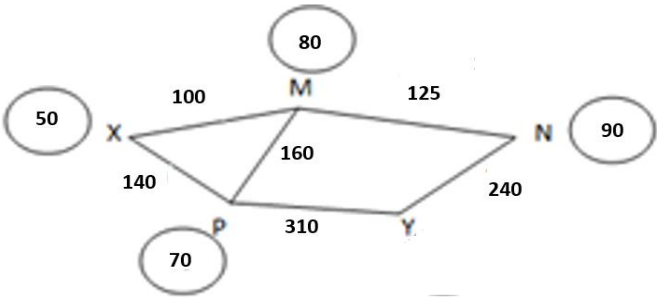
SASTRA ENGINEERING · MANAGEMENT · LAW · SCIENCES · HUMANITIES · EDUCATION DEEMED TO BE UNIVERSITY (U/S 3 OF THE UGC ACT, 1956) THINK MERIT | THINK TRANSPARENCY | THINK SASTRA	**School of Computing** **Second CIA Exam – Mar 2025** Course Code: INT314 Course Name: Artificial Intelligence and Logical Reasoning Duration: 90 minutes Max Marks: 50

1. Bot wants to reach railway station in a city from your college (X). The SLD values are given in circle. Path costs are given in edges. First find the goal from these values. Then apply A* search to get minimal cost. Step by step process along with formula should be given. (10)



f(n)=g(n)+h(n) (1)

Tree with f(n) and solution path

Best optimum informed search : A* search (6)

f(x)=0+50=50

X:- f(p)=140+70=210 (h1)

f(M)= 100+80=180

f(M)<f(P), so go to M

M:- f(P)=100+160+70=330 (h3)

f(N)=100+125+90=315 (h2)

h1<f(P), so go to P-h1

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f(h1):- f(Y)= 140+310+0=450 (h5)

f(M)=140+160+80=380 (h4)

h2<h3<f(M)<f(Y), so go to P-h2

Y(h2):- f(Y)= 100+125+240+0=465 (h6),

though goal is reached, need to check other lessor values

h3<h4<h5<f(N), so go to P-h3

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f(h3):- f(Y)= 100+160+310+0=570 (h7)

h4<h5<h6<f(Y), so go to M-h4

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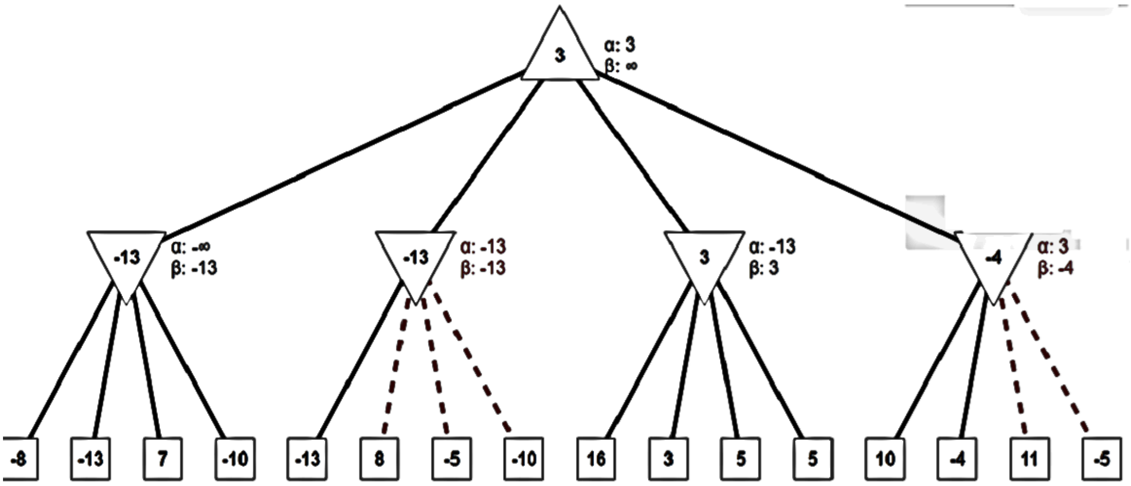
f(h4)=140+160+125+90=515 (h8)

No other hold value less than 450 (h5) <h6<h7<h8 and goal Y is reached.

Path is : X-P-Y =450

2. Consider the following tree is a part of Tic-Tac-Toe game played by two palyers. Apply alpha-beta pruning process to reduce the number of branches or nodes to be searched by. (α,β values are to mentioned) (10)



3. Illustrate 'for all' and 'there exists' Quantifiers of FOL statements. (10)

- "All kings are persons,'' is written in first-order logic as
- ∀x *King(x)* ⇒*Person(x)*
- ∀is usually pronounced "For all . . .".
- Thus, the sentence says, "For all *x,* if *x* is a king, then xis a person." The symbol x is called a **variable.** By convention, variables are lowercase letters.
- A variable is a term all by itself, and as such can also serve as the argument of a function-for example, *LeftLeg(x).*
- A term with no variables is called a **ground term.**
- Intuitively, the sentence ∀*x P,* where *P* is any logical expression, says that *P* is true for every object *x.*
- More precisely, ∀*x* P is true in a given. model under a given interpretation if P is true in all possible **extended interpretations** constructed from the given interpretation, where each extended interpretation specifies a domain element to which x refers.

Existential quantification (∃)

- Universal quantification makes statements about every object. Similarly, we can make a statement about some object in the universe without naming it, by using an existential quantifier.
- To say, for example, that King John has a crown on his head, we write

  ∃ *x Crown(x) A OnHead (x, John)* .
- ∃ xis pronounced "There exists an x such that . . ."or "For some x . . .".
- Intuitively, the sentence ∃x P says that *P* is true for at least one object *x.*
- More precisely, ∃x P is true in a given model under a given interpretation if P is true in *at* least *one* extended interpretation that assigns *x* to a domain element.
- For our example, this means that at least one of the following must be true:
  - Richard is a crown ∧ Richard is on John's head;
  - King John is a crown ∧ King John is on John's head;
  - Richard's left leg is a crown ∧ Richard's left leg is on John's head;
  - John's left leg is a crown ∧ John's left leg is on John's head;
  - The crown is a crown ∧ the crown is on John's head.

4. a) Convert the following sentences into FOL statements

"There is a course that is hard and interesting "

$\exists c(Course(c) \land Hard(c) \land Interesting(c))$ (2)

“A number x is **even** if and only if x is **divisible by 2**”

$\forall x(Even(x) \leftrightarrow DivisibleBy(x,2))$

Or $\forall x(Number(x) \land Even(x) \leftrightarrow DivisibleBy(x,2))$

Or $\forall x(Even\_number(x) \leftrightarrow DivisibleBy(x,2))$ (3)

b) Differentiate Greedy best first search, A star search and Memory bounded A star search. (5)

Greedy	**A Star**	**Memory bounded A Star**
f(n)=h(n)	f(n)=g(n)+h(n)	f(n)= g(n)+h(n)
Immediate lessor h(n) will be considered as next state	Compare the current f(n) with other siblings or siblings of parents.	Compare the current f(n) with next highest.
Each node with f(n) is stored, higher space complexity	Each node with f(n) is stored, higher space complexity	Only one next highest f(n) is stored, so less space complexity
Not optimal search	Optimal search	Optimal search
Basic Best first search	Improved (optimized) compared to Greedy	Improved (optimized & leass memory) compared to Greedy and A star

5. a) If agent struck at a point and unable to reach the goal, how can you help as per hill climbing (7)

1. Sideways: When there is no uphill move, infinite loop will occur due to flat surface or shoulder, so sideways move are allowed. Limit the sideways around 100, so that solution % will increase from 14 to 90.
2. Stochastic hill climbing: Chooses a random from among the uphill moves, the probability of selection vary with the steepness of the uphill move. Slow, but better solution.
3. First Choice hill climbing: implementing stochastic hill climbing by generating successors randomly until one is generated better than the current state. Good with many successors.
4. Random Restart hill climbing: it conducts series of hill climbing searches from randomly generated initial states, stopping when a goal is found. It is complete with the probability of approaching 1. Good local maximum can be found after small number of restarts.

b) Remove implication from the following FOL statement.

$Mother(Alice) \leftrightarrow (Child(Bob) \land Parent(Alice,Bob))$ (3)

Fw implication

$\neg Mother(Alice) \lor (Child(Bob) \land Parent(Alice,Bob))$

Bw implication

$\neg(Child(Bob) \land Parent(Alice,Bob)) \lor Mother(Alice)$

$(\neg Child(Bob) \lor \neg Parent(Alice,Bob)) \lor Mother(Alice)$

combine

$\neg Mother(Alice) \lor (Child(Bob) \land Parent(Alice,Bob)) \land$
$(\neg Child(Bob) \lor \neg Parent(Alice,Bob)) \lor Mother(Alice)$

Answer the question PART B 1x 10 = 10 Marks

6. Answer the following questions (10)

a) Illustrate Manhattan distance as heuristic value.

Def -1, example-1

b) Define Crossover of genetic algorithm using 8-queen problem.

Def with example -2 marks

c) Recall any two properties of knowledge representation. – 2 marks

Any two of:

1. Representational Adequacy
The ability to represent all kinds of knowledge that are needed in that domain.
2. Inferential Adequacy
Also, The ability to manipulate the representational structures to derive new structures corresponding to new knowledge inferred from old.
3. Inferential Efficiency
The ability to incorporate additional information into the knowledge structure that can be used to focus the attention of the inference mechanisms in the most promising direction.
4. Acquisitional Efficiency
Moreover, The ability to acquire new knowledge using automatic methods wherever possible rather than reliance on human intervention

d) Convert the following sentence into equivalent existential quantifier sentence: (4)

: $\exists x (Bird(x) \land \neg CanFly(x)$

$$\exists x\, P(x) \equiv \neg \forall x\, \neg P(x)$$

Applying this to our given formula:

1. Let $P(x) = Bird(x) \land \neg CanFly(x)$, so we rewrite:

$$\exists x (Bird(x) \land \neg CanFly(x)) \equiv \neg \forall x \neg (Bird(x) \land \neg CanFly(x))$$

2. Apply **De Morgan's Law** inside the negation:

$$\neg \forall x (\neg Bird(x) \lor CanFly(x))$$

$$\forall x (Bird(x) \rightarrow CanFly(x))$$