

## CHAPTER – TWO

### HUMAN IN HCI

- ❑ Humans are limited in their capacity to process information. This has important implications for design.
- ❑ **Information** is received and responses are given via a number of **input** and **output** channels:
  - visual channel
  - auditory channel
  - haptic channel
  - movement.

## HUMAN IN HCI ...

❑ Information is stored in memory:

- sensory memory

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- short-term (working) memory

- long-term memory.

❑ Information is processed and applied:

- reasoning

- problem-solving

- skill acquisition

- error.

# VISION

❑ Two stages in vision:

✓ **physical reception of stimulus**

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✓ **processing and interpretation of stimulus**



## **The Eye - physical reception**

- mechanism for receiving light and transforming it into electrical energy
- light reflects from objects
- images are focused upside-down on retina
- retina contains rods for low light vision and cones for colour vision
- ganglion cells (brain!) detect pattern and movement

## Interpreting the signal

### □ Size and depth

- visual angle indicates how much of view object occupies  

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(relates to size and distance from eye)
- visual acuity is ability to perceive detail (limited)
- familiar objects perceived as constant size  
(in spite of changes in visual angle when far away)
- cues like overlapping help perception of size and depth

## Interpreting the signal ...

### □ Brightness

- subjective reaction to levels of light
  - affected by luminance of object
- 
- measured by just noticeable difference
  - visual acuity increases with luminance as does flicker

### □ Colour

- made up of hue, intensity, saturation
- cones sensitive to colour wavelengths
- blue acuity is lowest
- 8% males and 1% females colour blind

## Interpreting the signal ...

- The visual system compensates for:
  - ✓ movement
  - ✓ changes in luminance.

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- Context is used to resolve ambiguity
- Optical illusions sometimes occur due to over-compensation

# Optical Illusions

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the Ponzo illusion



the Muller Lyer illusion

# Reading

## ❖ Several stages:

- visual pattern perceived
  - decoded using internal representation of language
  - interpreted using knowledge of syntax, semantics, pragmatics
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## ❖ Reading involves saccades and fixations

## ❖ Perception occurs during fixations

## ❖ Word shape is important to recognition

## ❖ Negative contrast improves reading from the computer screen

# Hearing

- Provides information about environment:  
distances, directions, objects etc.
- *Physical apparatus:*

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  - outer ear           — protects inner and amplifies sound
  - middle ear       — transmits sound waves as vibrations to inner ear
  - inner ear         — chemical transmitters are released and cause impulses in auditory nerve
- Sound
  - pitch             — sound frequency
  - loudness         — amplitude
  - timbre           — type or quality

## Hearing ...

- Humans can hear frequencies from 20Hz to 15kHz
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- ✓ less accurate in distinguishing high frequencies than low.

- Auditory system filters sounds

- ✓ can attend to sounds over background noise.

- ✓ for example, the cocktail party phenomenon.

# Touch

- Provides important feedback about environment.
- May be key sense for someone who is visually impaired.
- Stimulus received via receptors in the skin:
  - ✓ **thermoreceptors – heat and cold**
  - ✓ **nociceptors – pain**
  - ✓ **mechanoreceptors – pressure**  
**(some instant, some continuous)**
- Some areas more sensitive than others e.g. fingers.
- Kinethesis - awareness of body position
- affects comfort and performance.

## Movement

- Time taken to respond to stimulus: **reaction time + movement time**
- Movement time dependent on age, fitness etc.
- Reaction time - dependent on stimulus type:
  - visual ~ 200ms
  - auditory ~ 150 ms
  - pain ~ 700ms
- Increasing reaction time decreases accuracy in the unskilled operator but not in the skilled operator.

## Movement ...

- Fitts' Law describes the time taken to hit a screen target:
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$$M_t = a + b \log_2(D/S + 1)$$

where:  $a$  and  $b$  are empirically determined constants

$M_t$  is movement time

$D$  is Distance

$S$  is Size of target

- targets as large as possible
- distances as small as possible

# Memory

➤ There are three types of memory function:

➤ Sensory memories



**Attention**

➤ Short-term memory or working memory



**Rehearsal**

➤ Long-term memory

➤ Selection of stimuli governed by level of arousal.

## **sensory memory**

- Buffers for stimuli received through senses

- ✓ **iconic memory: visual stimuli**

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- ✓ **echoic memory: aural stimuli**

- ✓ **haptic memory: tactile stimuli**

- Examples

- ✓ **“sparkler” trail**

- ✓ **stereo sound**

- Continuously overwritten

## Short-term memory (STM)

- Scratch-pad for temporary recall
- 
- ✓ rapid access ~ 70ms
  - ✓ rapid decay ~ 200ms
  - ✓ limited capacity -  $7 \pm 2$  chunks

## Long-term memory (LTM)

- Repository for all our knowledge

- ✓ slow access ~ 1/10 second

- ✓ slow decay, if any

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- ✓ huge or unlimited capacity

- Two types

- ✓ **episodic**— serial memory of events

- ✓ **semantic** — structured memory of facts, concepts, skills

semantic LTM derived from episodic LTM

## Long-term memory (LTM) ...

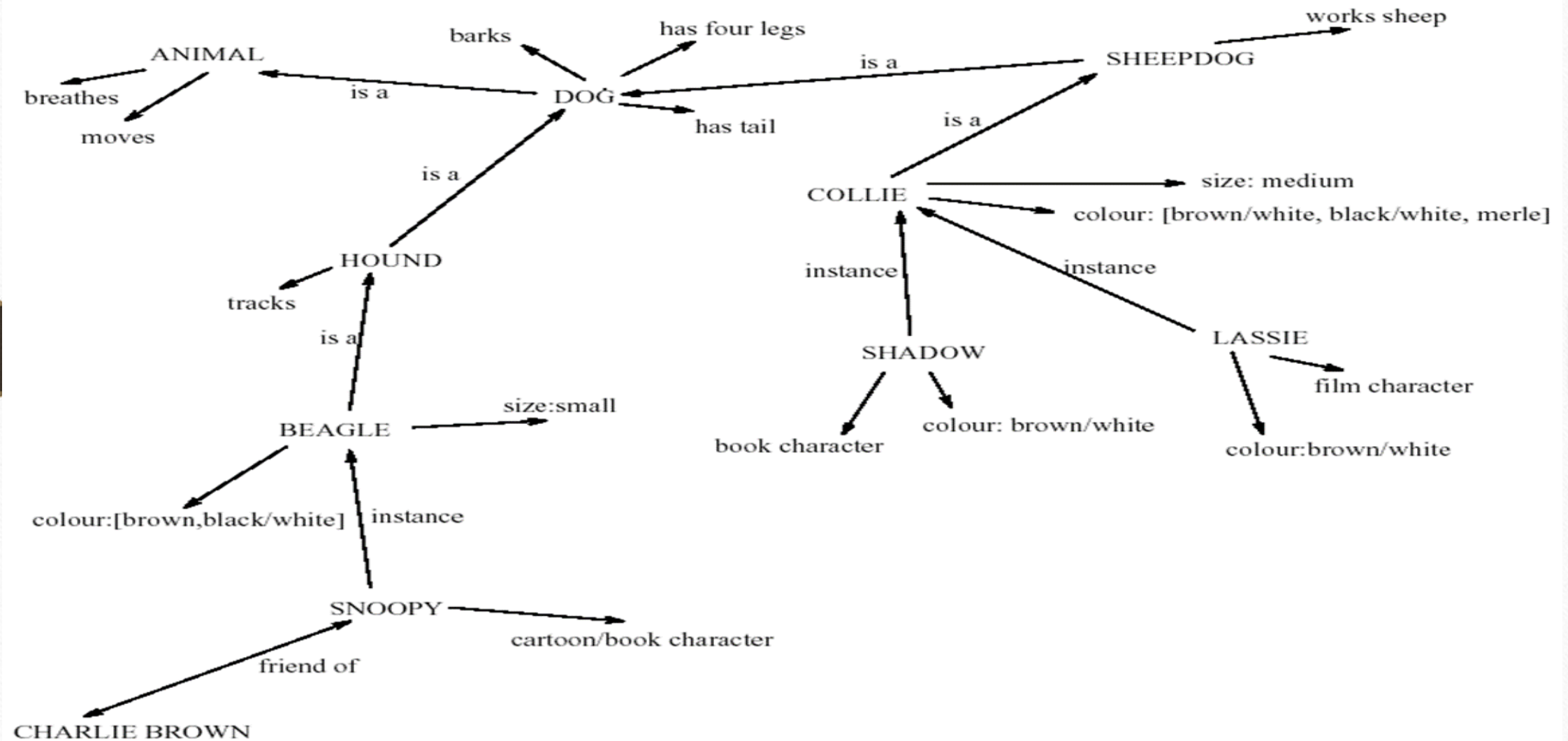
### ■ Semantic memory structure

- ✓ provides access to information
- ✓ represents relationships between bits of information
- ✓ supports inference

### ■ Model: semantic network

- ✓ inheritance – child nodes inherit properties of parent nodes
- ✓ relationships between bits of information explicit
- ✓ supports inference through inheritance

## LTM - semantic network



## Models of LTM - Scripts

- Model of stereotypical information required to interpret the situation
- Script has elements that can be instantiated with values for context

### DOG

Fixed

legs: 4

Default

diet: carnivorous

sound: bark

Variable

size:

colour

### COLLIE

Fixed

breed of: DOG

type: sheepdog

Default

size: 65 cm

Variable

colour

## Models of LTM - Frames

- Information organized in data structures
- Slots in structure instantiated with values for instance of data
- Type–subtype relationships

### Script for a visit to the vet

Entry conditions: *dog ill*  
*vet open*  
*owner has money*

Result: *dog better*  
*owner poorer*  
*vet richer*

Props: *examination table*  
*medicine*  
*instruments*

Roles: *vet examines*  
*diagnoses*  
*treats*  
*owner brings dog in*  
*pays*  
*takes dog out*

Scenes: *arriving at reception*  
*waiting in room*  
*examination*  
*paying*

Tracks: *dog needs medicine*  
*dog needs operation*

## Models of LTM - Frames

- Information organized in data structures
  - Slots in structure instantiated with values for instance of data
  - Type–subtype relationships
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## LTM - Storage of information

- rehearsal
  - ✓ information moves from STM to LTM
- total time hypothesis

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  - ✓ amount retained proportional to rehearsal time
- distribution of practice effect
  - ✓ optimized by spreading learning over time
- structure, meaning and familiarity
  - ✓ information easier to remember

## LTM - Forgetting

- **decay**

- ✓ information is lost gradually but very slowly

- **interference**

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- ✓ new information replaces old: retroactive interference
- ✓ old may interfere with new: proactive inhibition

## LTM - retrieval

- **recall**

- ✓ information reproduced from memory can be assisted by cues, e.g. categories, imagery

- **recognition**

- ✓ information gives knowledge that it has been seen before
- ✓ less complex than recall - information is cue

- Reasoning

- ✓ deduction, induction, abduction

- Problem-solving

## Thinking

- Deductive Reasoning

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**Deduction:** derive logically necessary conclusion from given premises.

e.g. If it is Friday then she will go to work

It is Friday

Therefore she will go to work.

**Logical conclusion not necessarily true:**

e.g. If it is raining then the ground is dry

It is raining

Therefore the ground is dry

## Inductive Reasoning

- **Induction:** generalize from cases seen to cases unseen

e.g. \_\_\_\_\_ all elephants we have seen have trunks \_\_\_\_\_

therefore all elephants have trunks.

- **Unreliable:** can only prove false not true

... but useful!

- Humans not good at using negative evidence

e.g. Wason's cards.

## Abductive reasoning

- reasoning from event to cause

e.g.

**Sam drives fast when drunk.**

**If I see Sam driving fast, assume drunk.**

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- **Unreliable: can lead to false explanations**

## Problem solving

- Process of finding solution to unfamiliar task using knowledge.
- Several theories.
- Gestalt
  - ✓ problem solving both productive and reproductive
  - ✓ productive draws on insight and restructuring of problem
  - ✓ attractive but not enough evidence to explain 'insight' etc.
  - ✓ move away from behaviourism and led towards information processing theories

## Problem solving....

- Problem space theory

- problem space comprises problem states
- problem solving involves generating states using legal operators
- heuristics may be employed to select operators
  - e.g. means-ends analysis**
- operates within human information processing system
  - e.g. STM limits etc.**
- largely applied to problem solving in well-defined areas
  - e.g. puzzles rather than knowledge intensive areas**

# Problem solving....

## ■ **Analogy**

- analogical mapping:
    - ✓ novel problems in new domain?

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  - ✓ use knowledge of similar problem from similar domain
- analogical mapping difficult if domains are semantically different

## ■ **Skill acquisition**

- ✓ skilled activity characterized by chunking
  - ✓ lot of information is chunked to optimize STM
- ✓ conceptual rather than superficial grouping of problems
- ✓ information is structured more effectively

# Errors and mental models

- Types of error

- **slips**

- ✓ right intention, but failed to do it right
  - ✓ causes: poor physical skill, inattention etc.
  - ✓ change to aspect of skilled behaviour can cause slip
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- **mistakes**

- ✓ wrong intention
  - ✓ cause: incorrect understanding humans create mental models to explain behaviour.
- if wrong (different from actual system) errors can occur

# Emotion

- Various theories of how emotion works

- ✓ James-Lange: emotion is our interpretation of a physiological response to a stimuli

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- ✓ Cannon: emotion is a psychological response to a stimuli

- ✓ Schacter-Singer: emotion is the result of our evaluation of our physiological responses, in the light of the whole situation we are in

- Emotion clearly involves both cognitive and physical responses to stimuli

## Emotion ...

- The biological response to physical stimuli is called **affect**.
- Affect influences how we respond to situations

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  - ✓ **positive - creative problem solving**
  - ✓ **negative - narrow thinking**
- “Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks” (Donald Norman)

## Emotion ...

- Implications for interface design

- stress will increase the difficulty of problem solving
  - relaxed users will be more forgiving of shortcomings in design
  - aesthetically pleasing and rewarding interfaces will increase positive affect
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- Individual differences

- ✓ long term

- sex, physical and intellectual abilities

- ✓ short term

- effect of stress or fatigue

- ✓ changing

- age

**END OF CHAPTER - TWO**