Cognitive Frameworks for HCI

Lecture #6

Agenda

- Definition of HCI revisited
- Cognitive perspective in HCI
- Human information processing
- Role of cognition in HCI design

Definition of HCI Revisited

- There are two elements in HCI
  - Human (user)
  - Computer (technology)

- What is HCI and what makes it so important?

  Human is trying to do something interacting through the computer, but not interacting with the computer.

  - Terry Winograd, Professor, Stanford University in California

HCI is Important Because…

- Human-computer interaction is the kind of discipline which is neither the study of human, nor the study of technology but the bridging between those two

ACM SIGCHI Definition on HCI

- Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and the study of major phenomena surrounding them

Two Eyes Problem in HCI

- **Technology**
  - What can the technology do?
  - How can you build it?
  - What are the possibilities?
- **Human**
  - What are people doing?
  - How would this fit in?
  - What would they do with it?

Humans in HCI

- We have studied about technology, now it is necessary to study human
- Human elements
  - Human beings are highly tangible: often subject to
    - Lapses of concentration
    - Changes in mood
    - Changes in motivation and emotion
    - Make errors and misjudgments

Humans in HCI

- We have studied about technology, now it is necessary to study human

- Human elements
  - At the same time they
    - Can perceive and responds rapidly to external stimuli
    - Solve complex problems
    - Create masterpieces
    - Coordinate their actions with others

Humans in HCI

- HCI designer must pay enough attention to those human elements
- Must try to understand the human aspects of computing
  - To develop much more usable and useful systems that may also be a joy to use
  - To make system reliable and safe to use by humans

    (We know that people make errors, so we should design systems so that either people no longer makes errors, or the systems are error insensitive)

Humans in HCI

- HCI designer must pay enough attention to those human elements
- Must try to understand the human aspects of computing
  - By considering the way people act and react in their environment, systems can be designed to support their needs as well as to provide powerful functionalities
  - To achieve subjective accomplishment of humans, systems should be designed by examining and learning about **cognitive**, **social** and **organizational** aspects of human behavior

Humans in HCI

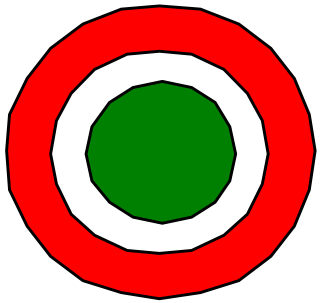
- **Cognitive psychology** can help to improve the design of systems by
  - Providing knowledge about what users can and cannot be expected to do
  - Identifying and explaining the nature and causes of the problems users encounter
  - Supplying modeling tools and methods to help build interfaces that are easier to use

Humans in HCI

- **Social knowledge** can help to improve the design of systems by
  - Providing knowledge about the context of use
  - Identifying and explaining how people work together and what sorts of computer systems are needed to support collaborative working
  - Supplying frameworks of social interaction and conversation that can form the basis of HCI frameworks

Humans in HCI

- **Organizational knowledge** can help to improve the design of systems by
  - Providing models of the processes and structures of organizations
  - Identifying trouble spots in organizations that are preventing computer systems from being used optimally and people from obtaining satisfaction from their work
  - Supplying organizational methods for the design and evaluation of new technologies that are being introduced into work settings



Cognitive Perspective of HCI

Cognition.. Cognition… Cognition…. Cognition….

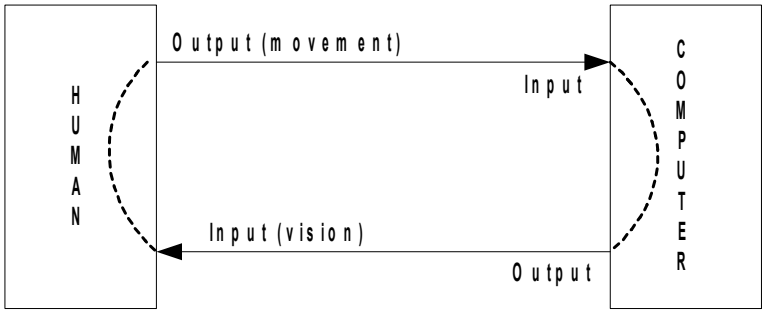
- **What do we mean by cognition?**
- In general
  - cognition refers to the processes by which we become acquired with things
- In other words
  - Cognition means to gain knowledge, which includes
    - Understanding, attending, being aware, acquiring skills and creating new ideas

How to Measure Cognition?

- Whether it is measurable at all!
- If it is measurable, what is/are the metric(s) for that?
  - Questionnaires
  - Interview
  - Watch

  so on ……

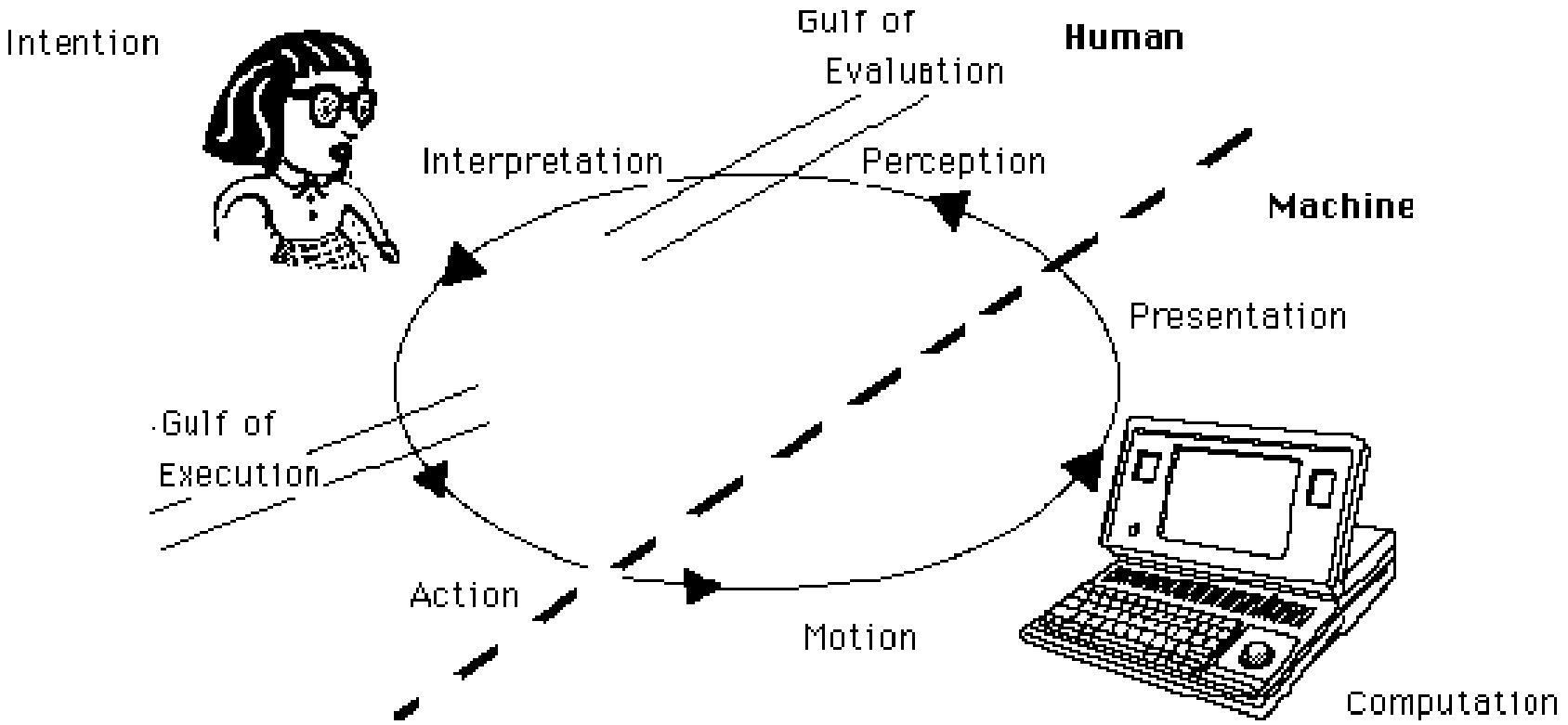
Why Cognition is an Issue?



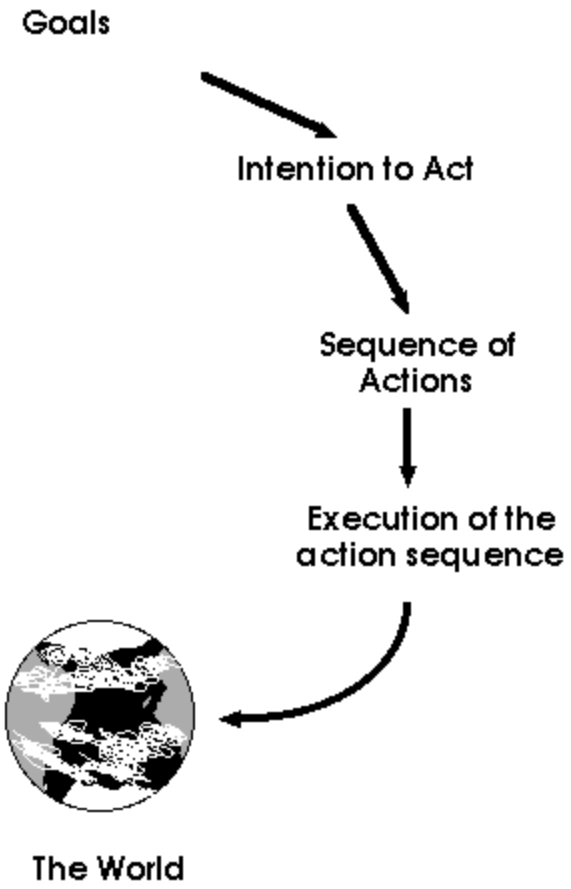
Knowledge transmission between human and computer

- In order to design good interfaces between humans and computers, the designer must have a basic understanding of
  - How human deals with information
  - How computer deals with similar information

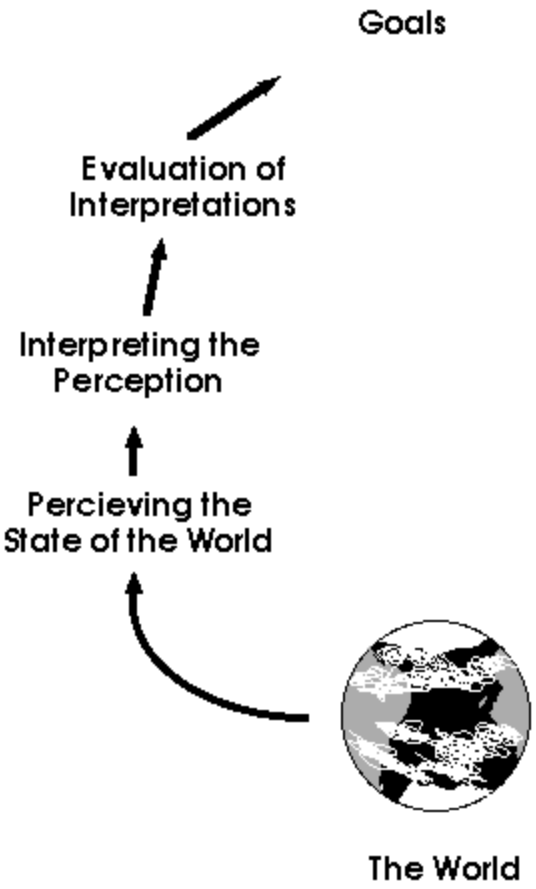
Cognition in Man-Machine Interaction



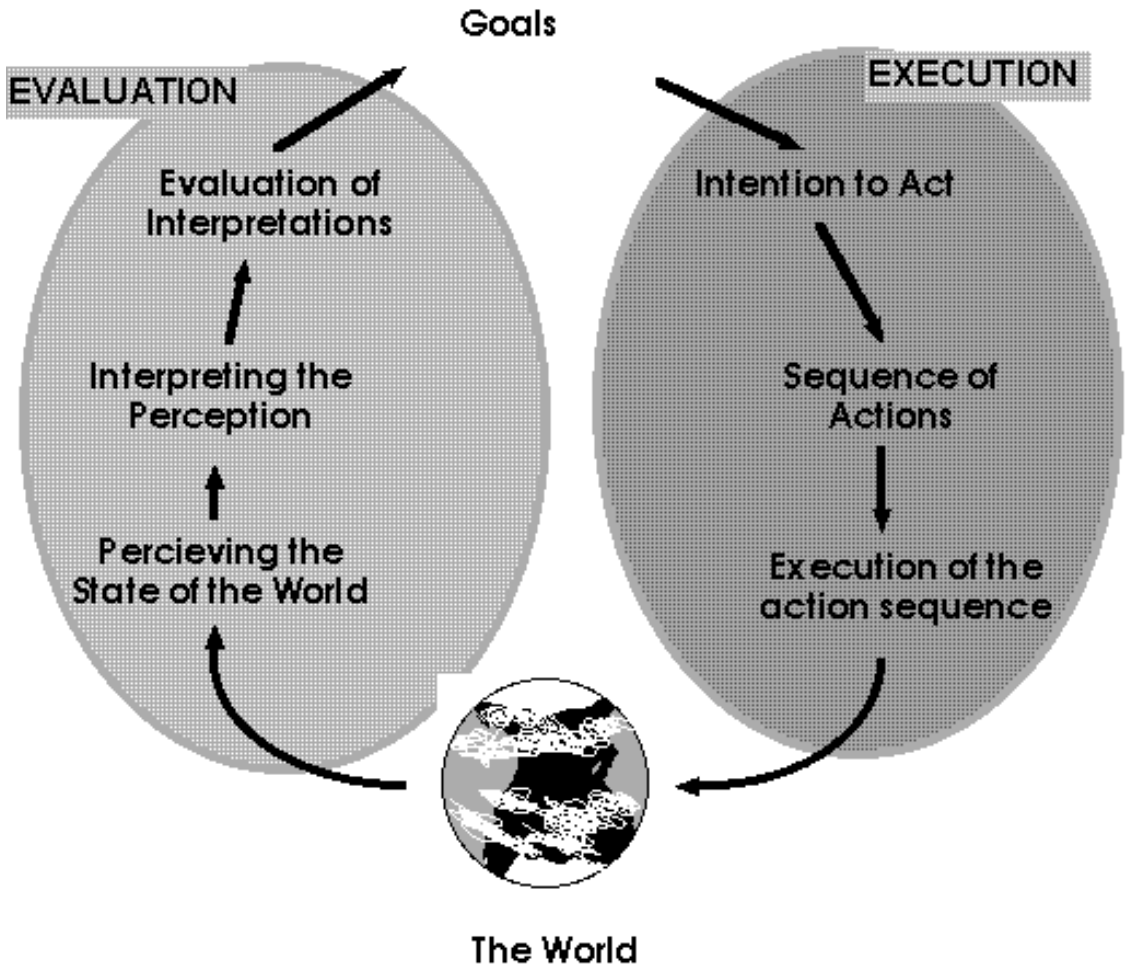
Norman's Gulf of Execution



Norman's Gulf of Evaluation



Norman's Two Gulfs

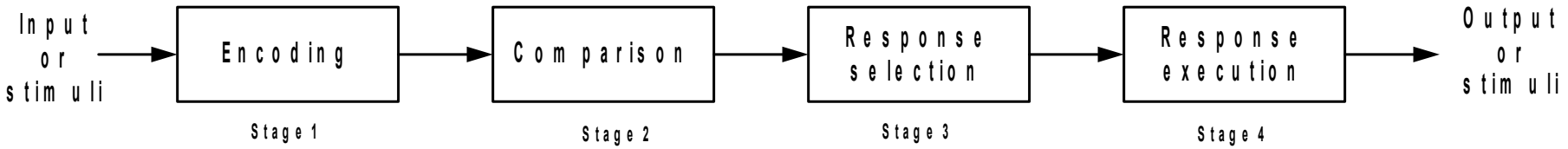


Human Information Processing

- The main paradigm in Cognitive Psychology is to characterize humans as information processor

- Everything that is sensed (sight, hearing, touch, smell and taste) is considered to be information which the mind processes

Model of Human Information Processor



Human information processing stages

- Information enters and exits the human mind through a series of ordered processing stages

Human Information Processing

- **Illustration 1:** Consider the sequence involved in sending a letter

  1. Letters are posted in a post-box
  2. A postman empties the letters from the post-box and takes them to central sorting office
  3. The letter is then sorted according to the area and sent via rail, road or air or ship to their destination
  4. On reaching their destination, the letter is further sorted into particular areas and then into street location and son on
  5. The letter is delivered to the recipient

- This things has a close resemblance with the information processing analysis task in our mind

Human Information Processing

- **Illustration 2:** To determine the phone number of a friend

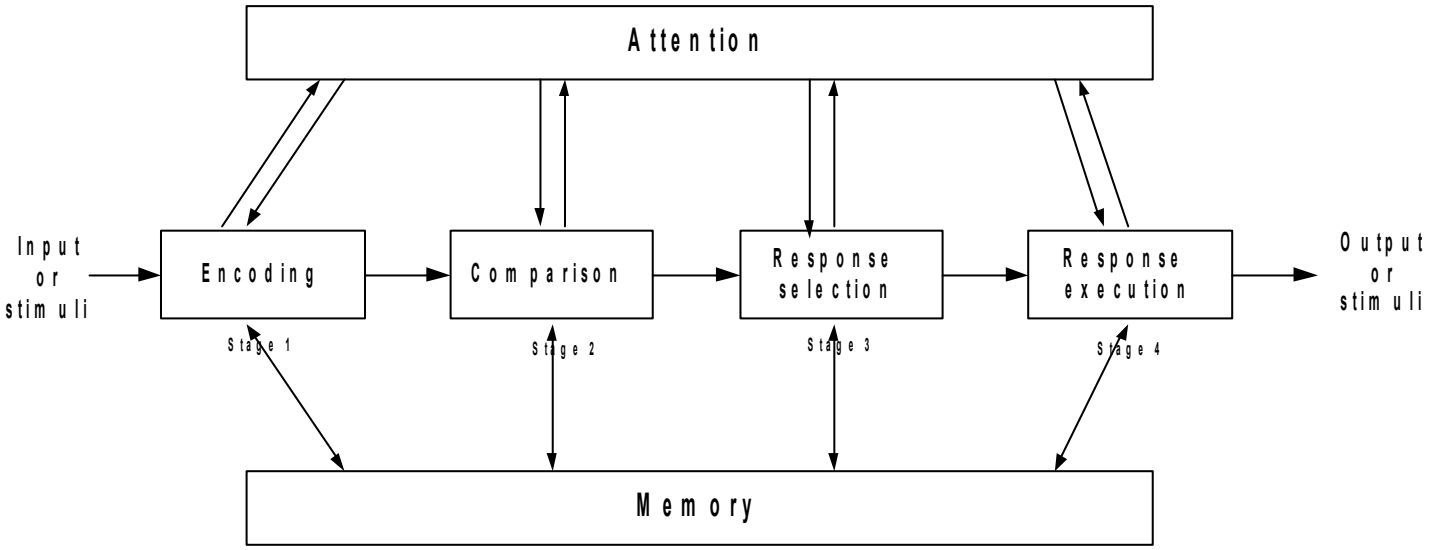
  1. Identify the words in this cognitive task and then retrieve their meaning
  2. Searching our memory for the solution of the problem
  3. On retrieving the number in the memory we generate a plan and formulate the answer into a representation
  4. Then we need to recite the digits or write down them down

- Note: The major aspects in information processing analysis is to trace the mental operations and their outcome for a particular cognitive task

Human Information Processing

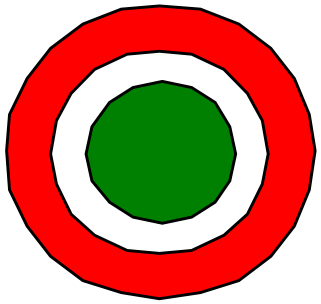
- Three aspects in human information processing
  - Perception
    - Visual
    - Audio
    - Other senses (tactile, Gustatory, Smell)
  - Cognition
    - Memory
    - Problem solving
    - Learning
  - Motor behavior
    - Speaking
    - Typing
    - Pointing
    - and others

Extended Model



Extended stages of human information processing model

- Here cognition is viewed in terms of
  1. How information is perceived by the perceptual processor
  2. How that information is attended to, and
  3. How that information is sorted in memory



Role of Cognition in HCI Design

- Quantitative measurement for HCI design
  - The model human processor provides a means of characterizing the various cognitive processes that are assumed to underlie the performance of a task
  - Card, Moran and Newell (1983) proposed a model for predicting the speed with which users could carry out tasks on a computer

Predicting the Cognition by Card et al.

- Essential parameters are

  t_p = time for perceiving a stimulus

  t_c = time for making a decision

  t_m = time for making a tapping motion

- Study reveals that

  t_p = 100 [50 ~ 200] ms

  t_c = 70 [20 ~ 170] ms

  t_m = 70 [30 ~ 100] ms

Predicting the Cognition by Card et al.

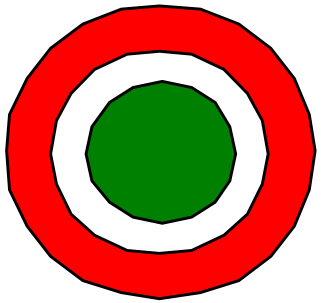
- Total time required for some user interface action is then predicted by the number of times each type of event must occur in the performance of that action

$$T = n_p t_p + n_c t_c + n_m t_m$$

More Study

- The human information process model as discussed is over simplified

- The improved model should take care
  - Knowledge representation
  - Mental models
  - Interface metaphor
  - Conceptual models
  - Learning in context



Recommended Materials

- My Home page
  http://facweb.iitkgp.ernet.in/~dsamanta
  (For the presentation slides of the current lecture

- Books

  The Psychology of Human-Computer Interaction, S. K. Card, T. P. Moran and A. Newell, Lawrence Erlbaum Associates, New Jersy

  Human-Computer Interaction Jenny Preece, Addison-Wesley, New York
  Chapter 3