesis Generation

Hypotheses are testable statements derived from theories. For example, if two small pizzas have a larger area than one large pizza, people should prefer the smaller pizzas. This can be tested through experiments.

4 Language Acquisition

Transitioning to language acquisition, children often make mistakes that reveal their understanding of language rules. For example, a child might say "I eat it" instead of "I ate it," indicating an assumption of regular verb conjugation.

4.1 Theory of Language

The theory posits that language operates through words and rules. This theory can be specified and implemented to generate hypotheses about language learning.

4.2 Cultural Transmission

Hayes argues that cognitive capabilities, including language, are not innate but acquired through cultural transmission. This challenges the notion of instincts and suggests that a general learning mechanism suffices for acquiring cognitive skills.

5 Cognitive Technologies

Cognitive technologies are mental structures and processes acquired through cultural evolution. They extend our cognitive capabilities, similar to how physical tools extend our physical abilities.

5.1 Language as a Cognitive Technology

The role of language in cultural transmission raises questions about its innate aspects. While some argue that language is innate, evidence from critical periods in language learning suggests that certain aspects may be learned.

5.2 Critical Periods

Critical periods indicate that certain cognitive functions must be acquired within specific time frames. For example, children exposed to language before puberty tend to learn it more naturally than those who start later.

6 Conclusion

The lecture concludes with a discussion on the implications of cognitive modeling and cultural transmission for understanding cognitive science. The iterative process of theory development and hypothesis testing is crucial for advancing our knowledge in this field.