

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
 - 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

✓ 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

(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

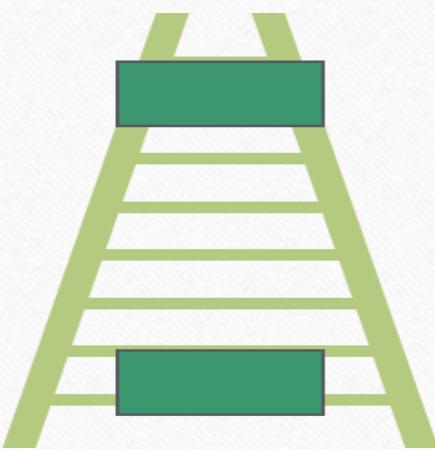
- made up of hue, intensity, saturation
- cones sensitive to colour wavelengths
- blue acuity is lowest
- 8% males and 1% females colour blind

Interpreting the signal ...

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

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

Optical Illusions



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

❖ 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:***

- 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

 - ✓ 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.
- Kinesthesia - 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:

$$Mt = a + b \log_2(D/S + 1)$$

where: a and b are empirically determined constants

Mt 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**
 - ✓ **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 ± 2 chunks

Long-term memory (LTM)

- Repository for all our knowledge

- ✓ slow access ~ 1/10 second

- ✓ slow decay, if any

- ✓ 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) ...

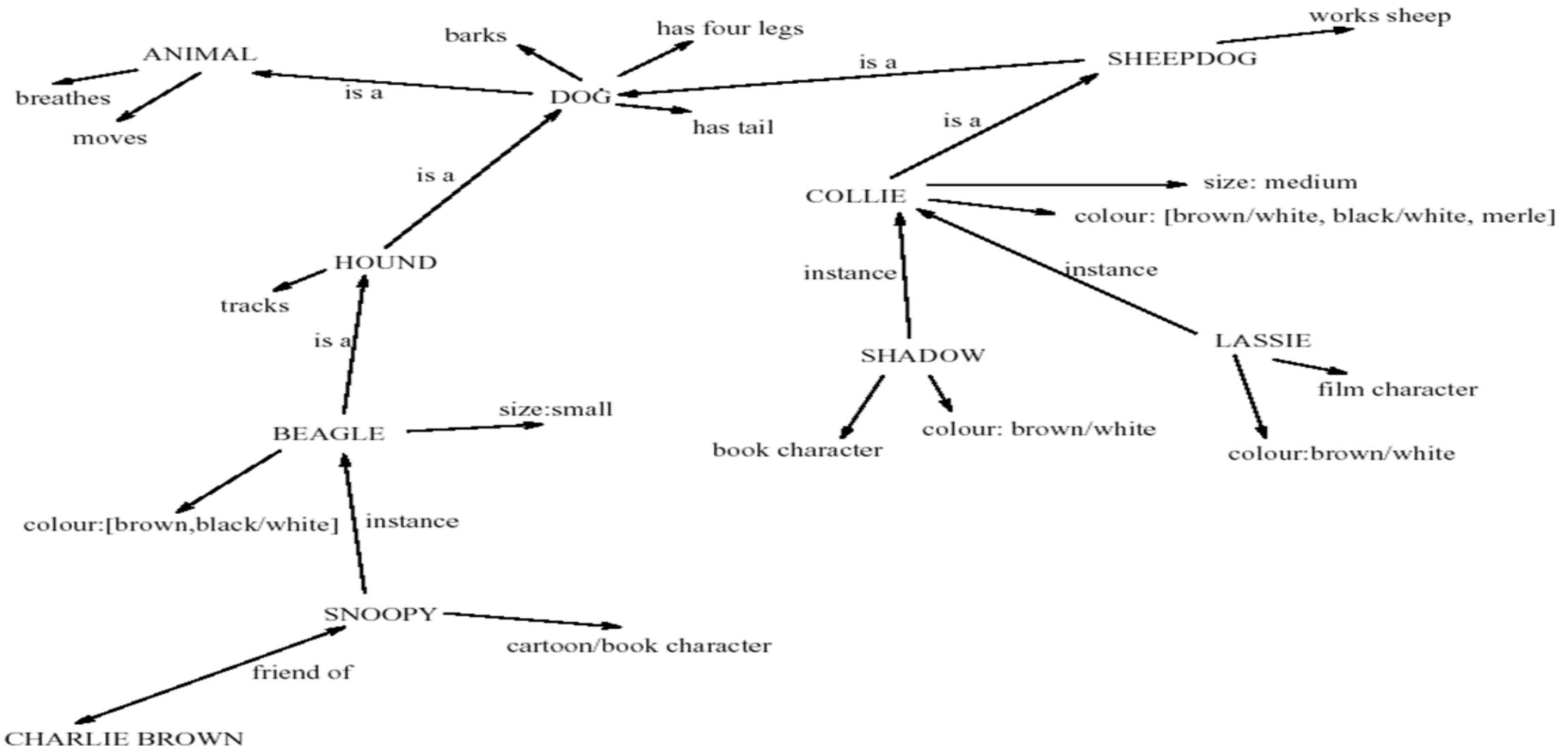
■ Semantic memory structure

- ✓ 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

LTM - Storage of information

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

- 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**

- ✓ 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**

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.

- **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?
 - ✓ 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

- **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
 - ✓ 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
 - ✓ **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
- Individual differences
 - ✓ long term
 - sex, physical and intellectual abilities
 - ✓ short term
 - effect of stress or fatigue
 - ✓ changing
 - age

END OF CHAPTER - TWO