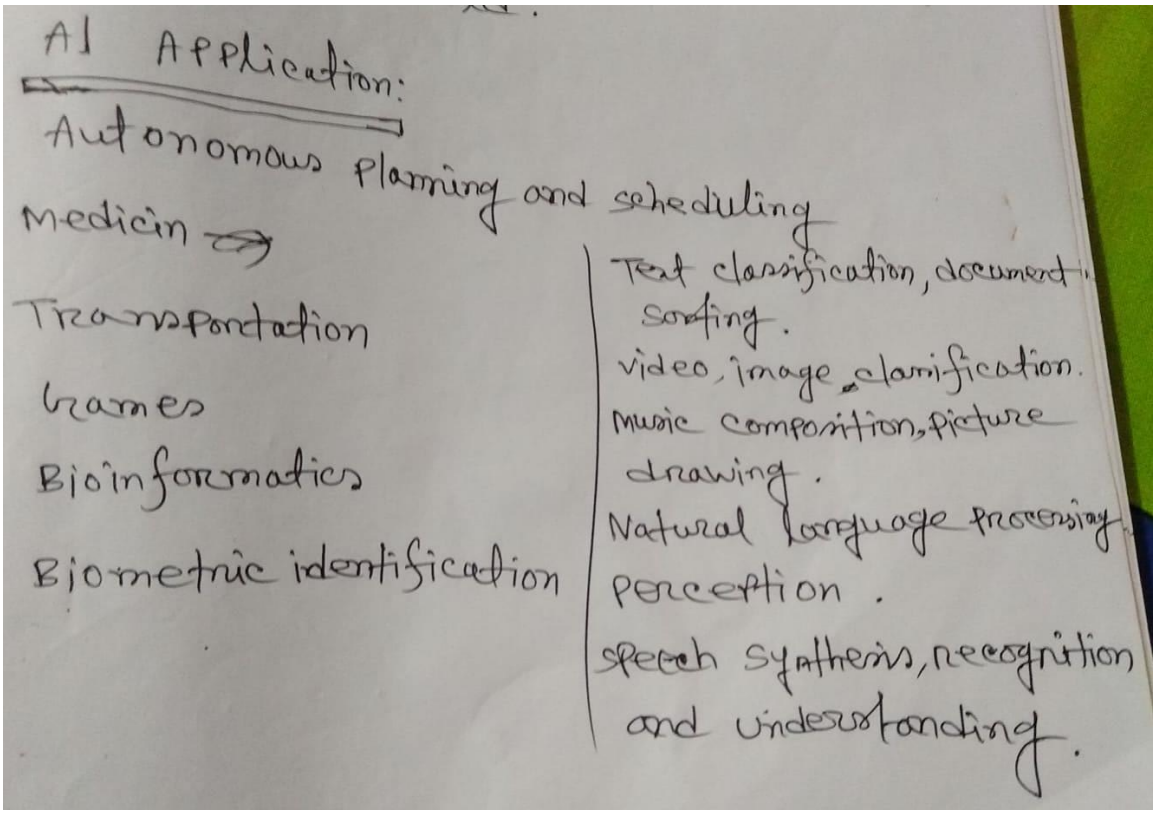
1 (a) AI: AI is a branch of Computer Science concerned with the study and creation of computer systems that exhibit some form of intelligence. It helps to perform other types of feats that require human types of intelligence.
AI is Discipline that systematizes and automates intellectual tasks to create machines to

- Act like humans
- Act rationally
- Think like humans
- Think rationally

Applications of AI: education, e-commerce, entertainment, agriculture, robotics, automotive industry, Astronomy, Healthcare, Gaming, Finance, Data Security, Social Media.



b) Knowledge: Knowledge is a theoretical or practical understanding of a subject. It helps us to make appropriate decisions. Knowledge is `condensed' information. It is a concise presentation of previous experience.

Knowledge can be defined as the body of facts and principles accumulated by humankind or the fact, or state of knowing. It is having a familiarity with language, concepts, procedures, rules, ideas, abstractions, places, customs, facts, and associations, coupled with an ability to use these notions effectively in modeling different aspects of the world.

Kinds of knowledge:

Procedural

- Compiled knowledge related to the performance of some task.
- knowing how to do something.
- Steps required to solve an algebraic equation.

Declarative

- Passive knowledge expressed as statements of facts the world.
- Knowing that something is true or false.
- Personal data in a database.

Heuristic

- For good judgments, or strategies, tricks, additional knowledge.

C) Knowledge Representation in AI describes the representation of knowledge. Basically, it is a study of how the beliefs, intentions, and judgments of an intelligent agent can be expressed suitably for automated reasoning. One of the primary purposes of Knowledge Representation includes modeling intelligent behavior for an agent.

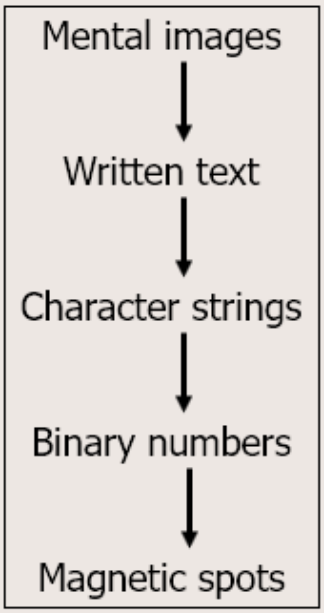
Rules as Knowledge Representation:

IF 'traffic light' is green
THEN action is go

IF 'traffic light' is red
THEN action is stop

IF car is dead AND 'fuel tank' is empty
THEN action is 'refuel the car'

John is the father of Jim



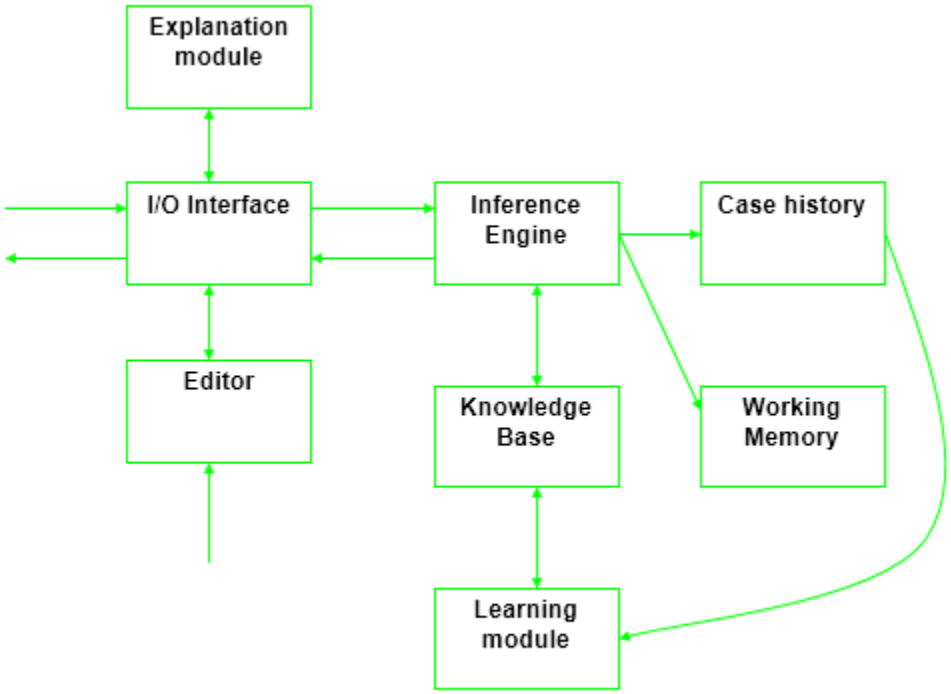
Different levels of knowledge representation

FATHER(john,jim) : Representation of a fatherhood family relationship

2 (a) Basic Characteristics of Expert System

- Use knowledge rather than data
- Knowledge is encoded and maintained as an entity separate from the control program
- Capable of explaining how a particular conclusion is reached and why requested information is needed
- Use symbolic representation and perform inference through symbolic computation
- Often reason with knowledge about themselves

(b) Basic architecture of Expert System



(c) Advantages & Disadvantages of Rule-Based Expert Systems

Advantages:

- natural knowledge representation,
- uniform structure,
- separation of knowledge from its processing

Disadvantages:

- especially opaque relations between rules,
- ineffective search strategy and
- inability to learn.

3. (a) Differentiate between Propositional and Predicate knowledge. Also give an example of each category.

Ans:

	Propositional Logic	Predicate Logic
Atomic symbols	Concrete objects, AND, OR, NOT, IF-THEN.	Propositional logic + variables + quantifiers: for all, exists.
Examples of formalizable statements	My son is at home **and** my dad is not. It **either** rains **or** it does not. **If** the president sleeps, **then** a war cannot start.	**All** husbands cheat. If **all** colleges are bad, CMU is bad. **At least one** chinchilla is smarter than at **least one** human.

In Propositional knowledge represent statements using propositional logic
we can only represent the facts, which are either true or false
PL is not sufficient to represent the complex sentences or natural language statements.
The propositional logic has very limited expressive power.

Connective symbols	Word	Technical term	Example
∧	AND	Conjunction	A ∧ B
∨	OR	Disjunction	A ∨ B
→	Implies	Implication	A → B
⇔	If and only if	Biconditional	A⇔ B
¬ or ~	Not	Negation	¬ A or ¬ B

Using Propositional Logic

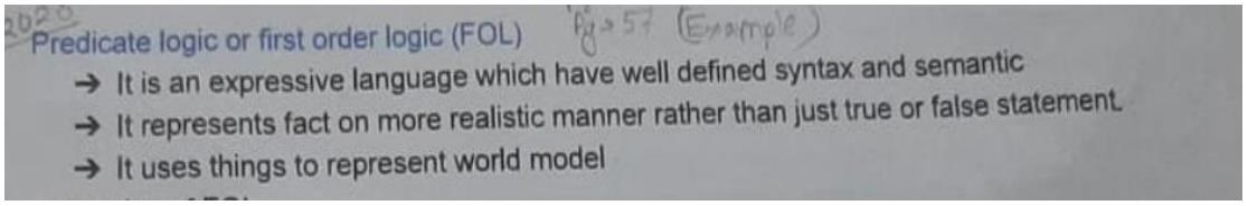
Representing simple facts

It is raining
RAINING

It is sunny
SUNNY

It is windy
WINDY

If it is raining, then it is not sunny
RAINING → ¬SUNNY



-In a predicate logic is an expression of one or more variables defined on some specific domain.
-In predicate logic, the subjectand predicateare further divided. For example,–Daisuke is a Japanese ◊J(Daisuke)–Daisuke is a human ◊H(Daisuke)

Example:

E1:All employees earning $1400 or more per year pay taxes.

E2:Some Employees are sick today

E3: No employees earns more than the president

Defining:

E(x) for x is an employee

P(x) for x is president

i(x) for the income of x

GE(u,v) for u is greater equal to v

S(x) for x is sick today

T(x) for x pays taxes

Then predicate representation:

E1': $\forall x((E(x) \&(GE(i(x), 1400) \rightarrow T(x))$

E2': $\exists y(E(y) \rightarrow S(y))$

E3': $\forall xy((E(x) \&P(y)) \rightarrow \neg GE(i(x), i(y)))$

3. b) Mention the application of Predicate knowledge.

Applications of Predicate Logic

- It is *the* formal notation for writing perfectly clear, concise, and unambiguous mathematical *definitions*, *axioms*, and *theorems* for *any* branch of mathematics.
- Statements like $x > 5$ are neither true nor false when the value of x is not specified.
- Predicate logic can be used to make propositions from such statements.

Practical Applications of Predicate Logic

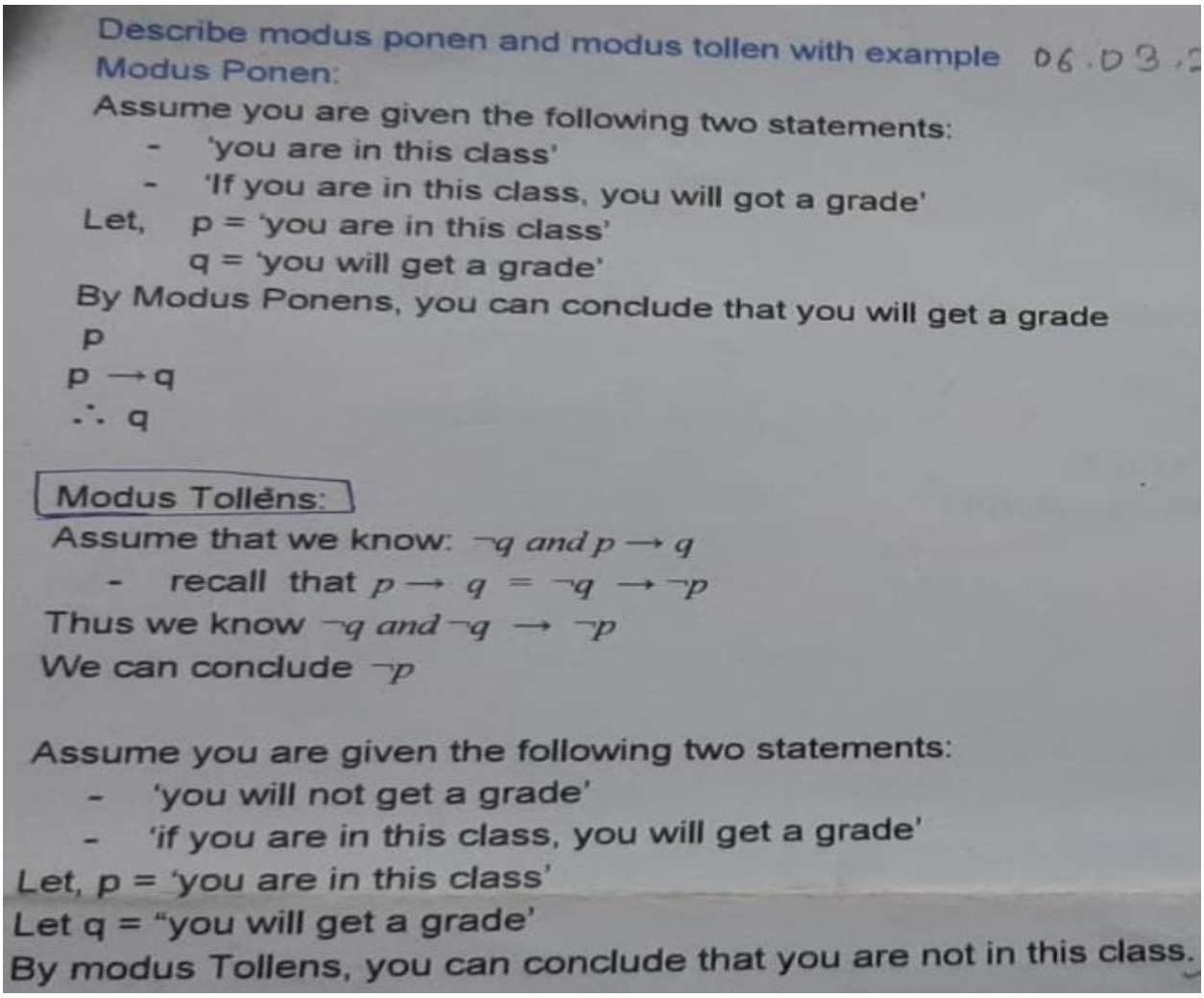
- It is the basis for clearly expressed formal specifications for any complex system.
- It is the basis for *automatic theorem provers* and many other Artificial Intelligence systems.
  - *E.g.* automatic program verification systems.
- Predicate-logic like statements are supported by some of the more sophisticated *database query engines* and *container class libraries*

Applications of Predicate Logic

It is the formal notation for writing perfectly clear, concise, and unambiguous mathematical *definitions*, *axioms*, and *theorems* (more on these in chapter 3) for any branch of mathematics.

Predicate logic with function symbols, the "=" operator, and a few proof-building rules is sufficient for defining any conceivable mathematical system, and for proving anything that can be proved within that system!

C) Describe Modus Ponen and Modus Tollen with example



Describe modus ponen and modus tollen with example 06.03.2

Modus Ponen:

Assume you are given the following two statements:

- 'you are in this class'
- 'If you are in this class, you will got a grade'

Let, p = 'you are in this class'
q = 'you will get a grade'

By Modus Ponens, you can conclude that you will get a grade

p

$p \rightarrow q$

$\therefore q$

Modus Tollens:

Assume that we know: $\neg q$ and $p \rightarrow q$

- recall that $p \rightarrow q = \neg q \rightarrow \neg p$

Thus we know $\neg q$ and $\neg q \rightarrow \neg p$

We can conclude $\neg p$

Assume you are given the following two statements:

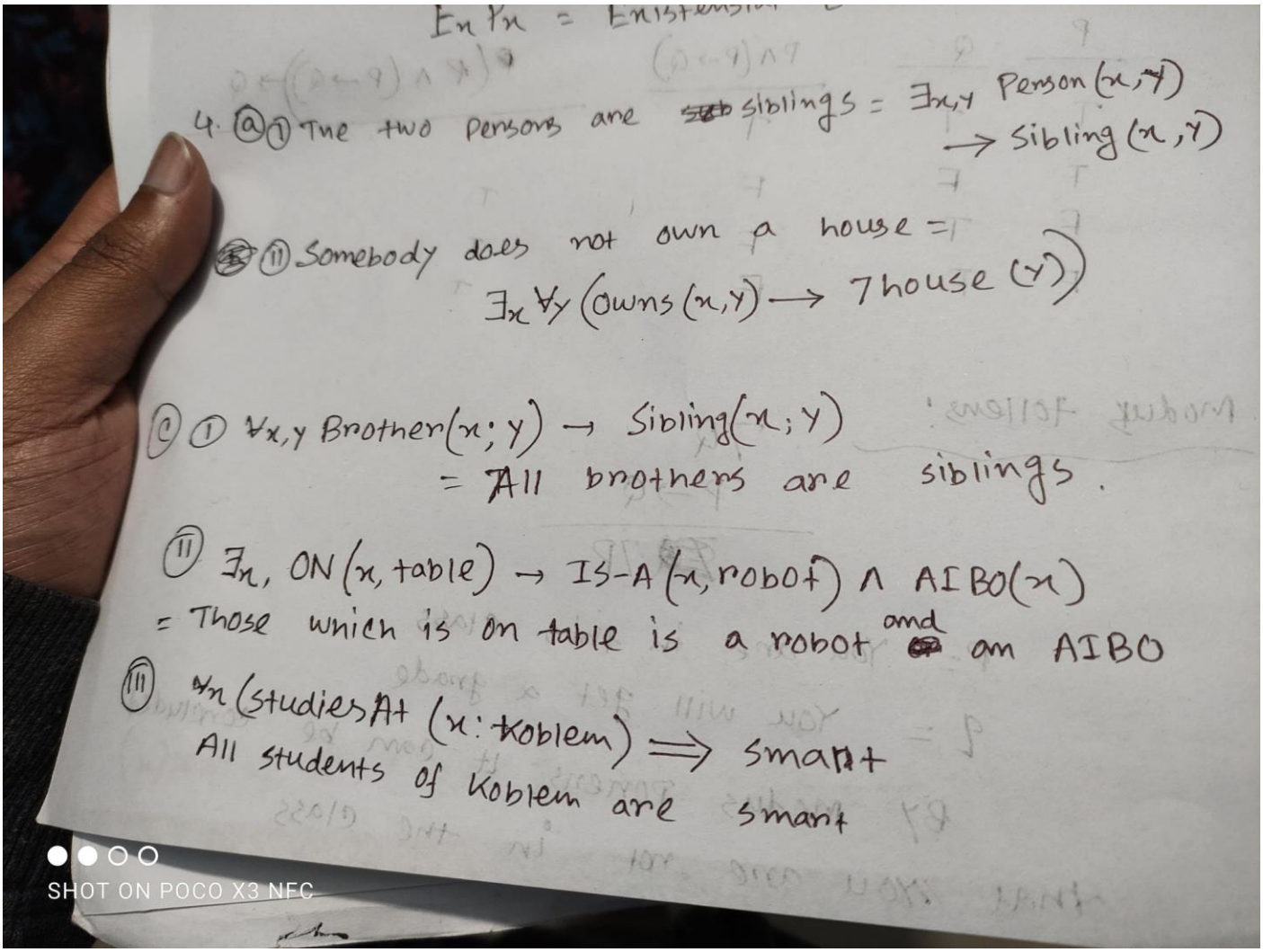
- 'you will not get a grade'
- 'if you are in this class, you will get a grade'

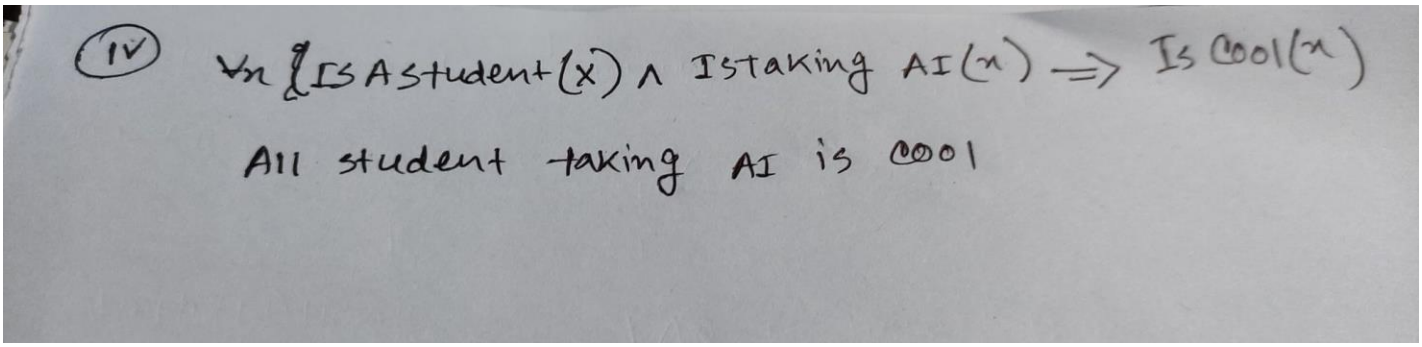
Let, p = 'you are in this class'

Let q = "you will get a grade'

By modus Tollens, you can conclude that you are not in this class.

4.


4. (a) (i) The two persons are siblings = ∃x,y Person(x,y) → Sibling(x,y)
(ii) Somebody does not own a house = ∃x ∀y (owns(x,y) → ¬house(y))
(c) (i) ∀x,y Brother(x;y) → Sibling(x;y)
= All brothers are siblings.
(ii) ∃x, ON(x, table) → IS-A(x, robot) ∧ AIBO(x)
= Those which is on table is a robot and an AIBO
(iii) ∀x (studies At (x: Koblem) ⟹ smart
All students of Koblem are smart
SHOT ON POCO X3 NFC



5 (a) Frame-Based Knowledge Representation

A frame is an artificial intelligence data structure used to divide knowledge into substructures by representing "stereotyped situations." Frames are the primary data structure used in artificial intelligence frame language. Frames are also an extensive part of knowledge representation and reasoning schemes

Each frame has:
- a name.
- slots: these are the properties of the entity that has the name, and they have values. A particular value may be:
  a default value
  an inherited value from a higher frame
  a procedure, called a demon, to find a value

Facet: Slot under slot is called facet. Facets are subfields of slot which may have names and any number of values.
For example, (hasan
(IS_A(VALUE Student))
(ADDRESS(STREET (VALUE 10/A))
(CITY (VALUE Dhaka))))

Demon: Slots with attached procedures such as *fget* and *if-needed* are called procedural attachments or demons. They are done automatically when a value is needed but not provided for in a slot.
For example, (hasan
(IS_A(VALUE Student))
(Date_of_Birth (VALUE 11-12-1985))
(AGE (VALUE fget)))

5(b)

Semantic Networks

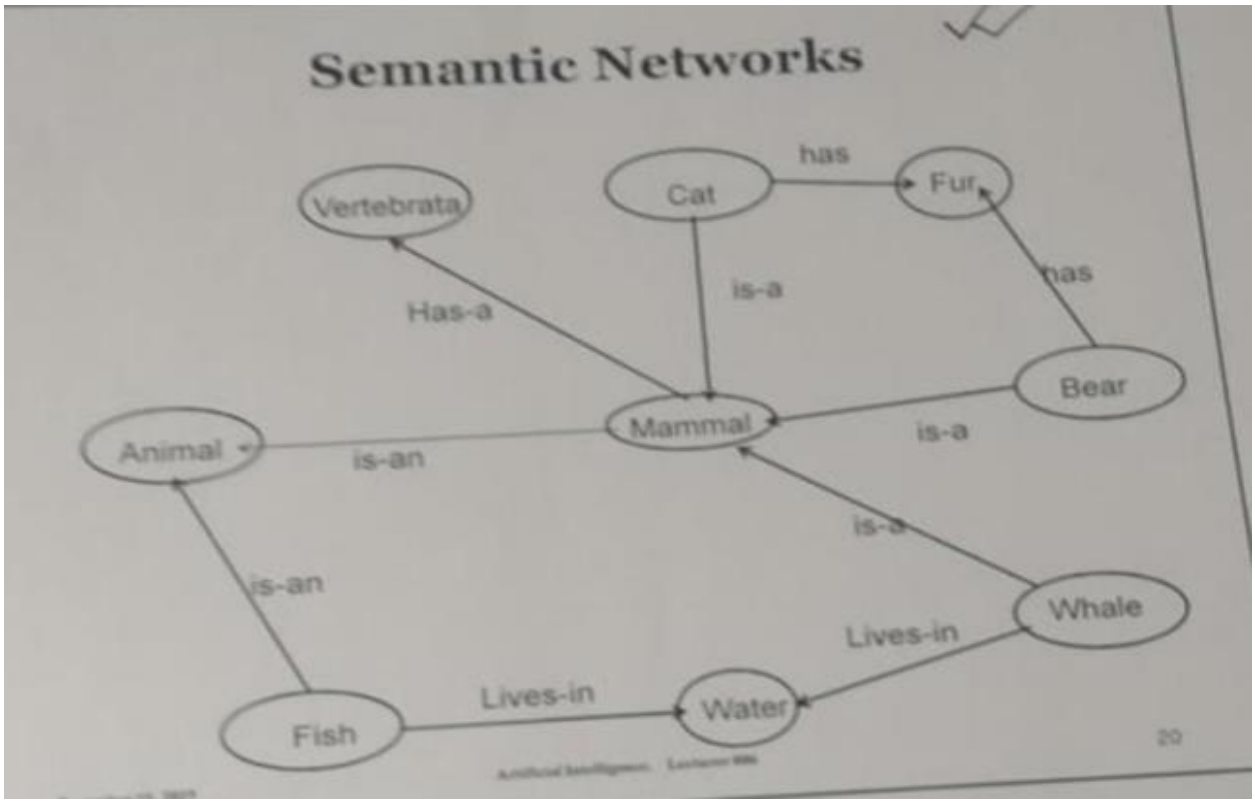
It is a directed graph consisting of vertices, which represent concepts, and edges, which represent semantic relations between the concepts.

Important semantic relations:
Meronymy (A is part of B, i.e. B has A as a part of itself)
Holonymy (B is part of A, i.e. A has B as a part of itself)
Hyponymy (or *troponymy*) (A is subordinate of B; A is kind of B)
Hypernymy (A is superordinate of B)
Synonymy (A denotes the same as B)
Antonymy (A denotes the opposite of B)

Semantic network is a way of representing relationships between concepts.

Each concept is represented by a word or set of words.

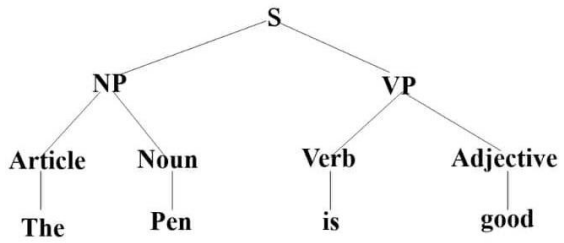
A simple example is a hierarchical network where the concepts are taxonomic terms from biology, and the only type of relationship is *type-of* (hyponymous relationship).



5 (c)

Semantic Analysis (Parsing)

❖Parsing is the process of building a parse tree for an input strings.



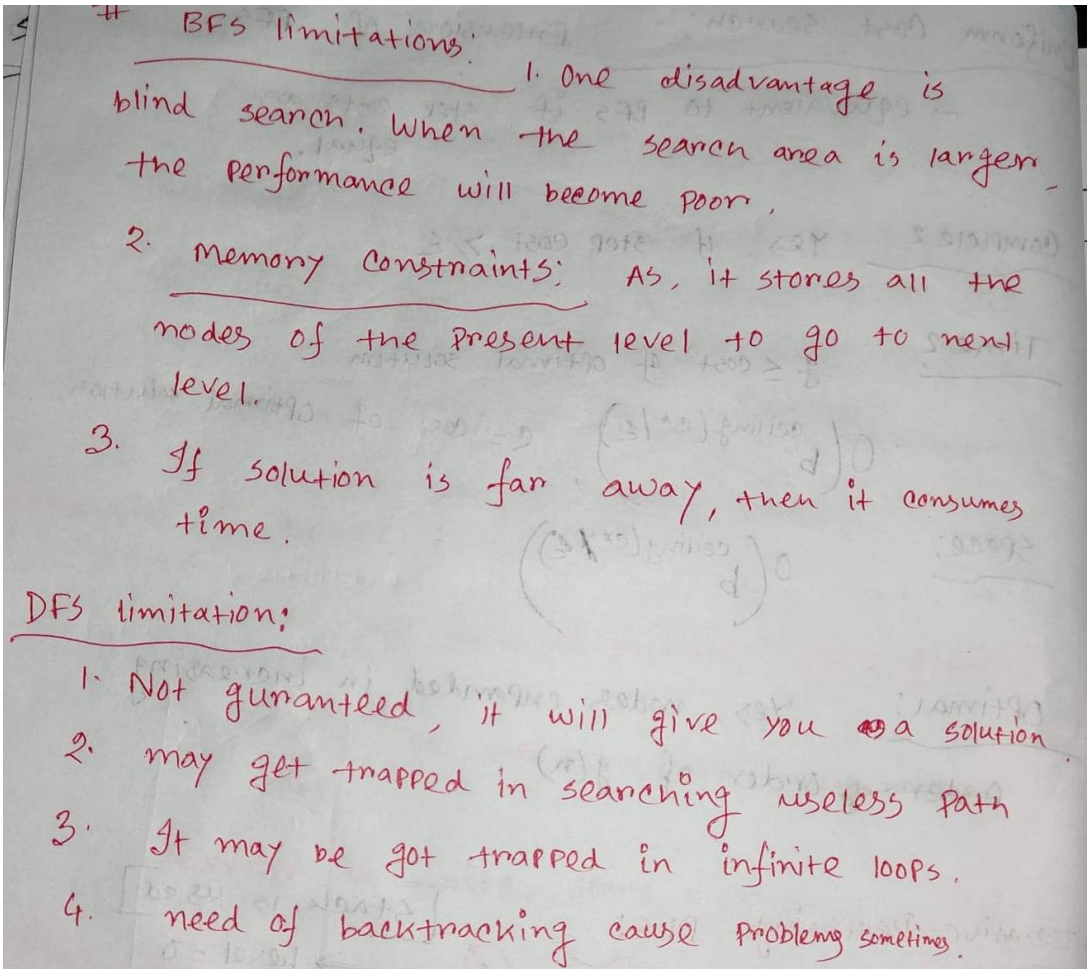
6 (a)

Tree Search Algorithm:

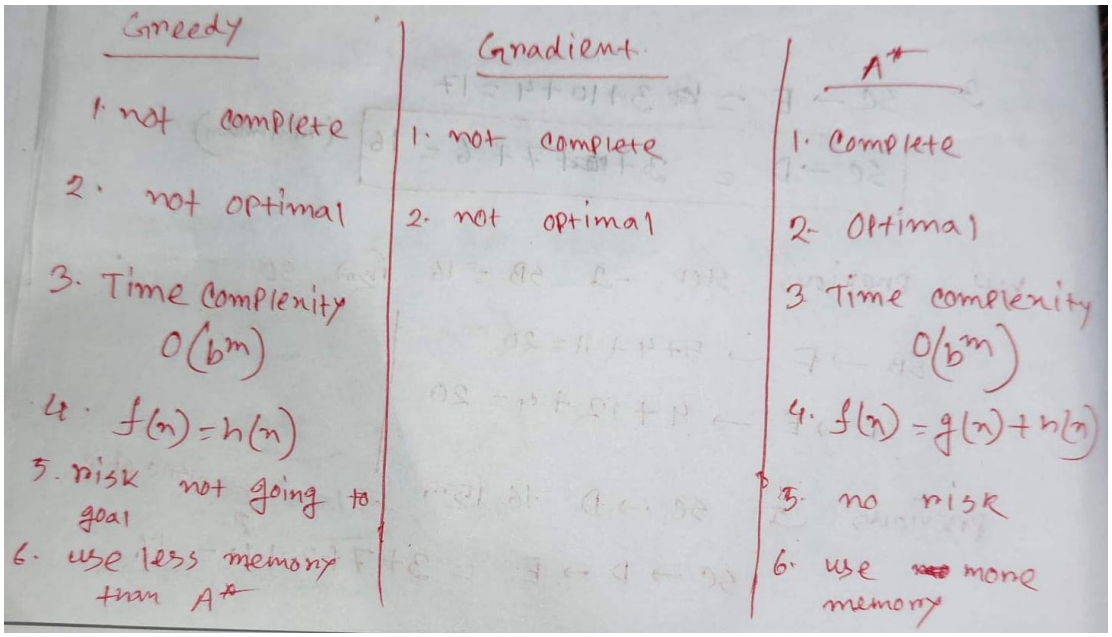
Function return a solution or failure initializes the search using the initial state of problem.

loop do

1. if no candidates for expansion then return failure
2. choose a leaf node for expansion according to strategy.
3. if the leaf contains a goal, then return solution.
   else expand the node and add the resulting nodes to the search tree.


BFS limitations:
1. One disadvantage is blind search. When the search area is larger the performance will become poor.
2. Memory constraints: As, it stores all the nodes of the present level to go to next level.
3. If solution is far away, then it consumes time.
DFS limitation:
1. Not guranteed, it will give you a solution.
2. may get trapped in searching useless path
3. It may be got trapped in infinite loops.
4. need of backtracking cause probleng sometimes.

6 (b)

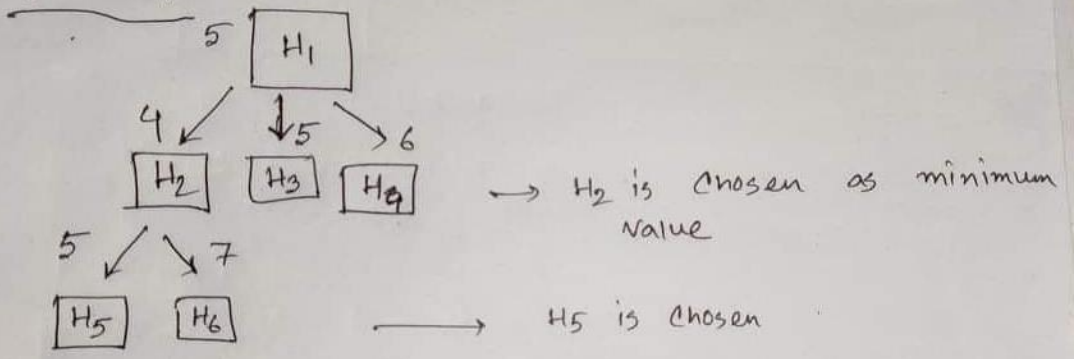

Greedy
1. not complete
2. not optimal
3. Time complexity O(b^m)
4. f(n) = h(n)
5. risk not going to goal
6. use less memory than A*
Gradient
1. not complete
2. not optimal
A*
1. Complete
2. Optimal
3 Time complexity O(b^m)
4. f(n) = g(n) + h(n)
5. no risk
6. use more memory

6 (c)

Hill climbing:

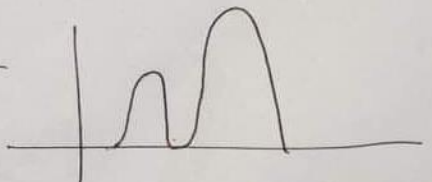
1. Local search algorithm.
2. no back tracking
3. greedy approach
4. if better than current state is found, that will be the new current state.

Example:



Problems:

1. Local maximum:



As it searches on the local domain, it finds max in local domain but there may be another maximum length hills which can not be reached

7. (a)

Evolution: A series of genetic changes by which a living organism acquires characteristics that distinguish it from other organisms.

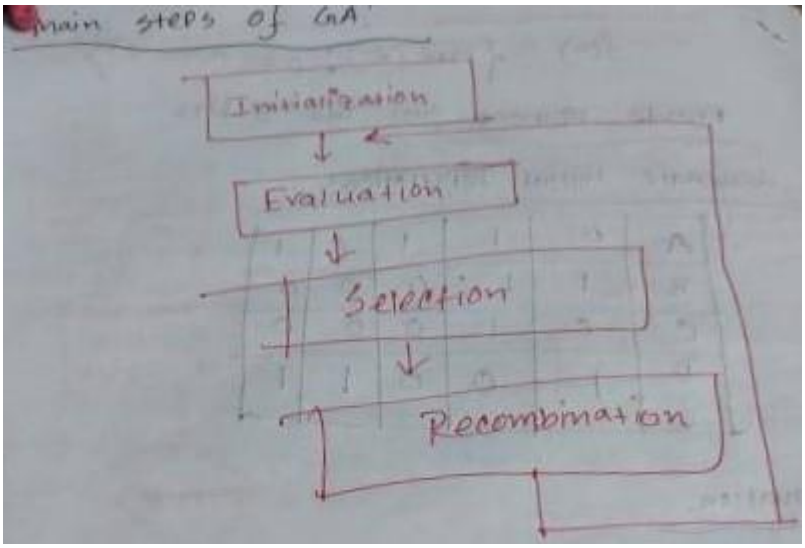
Human are the products of evolution.

Gene: A basic unit of chromosome that controls the development of a particular feature of a living organism. In Holland's (Founder of GA) Chromosome a gene is represented by either 0 or 1.

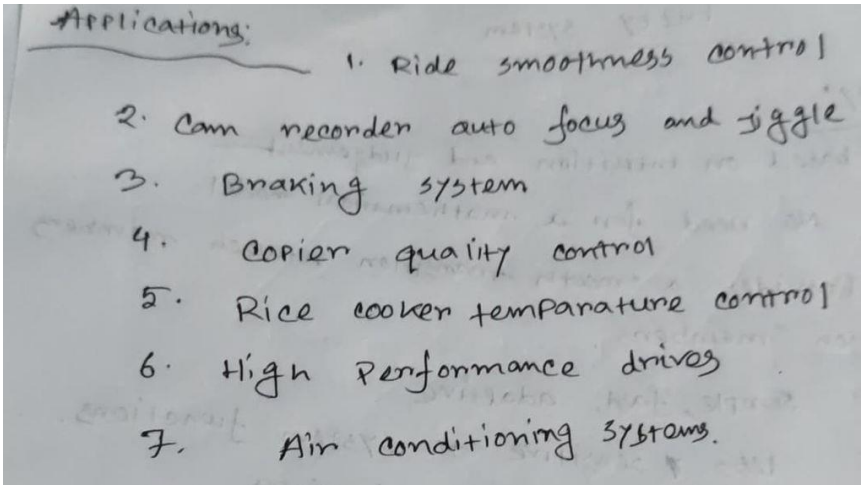
Chromosomes: A string of genes that represent an individual. Each chromosome consists of a number of gene.

Crossover Probability: A number between zero and one that indicates the probability of two chromosomes crossing over.

b)



8 (a)



Applications:

1. Ride smoothness control
2. Cam recorder auto focus and jiggle
3. Braking system
4. Copier quality control
5. Rice cooker temparature control
6. High Performance drives
7. Air conditioning systems.

Applications of Fuzzy Logic

Control Applications: Aircraft control, Sendai subway operation (Hitachi), Cruise control (Nissan), Automatic Transmission (Nissan, Sabaru), Self parking model car (Tokyo University), Space Shuttle docking (NASA)

Scheduling and Optimization:

Elevator scheduling (Hitachi, Fujitsu, Mitsubishi)

Stock Market Analysis: Yamichi securities

Signal Analysis for Tuning and Interpretation:

TV picture adjustment (Sony Corporation)

Handwriting Recognition: Sony Palmtop computer

Video Camera Autofocus: Sony and Canon

Video Image Stabilizer: Matsushita, Panasonic

8 (b) The distinguish between fuzzy logic and Boolean logic is that fuzzy logic is based on possibility theory, while Boolean logic is based on probability theory. In this way, fuzzy logic is a measure of a soil's similarity to a class, rather than its chance of belonging to it

8 (c)

Step 1: Fuzzification

- Fuzzifier converts a crisp input into a fuzzy variable.
- Definition of the membership functions must
  - reflects the designer's knowledge
  - provides smooth transition between member and nonmembers of a fuzzy set
  - simple to calculate
- Typical shapes of the membership function are Gaussian, trapezoidal and triangular.

Example 1

- Assume we want to evaluate the health of a person based on his height and weight.
- The input variables are the crisp numbers of the person's height and weight.
- Fuzzification is a process by which the numbers are changes into linguistic words

Step 2: Rules

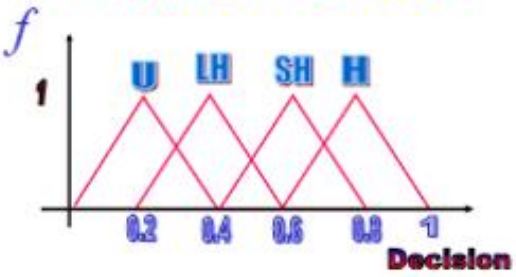
- Rules reflect experts decisions.
- Rules are tabulated as fuzzy words
- Rules can be grouped in subsets
- Rules can be redundant
- Rules can be adjusted to match desired results

Rules Function

- Rules are tabulated as fuzzy words
  - Healthy (H)
  - Somewhat healthy (SH)
  - Less Healthy (LH)
  - Unhealthy (U)
- Rule function *f*

$$f = \{U, LH, SH, H\}$$

Fuzzified Decision



$$f = \{U, LH, SH, H\}$$

Fuzzy Rules Table

Height \ Weight	Very Slim	Slim	Medium	Heavy	Very Heavy
Very Short	H	SH	LH	U	U
Short	SH	H	SH	LH	U
Medium	LH	H	H	LH	U
Tall	U	SH	H	SH	U
Very Tall	U	LH	H	SH	LH

Step 3: Calculate

- For a given person, compute the membership of his/her weight and height
- Example:
  - Assume that a person height is 6' 1"
  - Assume that the person's weight is 140 lb

Step 4: Activate Rules

Height \ Weight	Very Slim	Slim	Medium	Heavy	Very Heavy
Very Short	H	SH	LH	U	U
Short	SH	H	SH	LH	U
Medium			H	LH	U
Tall			H	SH	U
Very Tall	U	LH	H	SH	LH

Substitute Membership Values

Height \ Weight	0.8	0.2	Medium	Heavy	Very Heavy
Very Short	H	SH	LH	U	U
Short	SH	H	SH	LH	U
0.7	LH	H	H	LH	U
0.3	U	SH	H	SH	U
Very Tall	U	LH	H	SH	LH

Step 5: Compute Decision Function

	Weight	
	0.8	0.2
V. Short (0)	0	0
Short (3)	0	0
0.7	0.7	0.2
0.5	0.5	0.2
V. Tall (6)	0	0

	Weight	
	0.8	0.2
Very Short	H	SH
Short	SH	H
0.7	LH	H
0.5	U	SH
Very Tall	U	LH

$$f = \{U, LH, SH, H\}$$

$$f = \{0.3, 0.7, 0.2, 0.2\}$$

Step 6: Compute Final Decision

- *Use the fuzzified rules to compute the final decision.*
- *Two methods are often used.*
  - *Maximum Method (not often used)*
  - *Centroid*