Detailed Explanation of Semantic Memory Concepts

Introduction to Semantic Memory

Semantic memory refers to a type of long-term memory that stores general knowledge, facts, concepts, and rules about the world. Unlike episodic memory, which is time-dependent and stores personal experiences, semantic memory is organized based on meaning rather than temporal events. It encompasses information we use in our everyday lives, such as arithmetic rules, language, and factual knowledge.

Distinction Between Episodic and Semantic Memory

- Episodic Memory: Episodic memory is time-dependent and is concerned with personal experiences that are organized in a temporal sequence (e.g., remembering your graduation day).
- Semantic Memory: Semantic memory, in contrast, is meaning-based. It is independent of the time or place the information was learned and focuses on general knowledge (e.g., knowing the rules of arithmetic without recalling when you learned them).

In episodic memory, the focus is often on the self, with the person remembering events from their perspective. Semantic memory does not focus on the self but instead centers around world knowledge and facts.

Models of Semantic Memory

Several models have been proposed to explain how semantic memory is structured and processed. Two significant models discussed are:

1. Hierarchical Semantic Network Model (Collins and Quillian, 1969)

This model proposes that semantic memory is organized in a hierarchical structure where concepts

are stored as nodes. These nodes are connected by links or pointers that represent relationships between concepts.

- Nodes: Represent concepts (e.g., "bird").
- Pointers/Links: Represent relationships between nodes (e.g., "a bird has wings").

This model suggests that related concepts are stored close to each other, and the organization is efficient in terms of cognitive economy, which means that common properties are stored at higher levels of the hierarchy.

Criticism of the Hierarchical Model:

- It violates cognitive economy by sometimes storing redundant information at different levels.
- It does not always reflect real-life cognitive processes, where hierarchical relations are not strictly followed.

2. Feature Comparison Model

This model posits that semantic memory consists of features, and concepts are compared based on their defining and characteristic features.

- Defining Features: Essential attributes that must be present for a concept to belong to a category (e.g., "a bird has wings").
- Characteristic Features: Non-essential attributes that are often, but not always, present (e.g., "a bird can fly").

The comparison of features occurs in stages:

- First, characteristic features are compared.

- If the comparison is not decisive, defining features are compared.

If both sets of features match, the concept is confirmed to belong to the category; otherwise, it is rejected.

Spreading Activation Model (Collins and Loftus, 1975)

This model is an extension of the hierarchical network model, but with some key differences:

- Concepts are still represented as nodes connected by links.
- Spreading Activation: When a node is activated, energy spreads out to related nodes along the links. The strength of the activation decreases as it spreads out to more distant nodes.

For example, if the "animal" node is activated, the activation spreads to related nodes such as "bird," "mammal," and then to more specific concepts like "sparrow" or "lion." The more closely related two concepts are, the stronger the connection and the more energy will be transferred between them.

Strength of Connections:

The strength of the connection between two nodes depends on how similar the concepts are. For example, "king" and "queen" are strongly related and have a high-weight link, while "desk" and "airplane" are less related and have a weaker link.

Criticism of the Spreading Activation Model:

- Breadth of the Model: It covers a broad range of connections, making it difficult to test predictions clearly and empirically.
- Defining Similarity: The model does not explain what makes two concepts similar, leaving some ambiguity.

ACT-R Model (Anderson, 1976)

The ACT-R (Adaptive Control of Thought) model, proposed by John Anderson, focuses on a process-oriented view of memory. It divides memory into three main types:

- Declarative Memory: Contains facts and information about the world.
- Working Memory: Activated parts of declarative memory that are currently in use for processing.
- Procedural Memory: Contains production rules, or instructions, for how to perform actions based on goals, conditions, and procedures.

Declarative Memory in the ACT-R Model:

Declarative memory stores information in a network of nodes. Each node represents a concept, and nodes are connected by weighted links that represent relationships. For instance, similar concepts are connected by strong links, while less similar concepts are connected by weaker links.

Procedural Memory in the ACT-R Model:

Procedural memory consists of production rules (if-then statements) that guide behavior. These rules specify goals, conditions to be met, and actions to be performed. For example, if the goal is to study in a quiet environment, one production rule might be "If it is noisy, then go to the library."

Interaction Between Declarative, Working, and Procedural Memory:

In the ACT-R model, working memory retrieves information from declarative memory and applies production rules from procedural memory to achieve specific goals. This interaction allows for complex cognitive processes, such as decision-making and problem-solving.

Connectionist Model

The connectionist model, also known as the neural network model, simulates cognitive processes by

using interconnected nodes that mimic the activity of neurons in the brain.

- Input Units: Receive information from the environment.
- Hidden Units: Process information by adjusting weights between nodes.
- Output Units: Generate the final response based on the processed information.

The strength of the connections between units changes with experience, enabling learning. For instance, when a person learns that "a robin is a bird," the connection between "robin" and "bird" becomes stronger. Over time, the system adjusts the weights between input and output layers to make more accurate predictions.

The backpropagation algorithm is commonly used in connectionist models to adjust the weights and improve the accuracy of the network's predictions.

Schemas and Scripts (Bartlett's Work)

Sir Frederic Bartlett proposed the concept of schemas, which represent organized knowledge about the world. A schema contains general information about a category, allowing individuals to make sense of new experiences by filling in gaps with default knowledge.

- Schemas: Are mental structures that help organize and interpret information.
- Scripts: Are specific types of schemas that represent knowledge about routine activities (e.g., going to a restaurant). A script outlines the sequence of actions or events that typically occur.

Bartlett's Experiment (War of the Ghosts):

Bartlett conducted an experiment in which participants read a complex story and were asked to recall it later. He found that people tended to remember the gist of the story but often altered or

omitted specific details, filling in gaps based on their schemas.

Uses of Schemas and Scripts

Schemas and scripts help individuals:

- Make Inferences: When information is incomplete, schemas allow us to fill in missing details (e.g., assuming someone paid the bill after dining at a restaurant).
- Organize Information: They help organize complex information and make sense of it by providing a structured framework.
- Provide Default Values: In everyday situations, schemas provide default assumptions (e.g., assuming a person referred to as "she" is female without explicitly stating it).

Conclusion

In this lecture, we explored various models of semantic memory, including the hierarchical network model, feature comparison model, spreading activation model, ACT-R model, and connectionist model. We also discussed how schemas and scripts organize general world knowledge and how these cognitive structures help individuals process and interpret information in their daily lives.