chapter 1

the human

the human

- Information i/o …
  - visual, auditory, haptic, movement
- Information stored in memory
  - sensory, short-term, long-term
- Information processed and applied
  - reasoning, problem solving, skill, error
- Emotion influences human capabilities
- Each person is different

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

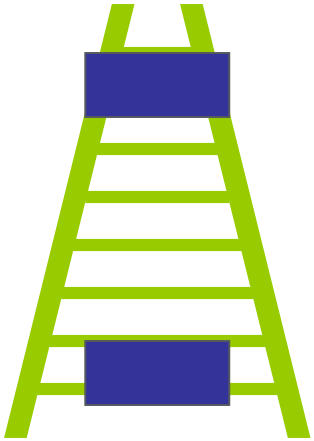
Interpreting the signal (cont)

- 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

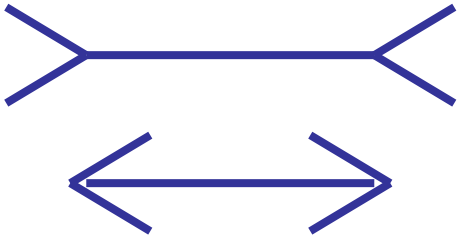
Interpreting the signal (cont)

- 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 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 (cont)

- Humans can hear frequencies from 20Hz to 15kHz
  - less accurate 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.

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.

Short-term memory (STM)

- Scratch-pad for temporary recall
  - rapid access ~ 70ms
  - rapid decay ~ 200ms
  - limited capacity - 7± 2 chunks

Examples

212348278493202

0121 414 2626

HEC ATR ANU PTH ETR EET

Long-term memory (LTM)

- Repository for all our knowledge
  - slow access ~ 1/10 second
  - slow decay, if any
  - huge or unlimited capacity

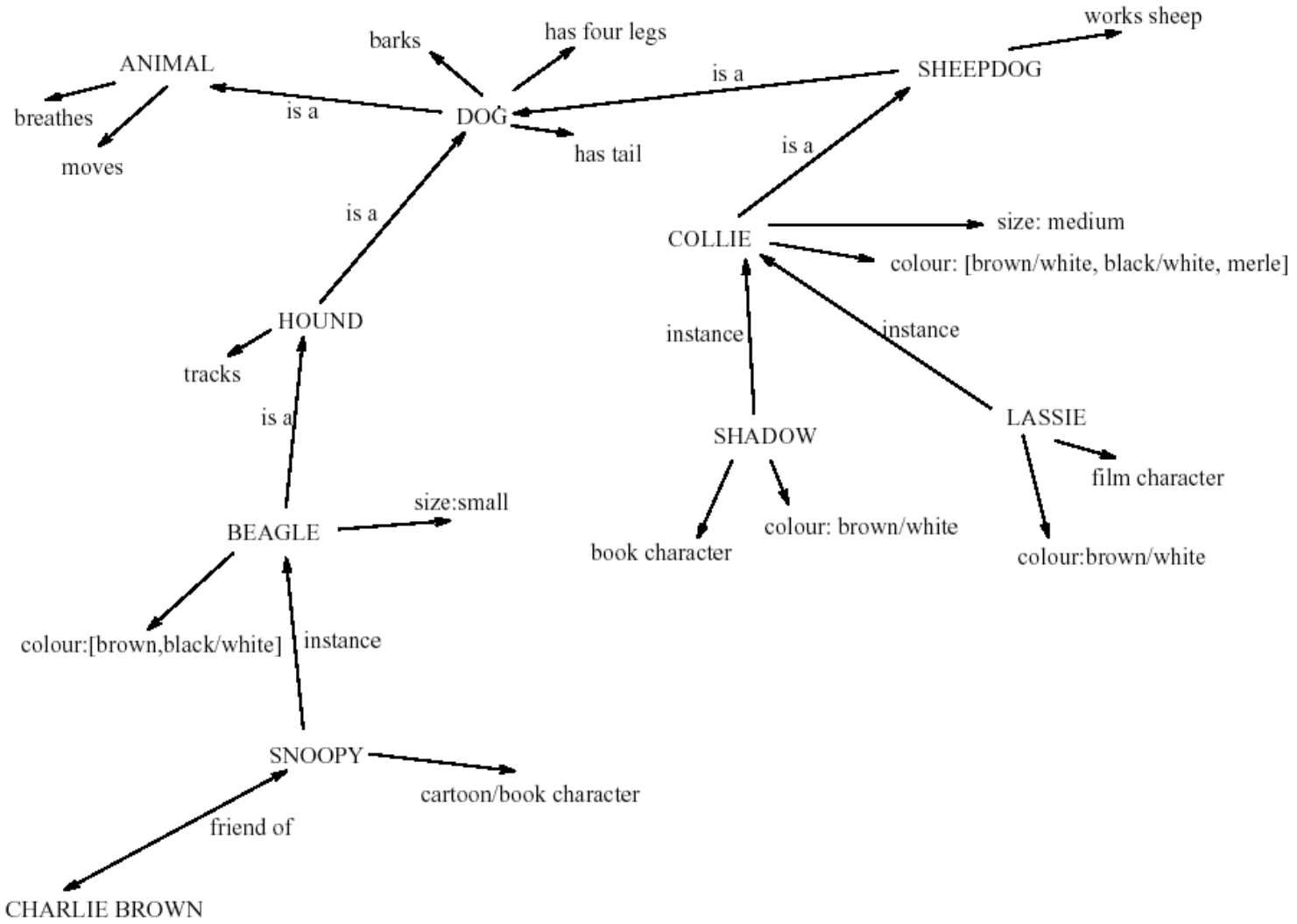
- Two types
  - episodic – serial memory of events
  - semantic – structured memory of facts,concepts, skills

  semantic LTM derived from episodic LTM

Long-term memory (cont.)

- 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 - Frames

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

DOG

Fixed
legs: 4

Default
diet: carniverous
sound: bark

Variable
size:
colour

COLLIE

Fixed
breed of: DOG
type: sheepdog

Default
size: 65 cm

Variable
colour

Models of LTM - Production rules

Representation of procedural knowledge.

Condition/action rules

if condition is matched

then use rule to determine action.

IF dog is wagging tail
THEN pat dog

IF dog is growling
THEN run away

LTM - Storage of information

- rehearsal
  - information moves from STM to LTM
- total time hypothesis
  - 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
- new information replaces old: retroactive interference
- old may interfere with new: proactive inhibition

so may not forget at all memory is selective …

… affected by emotion – can subconsciously `choose' to forget

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

LTM – Other than repetition

- However, repetition is not enough to learn information well. If information is
- not meaningful it is more difficult to remember. This is illustrated by the fact that it is more difficult to remember a set of words representing concepts than a set of
- words representing objects. Try it. First try to remember the words in list A and test yourself.

- List A: Faith Age Cold Tenet Quiet Logic Idea Value Past Large
- Now try list B.
- List B: Boat Tree Cat Child Rug Plate Church Gun Flame Head

Thinking

Reasoning

deduction, induction, abduction

Problem solving

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

Deduction (cont.)

- When truth and logical validity clash …

  e.g. Some people are babies
  Some babies cry
  Inference - Some people cry

  Correct?

- People bring world knowledge to bear

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 (cont.)

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 (cont.)

- 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 (cont.)

- 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 (cont.)

- 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
  - Gender, physical and intellectual abilities
- short term
  - effect of stress or fatigue
- changing
  - age

Ask yourself:
will design decision exclude section of user population?

Psychology and the Design of Interactive System

- Some direct applications
  - e.g. blue acuity is poor
    $\Rightarrow$ blue should not be used for important detail

- However, correct application generally requires understanding of context in psychology, and an understanding of particular experimental conditions

- A lot of knowledge has been distilled in
  - guidelines (chap 7)
  - cognitive models (chap 12)
  - experimental and analytic evaluation techniques (chap 9)