8)

# Important Question and Numerical Questions (with solutions)

## ① Predicate Logic

convert English to FOL

① Every gardener likes the sun.

$\forall x \quad gardener(x) \rightarrow likes(x, sun)$

② you can fool some of the people all of the time.

$\exists x \quad person(x) \wedge \forall t \; (time(t) \rightarrow canfool(x,t))$

③ All purple mushrooms are poisnous.

$\forall x \quad mushroom(x) \vee purple(x) \rightarrow poisnous(x)$

④ No purple mushroom is poisnous.

$\forall x \quad mushroom(x) \wedge mushroom(x) \wedge poisnous(x)$

⑤ There are exactly two purple mushrooms.

$\exists x \exists y \quad mushroom(x) \wedge purple(x) \wedge mushroom(y) \wedge purple(y)$

⑥ Deb is not tall

$\neg tall(Deb)$

(14) Alison eats everything that she likes

$\forall x$ ( likes (alison, x) $\rightarrow$ eats (alison, x

(15) There exist some bird that doesn't fly

$\exists x$ bird (x) $\wedge \neg$ flies (x)

(16) Every person has something that they love

$\forall x$ person(x) $\rightarrow \exists y$ (loves (x, y)

(17) Every apple is either green or yellow

$\forall x$ (A(x) $\rightarrow$ G(x) $\vee$ Y(x))

(18) No apple is blue

$\neg \exists x$ (A(x) $\wedge$ B(x))

(19) All apples are not blue

$\forall(x)$ (A(x) $\rightarrow \neg$ B(x))

(7) John likes all kind of food

$\forall x$ : food (x) $\rightarrow$ likes (John, x)

(8) Apple and vegetable are food

food (Apple) $\wedge$ food (vegetables)

(9) anything anyone eats and not killed is food

$\forall x \forall y$ : eats (x, y) $\wedge \neg$ killed (x) $\rightarrow$ food (y)

(10) Anil eat peanuts and still alive

eats (Anil, peanuts) $\wedge$ alive (anil)

(11) Harry eats everything that anil eats

$\forall x$ : eats (Anil, x) $\rightarrow$ eats (Harry, x)

(12) If alison is friends with Richard then alison likes Richard

friends (alison, richard) $\rightarrow$ likes (alison, richard)

(13) Alison likes Richard or Alison likes chocolate

likes (alison, richard) $\vee$ likes (alison, chocolate)

8) Every ... yellow ... A(x) ⇒

(1) What is a script? Construct a script for going to bank for withdrawing money (class notes)

(2) Describe basic concepts of control system, feedback components, actuators and power transmission systems used in robots.

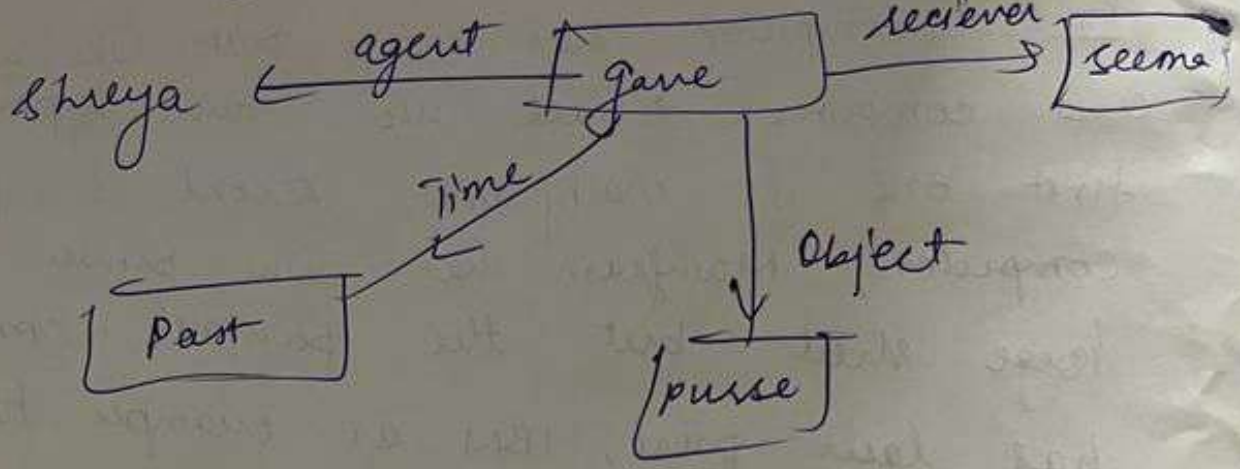
(3) Discuss expert system in domain of medicine using suitable case study. (class notes) Explain its architecture describing its components.

(4) What is conceptual dependency? Give conceptual dependency representation for (class notes)
a). I gave book to Ram.
b). Joe pushed the door.

5). Write a script for a customer going to bank to withdraw some money from his saving account. (class notes) Consider following as component of the script:

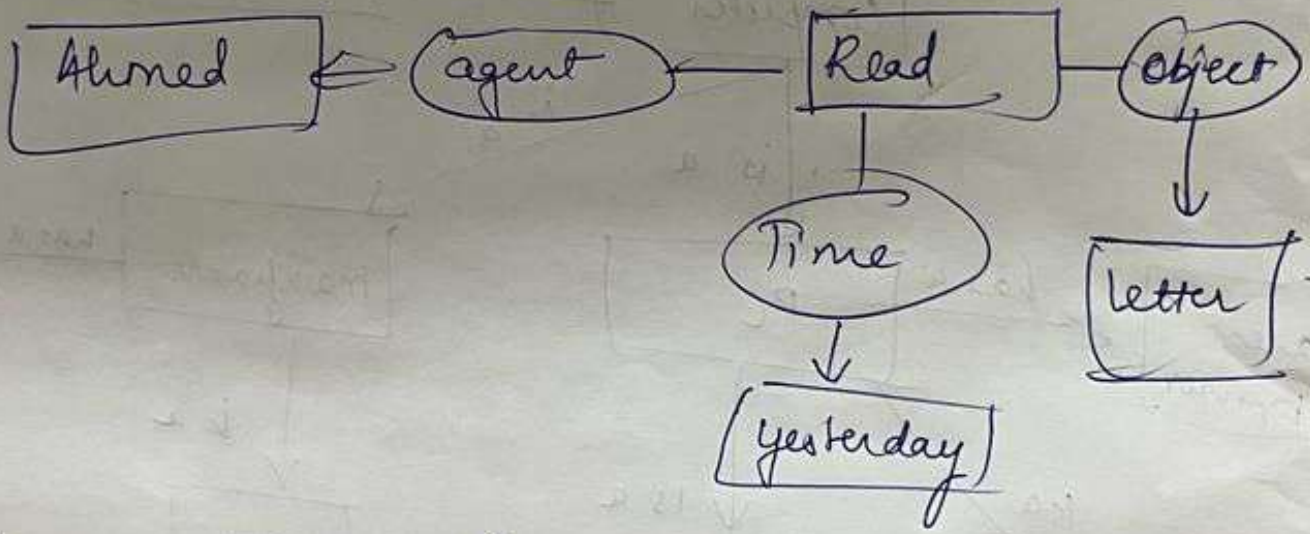
Pros: money, counter, form, token
Roles: P = customer, E - employee, C = cashier
Entry condition: 1) P has more or less money
2) Bank is open
Result: P has more money.

Ex ② Shreya gave purse to Seema

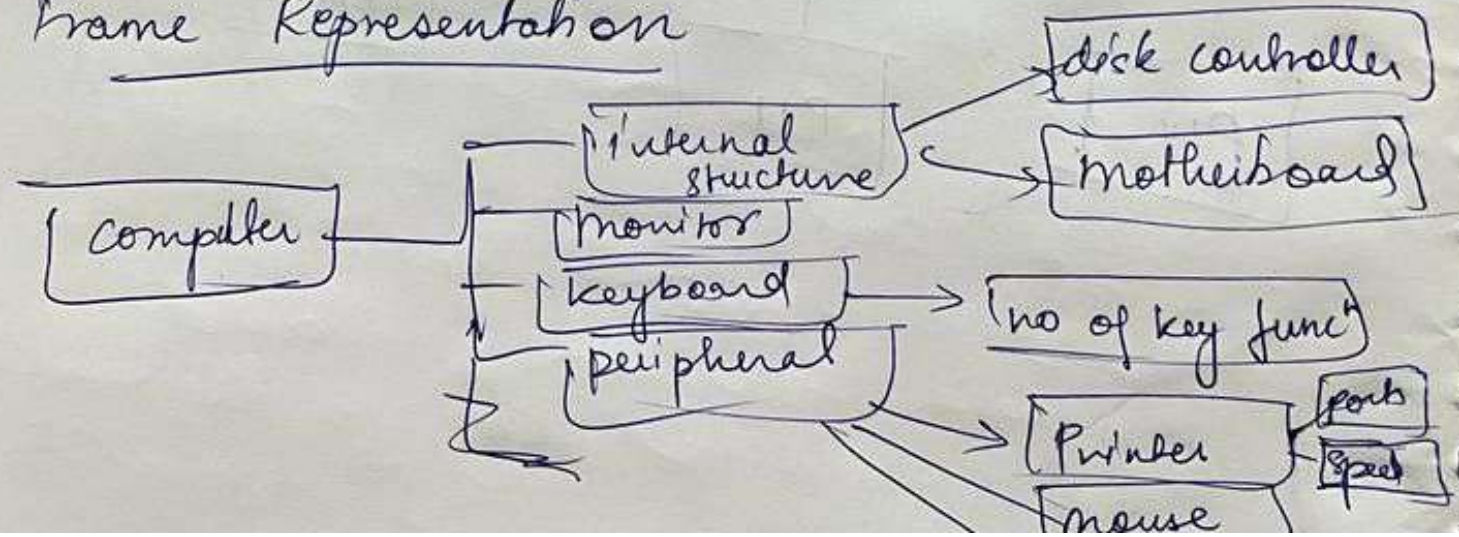



## conceptual graph

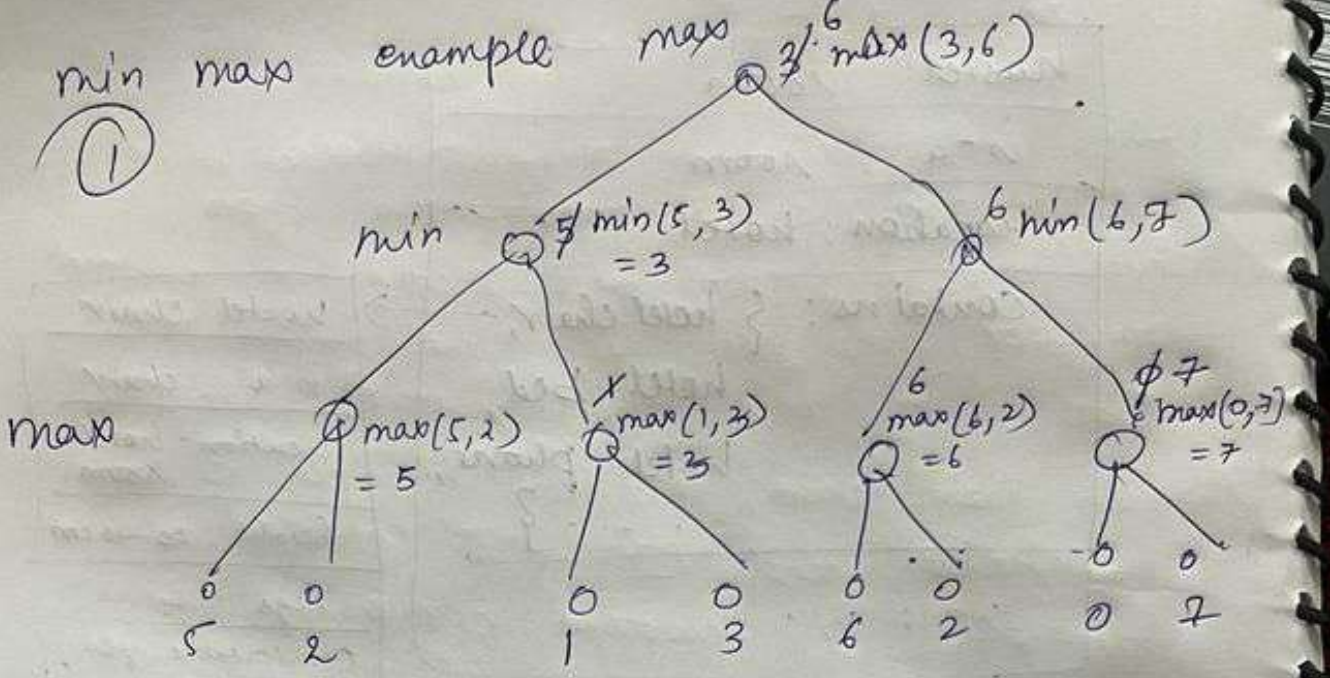
Ex ① Ahmed read a letter yesterday

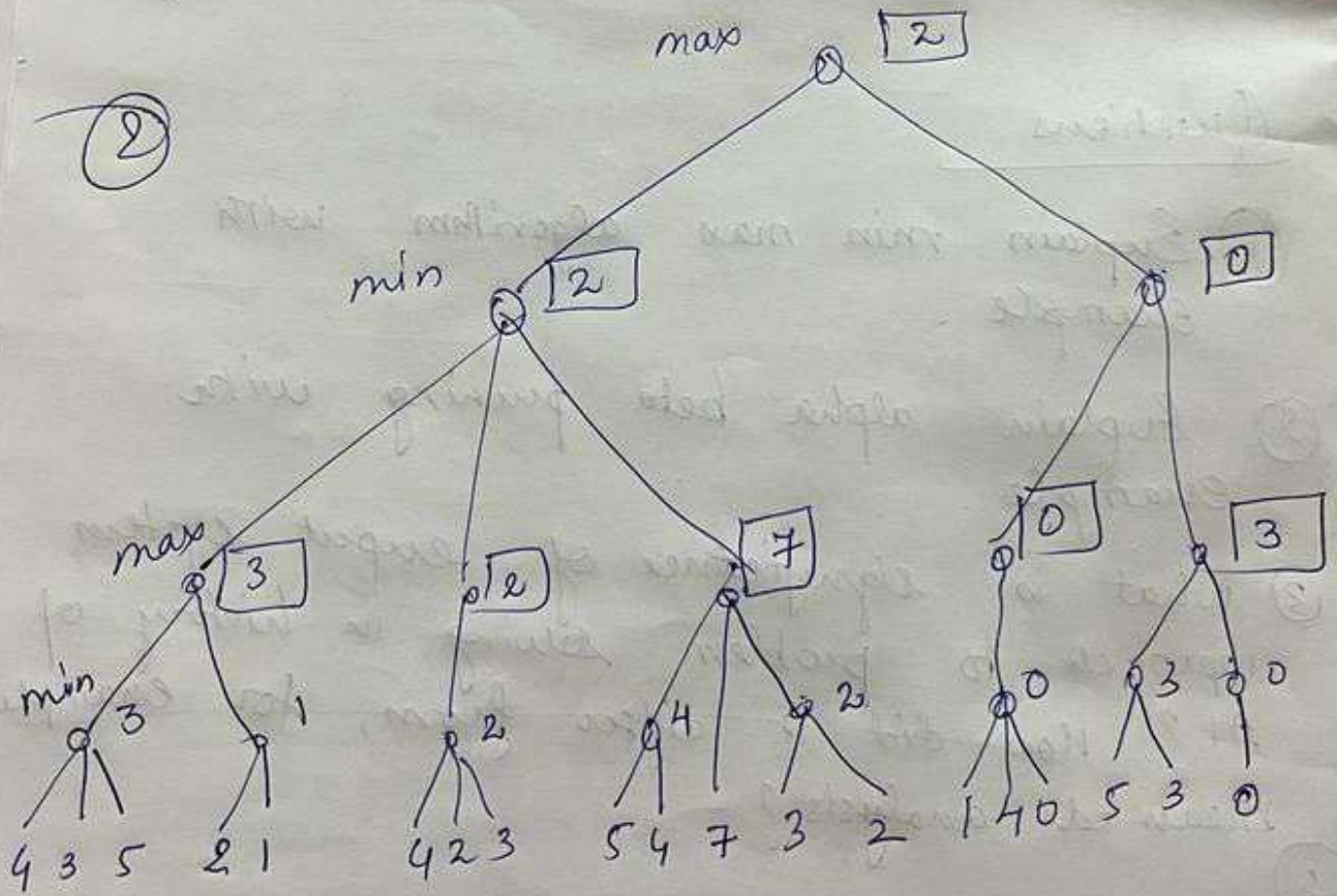



## Frame Representation



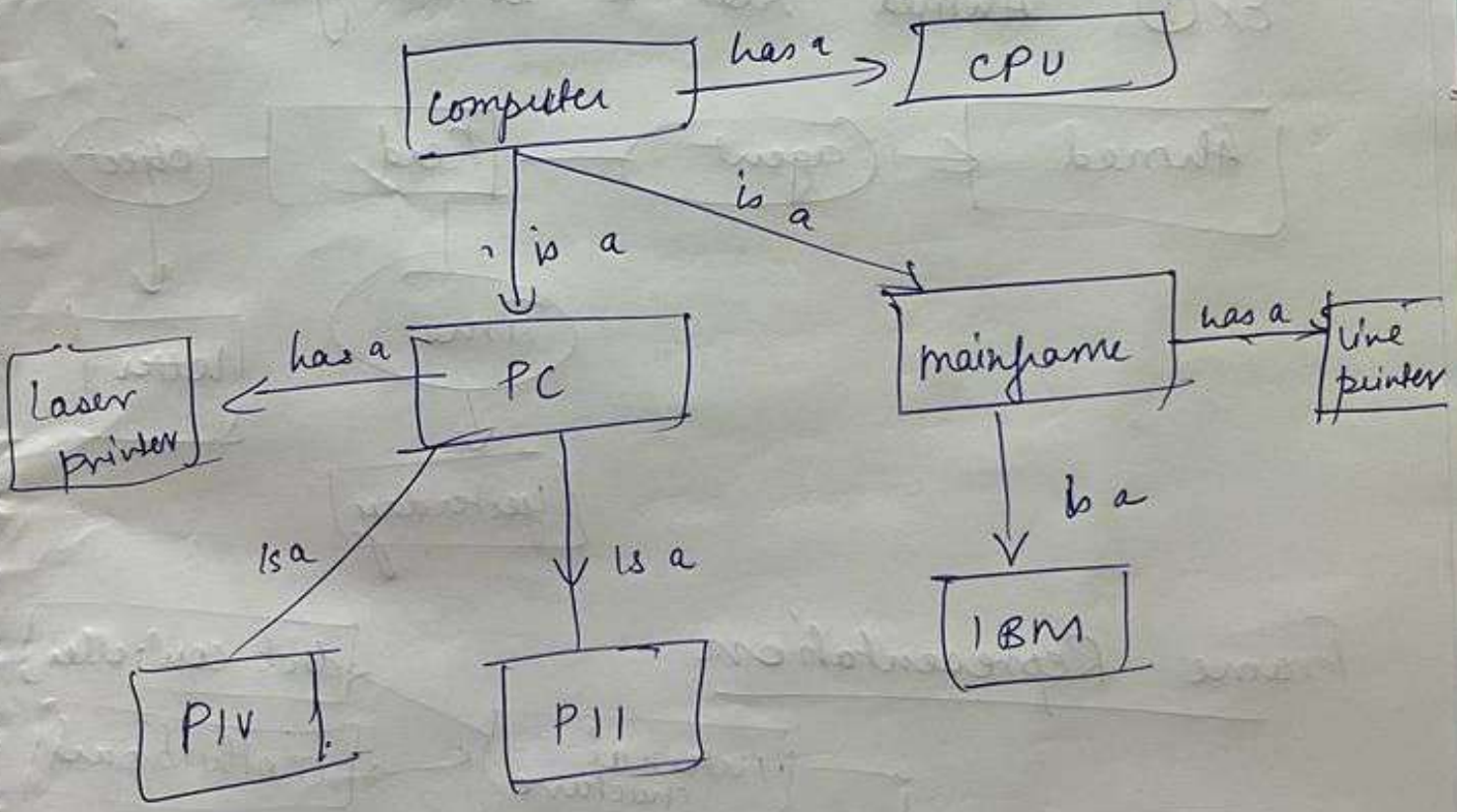
min max example



# Semantic Net

Sol: Computer has many parts like a CPU and computer divided into two types, first one is mainframe, second is personal computer, Mainfram has line printer with large sheet but the personal computer has laser print, IBM as example to the mainframe and PIII and PIV as a example to personal comp.



6). There is a monkey at the door in a room. In the middle of room a bunch of banana is hanging from the ceiling. The money is hungry and wants to get the banana, but the cannot stretch high enough from the floor. At the window of the room there is a box. Represent the information used in the above mentioned problem in predicate logic.

8) Every apple yellow ∀(x) ⇒ G...

Question is
Can monkey get the banana?
the initial state can be determined by

1. Monkey is at door
2. Monkey is on floor
3. Box is at window
4. Monkey does not have banana

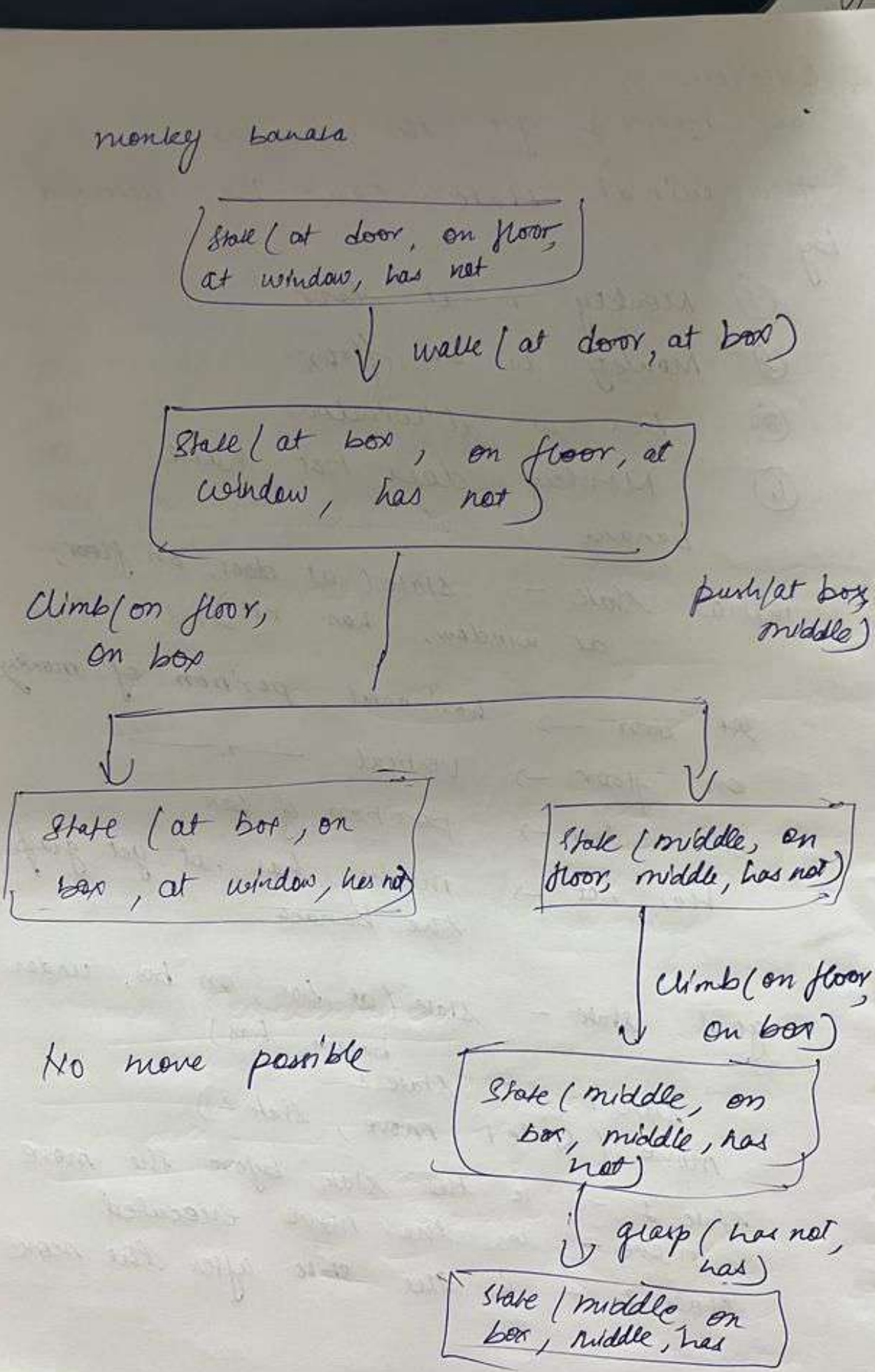
Initial state - state ( at door, on floor, at window, has not)

at door → horizontal position of monkey
on floor → vertical ——"——
at window → position of box
Ha not → monkey has not yet grasp the banana.

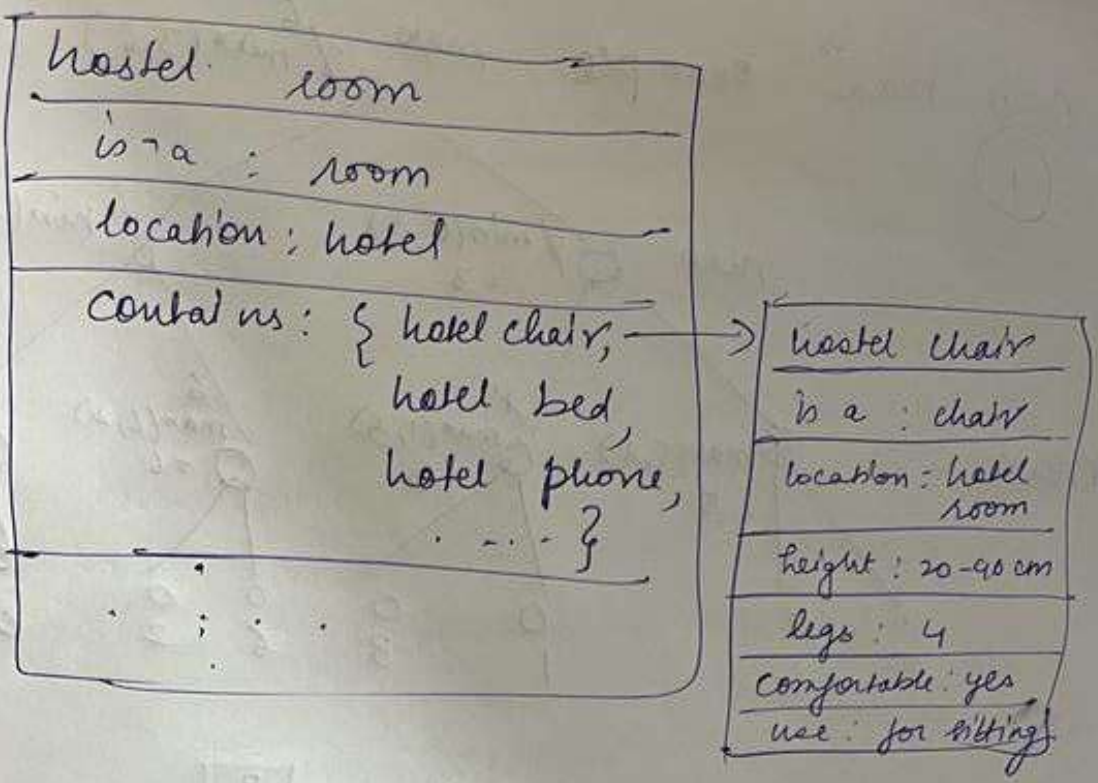
goal state - state (at box, on box, under banana, has)

state 1 → state 2
move (state 1, move, state 2)
state 1 - is the state before the move.
move - is the move executed
state 2 - is the state after the move

monkey banana



## frame




## Questions

(1) Explain min max algorithm with example.

(2) Explain alpha beta pruning with example.

(3) what is significance of expert system approach to problem solving in history of AI? ~~How did it differ from, for example means-ends analysis?~~

(4) what are heuristics and what is their importance. Describe their type with help of examples. Also justify "Heuristics are not sure to lead to a sol yet the field of AI is full of them".

# 1. Logical Representation

Logical representation is a language with some concrete rules which deals with propositions and has no ambiguity in representation. Logical representation means drawing a conclusion based on various conditions. This representation lays down some important communication rules. It consists of precisely defined syntax and semantics which supports the sound inference. Each sentence can be translated into logics using syntax and semantics.

logic → procedures → reasoning process

## Syntax:

I/P → O/P (conclusion)

- Syntaxes are the rules which decide how we can construct legal sentences in the logic.
- It determines which symbol we can use in knowledge representation.
- How to write those symbols.

## Semantics:

- Semantics are the rules by which we can interpret the sentence in the logic.
- Semantic also involves assigning a meaning to each sentence.

Logical representation can be categorised into mainly two logics:

a. Propositional Logics → simplest form of logic → statement → proposition (true or false) 1 or 0

b. Predicate logics

Note: We will discuss Prepositional Logics and Predicate logics in later chapters.

## Advantages of logical representation:

1. Logical representation enables us to do logical reasoning.
2. Logical representation is the basis for the programming languages.

## Disadvantages of logical Representation:

1. Logical representations have some restrictions and are challenging to work with.
2. Logical representation technique may not be very natural, and inference may not be so efficient.

Note: Do not be confused with logical representation and logical reasoning as logical representation is a representation language and reasoning is a process of thinking logically.

## 2. Semantic Network Representation

Semantic networks are alternative of predicate logic for knowledge representation. In Semantic networks, we can represent our knowledge in the form of graphical networks. This network consists of nodes representing objects and arcs which describe the relationship between those objects. Semantic networks can categorize the object in different forms and can also link those objects. Semantic networks are easy to understand and can be easily extended.

graphical representation of knowledge. nodes - object arc - relationship.

This representation consist of mainly two types of relations

a. IS-A relation (Inheritance)
b. Kind-of-relation

**Example:** Following are some statements which we need to represent in the form of nodes and arcs.

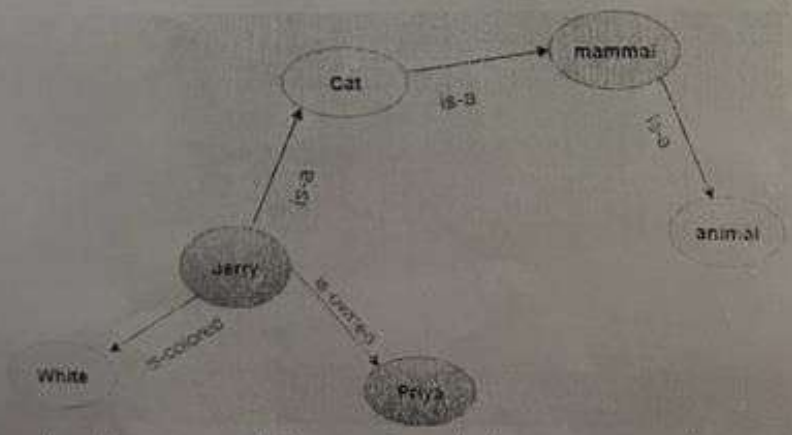
Eg- Tree is a living thing
relationship
Object Object

### Statements:

a. Jerry is a cat.
b. Jerry is a mammal
c. Jerry is owned by Priya.
d. Jerry is brown colored.
e. All Mammals are animal.

Tree → is a → living thing

→ more knowledge can be added by adding object & relations.

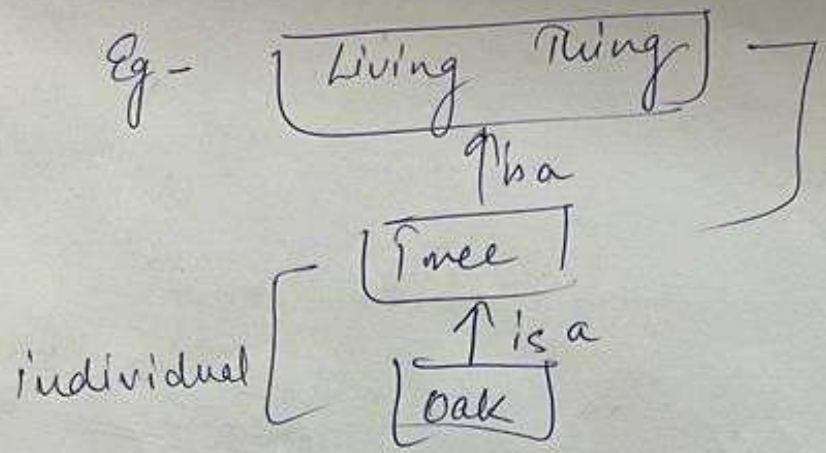



Tree → is a → LT
↓ has
leaves

nodes - object, entities, states, attributes experts.

Classification of Nodes

① Generic Node
② individual (instance)




Generic Node

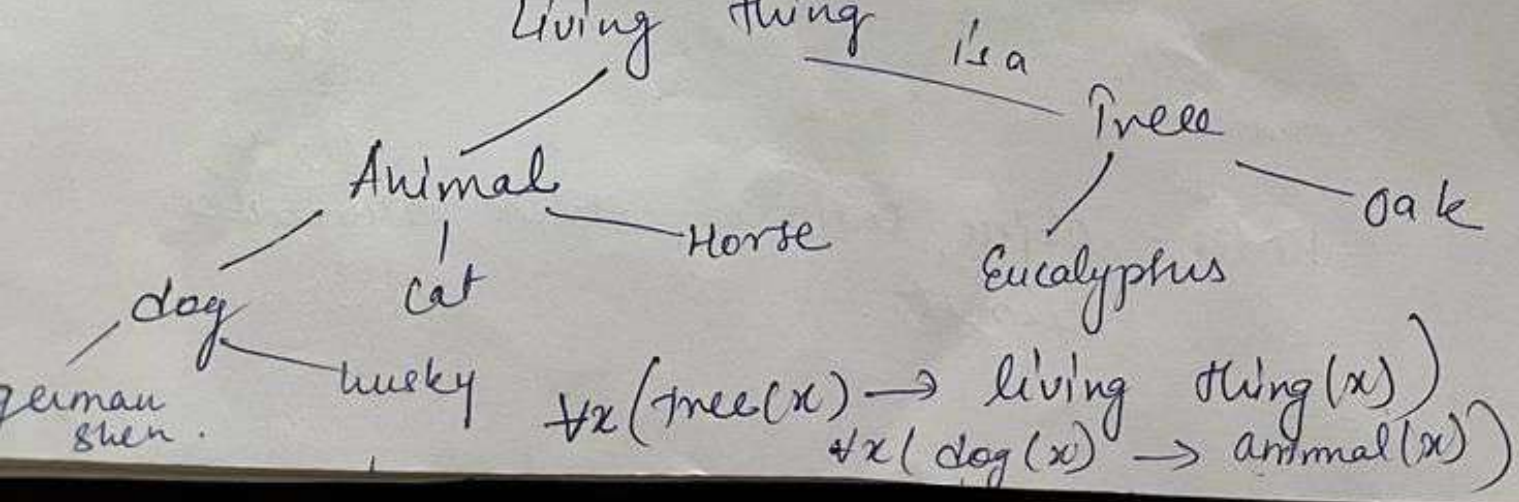
Tree —is a→ Living Thing

Individual Node

Oak —is a→ Tree

→ It is similar to logical representation.

is a link structure



Frames are derived from semantic networks and later evolved into our modern-day classes and objects. A single frame is not much useful. Frames system consist of a collection of frames which are connected. In the frame, knowledge about an object or event can be stored together in the knowledge base. The frame is a type of technology which is widely used in various applications including Natural language processing and machine visions.

Types of Frames —

① Declarative frame.
Slot → contain descriptn
→ about object

② Procedural
(how to solve particular problem)
Slot → how to perform things.
→ Action frame
or
Action-procedure frame

## Example: 1

Let's take an example of a frame for a book

| Slots | Filters |
|---|---|
| Title | Artificial Intelligence |
| Genre | Computer Science |
| Author | Peter Norvig |
| Edition | Third Edition |
| Year | 1996 |
| Page | 1152 |

## Example 2:

Let's suppose we are taking an entity, Peter. Peter is an engineer as a profession, and his age is 25, he lives in city London, and the country is England. So following is the frame representation for this:

↳ Type of slot

| Slots | Filter |
|---|---|
| Name | Peter |
| Profession | Doctor |
| Age | 25 |
| Marital status | Single |
| Weight | 78 |

→ Actor slot
→ object slot
→ source slot
→ destination slot
→ Task slot

## Advantages of frame representation:

In the above diagram, we have represented the different type of knowledge in the form of nodes and arcs. Each object is connected with another object by some relation.

## Drawbacks in Semantic representation:

1. Semantic networks take more computational time at runtime as we need to traverse the complete network tree to answer some questions. It might be possible in the worst case scenario that after traversing the entire tree, we find that the solution does not exist in this network.
2. Semantic networks try to model human-like memory (Which has 1015 neurons and links) to store the information, but in practice, it is not possible to build such a vast semantic network.
3. These types of representations are inadequate as they do not have any equivalent quantifier, e.g., for all, for some, none, etc.
4. Semantic networks do not have any standard definition for the link names.
5. These networks are not intelligent and depend on the creator of the system.

## Advantages of Semantic network:

1. Semantic networks are a natural representation of knowledge.
2. Semantic networks convey meaning in a transparent manner.
3. These networks are simple and easily understandable.

→ represent knowledge graphically → easily translated to prolog.

# 3. Frame Representation

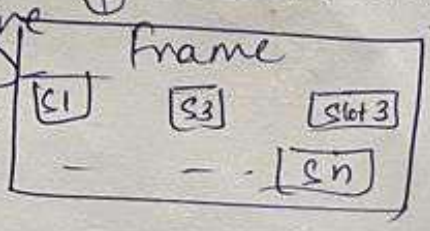
A frame is a record like structure which consists of a collection of attributes and its values to describe an entity in the world. Frames are the AI data structure which divides knowledge into substructures by representing stereotypes situations. It consists of a collection of slots and slot values. These slots may be of any type and sizes. Slots have names and values which are called facets.

Slot filter knowledge

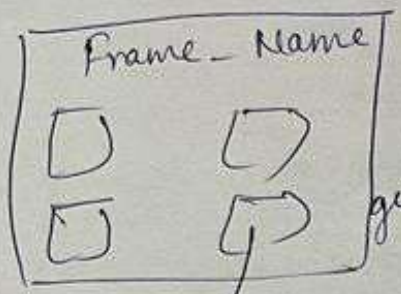
**Facets:** The various aspects of a slot is known as **Facets**. Facets are features of frames which enable us to put constraints on the frames. Example: IF-NEEDED facts are called when data of any particular slot is needed. A frame may consist of any number of slots, and a slot may include any number of facets and facets may have any number of values. A frame is also known as **slot-filter knowledge representation** in artificial intelligence.

→ It represents declarative knowledge (factual knowledge)

→ procedural knowledge (interpretive knowledge)




→ object facts procedure




generic Slots can be filled by

individual instance frame → Values
→ procedures

* pointer to other frame (not slot)) → pointers to other frame.

Eg.

Root frame

Name: School

Classroom

Staff room

Auditorium

Library

Labs

Staff room

Slots.

name, Classroom

no. of section

no. of benches

Leaf frame

Labs

System

Type of lab

Instrument

Tree generic

Oak instance

→ Concept of Inheritance (is a relationship)

Root frame.

Name: Library

No of books

Types of books

Leaf frame

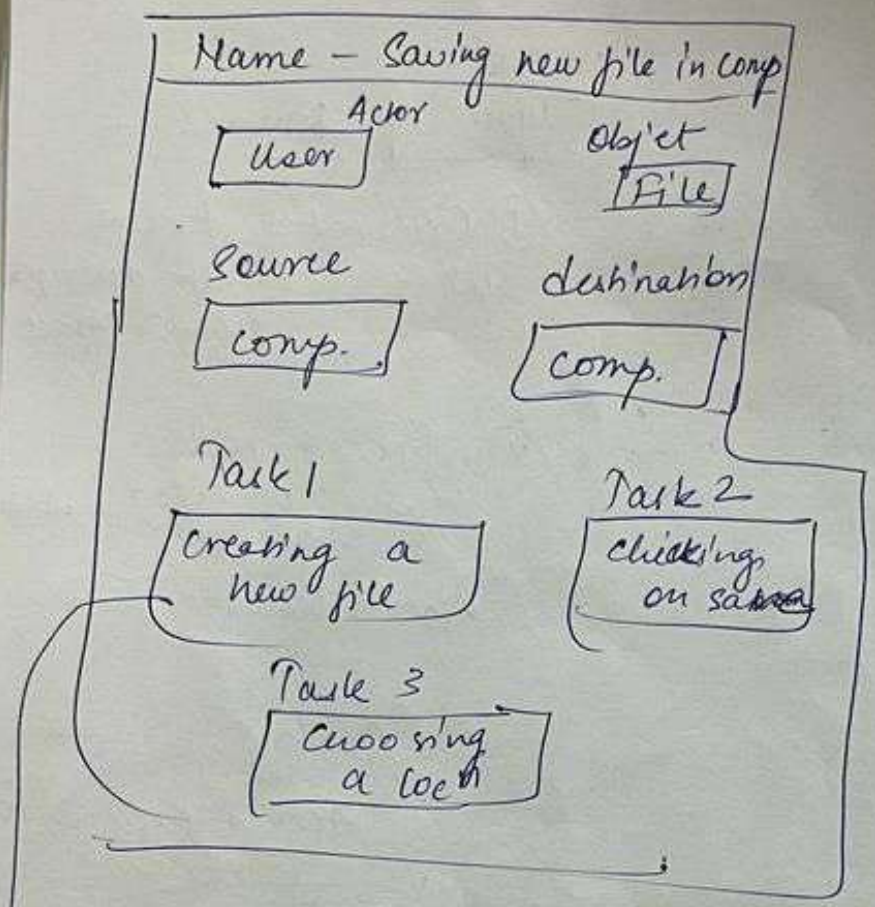
Name: Type of book

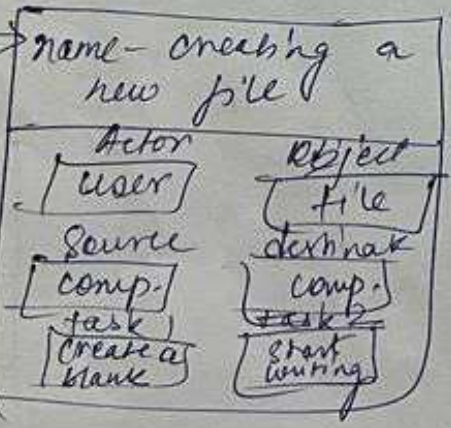
Comics

Fantasy

Action

Procedural Frame.




Adv

→ can add slots easily
→ make prog easier
→ used by appln in AI
→ easy to understand & visualize.
→ groups related data
→ flexible.

## Scripts

→ used to represent knowledge
→ similar to frame str
→ have slots
→ with each slot
  → script contains info abt slots.
→ represents situation & event
  ⇒ what can happen in particular situation
  what events can happen

Eg - ① Going market,
  purchasing
  paying bill

② going to restaurant, ordering food,
  paying bill

Components of script
→ entry conditions
→ results - condition after event has occured
→ props - slots represent object involve in events
→ roles - actions
→ Track (specific instance.
  (Restaurant is SI of hotel
  OAK → Tree
→ scene sequence of events.

| | | |
|---|---|---|
| ATRANS | transfer a relationship | give |
| PTRANS | transfer physical loc | go |
| PROPEL | apply physical force to an object | push |
| MOVE | move body part by owner | kick |
| MTRANS | transfer mental info | tell |
| ATTEND | focus sense organ | listen |

Example - Script for going to bank to withdraw money

SCRIPT - Withdraw money

TRACK : Bank

PROPS: Money
Counter
Form
Token

ROLES : P = customer
E = employee
C = cashier

Entry conditions: P has no or less money.
The bank is open

Results: P has more money

Scene 1: Entering
P PTRANS P into Bank
P ATTEND eyes to E
P MOVE P to E

Scene 2 Filling Form
P MTRANS signal to E
E ATRANS form to P
P PROPEL form for writing
P ATRANS form to P
E ATRANS ~~from~~ to P token

Scene 3 Withdrawing money
P ATTEND eyes to counter
P PTRANS token to C
C ATRANS money to P

Scene 4 Exiting the bank
P PTRANS P to out of bank.

Advantages

- → ability to predict events
- → a single coherent interpretation build up from collection of observations.

Disadvantages.

- → less general than frames.
- → may not be suitable for all kind of knowledge.

Conceptual Dependency

→ CD was originally developed to represent knowledge acquired from natural language input

→ To be independent of word used in original input i.e independent of language in which it is initial states.

→ For any 2 sentences identical in meaning there should be one representant of meaning

CD defines 11 primitive actions called acts.

1). ATRANS give
2) PTRANS go
3). MTRANS tell
4) PROPEL push
5). MBUILD decide
6). SPEAK say
7) ATTEND listen, watch
8). MOVE punch, kick
9). GRASP clusk
10) INGEST eat
11). EXPEL sweat, cry

1. The frame knowledge representation makes the programming easier by grouping the related data.
2. The frame representation is comparably flexible and used by many applications in AI.
3. It is very easy to add slots for new attribute and relations.
4. It is easy to include default data and to search for missing values.
5. Frame representation is easy to understand and visualize.

### Disadvantages of frame representation:

1. In frame system inference mechanism is not be easily processed.
2. Inference mechanism cannot be smoothly proceeded by frame representation.
3. Frame representation has a much generalized approach.

## 4. Production Rules

Production rules system consist of (**condition, action**) pairs which mean, "If condition then action". It has mainly three parts:

- The set of production rules
- Working Memory
- The recognize-act-cycle

In production rules agent checks for the condition and if the condition exists then production rule fires and corresponding action is carried out. The condition part of the rule determines which rule may be applied to a problem. And the action part carries out the associated problem-solving steps. This complete process is called a recognize-act cycle.

The working memory contains the description of the current state of problems-solving and rule can write knowledge to the working memory. This knowledge match and may fire other rules.

If there is a new situation (state) generates, then multiple production rules will be fired together, this is called conflict set. In this situation, the agent needs to select a rule from these sets, and it is called a conflict resolution.

### Example:

- **IF (at bus stop AND bus arrives) THEN action (get into the bus)**


- **IF (on the bus AND paid AND empty seat) THEN action (sit down).**
- **IF (on bus AND unpaid) THEN action (pay charges).**
- **IF (bus arrives at destination) THEN action (get down from the bus).**

## Advantages of Production rule:

1. The production rules are expressed in natural language.
2. The production rules are highly modular, so we can easily remove, add or modify an individual rule.

## Disadvantages of Production rule:

1. Production rule system does not exhibit any learning capabilities, as it does not store the result of the problem for the future uses.
2. During the execution of the program, many rules may be active hence rule-based production systems are inefficient.

# Propositional logic in Artificial intelligence

Propositional logic (PL) is the simplest form of logic where all the statements are made by propositions. A proposition is a declarative statement which is either true or false. It is a technique of knowledge representation in logical and mathematical form.