Human Computer Interactions

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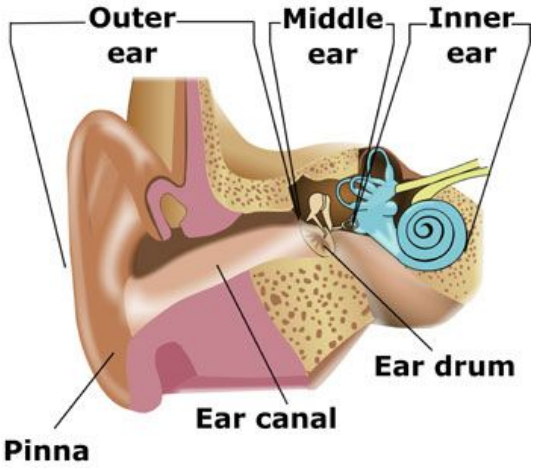
HEARING



- Provides information about environment:
  - Distances, objects, directions etc.

  Physical apparatus
  - Outer ear (pinna, auditory canal)

  Pinna: structure that is attached to the sides of the head

  Auditory canal: sound waves are passed to the middle ear, contains wax which prevents dust, dirt and over-inquisitive insects reaching the middle ear, maintains the middle ear at a constant temperature
  - Middle ear: ear drum, ossicles
  - Sound waves pass along the auditory canal and vibrate the ear drum which in turn vibrates the ossicles, which transmit the vibrations to the cochlea.
  - Inner ear : cochlea, transmitting sound waves via the ossicles the sound waves are concentrated and amplified.

  Sound
  - Pitch : sound frequency
  - Loudness : amplitude
  - Timbre : type of sound

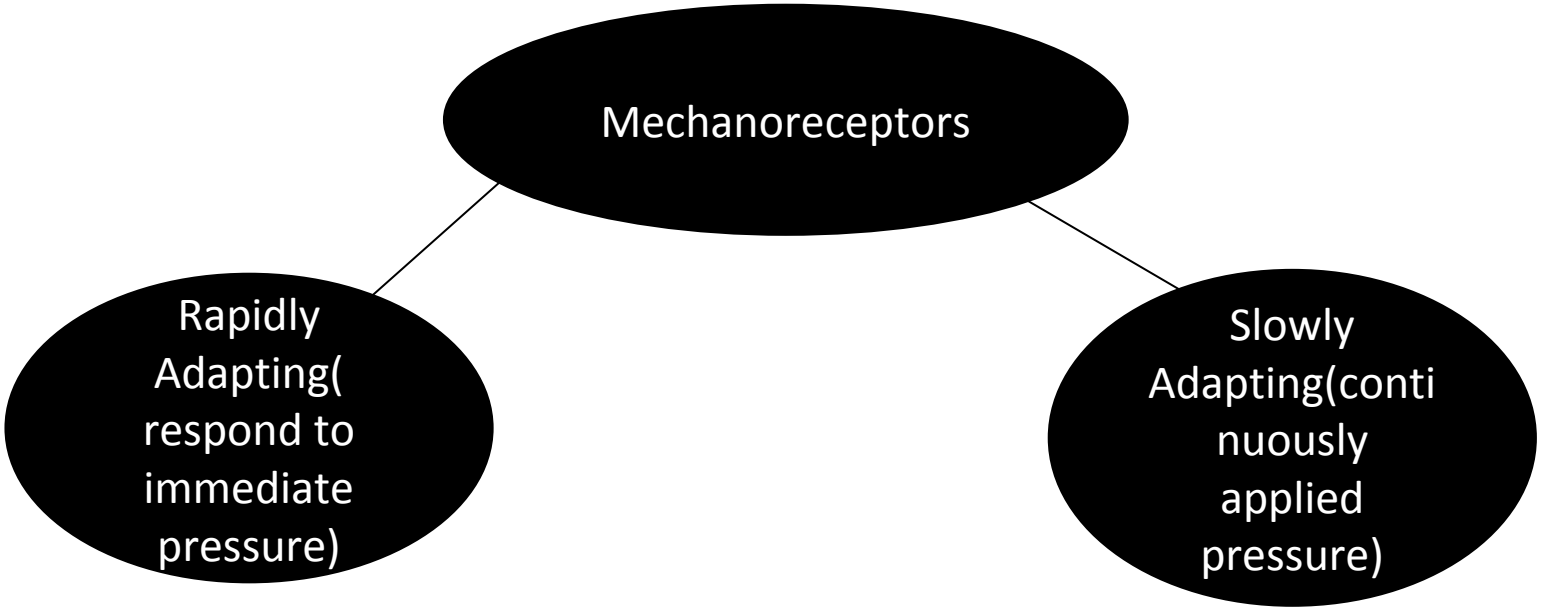
PROCESSING SOUND

- Human ear can hear frequencies from about 20 Hz to 15 kHz
- auditory system filters(ignore background noise and concentrate on important information)
- cocktail party effect (name spoken across a crowded noisy room)

TOUCH

- Information about environment
- Feeling buttons depress, feel its shape, the speed and accuracy of the action
- Primary source of information for impaired persons e.g braille
- sensory receptor: **thermoreceptors** respond to heat and cold, **nociceptors** respond to intense pressure, heat and pain, and **mechanoreceptors** respond to pressure.

TOUCH

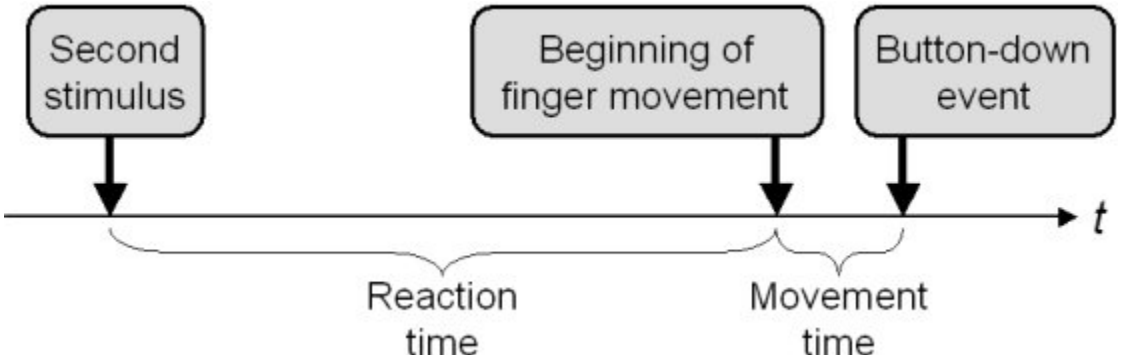

Mechanoreceptors
Rapidly Adapting(respond to immediate pressure)
Slowly Adapting(continuously applied pressure)

TOUCH

- kinesthesis: awareness of the position of the body and limbs.
- receptors in the joints.
- **Rapidly adapting**, which respond when a limb is moved in a particular direction
- **Slowly adapting**, which respond to both movement and static position
- **Positional receptors**, which only respond when a limb is in a static position
- Touch typist relative positions of the fingers and feedback from the keyboard are very important.

MOVEMENT

- Brain tells the appropriate muscles to respond
- Movement time is dependent largely on the physical characteristics of the subjects: their age and fitness
- Reaction time varies according to the sensory channel through which the stimulus is received.



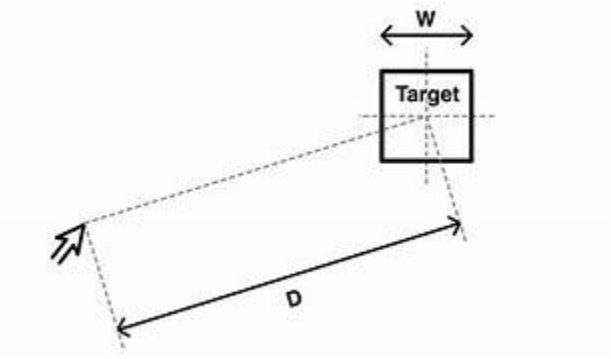
MOVEMENT

- Person can react to an **auditory signal 150 ms**, to a **visual signal in 200** ms and to **pain in 700 ms.**
- requiring increased reaction time reduces accuracy?
- Speed and accuracy of movement are important considerations in the design of interactive systems

FITT'S LAW

- The time taken to hit a target is a function of the size of the target and the distance that has to be moved

Movement time = a + b log2(distance/size + 1)



HUMAN MEMORY

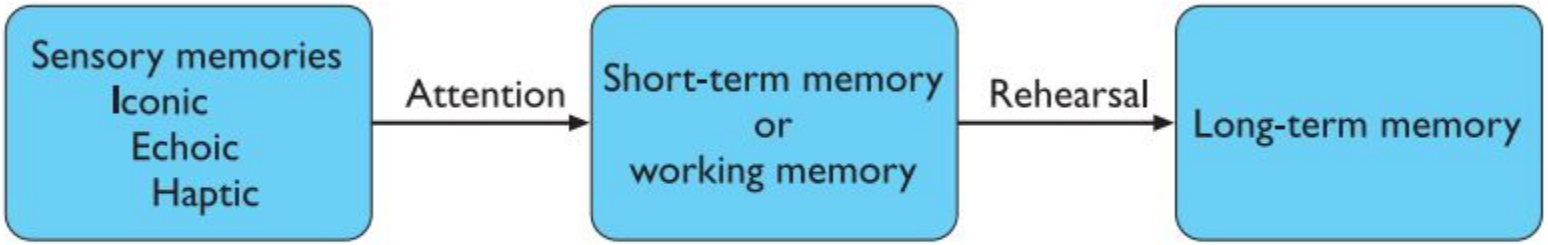
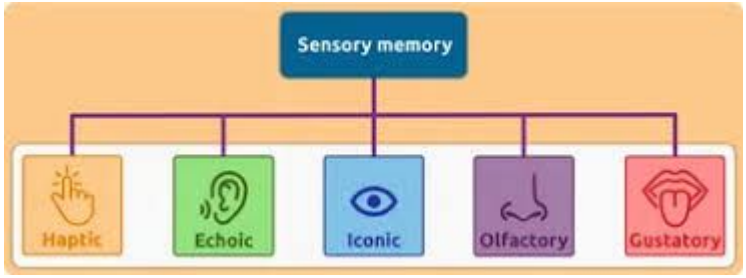


Figure 1.9 A model of the structure of memory

SENSORY MEMORY



- Iconic memory : information remain for 0.5 sec
- Echoic Memory : Allow brief play-back of information
- Attention is the concentration of the mind on one out of the competing thoughts.
- We can focus our attention successfully.

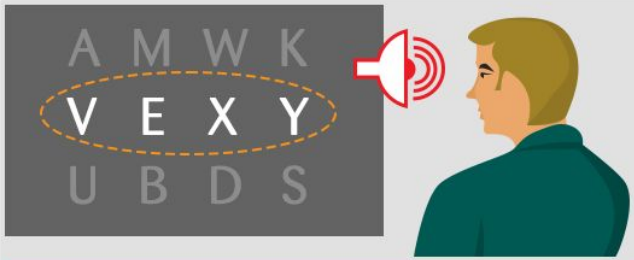
1

12 letters are flashed on the screen for 50 milliseconds.

2

Screen goes blank.

3



A tone is sounded within 250 milliseconds of the flash as a signal to recall letters from one of the rows.

4

Subject is able to recall 3 out of 4 letters from that row.

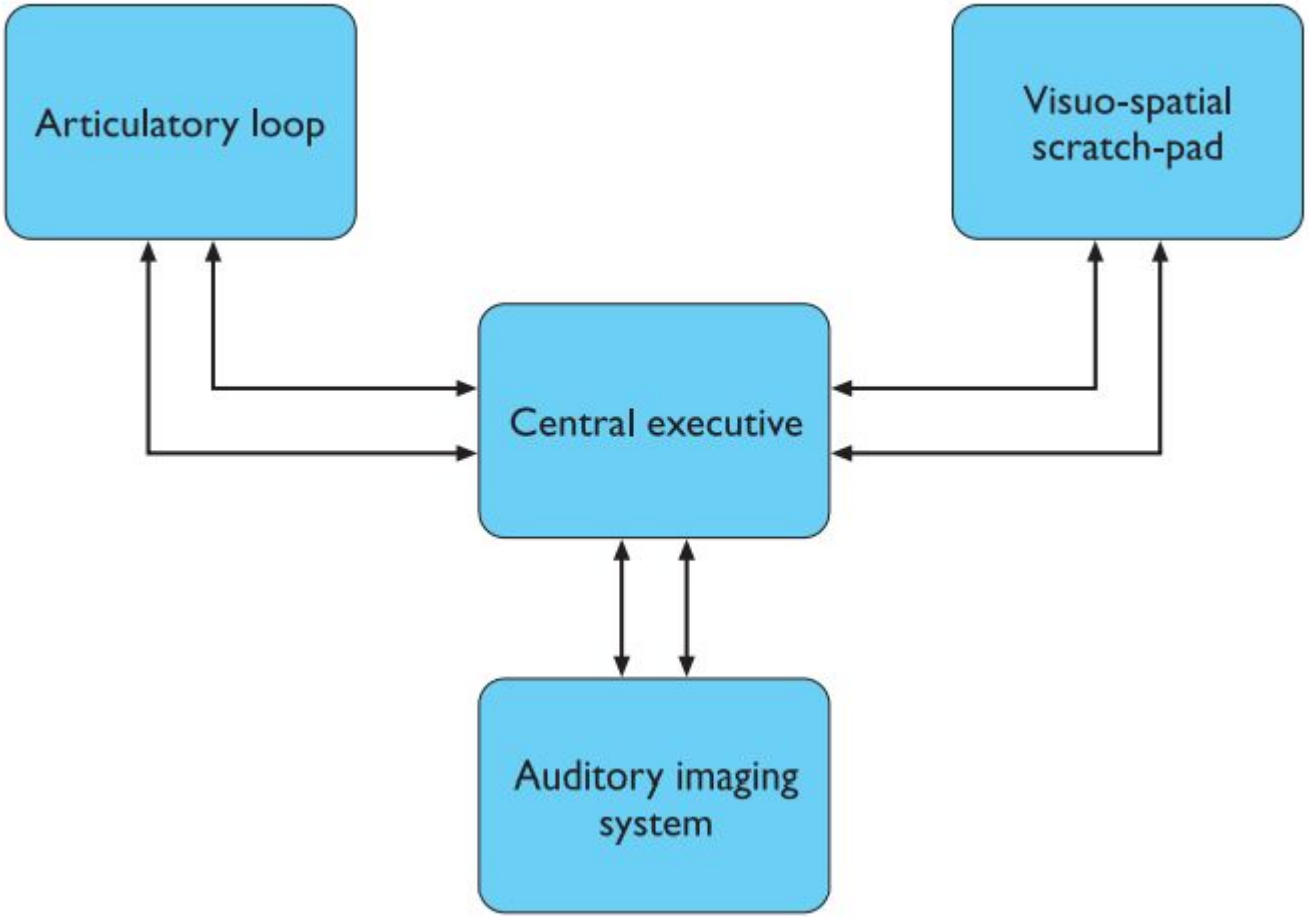
SHORT TERM MEMORY

- ‘scratch-pad’ for temporary recall of information, limited capacity E.g 35 X 6
- Short-term memory can be accessed rapidly, in the order of 70 ms
- decays rapidly, information is temporarily held , in the order of 200 ms.
- average person can remember 7 ± 2 digits
- Information in chunks can increase the capacity

SHORT TERM MEMORY

- HEC ATR ANU PTH ETR EET
- Recency effect: last words presented is better than recall of those in the middle
- short-term memory recall is damaged by interference of other information, not necessarily
- Interference occurs when same channel is utilized.

SHORT TERM MEMORY

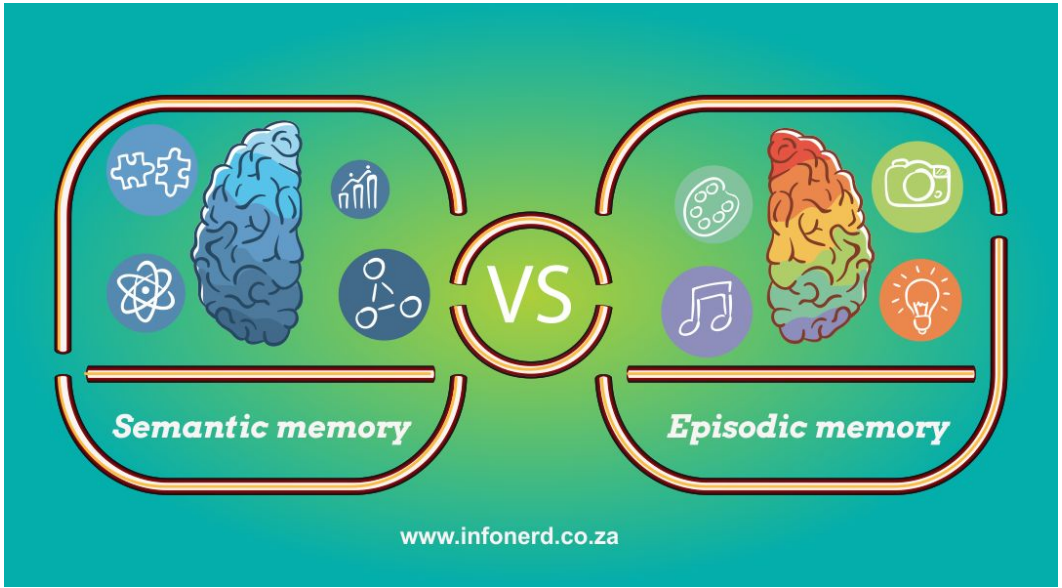


LONG TERM MEMORY

- Episodic memory and semantic memory
- Episodic memory represents our memory of events and experiences in a serial form.
- Reconstruct the actual events that took place at a given point in our lives

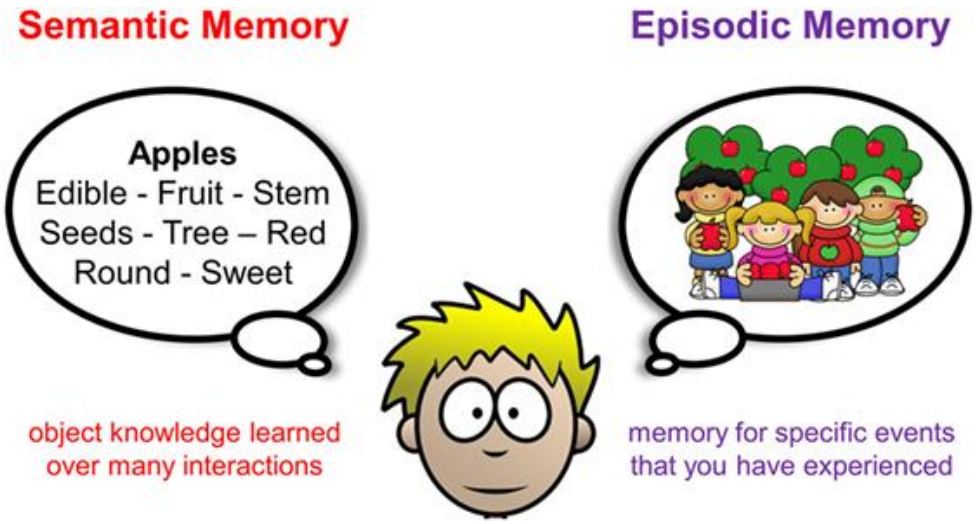
LONG TERM MEMORY

- Semantic memory is a structured record of facts, concepts and skills that we have acquired. Info derived from that in our episodic memory, such that we can learn new facts or concepts from our experiences.



LONG TERM MEMORY

Representation of relationships between pieces of information



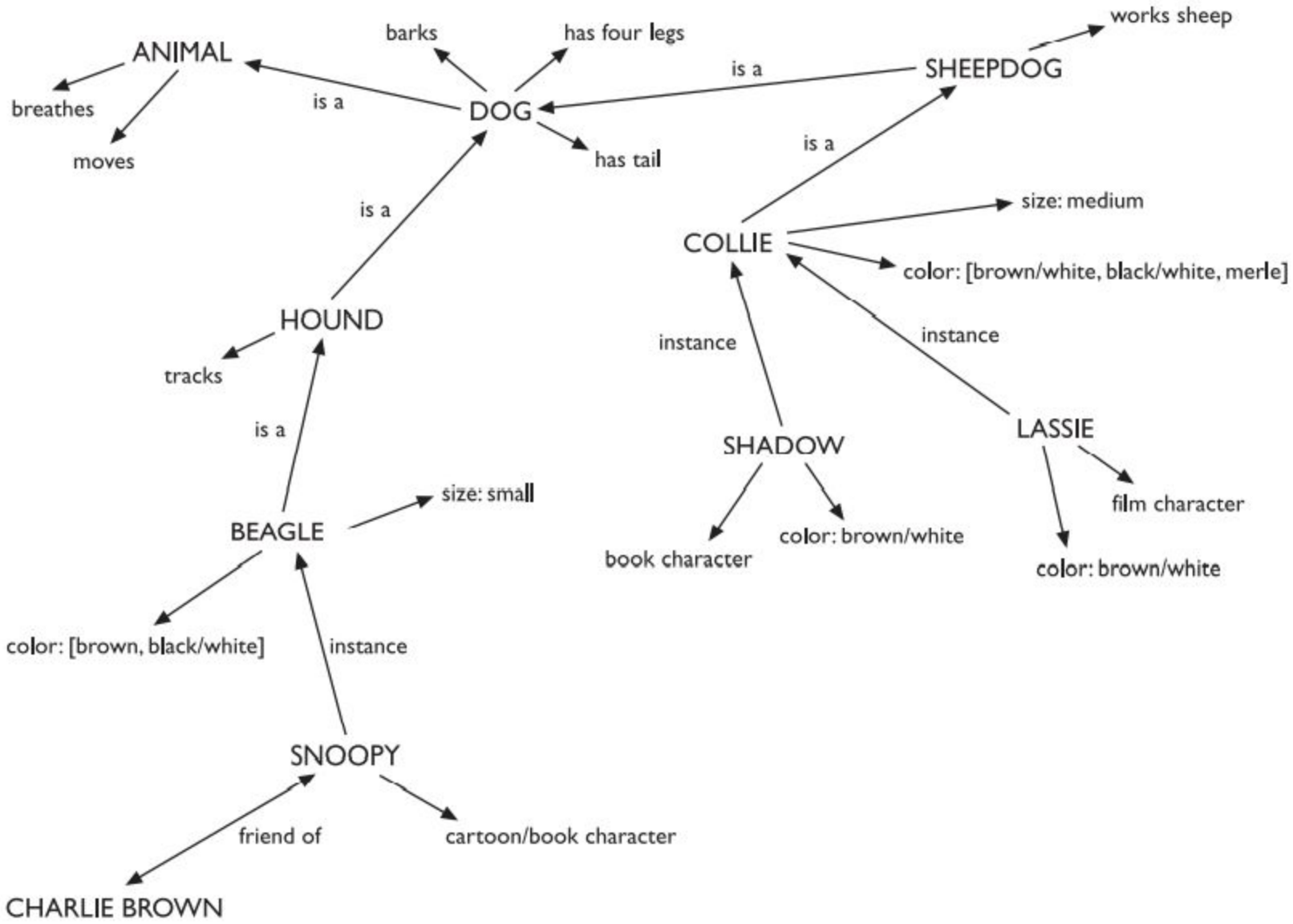
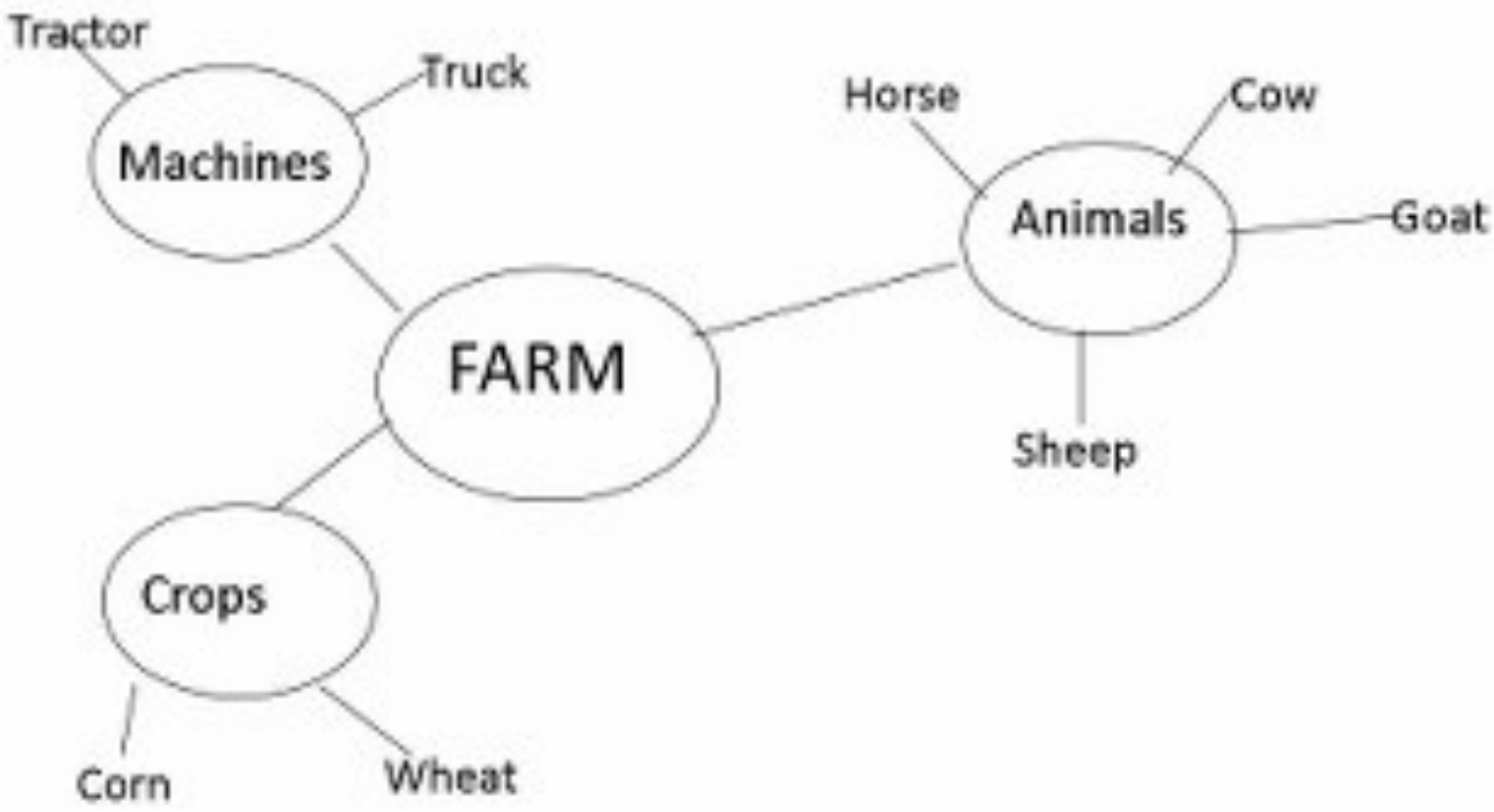


Figure 1.11 Long-term memory may store information in a semantic network


Tractor
Truck
Machines
Horse
Cow
Animals
Goat
FARM
Sheep
Crops
Corn
Wheat

LONG TERM MEMORY

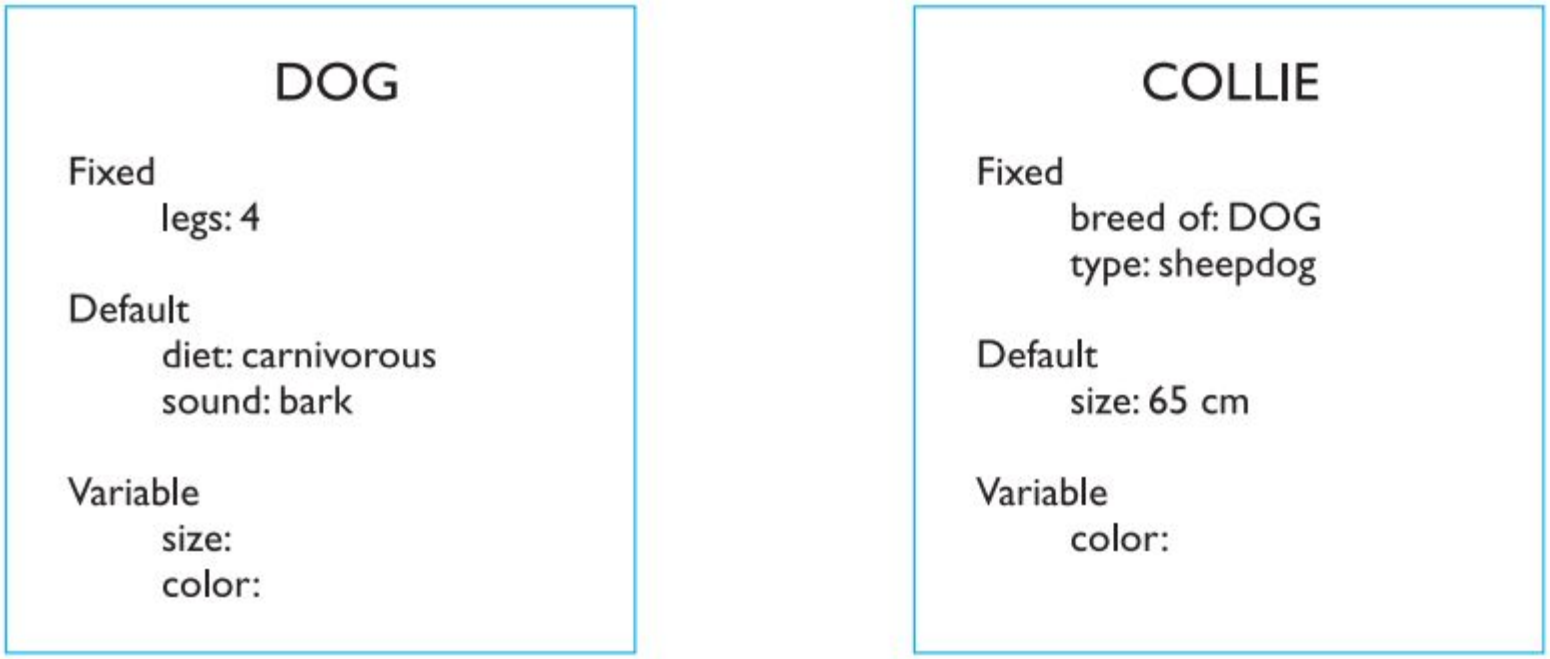


Figure 1.12 A frame-based representation of knowledge

LONG TERM MEMORY

- There are three main activities related to long-term memory: storage or remembering of information, forgetting and information retrieval
- Information from short-term memory is stored in long-term memory by rehearsal

LONG TERM MEMORY

- Total time hypothesis(Ebbinghaus)
  - learned was directly proportional to the amount of time spent learning
- Distribution of practice effect
  - Baddeley and others suggest that learning time is most effective if it is distributed over time

List A: Faith Age Cold Tenet Quiet Logic Idea Value Past Large

List B: Boat Tree Cat Child Rug Plate Church Gun Flame Head

LONG TERM MEMORY

- Sentences, objects, stories, concepts are easy to remember
- Theories of forgetting:
  - decay and interference
  - Jost's law states that if two memory traces are equally strong at a given time the older one will be more durable

LONG TERM MEMORY

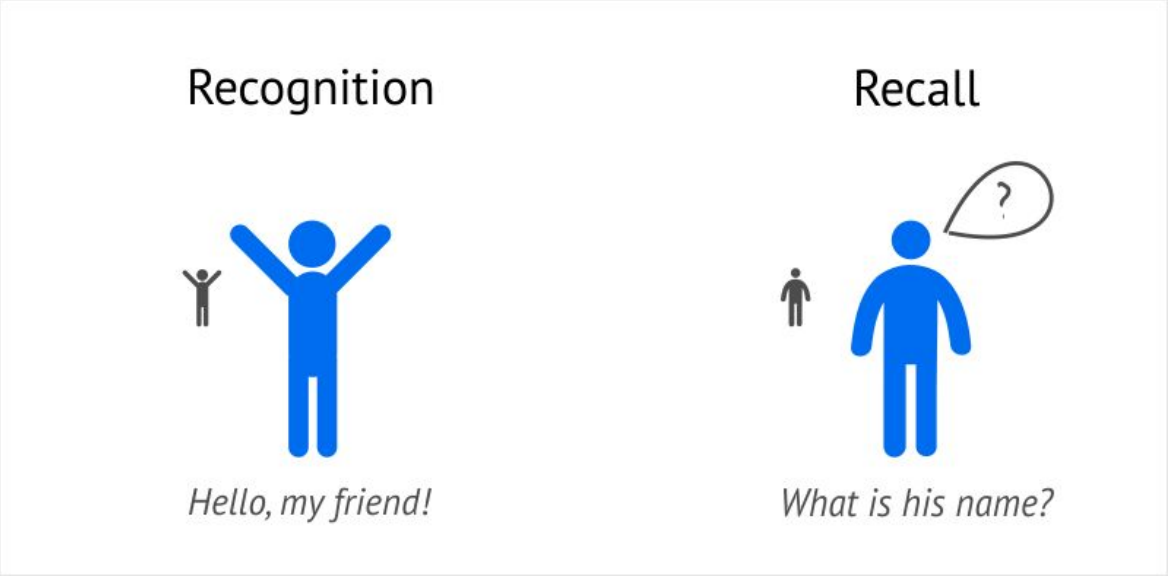
- Acquiring new information causes the loss of old information. New association masks the old. This is termed **retroactive interference (**memorizing old telephone number**)**
- Old memory trace breaks through and interferes with new information. This is called **proactive inhibition**. An example of this is when you find yourself driving to your old house rather than your new one.
- Human beings easily remember positive information rather than negative

LONG TERM MEMORY

- Leads us to information retrieval
  - proactive inhibition demonstrates the recovery of old information even after it has been ‘lost’ by interference
  - ‘tip of the tongue’ experience
  - information may not be recalled but may be recognized

LONG TERM MEMORY

- Recall: information is reproduced from memory.
- Recognition: presentation of the information provides the knowledge that the information has been seen before. It is less complex.




OH MY GOD, I LOVE THIS ALBUM! I KNOW EVERY WORD OF EVERY SONG! AS A MATTER OF FACT, I HAVE THE ACTUAL RECORD IN THE OTHER ROOM! LEMME GO GRAB IT!
WAIT– WHAT THE HELL DID I COME IN HERE FOR?

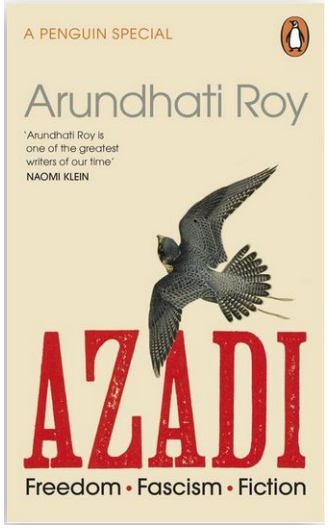
REASONING

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

Deductive Reasoning

- Deductive reasoning, also deductive logic, is the process of reasoning from one or more statements (premises) to reach a logical conclusion.

- Example: Arundhati Roy wrote only in English. These essays are by Arundhati Roy. Therefore, they are written in English.



Deductive Reasoning - Structure

Example: Arundhati Roy wrote only in English. These essays are by Arundhati Roy. Therefore, they are written in English.

Premises:

1. Arundhati Roy wrote only in English.
2. This essay is by Arundhati Roy.

Conclusion:

Therefore, they are written in English.

Deductive Reasoning – Worked Example #1

- Pick a number. Multiply the number by 8, add 6 to the product, divide the sum by 2, and subtract 3.

- Use deductive reasoning to show that we always get a number that is four times the original.

Deductive Reasoning – Worked Example #1

Pick a number. Multiply the number by 8, add 6 to the product, divide the sum by 2, and subtract 3.

Use deductive reasoning to show that we always get a number that is four times the original.

Let n represent the original number

Notice that we are not picking a specific number like 17 or 356 or a billion.

Instead we are using a letter to represent or stand for ***any*** positive counting number. This is called a variable.

Now, let's apply the procedure to our variable n:

Multiply the number by 8: $8n$

Add 6 to the product: $8n + 6$

Divide the sum by 2: $(8n+6) / 2 = 4n + 3$

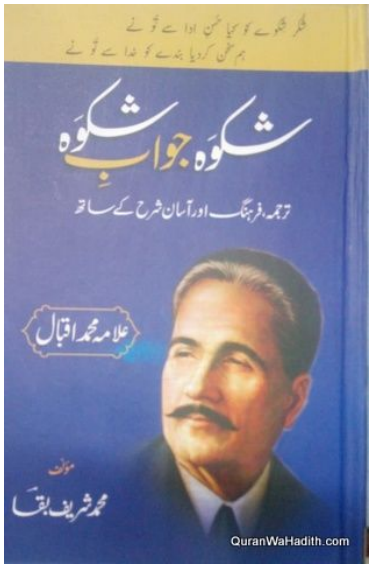
Subtract 3: $4n + 3 – 3 = 4n$

Conclusion: the final number is always 4 times the original number, regardless of which number we choose.

Inductive Reasoning

- The process of reaching a general conclusion by examining specific examples

- Example: My friend likes to read poetry by Iqbal, so I'm sure she'll love shikwa jawab e shikwa as well.



Inductive Reasoning – Worked Example #1

- Use inductive reasoning to predict the most probable next number in each of the following lists.

a. 3,6,9,12,15,?

b. 1,3,6,10,15, 21,?

"Forming a Conjecture by inductive reasoning"

Inductive Reasoning – Worked Example #2

- Pick a number. Multiply the number by 8, add 6 to the product, divide the sum by 2, and subtract 3.

- Complete the procedure for several different numbers.

- Use inductive reasoning to *make a conjecture* about the *relationship* between:
  - the size of the resulting number, and,
  - the size of the original number.

Inductive Reasoning – Worked Example #2

- Pick a number. Multiply the number by 8, add 6 to the product, divide the sum by 2, and subtract 3.

2 --> 8

5 --> 20

7 --> 28

10--> 40

15 --> 60

- Complete the procedure for several different numbers.

- Use inductive reasoning to *make a conjecture* about the *relationship* between:
  - the size of the resulting number, and,
  - the size of the original number.

Inductive vs Deductive Reasoning

Inductive reasoning

- Look for patterns
- Go from specific examples to a general conclusion
- Not conclusive, not a reliable method of finding proofs as counterexamples may exist

deductive reasoning

- Find a structure
- Proceed from general premises to specific conclusions
- Follows the rules of deductive logic
- Reliable method of finding proofs

Inductive or Deductive ?

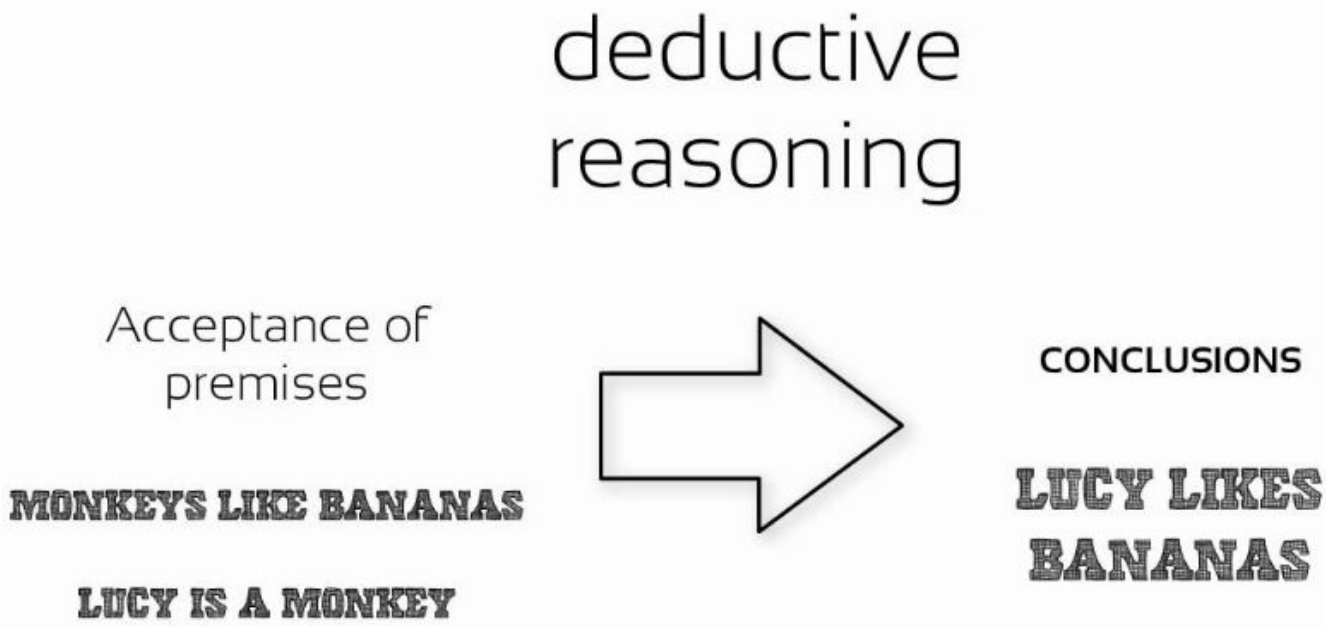
- During the past 10 years, a tree has produced plums every other year. Last year the tree did not produce plums, so this year the tree will produce plums.

- All home improvements cost more than the estimate. The contractor estimated my home improvement will cost $35,000. Thus my home improvement will cost more than $35,000.

DEDUCTIVE REASONING

- Deductive reasoning derives the logically necessary conclusion from the given premises.
- A premise is a statement in an argument that provides reason or support for the conclusion.

DEDUCTIVE REASONING



INVALID DEDUCTIVE REASONING

- All swans are white. Jane is white. Therefore, Jane is a swan.
- All farmers like burgers. Jethro likes chicken wings. Therefore, Jethro is not a farmer.

INDUCTIVE REASONING

- Inductive reasoning begins with observations that are specific and limited in scope, and proceeds to a generalized conclusion that is likely, but not certain, in light of accumul evidence
- Induction is generalizing from cases we h seen to infer information about cases we have not seen.

INDUCTIVE REASONING

- For example, if every elephant we have ever seen has a trunk, we infer that all elephants have trunks. Of course, this inference is unreliable and cannot be proved to be true; it can only be proved to be false.
- No amount of inductive evidence guarantees the conclusion
- There is no way to know that all the possible evidence has been gathered, and that there exists no further bit of unobserved evidence that might invalidate my hypothesis

PROBLEM SOLVING

- Problem solving is the process of finding a solution to an unfamiliar task, using the knowledge we have.

Overlaps

How many times a day do a clock's hands (hour and minute hands only) overlap?

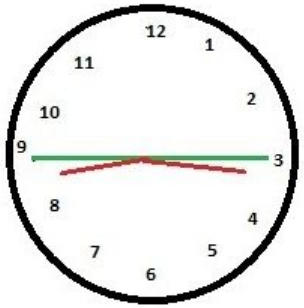
Answer: 22 times

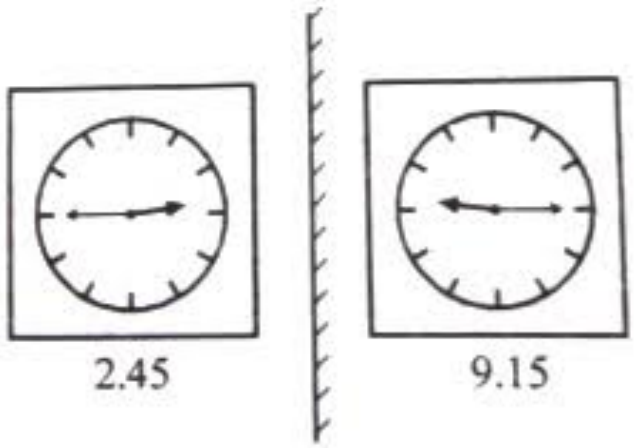
AM	PM
12:00 1:05 2:11 3:16 4:22 5:27 6:33 7:38 8:44 9:49 10:55	12:00 1:05 2:11 3:16 4:22 5:27 6:33 7:38 8:44 9:49 10:55

Mirror image

A clock seen through a mirror reads a quarter to nine. What is the actual time?

Answer





Measure water

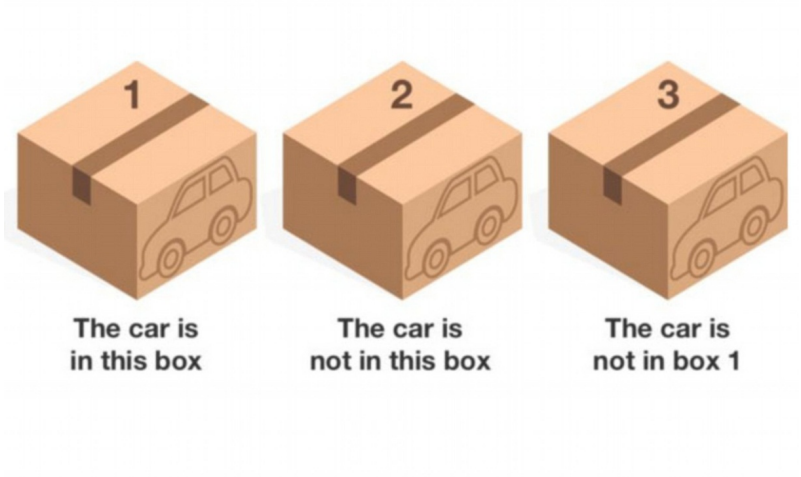
You have unlimited access to water and two jars: 5 L and 3 L. Measure 4 liters precisely

Answer

- Fill the 5-liter jar with water, and use it to fill the 3-liter jar. Then empty the 3 liter jar. Now you have 2 liters left in 5-liter jar. take the 5-liter jar, and pour the remaining 2 liters into the 3-liter jar. Then fill the 5-liter jar again, and pour the water (1 liter) into the 3-liter jar until you fill it.
- Thus, you'll get 4 liters of water in the 5-liter jar

Car in the box

There are 3 boxes. One of them has a toy car that you get to keep. On each box there is a statement. You know that only one of the statements is true. Which box has the car?



Answer: Box # 2

If Box 1 then :

Statement of Box 1 true

Statement of Box 2 true

Statement of Box 3 false

If box 3 :

Statement of Box 1 false

Statement of Box 2 true

Statement of Box 3 true

Numbers

A detective who was mere days away from cracking an international oil smuggling ring has suddenly gone missing. While inspecting his last known location, officers find a note: 710 57735 34 5508 51 7718.

Currently there are three suspects: Bill, John, and Todd. Can you break detective's code and the criminal's name?

Answer: Bill

Bill is the suspect, if read upside down the numbers read:

Rich people

A man is found murdered on a Sunday morning. His wife calls the police, who question the wife and the staff. The wife says she was sleeping, the butler was cleaning the closet, the gardener was picking vegetables, the driver went to bank for paying electricity bill. The cook was preparing breakfast. Immediately, the police arrested the murderer. Who did it and how did the police know?

Answer: Driver

Banks remain closed on Sundays.

XYZ

A car's number plate contains three digits XYZ whose product is 32.

With the following information can you identify the complete number:

- the first and the last digits are same
- the middle digit is the largest of all

Answer

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Problem Solving Class Activity

- Lets play games
  - Sudoku
  - Dots & Boxes

Skill acquisition

- Much of the time, the problems that we face are not completely new

EMOTIONS

- “Are all those feelings that so change men as to affect their judgements, and that are also attended by pain or pleasure. Such are anger pity, fear and the like, with their opposites”
  wrote Aristotle
- Positive emotions enable us to think more creatively, to solve complex problems, whereas negative emotion pushes us into narrow, focused thinking. A problem that may be easy to solve when we are relaxed, will become difficult if we are frustrated or afraid.

- Design considers the needs, particular limits and capabilities, workflow, and functional conceptualization (“mental model”) of the intended user. Cognitive functions, such as attention, memory, information processing, appreciation, Perception**,** Memory, Visual Acuity, Foveal and Peripheral Vision, Information Processing, problem solving, movement, Emotions.

PRACTICE QUESTIONS

- Devise experiments to test the properties of (i) short-term memory (ii) long term memory, using the experiments
- Consider any shopping website. List down features in the website that are designed to reduce long term memory load for the user.
- As we know “recognition is easy then recall” how you can utilize this statement when designing an interface.
- You are a UI designer. And you have studied and you know strengths and weaknesses of human cognitive and perceptual processes. Think about challenges from HCI perspective you may face.

PRACTICE QUESTIONS

List issues w.r.t Human perspective

Screen-based challenges	Affordance of screens
	Tactile user feedback
User-based challenges	Ergonomics
	Individual differences
	Accessibility
Input-based challenges	Gestures and patterns
	Supporting data input
	Multi-user support