Questions and Answers for the Lectures on HCI

Module 8

1. Discuss the two approaches to model human cognition.

   Answer: The two broad approaches to model human cognition are (a) the computational approach, in which human cognition is modeled using computer metaphors, such as processor, memory etc., and (b) the connectionist approach, in which biological metaphors, such as neurons, are used.

2. Define cognitive architecture. What is a production system?

   Answer: A cognitive architecture is defined as a broad theory of human cognition based on a wide selection of human experimental data, and implemented as a running computer simulation program. These belong to the computational approach of modeling cognition.

   Production systems are one type of cognitive architectures, in which the cognition is implemented with the help of a set of production (IF- ELSE) rules.

3. Discuss in brief the organization and working of the Model Human Processor (MHP).

   Answer: The MHP contains three interacting subsystems: (a) the perceptual subsystem representing the process of taking sensory input from the environment, (b) the cognitive subsystem representing the process of cognition and (c) the motor subsystem representing the motor actions in response to some perceptual or cognitive stimulus. Each of these subsystems has their own memory and processors. The perceptual subsystem consists of two types of memory, namely the visual (decay time ≈ 200 ms) and the auditory (decay time ≈ 1500 ms) stores. The perceptual cycle takes about 100 ms. The cognitive subsystem depends on the short term (working) memory with limited storage capacity (decay time ≈ 7s for each chunk of information) and the long term memory (infinite storage capacity, no decay). A cognitive cycle takes about 70 ms. The working memory also acts as the memory component of the motor subsystem. Execution of a motor action (cycle) takes about 70 ms.

   There are ten principles of operations that govern the working of the subsystems in the MHP, as listed below.

   i. P0 -- Recognize-Act cycle of the cognitive processor

   ii. P1 -- Variable perceptual processor rate

iii. P2 -- Encoding specificity principle

iv. P3 -- Discrimination principle

v. P4 -- Variable cognitive processor rate principle

vi. P5 -- Fitts's law

vii. P6 -- Power law of practice

viii. P7 -- Uncertainty principle

ix. P8 -- Rationality principle

x. P9 -- Problem space principle

4. What are the two principles of operations most important for the working of MHP? Explain those briefly.

Answer: The principles P8 and P9, in the listing of principles in Q3, are the two most important principles governing the working of MHP. The principle P8, the rationality principle, states that the human behavior is determined by a set of factors that include goals, task, inputs and knowledge. The problem space principle or P9 states that any goal directed activity can be described in terms of a set of states of knowledge, operators for changing one state into another, constraints on applying operators and control knowledge for deciding which operator to apply next (see slides 10-20, Lecture 2, Module 8 for more details on P9).

5. How the process of cognition is implemented in MHP?

Answer: In MHP, the cognition is implemented using the notion of "cognitive cycles", which are essentially pattern-matching processes. The long term memory contains two types of knowledge: procedural containing a set of IF-ELSE (production) rules and declarative, where facts about the world are stored. In a cognitive cycle, the procedural memory is activated. The IF parts are then matched with the content of the working memory. If a match is found, the rule is "fired" (i.e., the THEN part is executed by the cognitive process, which may involve retrieving knowledge from the declarative memory). There can be multiple rule firings for the same input. The result of rule firing is a change in the working memory (and possible also of the declarative memory) content, which may instigate further rule firings. This way the cycle continues till no more rules are fired. As we mentioned before (Q3), on an average these cycles take about 70 ms to complete.

The process described above is also known as the "recognize-act cycle" (principle P0 in the set of principles of operations).