Classic Papers: Review/Analysis

Title and Author:

Title: Computer Science as Empirical Inquiry: Symbols and Search

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Knowledge Relating to the Cognitive Science Program Learning Outcomes

1. **Symbol Systems:**
    a. A physical symbol system consists of a set of entities, called symbols, which are physical patterns that can occur as components of another type of entity called an expression (or symbol structure) … A physical symbol system is a machine that produces through time an evolving collection of symbol structures. Such a system exists in the world of objects wider than just these symbolic expressions themselves (116).
2. **Symbol Systems**
    a. *The Physical Symbol System Hypothesis*. A physical symbol system has the necessary and sufficient means for general and intelligent action.

    By "necessary", we mean that any system that exhibits general intelligence will prove upon analysis to be a physical symbol system. By "sufficient" we mean that any physical symbol system of sufficient size can be organized further to exhibit general intelligence. By "general intelligent action" we wish to indicate the same scope of intelligence as we see in human action: that in any real situation behavior appropriate to the ends of the system and adaptive to the demands of the environment can occur, within some limits of speed and complexity.

3. **Formal Systems and Theories of Computation:**
    a. A Turing machine consists of two memories: an unbounded tape and a finite state control. The tape holds the data, i.e. the famous zeroes and ones. The machine has a very small set of proper operations – read, write, and scan operations – on the tape. The read operation is not a data operation, but provides conditional branching to a control state as a function of the data under the read head.
4. **Psychological Investigations:**
    a. The search for explanations of man's intelligent behavior in terms of symbol systems has had a large measure of success over the past twenty years; to the point where information processing theory is the leading contemporary point of view in cognitive psychology. Especially in the areas of problem solving, concept attainment, and long-term memory, symbol manipulation models now dominate the scene (119).
5. **Algorithms**
    a. A second law of qualitative structure for AI is that symbol systems solve problems by generating potential solutions and testing them, that it, by searching. Solutions are usually sought by creating symbolic expressions and modifying them sequentially until they satisfy the conditions for a solution. Hence symbol systems solve problems by searching (126).