HUMAN COMPUTER INTERACTION

LECTURE 1

Introduction to HCI

- DEFINITIONS
- **Definition 1** - HCI is the study and practice of usability – It is about understanding and creating software, other technology that people will want to use, will be able to use and will find effective when used.

Usability is one of the key concepts in HCI. It is concerned with making systems easy to learn and use. A usable system is:

- easy to learn
- easy to remember how to use
- effective to use
- efficient to use
- safe to use
- enjoyable to use

“A usable software is one that supports the effective and efficient completion of tasks in given work context”

Benefits of more usable software to users include

- Increased productivity
- Increased accuracy of data input and interpretation
- Decreased user errors
- Decreased user training and cost
- Decreased need for ongoing technical support.

- **Definition 2** – HCI is the study of how people use computer systems to perform certain tasks – HCI tries to provide us with all understanding of the computer and the person using it, so as to make the interaction between them more effective.
- **Definition 3** – HCI concerns with process of design, evaluation and implementation of interactive computing systems for human use, plus the study of major phenomena surrounding them.

Importance of HCI – HCI will be increasingly important in following areas

- As a part of software development process and system design methods.
- As a part of future legal requirements for software.
- As the basis for a set of usability criteria to evaluate and choose from competing products.
- As the basis for successful marketing strategy to small business user.

The Goals of HCI

The goals of HCI are to produce usable and safe systems, as well as functional systems. In order o produce computer systems with good usability.

Developers must attempt to:

- understand the factors that determine how people use technology
- develop tools and techniques to enable building suitable systems
- achieve efficient, effective, and safe interaction
- put people first

Underlying the whole theme of HCI is the belief that people using a computer system should come first. Their needs, capabilities and preferences for conducting various tasks should direct developers in the way that they design systems. People should not have to change the way that they use a system in order to fit in with it. Instead, the system should be designed to match their requirements.

The Field of HCI

(Human Computer Interaction)

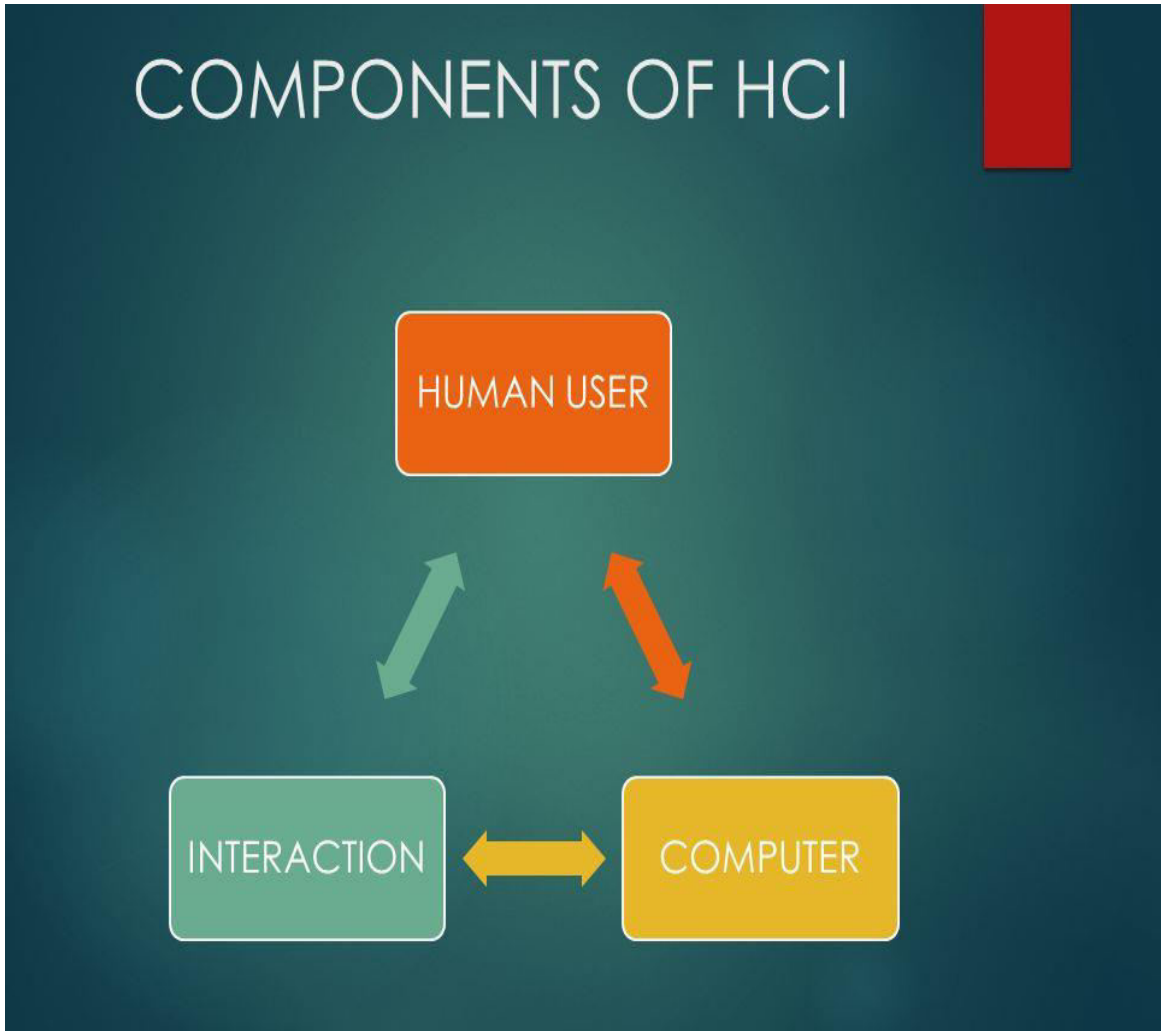
Disciplines contributing to HCI

The field of HCI covers a wide range of topics, and its development has relied on contributions from many disciplines.

Some of the main disciplines which have contributed to HCI are:

- **Computer Science**
  Technology, Software design, development & maintenance, User Interface Management Systems (UIMS) & User Interface Development Environments (UIDE), Prototyping tools, Graphics.
- **Cognitive Psychology**
  Information processing, Capabilities, Limitations, Cooperative working, Performance prediction.

- **Social Psychology**
  Social & organizational structures
- **Ergonomics/Human Factors**
  Hardware design
  Display readability
- **Linguistics**
  Natural language interfaces
- **Artificial Intelligence**
  Intelligent software
- **Philosophy, Sociology & Anthropology**
  Computer supported cooperative work (CSCW)
- **Engineering & Design**
  Graphic design, Engineering principles


COMPONENTS OF HCI
HUMAN USER
INTERACTION
COMPUTER

- Human – are good at sensing low level stimuli, pattern recognition, inductive reasoning, multiple strategies, adapting to hard things.

- Computers – good at counting and measuring, accurate storage and recall, rapid and consistent responses, data processing, repetitive actions.

- Interaction – The list of skills making humans to do what humans do best and computers to do their task.

User(Human)

By *user* we may mean an individual user, a group of users working together, or a sequence of users in an organization, each dealing with some part of the task or process. The user is whoever is trying to get the job done using the technology.

- The human is the central character in any discussion of interactive systems. The requirements of the user should therefore be our first priority.

Study of the human psychology is the basic for HCI. This may seem inappropriate for designing and building interactive systems but it is not.

- In order to design something for someone understanding of their capabilities and limitations is a must. There is need to find if there are things that they will find difficult or even impossible.
- This understanding helps in encouraging which people feel more comfortable.

- The study of psychology involves how humans perceive the world around them, how they store and process information and solve problems.
- For this study there are many models which were proposed earlier such as "**Model human processor**" which is a simplified view of the human processing involved in interaction with computer systems.

Model human processor

The model comprises three subsystems

1.The perceptual system- handling sensory stimulus from the outside world.

2.The motor system which controls actions.

3.The cognitive system which provides the processing needed to connect the two

- Each of these subsystems has its own processor and memory, although the complexity of these varies depends upon the tasks the system has to perform.
- The model also includes a member of principles of operation which dictate the behavior of the system under certain conditions.

- The study needed for HCI is done by treating user as an information processing system , by comparing with conventional computer system.
- Information comes in , is stored and processed, and information is passed out.

- Therefore the study focuses on three components of the system as

1. Input-output channels
2. Memory
3. Processing

- In the study of human, we are dealing with an intelligent information processing system, and therefore it includes problem solving , learning and making mistakes.
- The human, unlike the computer is also influenced by external factors such as the social and organizational environment and there is need to be aware of these influences.

HUMAN COMPUTER INTERACTION

LECTURE 2

Input-Output channels:

- A persons interaction with the outside world occurs through information being received and sent.
- Input in human occurs mainly through senses and output through the motor control of the effectors.
- Here are five senses

1. Sight
2. Hearing
3. Touch
4. Taste
5. Smell

- The first three are the most important to HCI

Vision:

- Human Vision is a highly complex activity with a range of physical and perceptual limitations, yet it is the primary source of information.

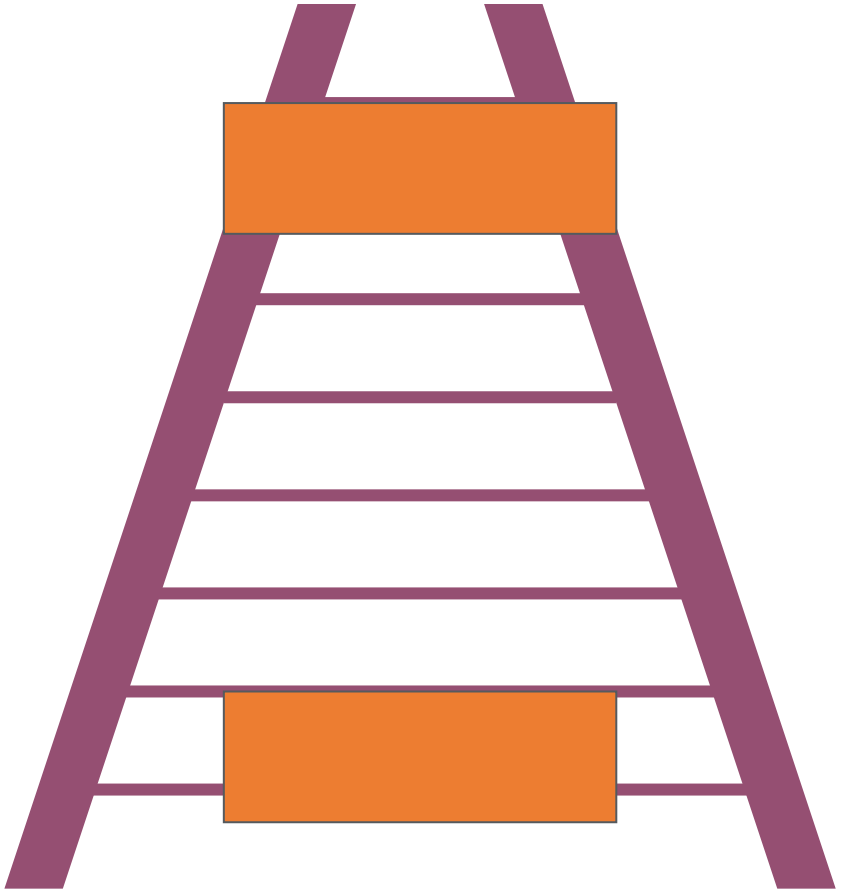
Visual perception is divided into two stages-The physical reception of the stimulus from the outside world, and the processing interpretation of that stimulus.

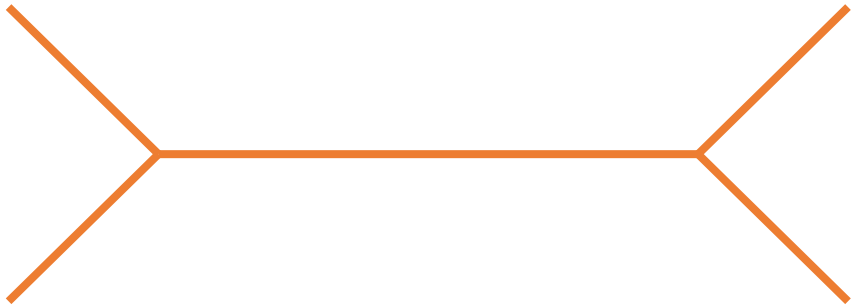
- We need to understand both stages as both influence what can and what cant be perceived visually by a human being, which is turn directly affects the way that we design computer systems.

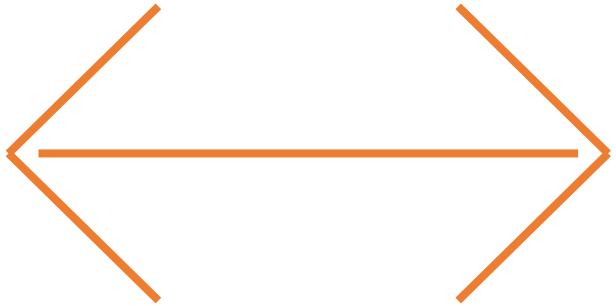
- Human eye-Vision begins with light. The eye is a mechanism for receiving light and transforming it into electrical energy.
- Light is reflected from objects in the world and their image is focused upside down on the back of the eye. The receptors in the eye transform it into electrical signals which are passed to the brain.
- The retina of the eye is light sensitive and contains two types of photo receptors : Rods and Cones.
- Rods are highly sensitive to light and therefore allow us to see under a low level of illumination.
- Cones are the second type of receptor in the eye. They are less sensitive to light than the rods and can therefore tolerate more light.
- There are three types of cone, each sensitive to a different wavelength of light. This allows color vision.

Visual Perception:

- Understanding the basic construction of the eye goes somewhere to explaining the physical mechanism of the vision but physical perception is more than this.
- The information received by the visual apparatus must be filtered and passed to processing elements which allow us to recognize coherent scenes, disambiguate relative distance and differentiate color.
- **Perceiving size and depth –** Eye perceive size, depth by considering how the image appears on the retina. The size of the image is specified as visual angle.
- If we draw a line from the top of the object to a central point on the front of the eye and second line from the bottom of the object to the same point, the visual angle of the object is the angle between these two lines.
- Visual angle is affected by both the size of the object and its distance from the eye.







- **Perception of size –** Visual angle of object is reduced as it gets away, we might expect that we would perceive the object as smaller.
- In fact, our perception of an object size remains constant even if its visual angle changes.
- So a person height is perceived as constant even if they move far from you.
- This is the law of size constancy and it indicates that our perception of size relies on factors other than visual angle.
- **Perception of depth –** If objects overlap, the object which is partially covered is perceived to be in the background and therefore far away.
- Similarly the size and height of the object in our field of view provides a hint of its distance.
- If we expect an object to be of a certain size then we can judge its distance accordingly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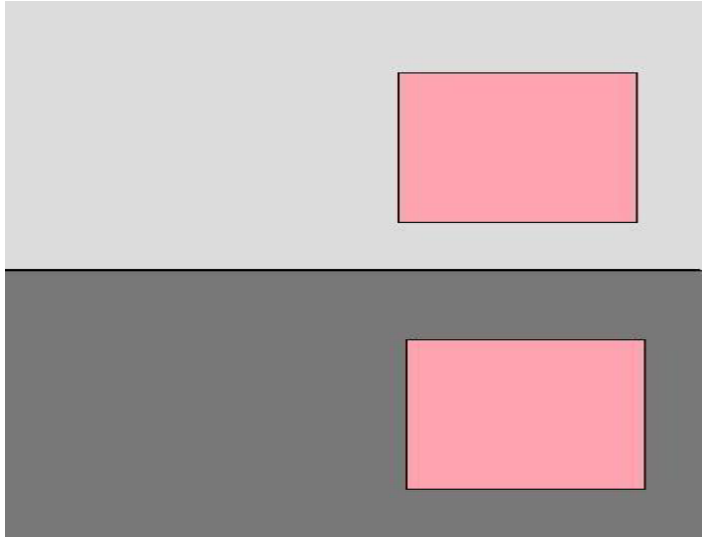
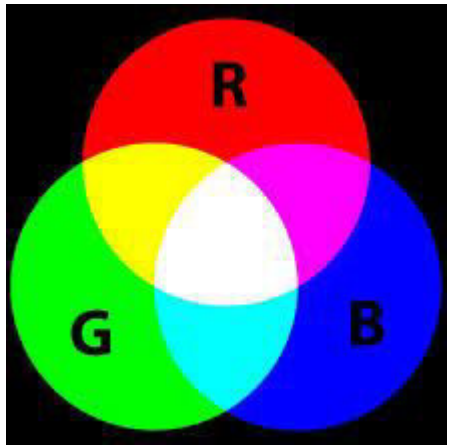
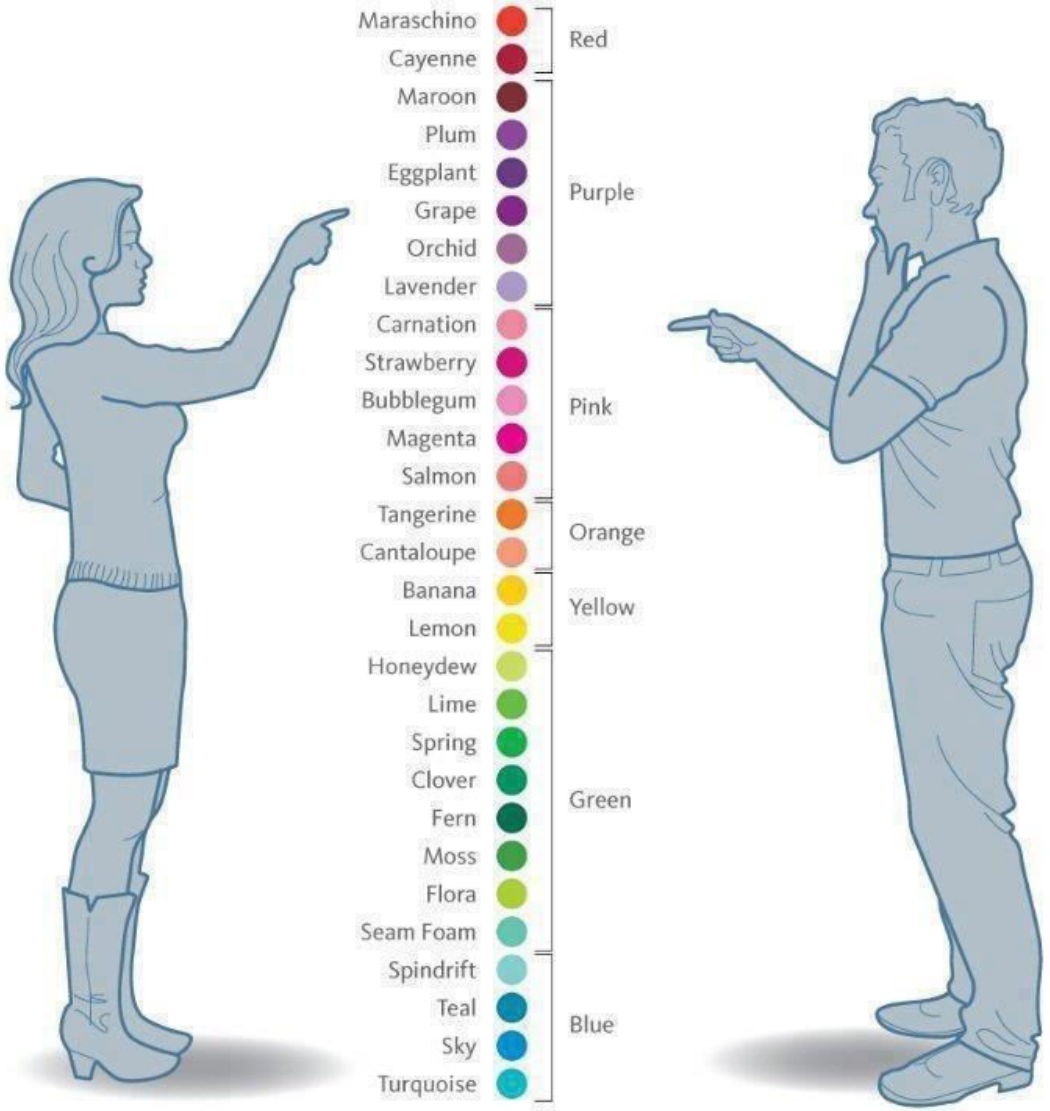
- **Perceiving Brightness** – Brightness is in fact a subject to reaction to levels of light. It is affected by luminance which is the amount of light falling on the object surface and its reflective properties.
- Contrast is relative to luminance it is a function of the luminance of an object and the luminance of its background. Visual activity increases with increased luminance.

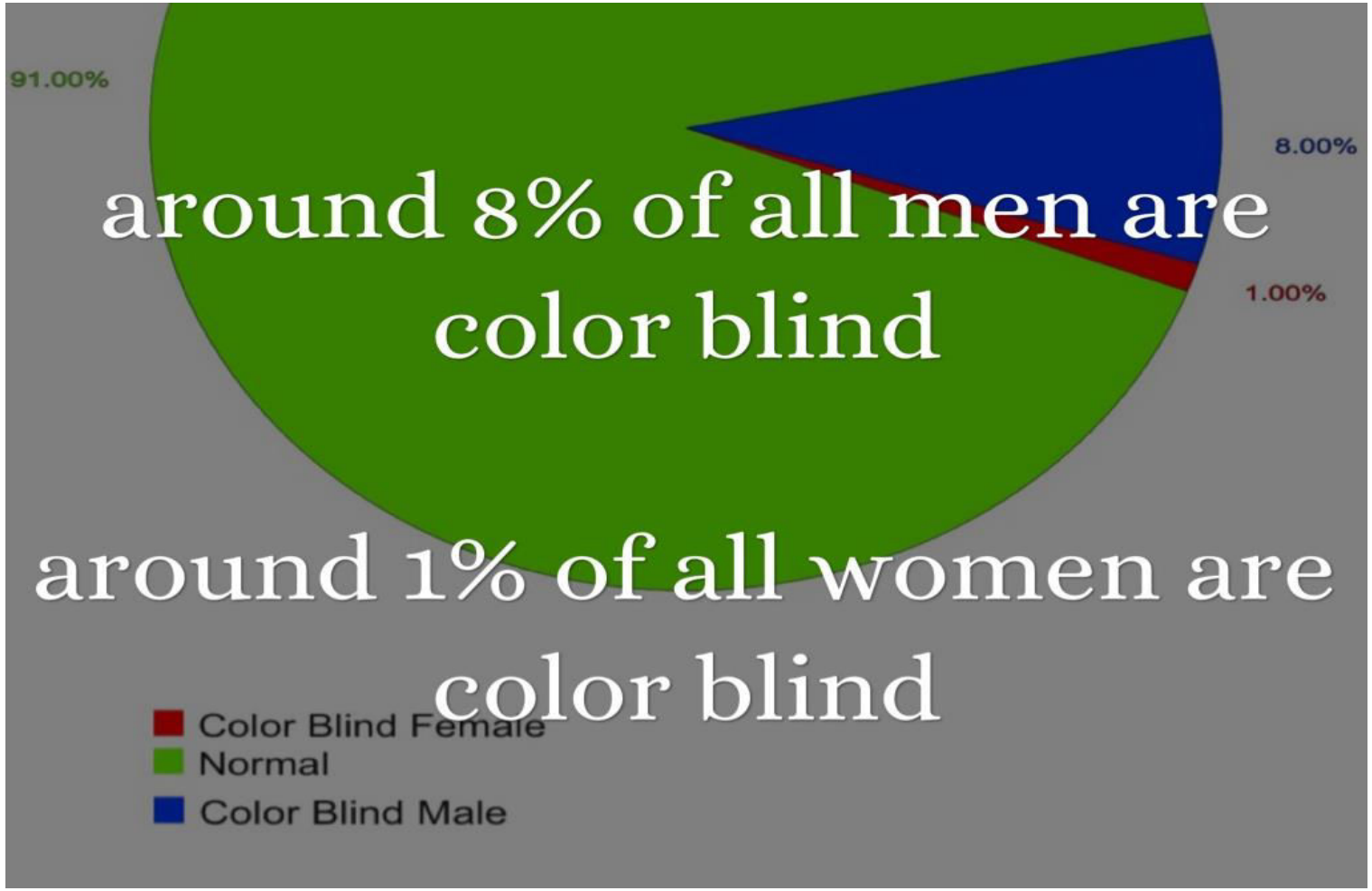


Perceiving Color –Color is usually regarded is being made up of three components: hue, intensity and saturation.

- Hue is determined by the spectral wavelength of light.
- Blues have short wavelength ,green medium and red long.
- Intensity is brightness of color and saturation is the amount whiteness in the color.
- By varying these two, we can perceive seven million different colors.
- However, the number of colors that can be identified by an individual without training is very few.






91.00%
8.00%
1.00%
around 8% of all men are color blind
around 1% of all women are color blind
Color Blind Female
Normal
Color Blind Male

- **Hearing**-the sense of hearing is often considered secondary to sight but we tend to underestimate the amount of information that we receive through ears.
- Hearing begins with vibrations in the air or sound waves.
- The ear receives their vibrations and transmits them through various stages, to the auditory nerves.
- Sound is changed or vibrations in air pressure.
- It has number of characteristics which we can differentiate.
- Pitch is the frequency of the sound. A low frequency produces low pitch. A high frequency produces high pitch.
- Loudness is proportional to the amplitude of the sound , the frequency remains constant.

- Timbre relates to the types of the sound: sound may have same pitch and loudness but be made by different instruments and so vary in timbre.
- Location of sound can be identified since the two ears receive slightly different sound, owing to the time difference between the sound reaching the two ears and the reduction in intensity caused by the sound waves reflecting from the head.
- The human ear can hear frequencies from above 20HZ to 15KHZ.
- The auditory system performs some filtering of the sounds received , to ignore background noise and concentrate on important information.
- Sound can convey a remarkable amount of information but rarely used to its potential in interface design.
- The ear can differentiate sound changes and can recognize familiar sounds without concentrating attention on the sound source.
- This suggests that sound could be used more extensively in interface design.

- **Touch –** The third and last of senses important for HCI is Touch or haptic perception. Touch is an important means of feedback and is needed in using computer systems.
- Feeling buttons depress is an important part of the task of pressing button.
- For average person, haptic perception is a secondary source of information but those whose often senses are impaired, it may be more important.
- For such users, interfaces such as braille may be the primary source of information in the interaction.
- In Haptic perception, we receive stimuli through the skin
- The skin contains three types of sensory receptor: Thermoreceptors-respond to heat and cold, non receptors respond to intense pressure, heat and pain and mechanoreceptors respond to pressure.
- It is the last of these that we are concerned with in relation to HCI.

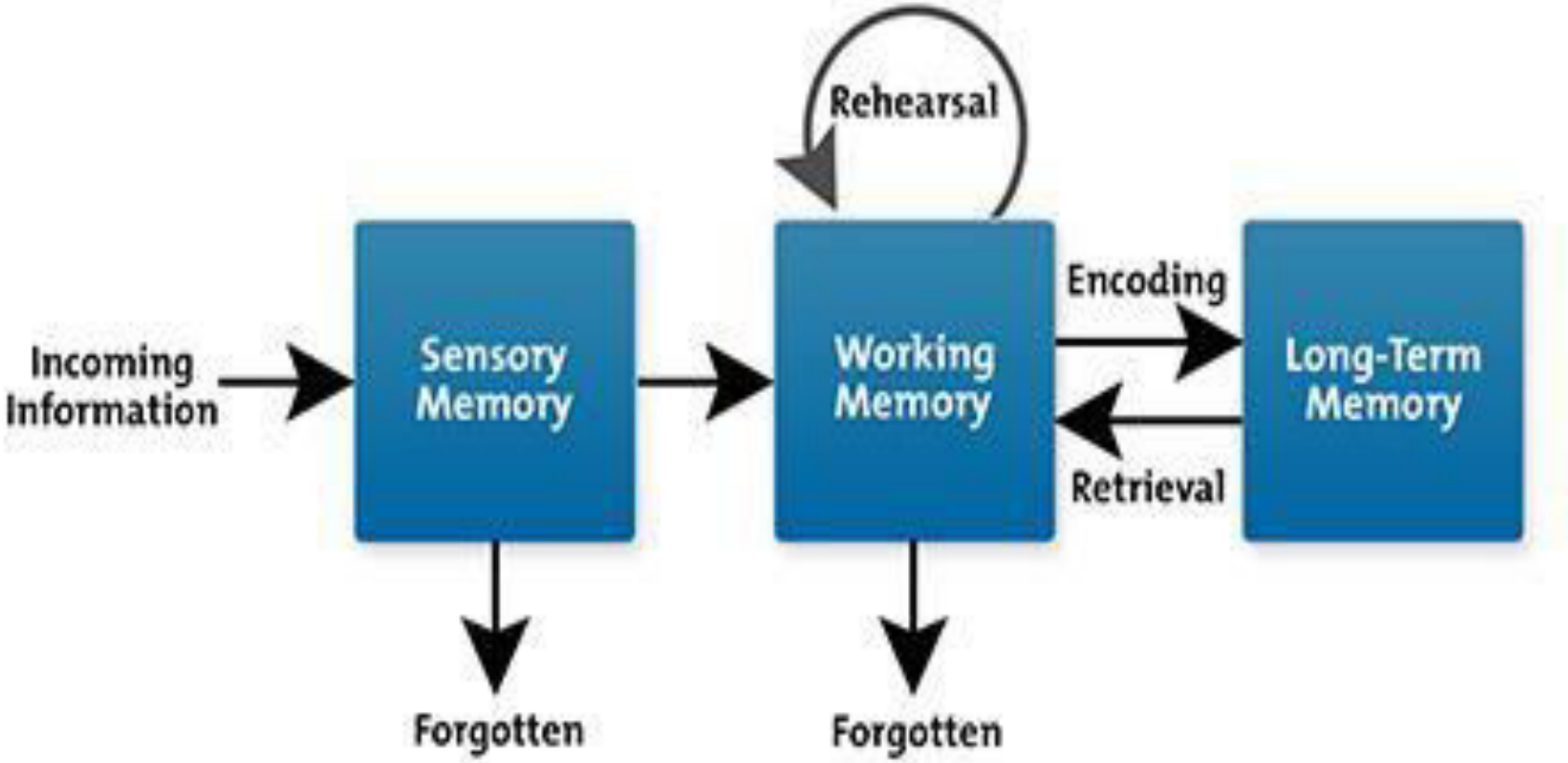
- There are two kinds of mechanoreceptors which respond to different type of pressures.
- **Rapidly adapting mechanoreceptors** respond to immediate pressure. These receptors also react more quickly with increased pressure.
- **Slowly adapting mechanoreceptors** respond to continuously applied pressure.
- Although the whole body contains such receptors, some areas have greater sensitivity than others. The figures and thumbs have the highest sensitivity.

HUMAN COMPUTER INTERACTION

LECTURE 3

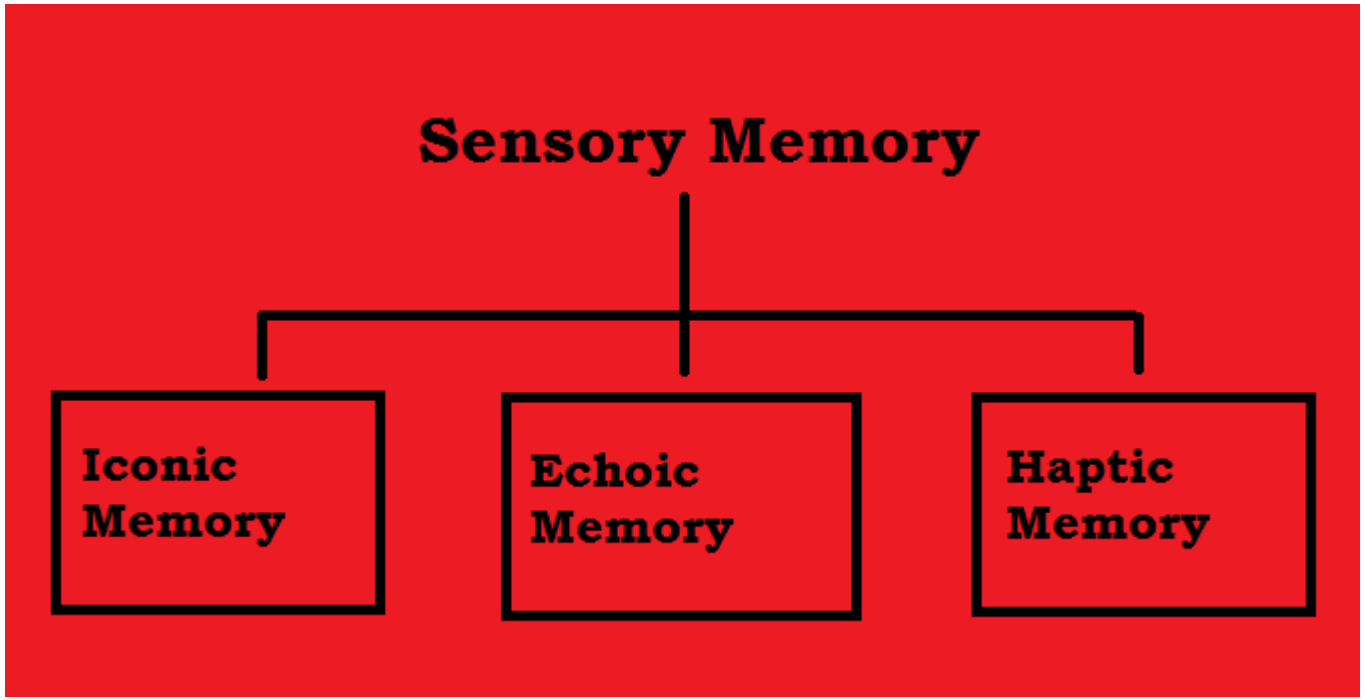
Human Memory:

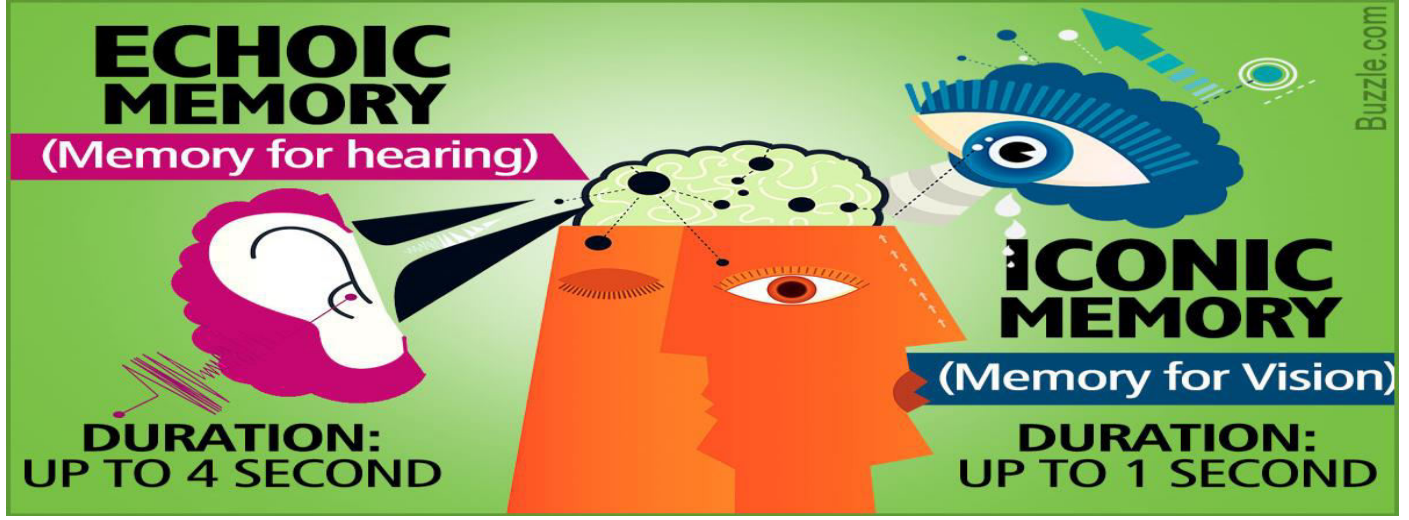
- There are three types of memory - sensory buffers, short-term memory, long-term memory



Sensory Memory – The sensory memory act as buffers for stimuli received through the sensors.

- A sensory memory exists for each sensory channel. These memories are constantly overwritten by new information coming in on these channels.

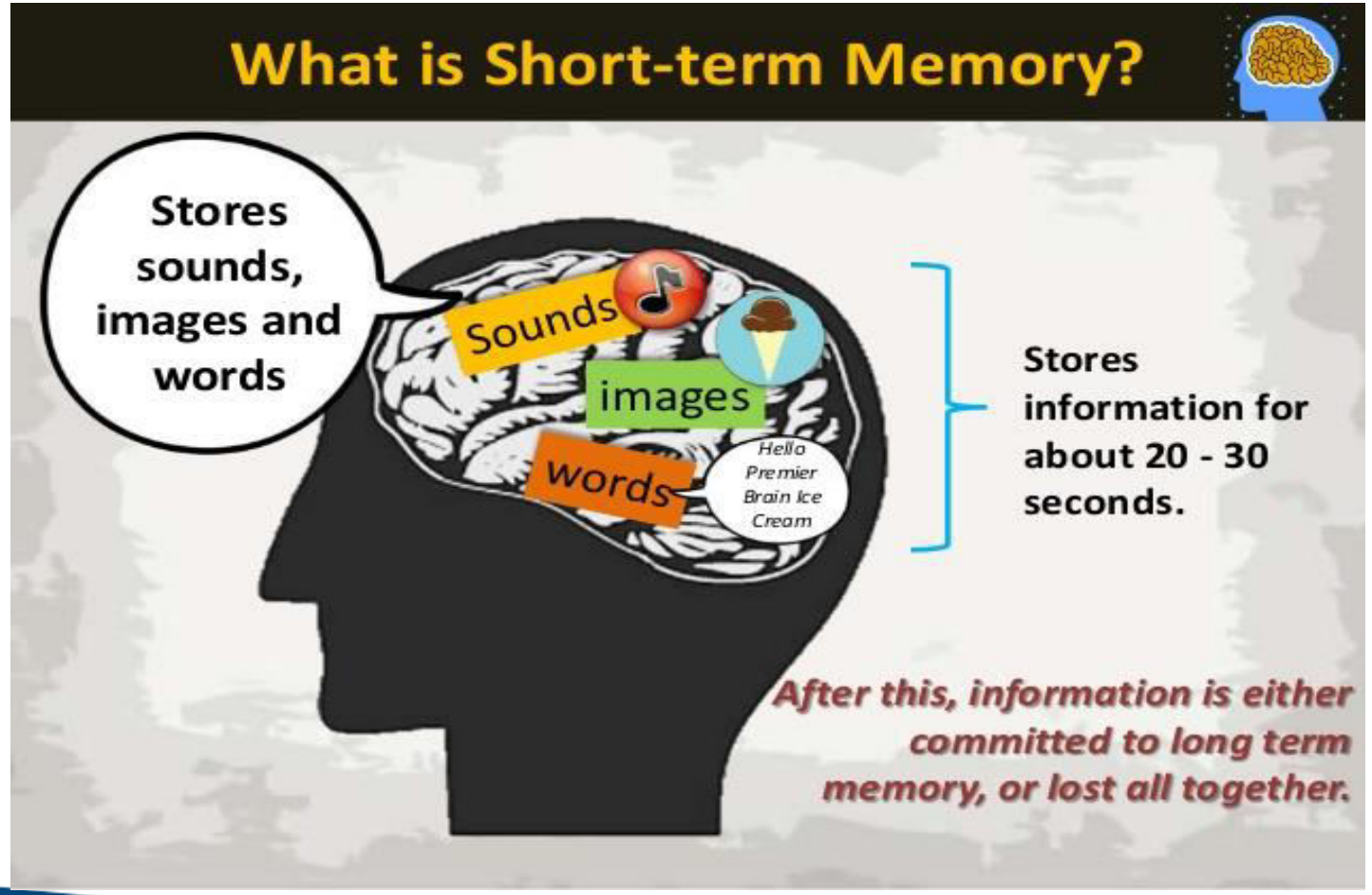




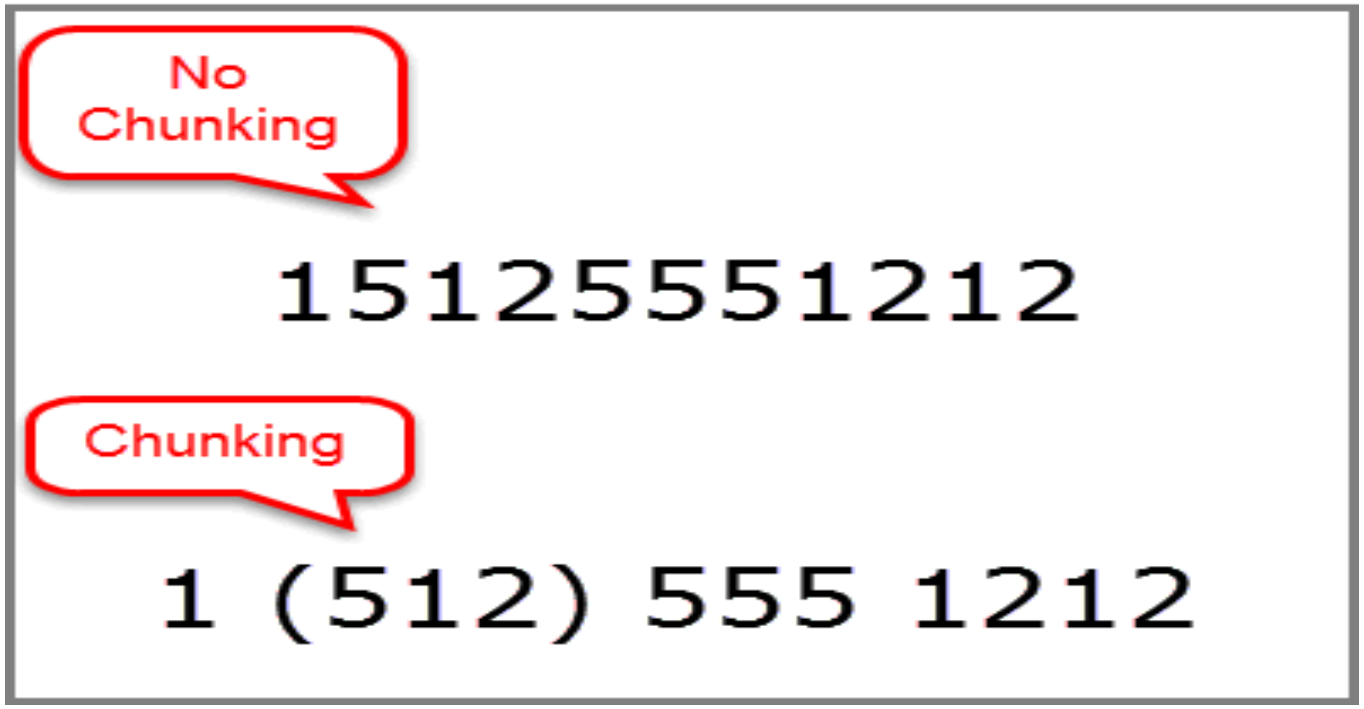
- Information is passed from sensory memory into short-term memory by attention, thereby filtering the stimuli to only those which are of interest at a given time.
- It is clear that we are able to focus our attention selectively, choosing to attend to one thing rather than other.
- This is due to limited capacity of our sensory and mental process.

- **Short term memory** - Short term memory or working memory acts as a 'Scratch-pad' for temporary recall of information.

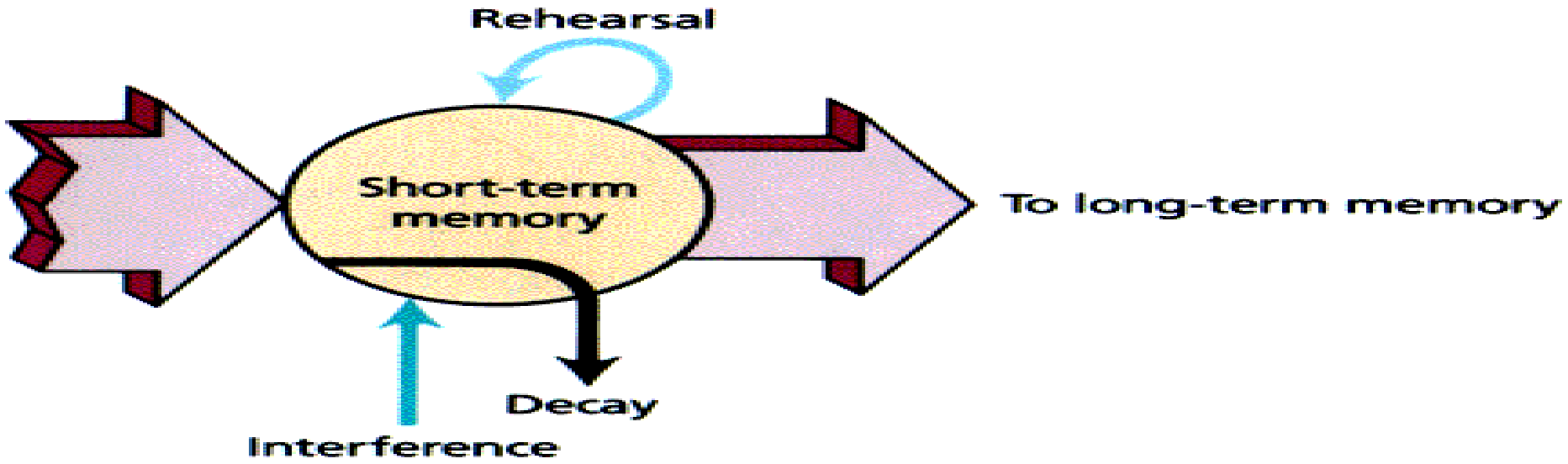
- Short term memory can be accessed rapidly in the order of 70ms.However, it also decays rapidly in the order of 200ms.



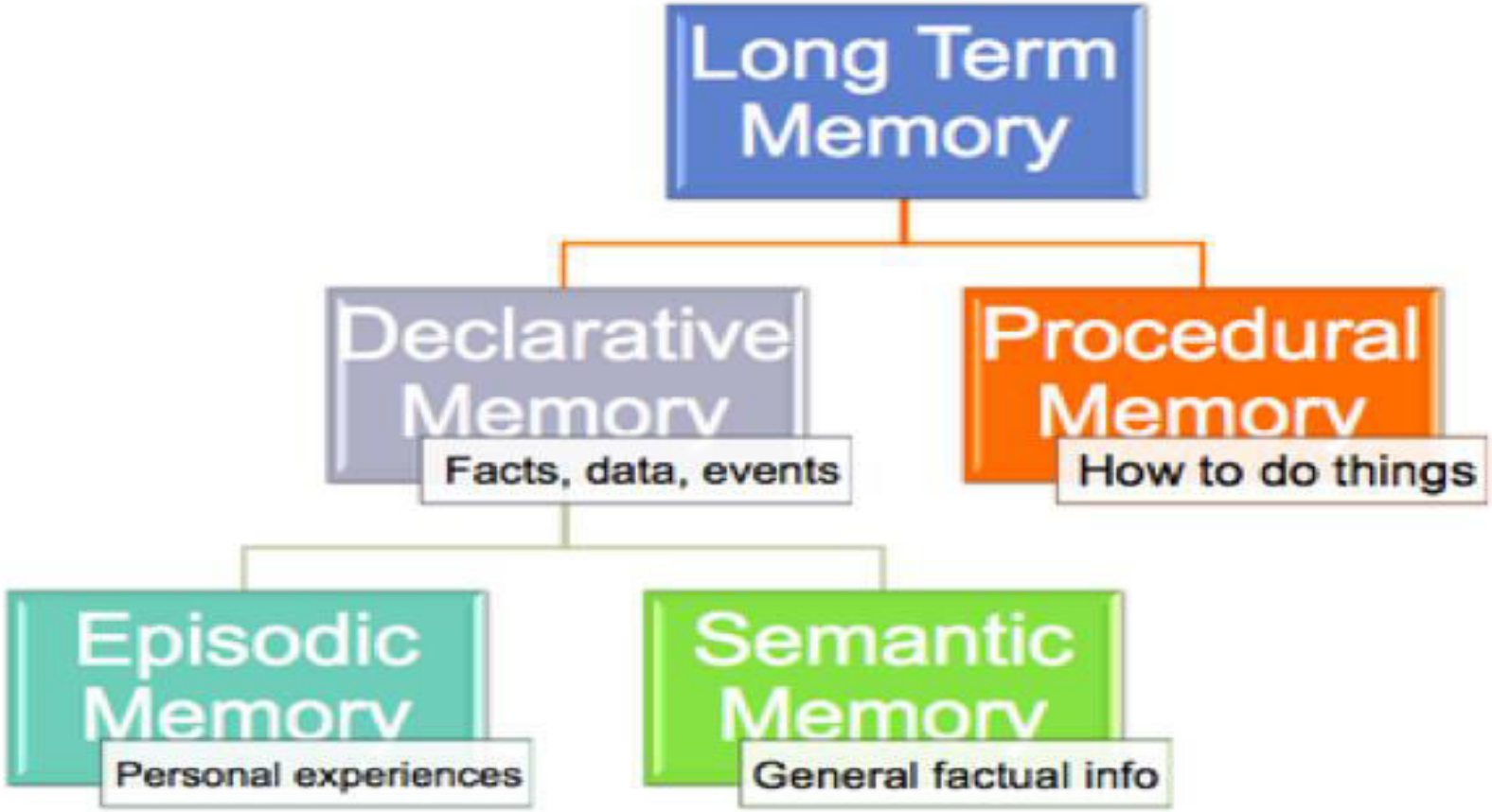
- Chunking information can increase the short term memory capacity.
- The limited capacity of Short term memory produces a subconscious desire to create chunks to optimize the use of memory.
- The successful formation of a chunk is known as closure.



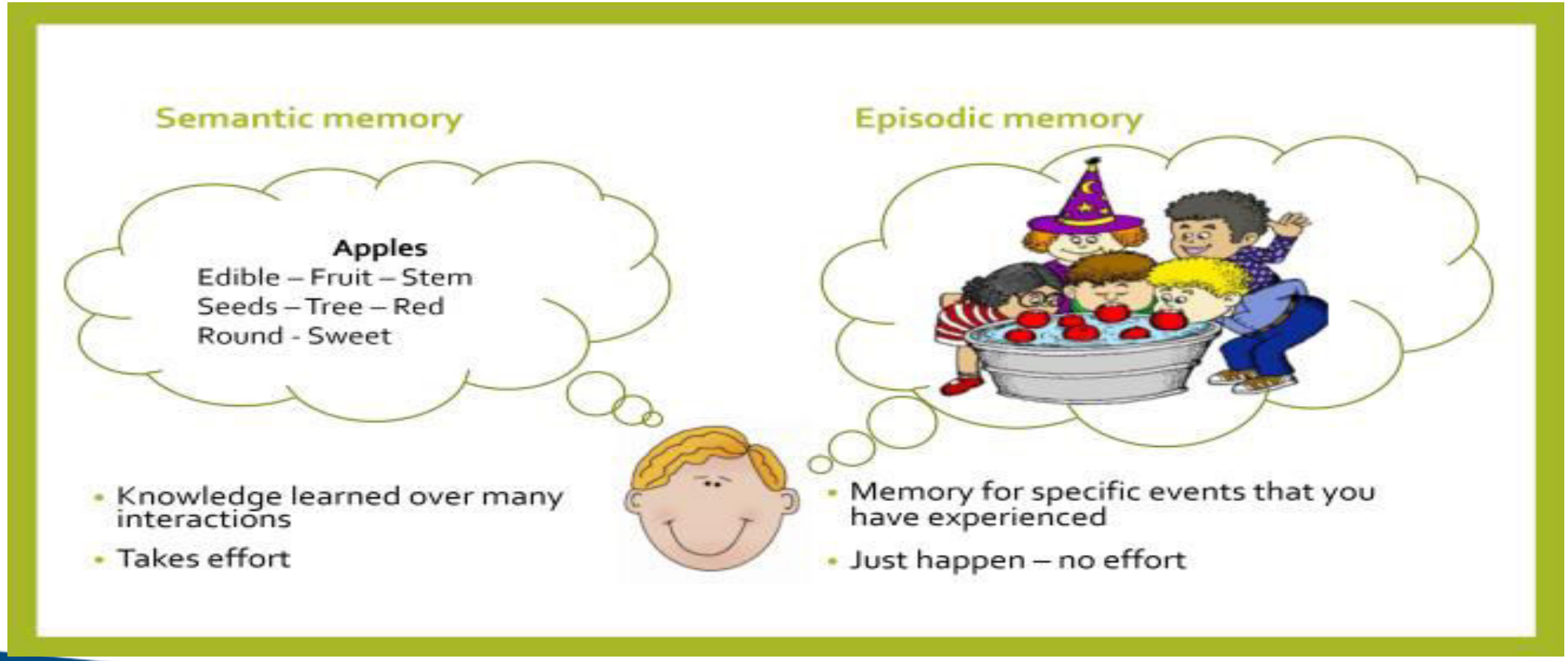
- Short term memory recall is damaged by interference of other information but not necessarily.
- Short term memory is not a unitary system but is made up of number of components, including a visual channel and articulatory channel.
- Interference only occurs if tasks utilize the same channel.



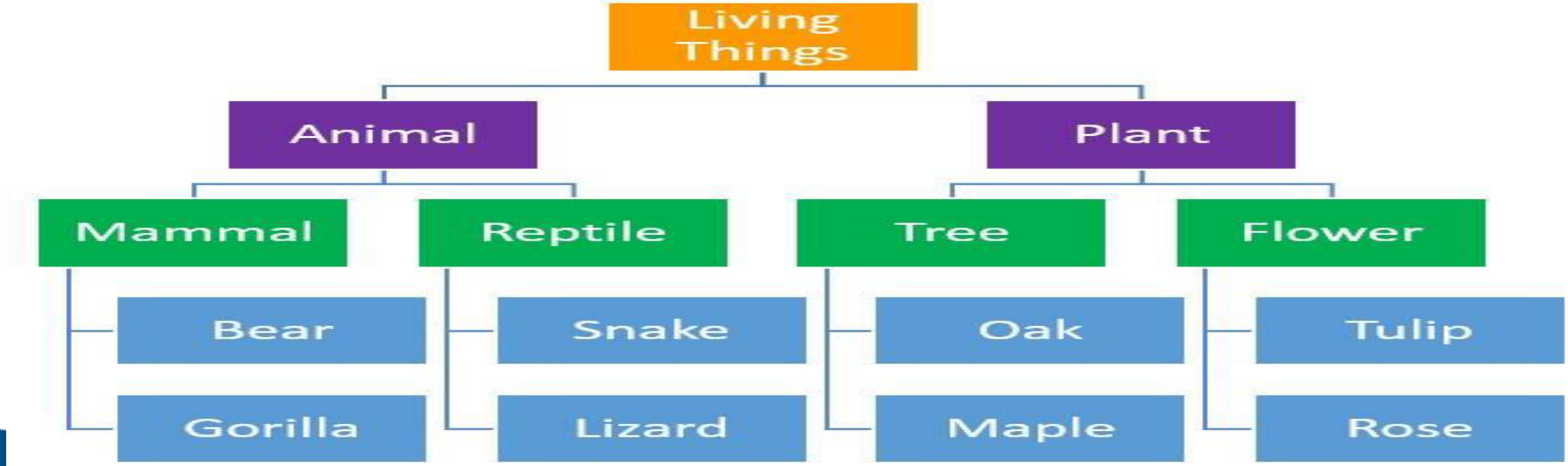
- **Long term memory** – there are two types of long term memory- episodic memory and semantic memory.



- **Episodic memory** represents our memory of events and experiences in a serial form. It is from this memory that we can reconstruct the actual events that took place at a given point in our lives.



- **Semantic memory** is a structured record of facts, concepts and skills that we have acquired. Semantic memory is structured in some way to allow access to information, representation of relationships between pieces of information and inference.
- One model for the way in which semantic memory is structured is as a network. Items are associated to each other in classes, and may inherit attributes from parent classes.
- This model is known as semantic network.

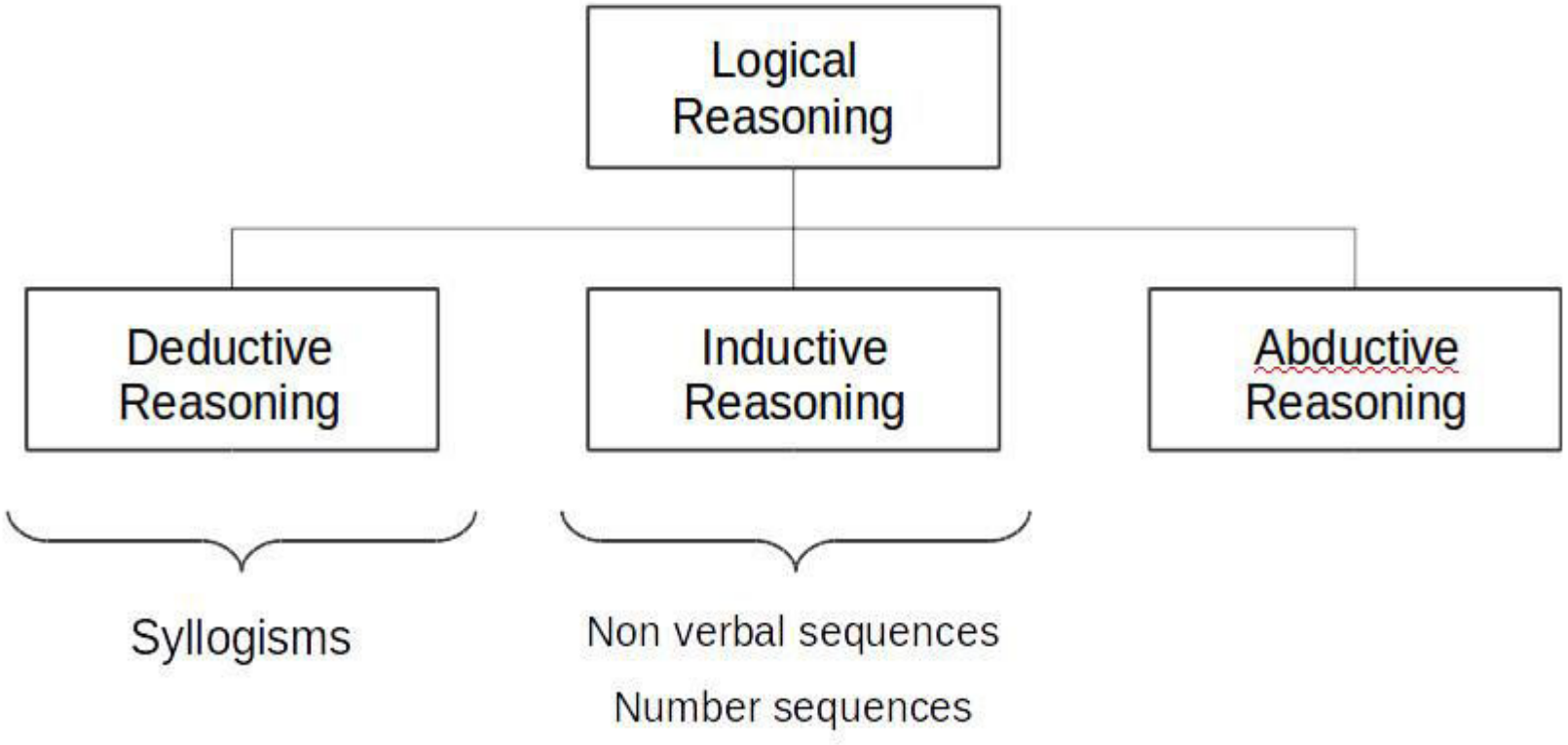


Thinking – Reasoning and Problem Solving:-

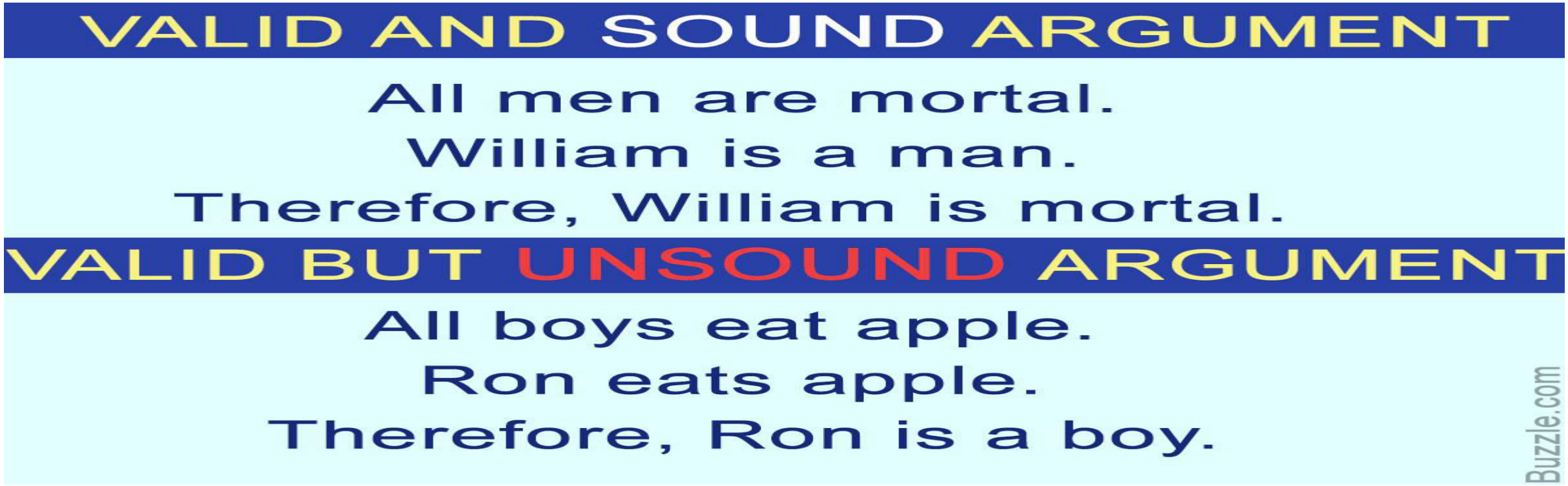
- The process of how information is processed and manipulated in human is most complex and it is the one which separates human from other information processing systems.
- When compared to other information processing system, humans are able to reason and solve problems even if the information is partial and unavailable.
- We are able to think about things of which we have no experience and solve problems which we have never seen before.
- Thinking can require different amounts of knowledge. Some thinking activities are very directed and knowledge required is constrained. Other requires vast amounts of knowledge from different domains.
- There are two categories of thinking – Reasoning and Problem solving.

Reasoning: Reasoning is the process by which we use the knowledge we have to draw conclusions or infer something new about the domain of interest.

- There are different types of reasoning – Deductive, Inductive, Abductive.



Deductive Reasoning: Deductive Reasoning drives the logically necessary conclusion from the given premises. It is important to note that this is the logical conclusion not necessarily have to be a truth.



Inductive Reasoning: Induction is generalizing from cases we have seen to infer information about cases we have not seen. Induction is useful process, which we use constantly in learning about our environment.

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Examples of Inductive Reasoning

- ✓ Every quiz has been easy. Therefore, the test will be easy.
- ✓ The teacher used PowerPoint in the last few classes. Therefore, the teacher will use PowerPoint tomorrow.
- ✓ Every fall there have been hurricanes in the tropics. Therefore, there will be hurricanes in the tropics this coming fall.

- **Abductive Reasoning**: Abductive reasons from a fact to the action or state that caused it. This is the method we use to derive explanations for the events we observe. In spite of its unreliability it is clear that people do infer explanations in and hold on to them until they have evidence to support an alternative theory.

Abductive Reasoning - Examples

The bus is late. I heard about a motorbike crash on the radio. The crash has probably held the bus up.	That man looks tired and he's wearing gym clothes. He's probably been to the gym.	Cleaning the wound seems to prevent infection. Infectious materials might be carried in dirt.

In all of these cases we are starting with a fact (or a conclusion) and working backwards to try to find an explanation that fits best.
Hence: "*inference to the best explanation.*"

HUMAN COMPUTER INTERACTION

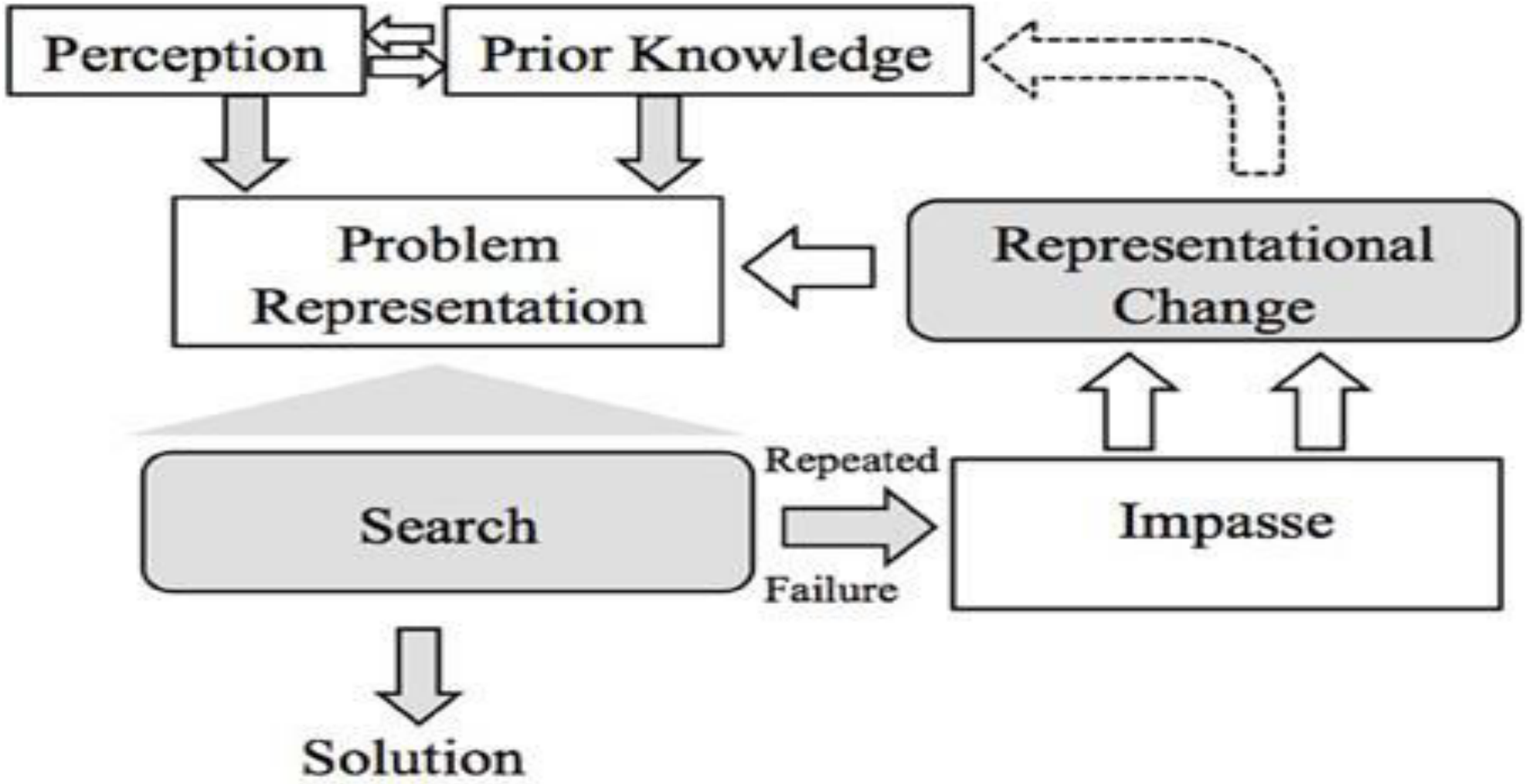
LECTURE 4

Problem solving: If reasoning is a means of inferring new information from what is already known, problem solving is the process of finding a solution to an unfamiliar task, using knowledge we have.

- Human problem solving is characterised by the ability to adapt the information we have to deal with new situations.
- There are number of different views of how people solve problems.
- The earliest is the Gestalt View that problem solving both reuse of knowledge and insight.
- A second major theory proposed was the problem space theory which takes the view that the mind is a limited information processor.

Gestalt Theory: Problem solving is both and productive and reproductive.

- Productive problem solving involves insight and restructuring of problem.
- Reproductive problem solving draws on previous experience.
- Reproductive problem solving could be a delay to finding solution, since a persons fixed thoughts of known aspects may dominate and so be unable to see novel interpretations that might lead to a solution.
- Although Gestalt theory is attractive in terms of its description of human problem solving, it does not provide sufficient evidence or structure to support its theories.
- It does not explain when restructuring occurs or what insight is .


Perception
Prior Knowledge
Problem Representation
Representational Change
Search
Repeated
Failure
Impasse
Solution

The Gestalt's Principle

PROXIMITY

When different elements are laid out close to each other, they are perceived to be belonging to the same group.

CLOSURE

Reification or closure refers to making something concrete, bringing something into being, or making something real.

SIMILARITY

Objects with shared visual characteristics are automatically taken to be related.

CONTINUITY

Elements which are aligned with each other are perceived as visually associated.

MULTI-STABILITY

Multi-stability is the ability of our eyes to see two different things within a single image or design..

DesignMantic

PROXIMITY

When objects placed together, the eye perceives them as a group.

SIMILARITY

When objects look similar to one another, the eye perceives them as a group or pattern.

CONTINUANCE

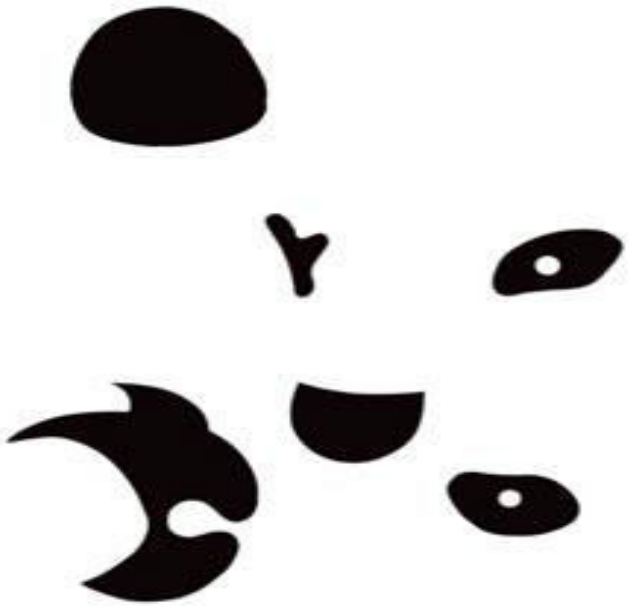
The eye is compelled to move from one object through another.

CLOSURE

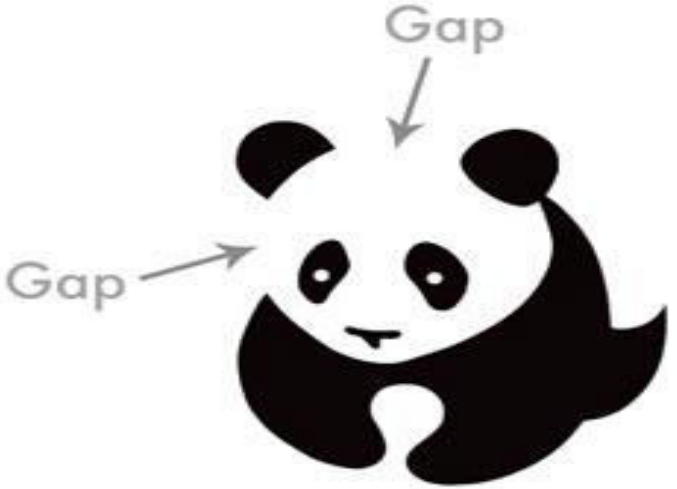
When an object is incomplete or not completely enclosed.

FIGURE & GROUND

When the eye differentiates an object from its surrounding area.



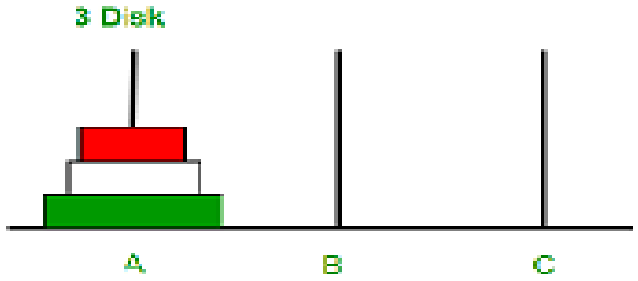
No Familiar Shape

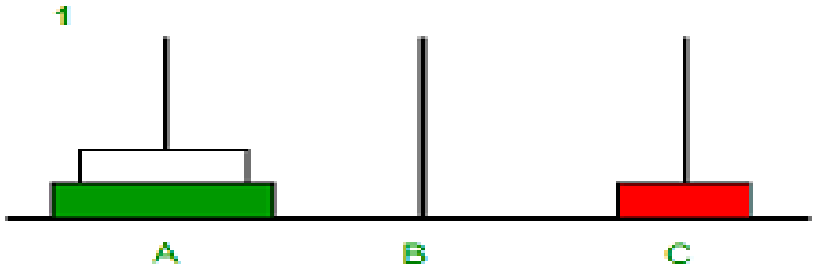


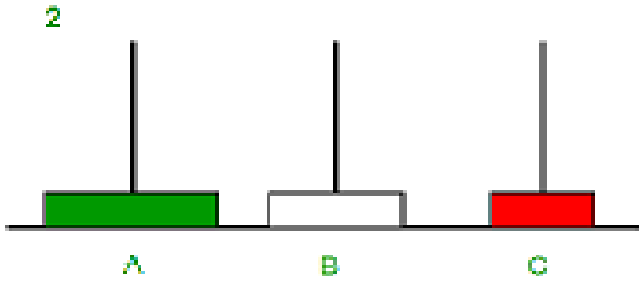
The Mind Fills the Gaps

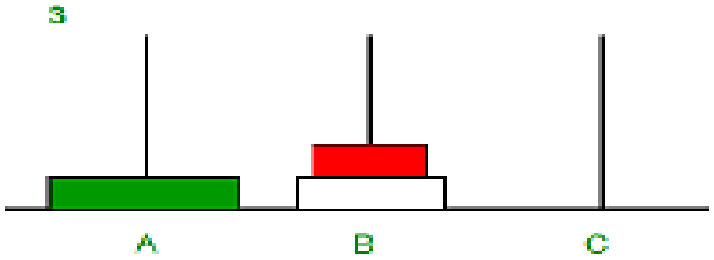
Figure / Ground

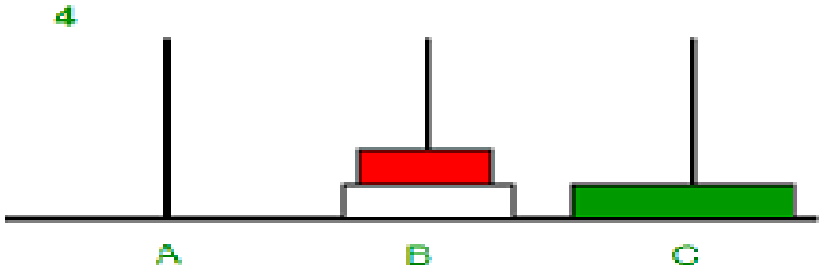
- **Problem Space Theory-** Theory propose that problem solving centres on problem space.
- The problem space comprises problem states, and problem solving involves generating these states using legal state transition operators.
- The problem has an initial state and a goal state and people use the operators to move from initial to goal state.
- If problem spaces are huge, heuristics are employed to select appropriate operators to reach the goal.
- One such approach is means – ends analysis.
- In means – ends analysis, the initial status is compared with goal state and an operator chosen to reduce the difference between two.

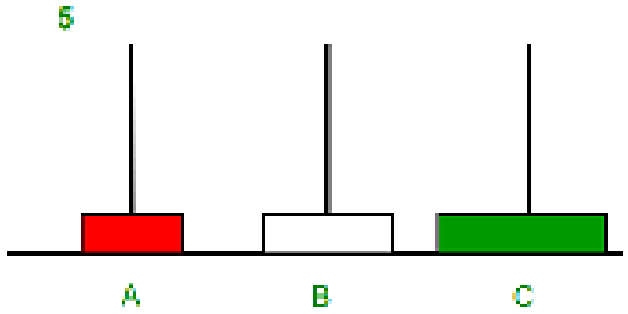


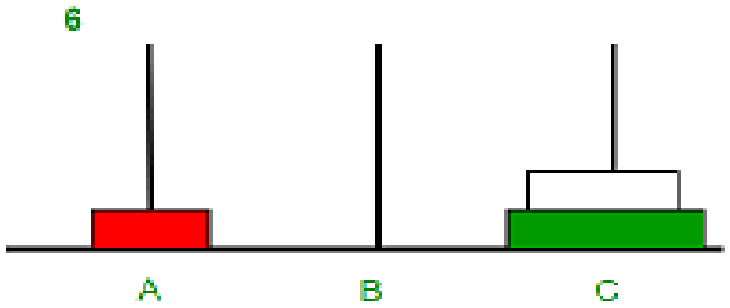


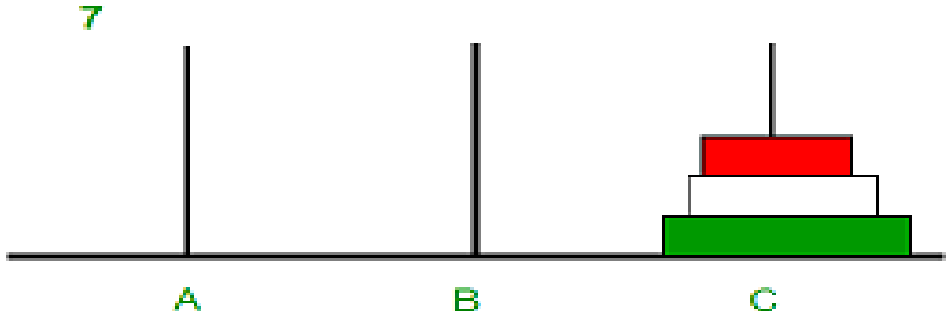




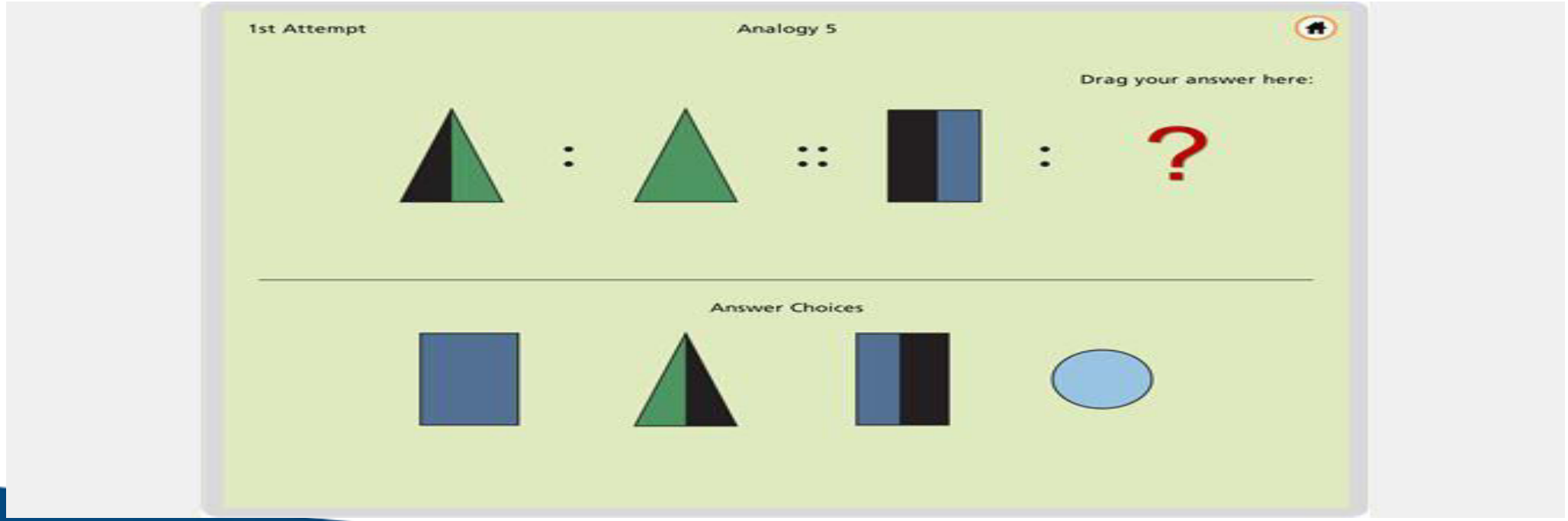








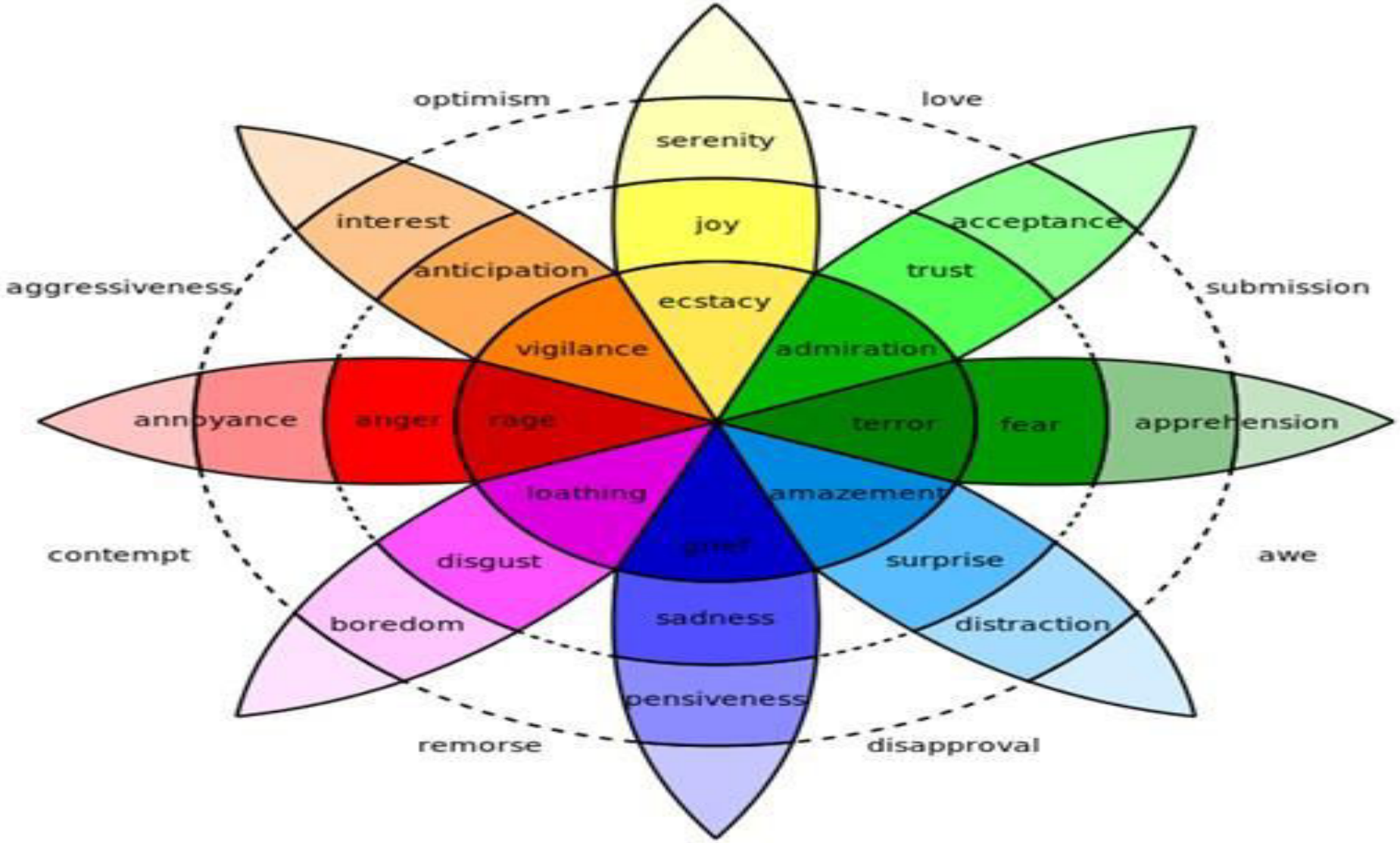
- Analogy in problem solving – A third element of problem solving is the use of analogy. Here we are interested in how people solve novel problems.
- One suggestion is that this is done by mapping knowledge related to similar known domain to new problem called analogical mapping.
- Similarities between the known domain and the new one are noted and operators from the known domain are transferred to the new one.



Emotion: Human emotion is more complex than human perceptual abilities.

- Our emotional response to situations affects how we perform.
- Positive emotions enable us to think more creatively to solve complex problems, whereas negative emotion pushes us into narrow thinking.
- A problem that may be easy to solve when user is relaxed will become difficult if we are frustrated or afraid.
- Emotion involves both physical and cognitive events.
- Our body responds biologically to an external stimulus and we interpret that in some way as a particular emotion.
- That biological response is known as affect- changes the way we deal with different situations and this has an impact on the way we interact with computer systems.

- Negative affect can make it harder to do even easy tasks, positive affect can make it easier to do difficult tasks.
- This suggests that in situations of stress, people will be less able to cope with complex problem solving or managing difficult interfaces, whereas if people are relaxed they will be more forgiving of limitations in the design.
- It suggests that if we build interfaces that promote positive responses for example by using aesthetics or reward then they are likely more successful.


optimism
love
serenity
interest
joy
acceptance
anticipation
trust
aggressiveness
ecstacy
submission
vigilance
admiration
annoyance
anger
rage
terror
fear
apprehension
loathing
amazement
contempt
grief
awe
disgust
surprise
boredom
sadness
distraction
pensiveness
remorse
disapproval

Psychology and the design of interactive systems:

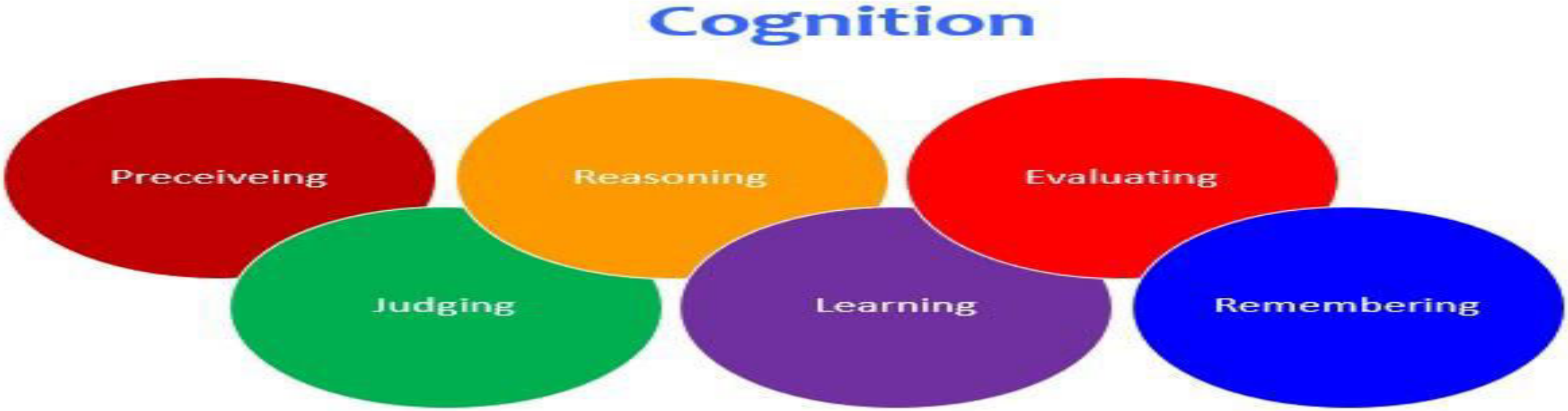
- The study of way human receive, process and store information, solve problem is completed but how to apply that knowledge is not clear.
- Some conclusion can be made such as recognition is easier than recall.
- In order to apply psychological principal in design, we need to understand its context, both in terms of when it fits in wider field of psychology and in terms of measures used and subjects involved.
- Principles and results from research in psychology have been included in guidelines of design, models to support design and techniques for evaluating design.

HUMAN COMPUTER INTERACTION

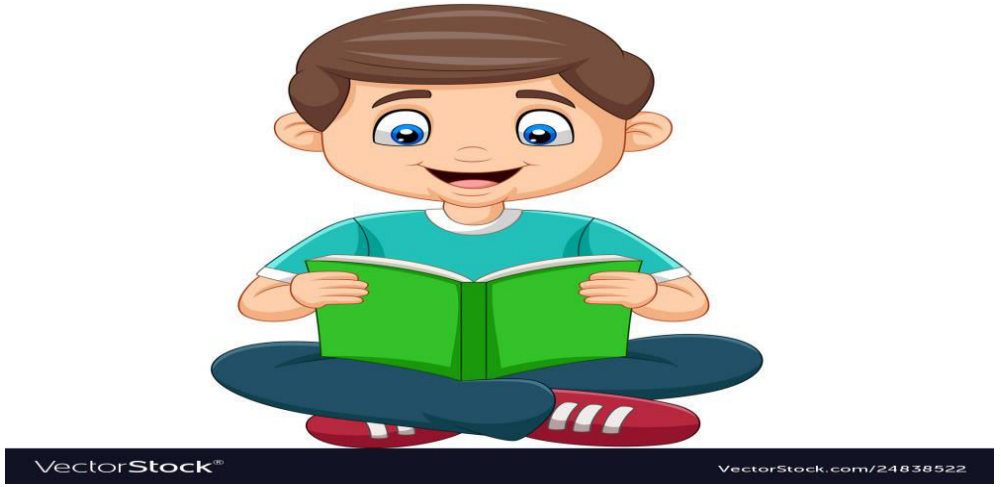
LECTURE 5,6

Cognition:

- Cognition is the mental action or process of acquiring knowledge and understanding through thought, experience and the senses.
- There are many different kinds of cognition such as thinking , remembering, learning, daydreaming, decision making, seeing, reading, writing and talking.



- There are two general modes of cognition : Experimental and Reflective cognition.
- **Experiential Cognition** is a state of mind in which we perceive , act and react to events around us effectively and effortlessly.
- It requires reaching a certain level of expertise and engagement.
- Examples include driving a car , reading a book, having a conversation, and playing a video game.



Reflective cognition involves thinking, comparing, and decision making. This kind of cognition is what leads to new ideas and creativity.

Examples include designing ,learning and writing a book .

- Both modes of cognition are essential for everyday life but each requires different kinds of technological support. The study of human cognition can help understand human abilities and limitations when interacting with technologies.
- HCI focusses on examining cognitive aspects of interaction design.
- We analyze about what humans are good and bad at and show how this knowledge can be used to inform the design of technologies that both extend human capabilities and compensate for their weakness.
- The study of cognitive based conceptual frameworks helps in explaining the way humans interact with computers.

Cognitive Frameworks:

- A number of conceptual frameworks and theories have been developed to explain and predict user behavior based on theories of cognition.
- There are three early **internal frameworks** that focus primarily on mental process and three **external frameworks** that explain how humans interact and use technologies.

Internal frameworks : Mental models

Gulfs of execution and evaluation

Information processing

External frameworks : Distributed cognition

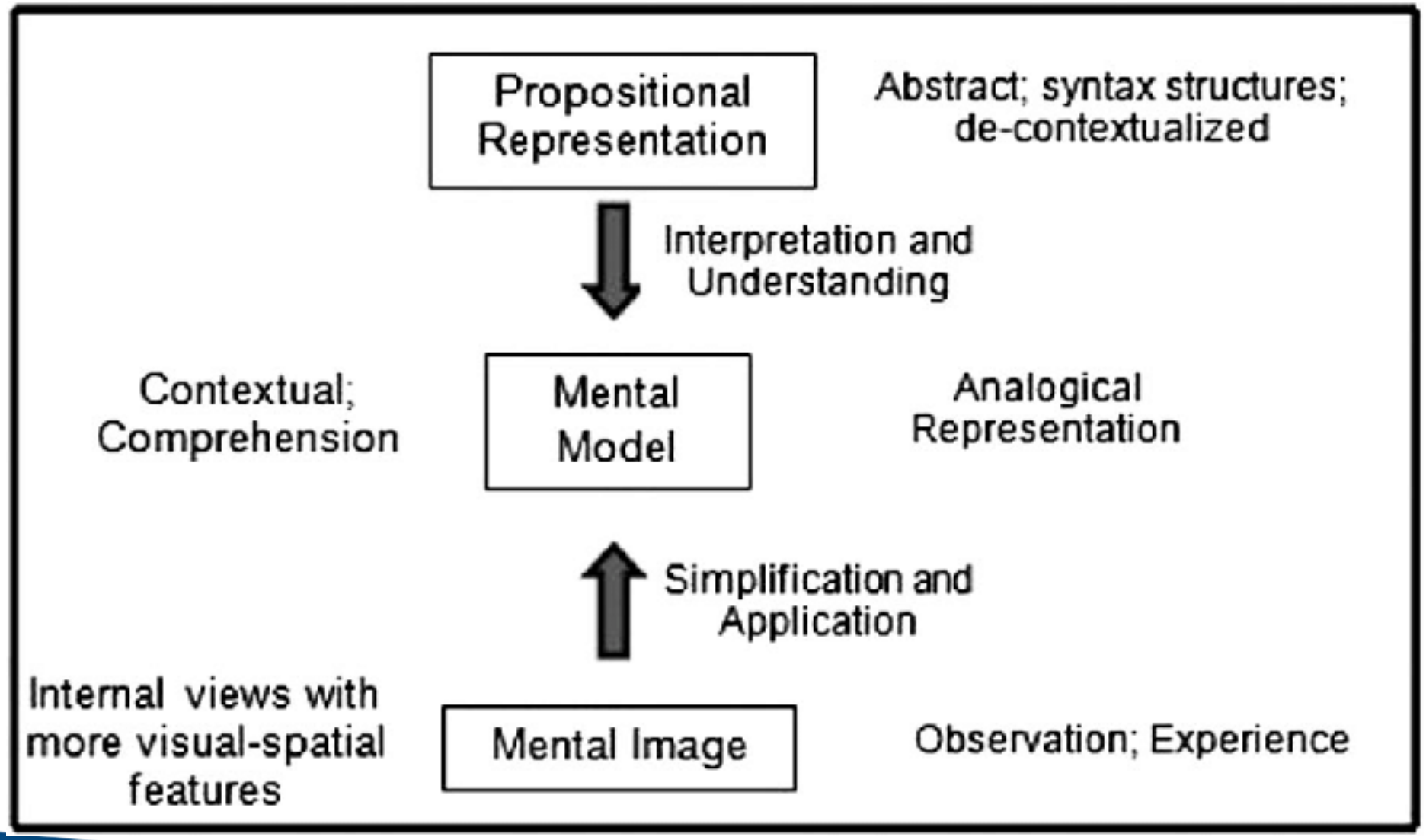
External cognition

Embodied interaction

Internal Frameworks

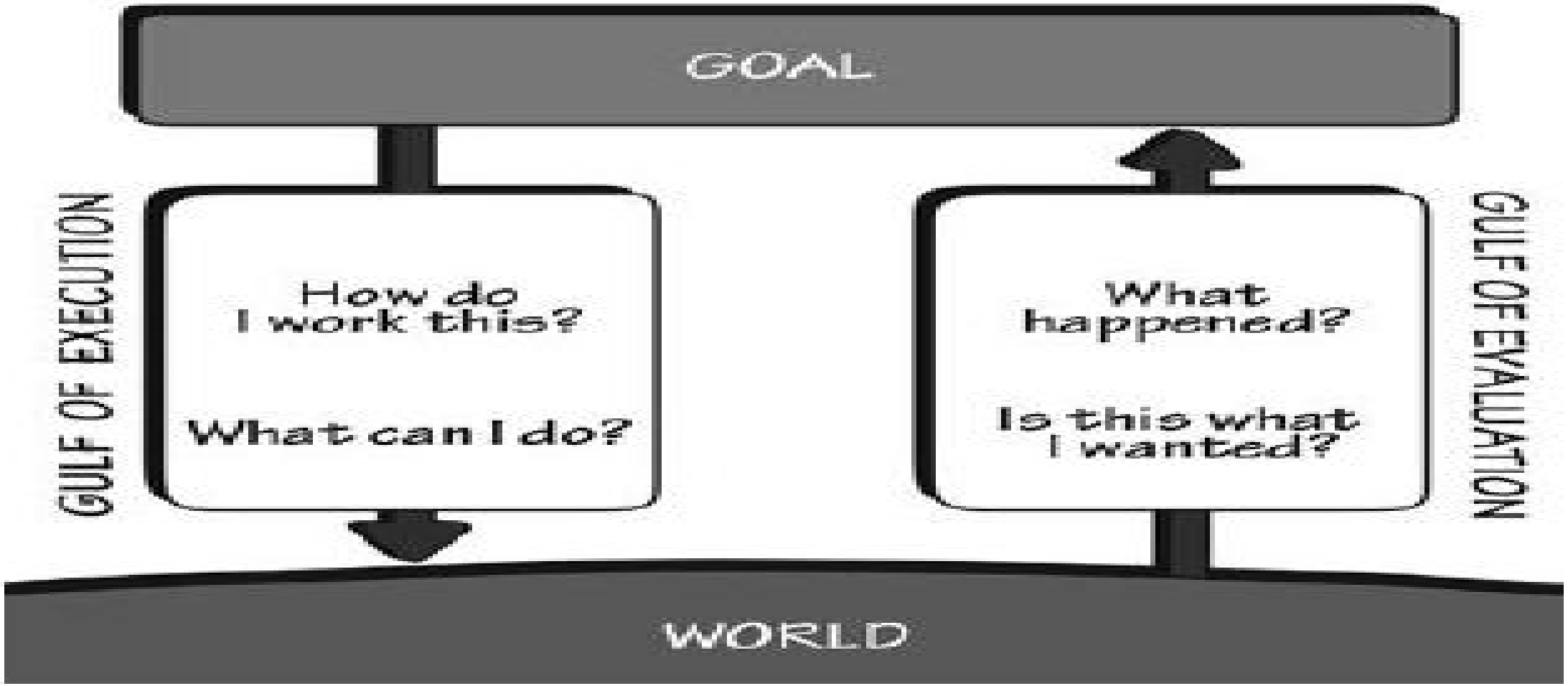
- **Mental models:** People primarily develop knowledge of how to interact with systems and to a lesser extent how that system works. The two kinds of knowledge were often referred to as users mental model.
- It is assumed that mental models are used by people to reason about a system and try to find out what to do when something unexpected happens. The more someone learn about a system and how it functions the more their mental model develops.
- Within cognitive psychology , mental models have been projected as internal constructions of some aspect of external world that are manipulated , enabling predictions and inferences to be made.
- This can involve both unconscious and conscious mental process where images and analogies are activated.

- If people could develop better mental models of interactive systems they would be in a better position to know how to carry out their tasks efficiently and know what to do if a system started malfunctioning.
- If Interactive technologies could be designed to be more transparent, then it might be easier to understand them in terms of how they work and what to do when they don't.
- Transparency involves
  -Useful feedback in response to user input.
  -Easy to understand and easy ways of interacting.
- It also requires providing the right kind and level of information in the form of
  -clear and easy to follow instructions.
  -appropriate online help and tutorials.
  -context sensitive guidance for users, at their level of experience.


Propositional Representation
Abstract; syntax structures; de-contextualized
Interpretation and Understanding
Contextual; Comprehension
Mental Model
Analogical Representation
Simplification and Application
Internal views with more visual-spatial features
Mental Image
Observation; Experience

Gulfs of execution and evaluation:

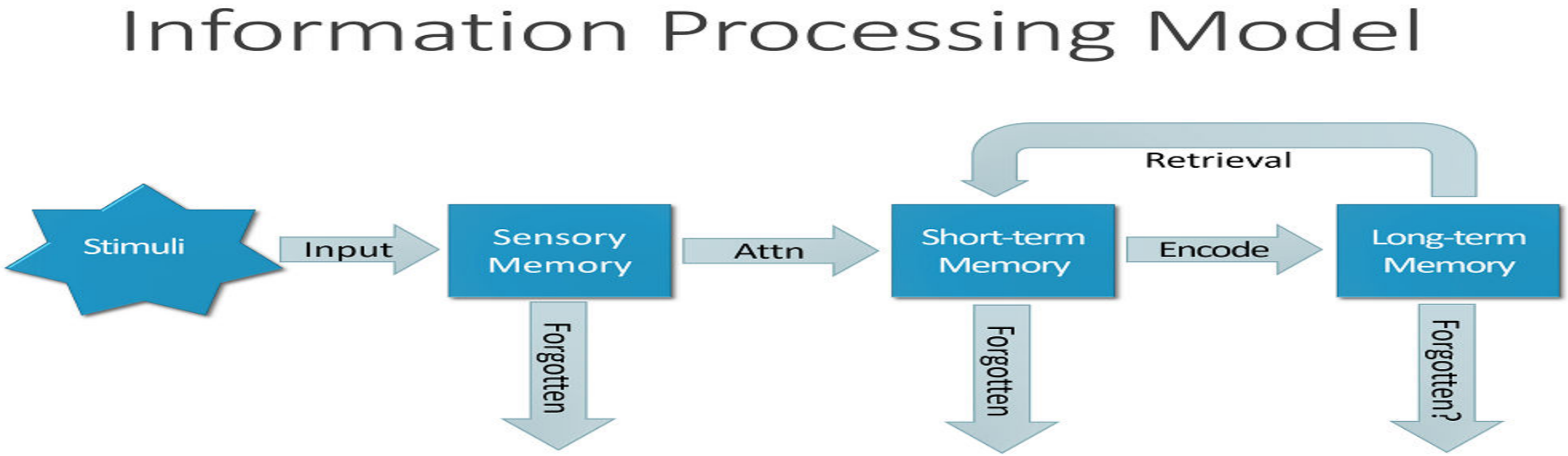
- The gulf of execution and the gulf of evaluation describe the gaps that exist between the user and the interface. They are intended to show how to design to enable the user to cope with them.
- The first one-The gulf of execution describes the distance from the user to the physical system, while the second one-the gulf of evaluation is the distance from physical system to the user.
- The designers and users need to concern themselves with how to bridge the gulfs in order to reduce the cognitive effort required to perform a task.
- This can be achieved by designing usable interfaces that match the psychological characteristics of the user and by the user learning to create goals, plans and actions sequences that fit with how the interface works.


GOAL
GULF OF EXECUTION
How do I work this?
What can I do?
What happened?
Is this what I wanted?
GULF OF EVALUATION
WORLD

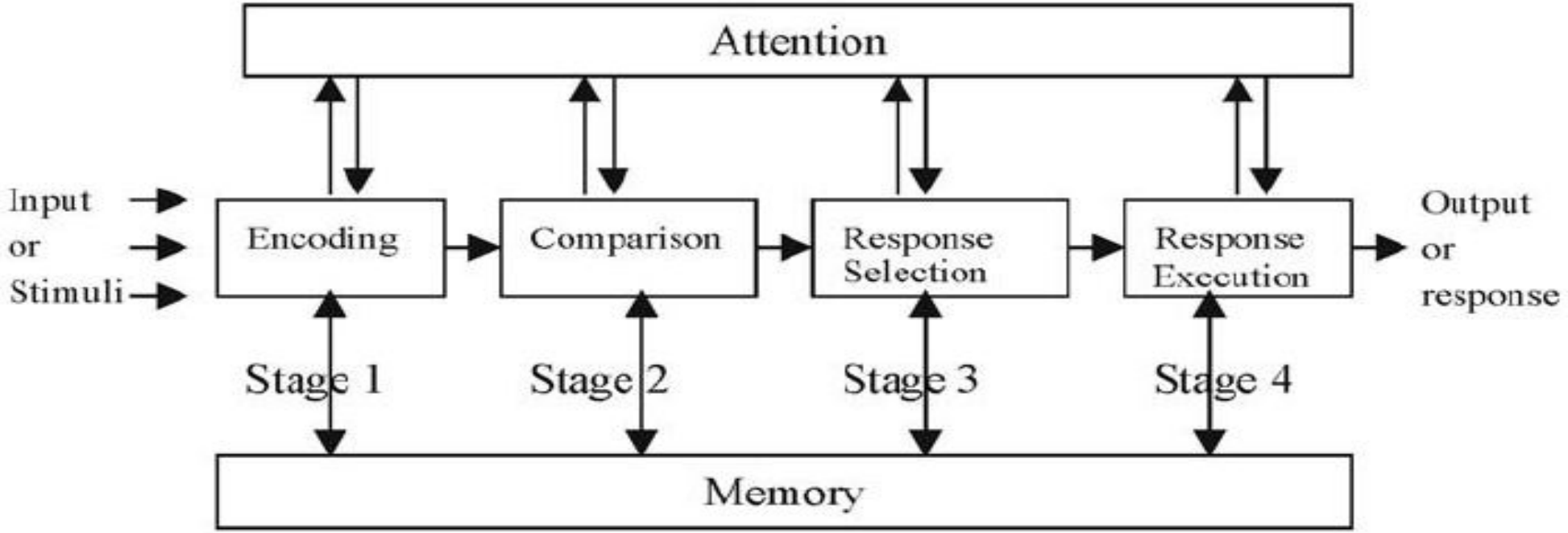

Gulf of Execution
Gulf of Evaluation
Intention
User has a goal
Evaluation
Action specification
Interpretation
Execution
Perception

Information processing:

- Another classic approach to conceptualizing how the mind works has been to use metaphors and analogies.
- One prevalent metaphor from cognitive psychology is the idea that the mind is an information processor.
- Information is thought to enter and exit in the mind through a series of ordered processing stages.



- Human Information processing model consists of four stages – Encoding, Comparison , Response Selection, Response Execution.



- Within these stages, various processes are assumed to act upon mental representations.

- Mental representations are assumed to comprise images, mental models, rules and other forms of knowledge.
- The information processing model provides a basis from which to make predictions about human performance.
- Hypothesis can be made about how long someone will take to perceive and respond to a stimulus and what occur if a person is overloaded with too much information.
- One of the first HCI models to be derived from the information processing theory was the human processor model, which modelled the cognitive processors of a user interacting with the computer.
- The model predicts which cognitive processors are involved when a user interacts with a computer, enabling calculations to be made of how long a user will take to carry out various tasks.

External Frameworks:

- **Distributed cognition** : The distributed cognition approach studies the nature of cognitive phenomena across individuals and internal and external representations.
- It involves describing a cognitive system , which projects interactions among people and environment there are working in.
- A primary objective of distributed cognition approach is to describe these interactions in terms of how information is propagated through different media.
- By this it is meant how information is represented and re-represented as it moves across individuals.
- These transformations of information are referred to as changes in representation state.

- A distributed cognition analysis involves examining:

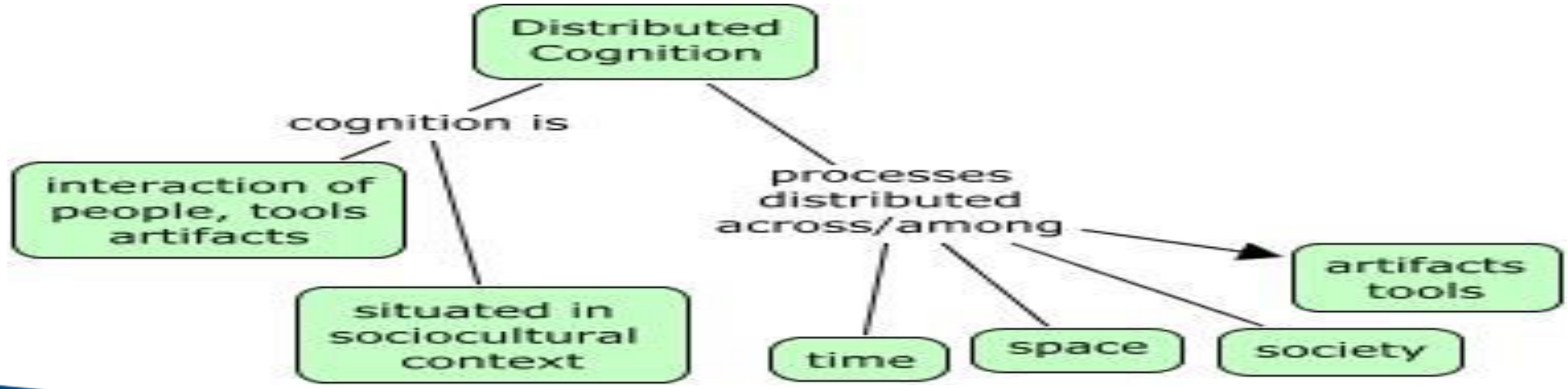
  -the distributed problem solving that takes place.

  -the role of verbal and non-verbal behaviour.

  -the various coordinating mechanisms that are used.

  -the various ways communication takes place as the collaboration activity process.

  -How knowledge shared and accessed.



External cognition:

- External cognition is concerned with explaining the cognitive processes involved when we interact with different external representations.
- A main goal is to explicate the cognitive benefits of using different representations for different cognitive activities and the process involved.
- The main ones include

1. Externalizing to reduce memory load.
2. Computational offloading.
3. Annotating and cognitive tracing.

Externalizing to reduce memory load:

- Numerous strategies have been developed for transforming knowledge into external representations to reduce memory load.
- Ones such strategy is externalizing things we find difficult to remember such as birthdays , appointments and addresses.
- Diaries , personal remainders are examples of cognitive artifacts that are commonly used for this purpose.
- Externalizing , therefore can help reduce peoples memory burden by

  -reminding them to do something.

  -reminding them of what to do.

  -reminding them of when to do something.

Computational offloading:

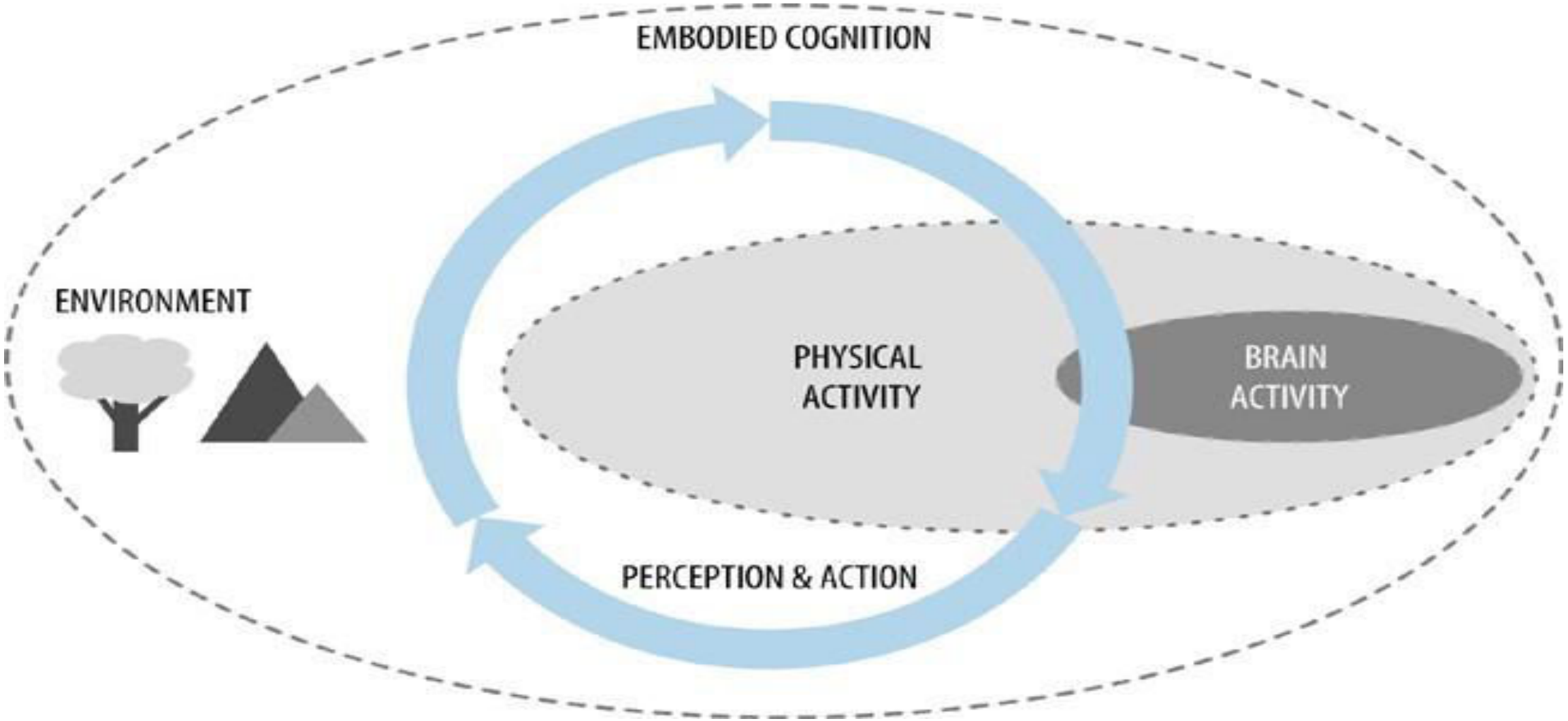
- Computational offloading occurs when we use a tool or device in conjunction with an external representation to help us carry on a computation.
- An example is using a pen and paper to solve math problem.

Annotating and cognitive tracing:

- Another way in which we externalized our cognition is by modifying representations to reflect changes that are taking place that we wish to mark.
- Annotating involves modifying external representations such as crossing off or underlying items.
- Cognitive tracing involves externally manipulating items into different orders or structures.

Embodied interaction:

- HCI which group out of collaboration between computer scientist and psychologist initially adopted an information processing perspective but was criticize as failing to account for the ways that people get things done in real situations.
- Approaches that focus on practical engagement in real social and physical contexts and the flexible ways were included into interaction.
- One of the approach is embodied interaction.
- This has been applied quite broadly to : hci , including work that focuses on the emotional quality of interaction with technology , on publicly available actions in physically shared spaces , and on the role of the body in mediating our interaction with technology.
- These theories of embodied cognition are more useful in the ways that people experience the world through physical interaction.


EMBODIED COGNITION
ENVIRONMENT
PHYSICAL ACTIVITY
BRAIN ACTIVITY
PERCEPTION & ACTION

HUMAN COMPUTER INTERACTION

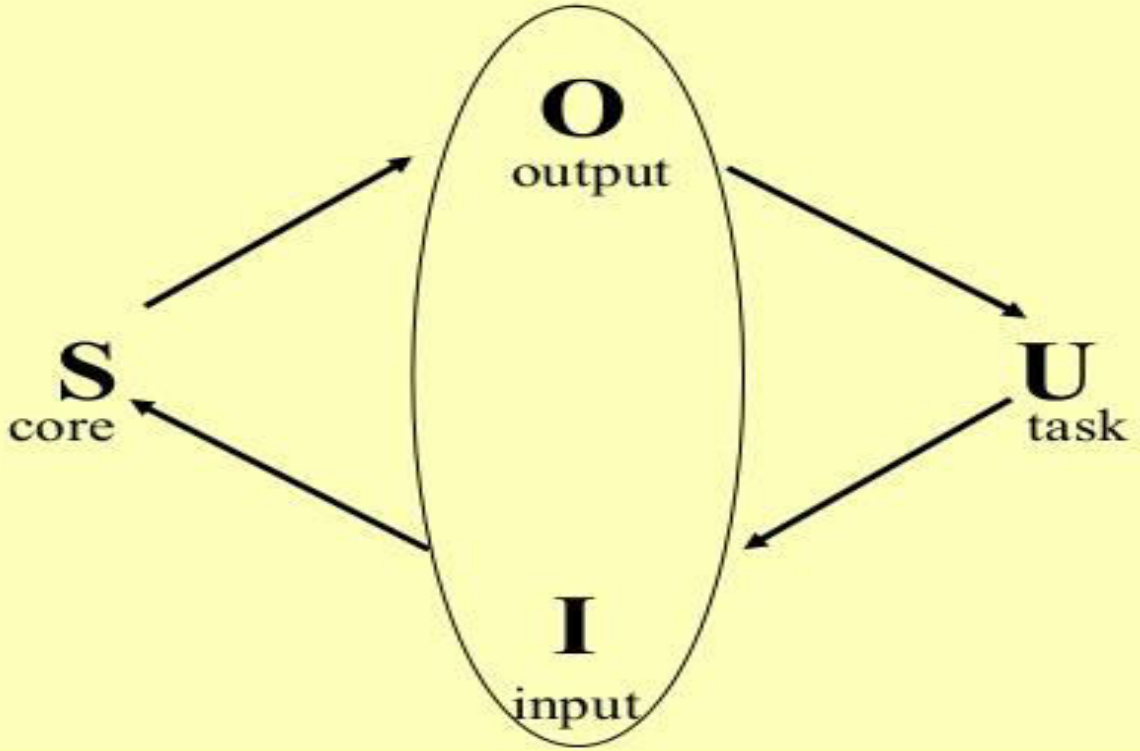
LECTURE 7,8

Models of Interaction:

- Interaction involves atleast two participants- the user and the system.
- Both are complex and very different from each other in the way that they communicate and view the domain and the task. The interface must therefore effectively translate between them to allow the interaction to be successful.
- The use of models of interaction can help to understand what is going on in interaction and identify the likely root of difficulties. They also provide us with a framework to compare different interaction styles and to consider interaction problems.

Interaction

Interaction framework



Interaction Model

Some terms of Interaction

domain – the area of work under study
e.g. graphic design

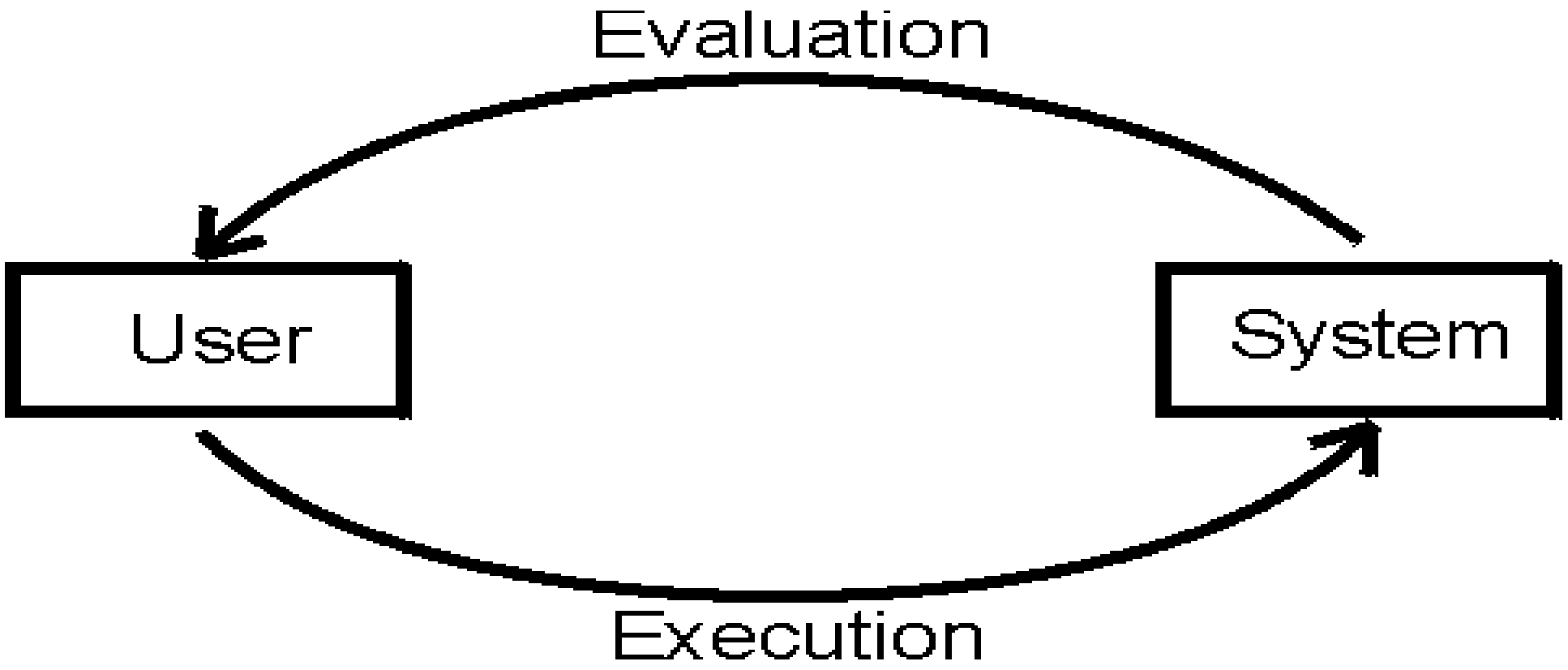
goal – what you want to achieve
e.g. create a solid red triangle

task – how you go about doing it
– ultimately in terms of operations or actions
e.g. … select fill tool, click over triangle

Note …
- traditional interaction …
- use of terms differs a lot especially task/goal !!!

The execution – evaluation cycle:

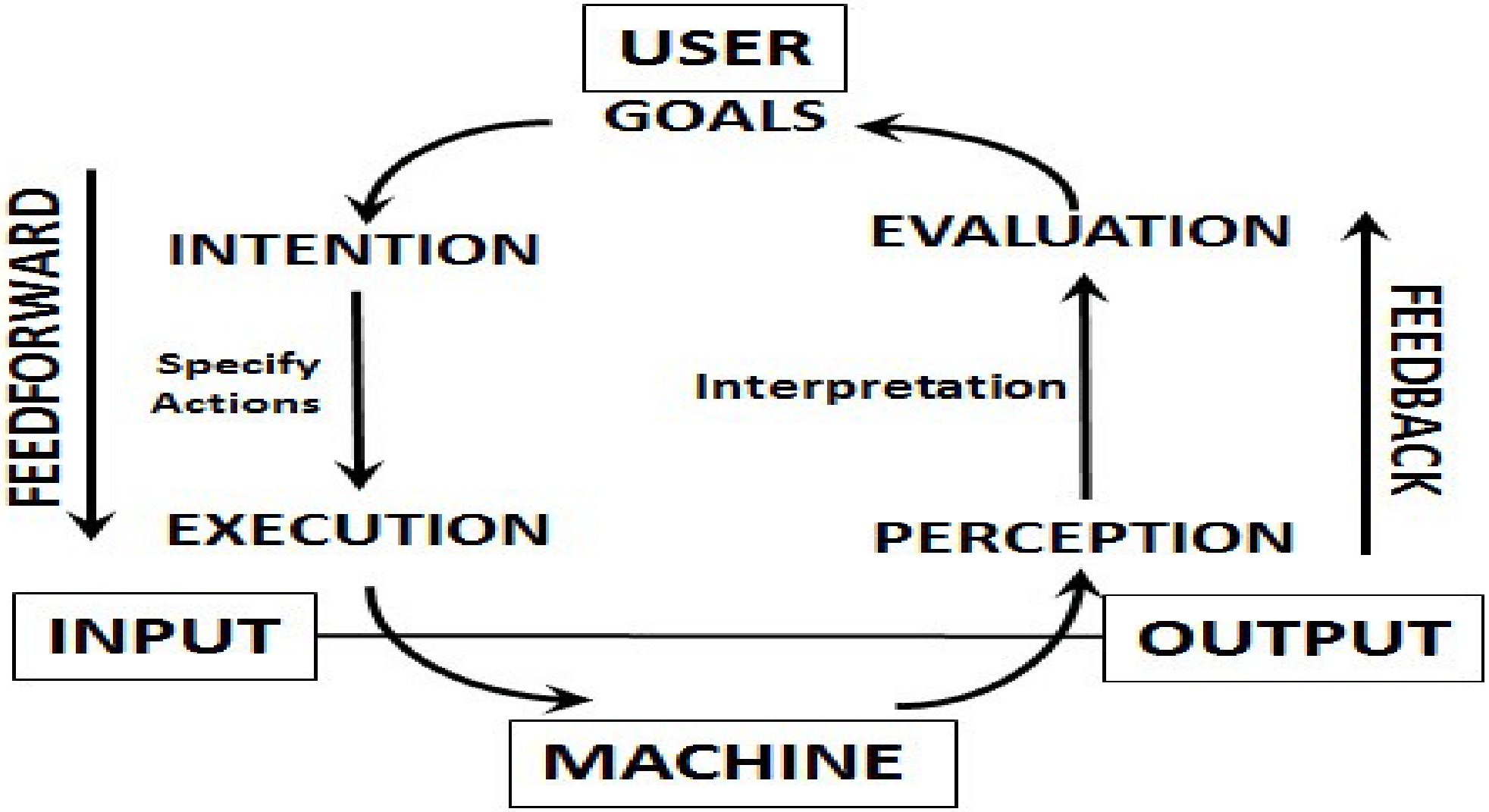
- Normans model of interaction is the most influential in HCI because of its closeness to understanding of the interaction between human user and computer.
- The user formulates a plan of action, which is then executed at the computer interface.
- When the plan, or the part of the plan, has been executed, the user observes the computer interface to evaluate the result of the executed plan to determine further actions.
- The interaction cycle can be divided into two major phases: execution and evaluation.



Norman's Interaction Cycle

- These can be sub-divided into seven stages.
- The stages in **Normans model of interaction** are as follows:

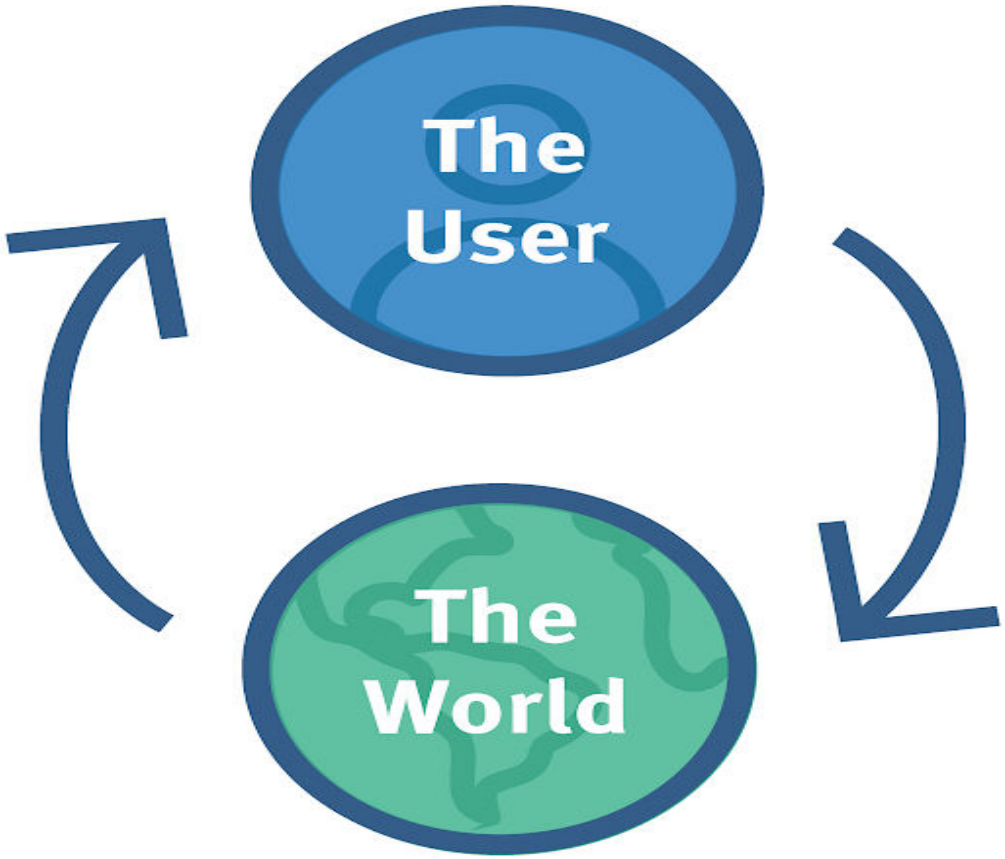
1. Establishing the goal
2. Forming the intention
3. Specifying the action sequence
4. Executing the action
5. Perceiving the system state
6. Interpreting the system state
7. Evaluating the system


USER
GOALS
FEEDFORWARD
INTENTION
Specify
Actions
EXECUTION
EVALUATION
Interpretation
PERCEPTION
FEEDBACK
INPUT
OUTPUT
MACHINE

- Each stage is an activity of user
- First the user forms a goal. This is the users notion of what needs to be done and is framed in terms of the domain, in the task language.
- It needs to be translated into more specific interaction, and the actual actions that will reach the goal, before it can be executed by the user.
- The user perceives the new state of the system, after execution of the action sequence and interprets it in terms of his expectations.
- If the system states reflects the user goals than the computer has done what user wanted and the interaction has been successful.
- Normans uses this model of interaction to demonstrate why some interfaces cause problems to their users.
- This is described in terms of Gulfs of execution and the Gulfs of evaluation.

Gulf of Evaluation

What's the current system state?



Gulf of Execution

How do I use this system?

nngroup.com NN/g

Using Normans model

Some systems are harder to use than others

Gulf of Execution

user's formulation of actions

$\neq$ actions allowed by the system

Gulf of execution is the difference between the user formulation of actions to reach the goal and the actions allowed by system

Gulf of Evaluation

user's expectation of changed system state

$\neq$ actual presentation of this state

Gulf of explanation (or evaluation) is the distance between the the physical representation of the system state and the expectation of the user

- The Gulfs of execution is the difference between user formulation of the actions to reach the goals and the action allowed by the system.
- The Gulf of evaluation is the distance between physical presentation of the system state and the expectation of the user.
- If the user can readily evaluate the presentation in terms of his goal, the Gulf of evaluation is small.
- The more effort that is required on the part of the user to interpret the presentation, the less effective the interaction.

Ergonomics:

- Ergonomics is the study of physical characteristics of the interaction: how the controls are designed, the physical environment in which the interaction takes place, and the layout and physical quantities of the screen.
- The primary focus is on user performance an how the interface chances this.
- To evaluate these aspects of interaction, Ergonomics will touch upon human psychology and system constraints.
- The Ergonomics deals about arrangement of controls and displays, the physical environment, health issues and the use of color.
- These are intended only to give an indication of types of issues and problems addressed by Ergonomics.

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Arrangement of controls and displays:

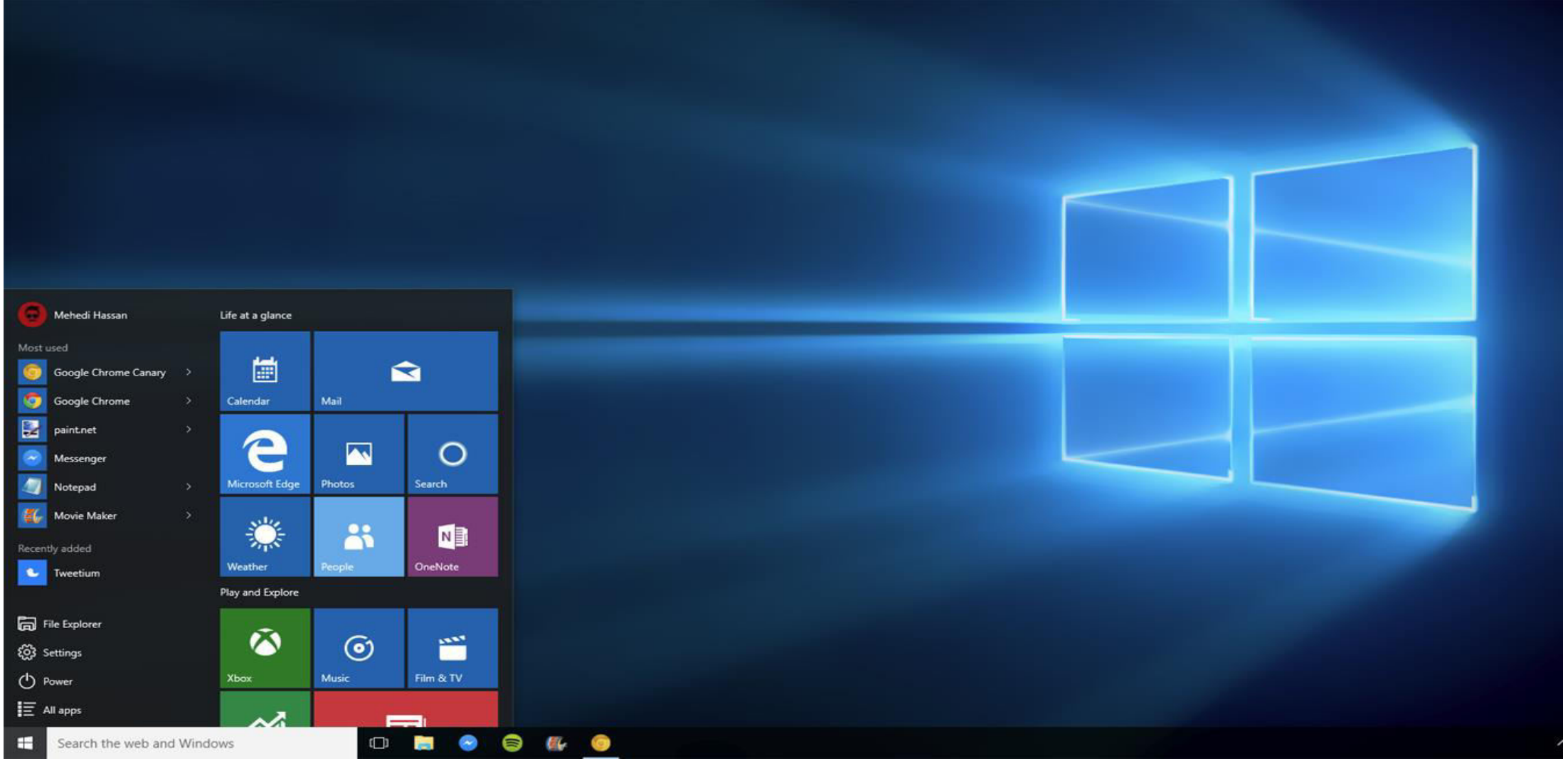
- In additional to cognitive aspects of design, physical aspects are also important.
- Sets of controls and parts of the display should be grouped logically to allow rapid access by user. Inappropriate placement of controls and displays can lead to inefficiency.
- The exact organization will depend in the domain and the application but possible organization include the following:

-Functional controls and displays are organized as that functionally related are placed together.

-sequential controls and displays are organized to reflect the order of their use in interaction.

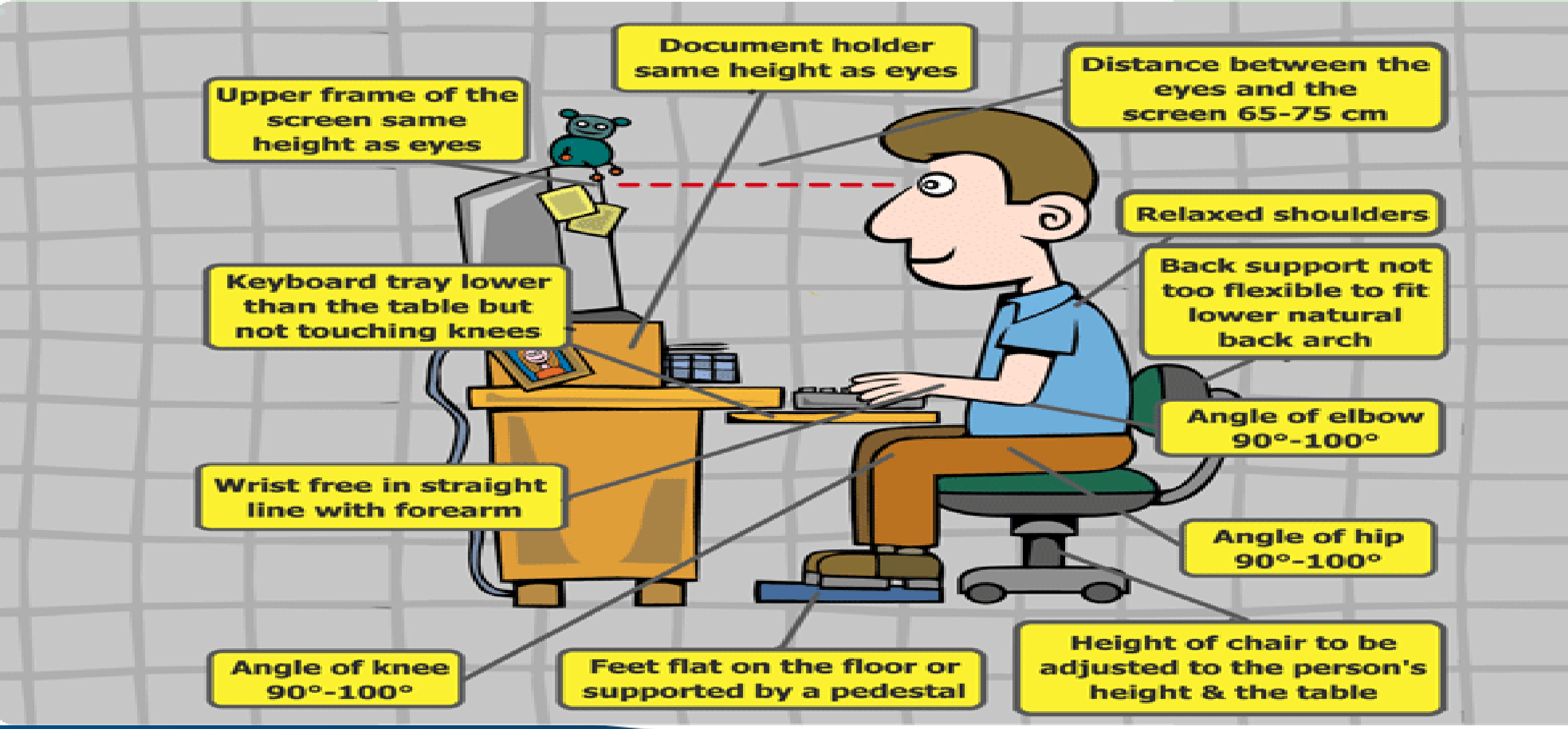
-frequency controls and displays are organized according to how frequently they are used.

- In addition to the controls and displays in relation to each other , the entire system interface must be arranged appropriately in relation to the users position.


Mehedi Hassan
Most used
Google Chrome Canary
Google Chrome
paint.net
Messenger
Notepad
Movie Maker
Recently added
Tweetium
File Explorer
Settings
Power
All apps
Life at a glance
Calendar
Mail
Microsoft Edge
Photos
Search
Weather
People
OneNote
Play and Explore
Xbox
Music
Film & TV
Search the web and Windows

The Physical Environment of Interaction:

- Ergonomics is also concerned with the design of work environment.
- The physical environment in which the system is used may influence how well it is accepted and even the health and safety of its users.
- In a system even a smallest user should be able to reach all the contexts.
- All users should be compatibly able to see critical displays and users should be seated comfort for long periods of use.


Document holder same height as eyes
Distance between the eyes and the screen 65-75 cm
Upper frame of the screen same height as eyes
Relaxed shoulders
Keyboard tray lower than the table but not touching knees
Back support not too flexible to fit lower natural back arch
Angle of elbow 90°-100°
Wrist free in straight line with forearm
Angle of hip 90°-100°
Angle of knee 90°-100°
Feet flat on the floor or supported by a pedestal
Height of chair to be adjusted to the person's height & the table

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GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

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PRESIDENCY GROUP OVER 40 YEARS OF ACADEMIC WISDOM

Health Issues- Possible consequences of our design on health and safety of users should be considered while designing interface.

- There are many factors that may effect the use of poorly design interface.
- These are the factors in physical environment that directly effect the quality of interaction and user performance

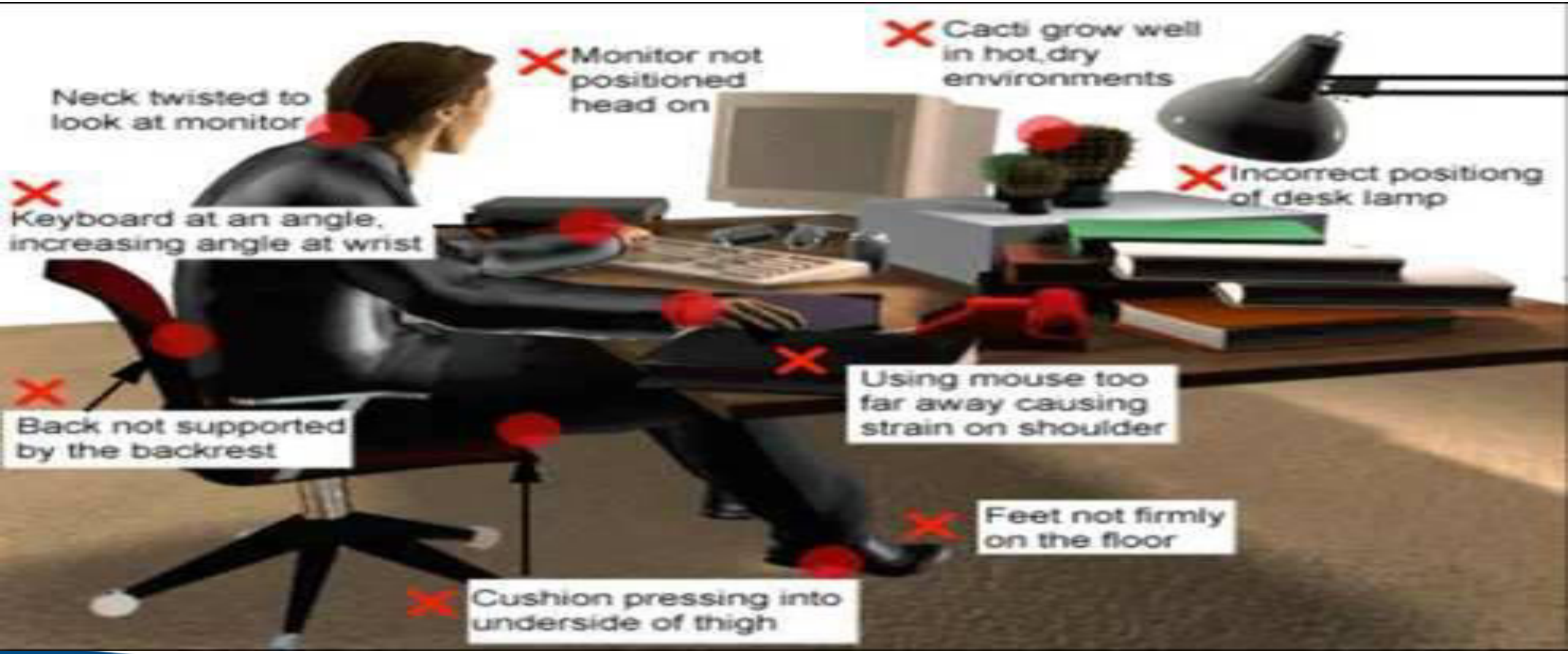
-Physical position – users should be able to reach all controls comfortably and see all displays.

-Temperature-experimental studies how the performance decreases at high and low temperatures with users being usable to concentrate effectively.

-Lighting -adequate lighting should be provided to allow users to see the computer screen without discomfort.

-Noise-noise levels should be maintained at a comfortable level in the work environment.

-Time- the time users spend using the system should also be controlled.


Neck twisted to look at monitor
Monitor not positioned head on
Cacti grow well in hot,dry environments
Incorrect positiong of desk lamp
Keyboard at an angle, increasing angle at wrist
Using mouse too far away causing strain on shoulder
Back not supported by the backrest
Feet not firmly on the floor
Cushion pressing into underside of thigh

The Use of Color - Ergonomics has a close relationship to human psychology in that it is also concerned with the perceptual limitations of humans.

- The use of color in displays is an ergonomics issue.
- Colors used in the display should be as distinct as possible and the distinction should not be effected by changes in contrast.
- The colors used should correspond to common conventions and user expectations.
- Designers should remember that color conventions are culturally are determined.
- Awareness of culture associations of color is particularly important is designing systems and websites for global market.

Red

The colour red is shown to increase the heart rate and blood flow. It is also said to invoke emotion and passion. Also it draws attention to items that are of the colour red. If the tasks involve physical activity this is a good colour to paint your office.

Blue

Blue is known to be an excellent colour for productivity.

It is said to be:
Stable and Calming
Help workers focus

Green

Research has linked green with calm and efficiency. There seems to be a positive association between nature and regrowth. Additionally it is said to be a good colour for those who work long hours as it doesn't cause eye fatigue.

Yellow

The colour yellow is thought to be a colour of optimism, additionally it is also said to improve creativity and is a good colour if you are a designer as it encourages innovation and creative thoughts.

COLOR MEANING AROUND THE WORLD

WHITE

White: Symbolizes mourning or death in East Asia
but happiness and purity in Australia,
New Zealand and the Untied States

BLUE

Blue: Is the most popular corporate color in the United States
but it represent cold and evil in East Asia.
However, it stands for warmth in the Netherlands
and in contrast coldness in Sweden,
death in Iran and purity in India.
Moreover, blue denotes femininity in Belgium
but masculinity in Sweden and the United States.

GREEN

Green: Represents danger or disease
in Malaysia, and envy in Belgium.
But, it stands for love and happiness in Japan,
and sincerity, trustworthiness, and
dependability in China

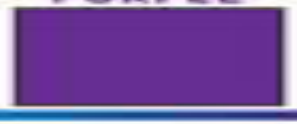
RED

Red: Reflects ambition and desire in India,
and love in China, Korea and Japan.
It can also mean lucky in China, Denmark and Argentina
but unlucky in Nigeria

YELLOW

Yellow: Represents warmth in the United States,
but infidelity in France.
It is also associated with jealousy in Russia
but pleasant, happy and good taste in China.
In contrast, Brazil, purple and yellow
symbolize sorrow and despair

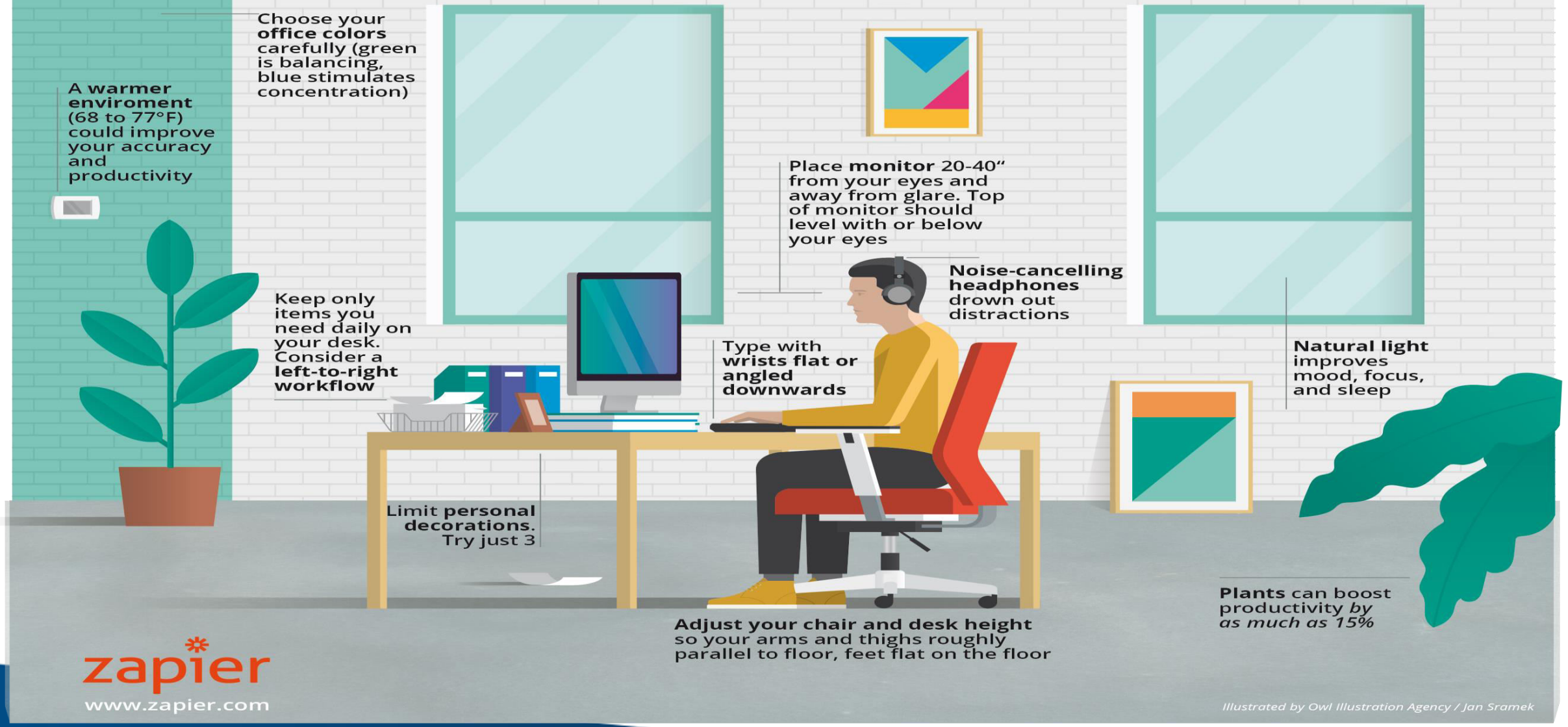
PURPLE



Purple: In western cultures, purple represents royalty.
However, in eastern cultures like China and
South Korea, it represents love

Different colors have different meanings in different cultures.

HOW TO SET UP YOUR DESK FOR PRODUCTIVITY & ERGONOMICS



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HUMAN COMPUTER INTERACTION

LECTURE 9

Universal Usability:

- The remarkable diversity of human abilities, backgrounds, motivations ,personalities, cultures and workstyles, challenges interface designers.
- Understanding the physical ,intellectual and personality differences between users helps in gaining broadest possible set of users.
- Ultimate goal of designer is to address the needs of all users .
- Universal usability introduces the challenges projected by physical , cognitive, perceptual , personality and cultural differences.

- Challenges faced are:

1. Variations in physical abilities and physical work places
2. Diverse cognitive and perceptual abilities
3. Personality differences
4. Cultural and international diversity
5. User with disabilities
6. Older adults and children
7. Accommodating hardware and software diversity

Variations in physical abilities an physical work places –.

- The great diversity in these static measures remind that there can be an average user and that compromises must be made or multiple versions of a system must be constructed.
- Since so much of work is related to perception, designers need to be aware of the ranges of human perceptual abilities especially with regard to vision.
- Work place design is also important in ensuring high job satisfaction, good performance and low error rates.
- Incorrect table heights, uncomfortable chairs or inadequate space to place documents can substantially delay work.

Diverse cognitive and perceptual abilities - A vital foundation for interactive system designers is an understanding of the cognitive and perceptual abilities of the user.

- Ergonomics abstracts this classification of human cognitive process.
- These vital issues of cognition and perception have a strong influence on design of interactive systems.
- In any application, background experience and knowledge in the task and interface domains play key role in learning and performance.

- **Personality differences** - There are four types of Carl Fungs personality types.
- Extroversion versus Introversion- extroverts focus on external stimuli and like variety and action, where as introverts prefer familiar patterns.
- Sensing versus intuition – sensing types are attracted to establish routines, and enjoy applying known skills, whereas intuitive types like solving new problems and discovering new relations.
- Perceptive versus Judging – perceptive types like to learn about new situations but may have trouble making decisions, whereas judging types like to make a careful plan and carry through the plan.
- Feeling versus thinking – feeling types are aware of other people feelings and relate well to most people whereas thinking types are unemotional.

- **Culture and international diversity –** Another perspective on individual differences has to do with culture, ethnic or linguistic background.
- Users from traditional culture may prefer interfaces with stable display from which they select a single item, while user from novelty based cultures may prefer animated screens and multiple clicks.
- More and more is being learned about computer users from different culture but designers are still struggling to establish guidelines for designing for multiple languages and culture.
- The growth of world wide computer market means that designers must prepare for internationalization.
- Software architects that facilitates customization of local versions of user interface offer a competitive advantage.
- To develop effective designs, companies run usability studies with users from different countries, cultures and language communities.

User with disabilities:

- The flexibility of desktop, web, and mobile devices makes it possible for designers to provide special services to users who have disabilities.
- The access board spells out the guidelines for vision-impaired, hearing-impaired, and mobility-impaired users; these include keyboard or mouse alternatives, color coding, font-size settings, contrast settings, textual alternatives to images, and web features such as frames, links, and plug-ins.
- Screen magnification to enlarge portions of a display and text-to-speech conversion can be done with hardware and software supplied by many vendors.
- Text-to-speech conversion can help blind users to receive e-mail or to read text files, and speech recognition devices permit voice-controlled operation of some user interfaces.
- Speech generation and auditory interfaces are also appreciated by sighted users under difficult conditions, such as when driving an automobile, riding a bicycle, or working in bright sunshine.

- Designers can benefit by planning early to accommodate users who have disabilities, since at this point substantial improvements can be made at low or no cost.
- The potential for benefit to people with disabilities is one of the gifts of computing.
- In addition, many users are temporarily disabled : they may forget their glasses, be unable to read while driving , or struggle to hear in a noisy environment.
- Improving designs for users with disabilities is an International concern.

Older Adult Users:

- Seniority offers many pleasures and all the benefits of experience, but aging can also have negative physical , cognitive and social consequences.
- Understanding the human factors of aging can help designers to create user interfaces that facilitates access by older adult users.
- The benefits to senior citizens include improved chances for productive employment and opportunities to use writing , email, and other computer tools , plus the satisfactions of education, entertainment ,social interaction , and challenge.
- The benefits to society include increased access to seniors , which is valuable for their experience and the emotional support they can provide to others.
- The further good news is that interface designers can do much to accommodate older adult users and , thus, to give older adults access to the beneficial aspects of computing and network communication.

- Desktop , web and mobile devices can be improved for all users by providing users with control over font sizes , display contrast ,and audio levels.
- Interfaces can also be design with easier-to-use pointing devices , clearer navigation paths ,consistent layouts ,and simpler command languages to improve access for older adults and every user.
- The older adults ,who explored email ,photo sharing ,and educational games ,felt quite satisfied with themselves and were eager to learn more.
- In summary ,making computing more attractive and accessible to older adults enables them to take advantage of technology and enables others to benefit from their participation.

Children:

- Another lively community of users is children ,whose users emphasize entertainment and education.
- Even pre-readers can use computer-controlled toys ,music generators and art tools.
- The noble aspirations of designers of children's software include educational acceleration, facilitating socialization with peers, and fostering the self-confidence that comes from skill mastery.
- For teenagers, the opportunity for empowerment are substantial.
- They often take the lead in employing new modes of communication, such as instant messaging and text messaging on cellphones, and in creating cultural or fashion trends that surprise even the designers.
- Appropriate design principles for children's software, recognize young people's intense desire for the kind of interactive engagement that gives them control with appropriate feedback and supports their social engagement with peers.

- Designers also have to find the balance between children's desire for challenge and parents requirements for safety.
- Children can deal with some frustrations and with threatening stories, but they also want to know that they can clear the screen, start over, and try again without severe penalties.
- Designing for younger children requires attention to their limitations.
- Designers of children's software also have a responsibility to attend to dangers, especially in web-based environments, where parental control over access to violent, racist materials is unfortunately necessary.
- The capacity for playful creativity in art, music, and writing and the value of educational activities in science and math remain potent reasons to pursue children's software.
- These and other opportunities have motivated efforts to bring low-cost computers to children around the world-hopefully coupled with rich content, parental guidance materials ,and effective teacher training.

Accommodating hardware and software diversity:

- In addition to accommodating different classes of users and skill levels, designers need to support a wide range of hardware and software platforms.
- The rapid progress of technology remains that newer systems may have a hundred or a thousand times greater storage capacity, faster processors, and higher band width networks.
- The challenge of accommodating diverse hardware is couple with the need to ensure access through many generations of software.
- This requirement can slow innovation, but the designers who plan ahead carefully to support flexible interfaces and self defining files will be rewarded with larger market shares.

- For at least the next decade, three of the main technologies will be:

1.Producing satisfying and effective internet interaction on high speed and slower connections - some technological break-throughs have already made in comparison algorithms to reduce file sizes for images, music, animations, and even video, more are needed. New technologies are needed to enable pre-fetching or scheduled down-loads.

2.Enabling access to web services from large displays and smaller mobile devices - Rewriting each web page for different display sizes may produce the best quality, but this approach is probably too costly and time-consuming for most web providers.

3.Supporting easy maintenance of or automatic conversion to multiple languages - Commercial operators recognize that they can spend their markets if they can provide access in multiple languages and across multiple countries. This means isolating text to allow easy substitution, choosing appropriate metaphors and colours, and addressing the needs of diverse cultures.

- The good news is that rethinking designs to accommodate these diverse needs can improve the quality for all users.
- As for cost, with appropriate software tools, e-commerce providers are finding that a small additional effort can expand markets by 20% or more.