

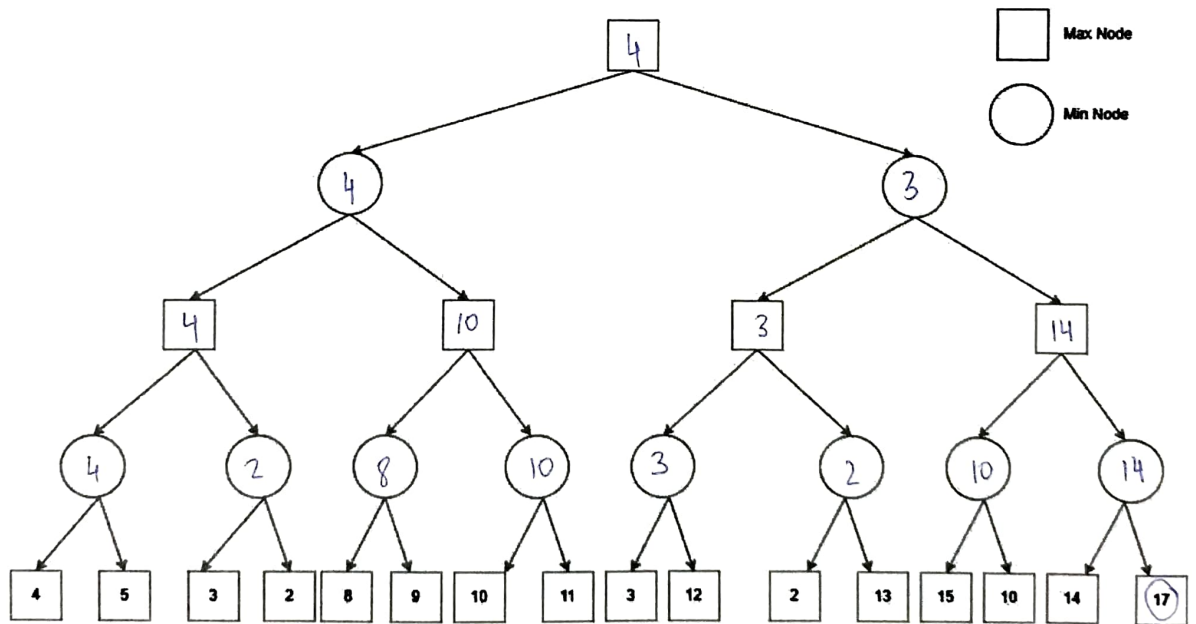


INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
Mid-Autumn Semester Examination 2024-25

Date of Examination: 18/09/2024 Session: FN Duration: 2 Hrs Full Marks: 50
Subject No. AI61005 Subject: Artificial Intelligence: Foundations and Applications
Department/Center/School: Department of Artificial Intelligence
Specific charts, graph paper, log book etc., required NO
Special Instructions (if any) : Answer all the parts of a question in same place

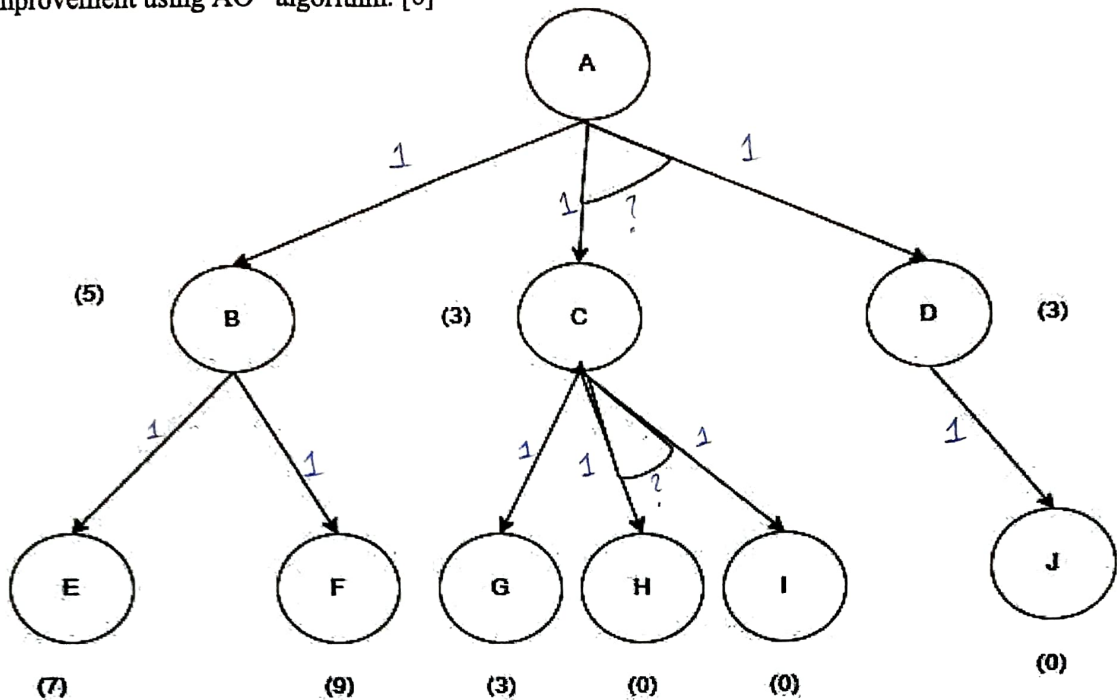
1) Consider the following tree and answer the questions. Show computations and **stepwise updates**.

- How many leaf nodes has to be explored for getting final result? [3]
- What are the final alpha and beta values in the root node? [5]
- Show the pruned branches by crossing (X) them out. [2]



- 2) Consider a search problem where all edges have cost 1 and the optimal solution has cost C . Let h be a heuristic which is $\max\{h^* - k, 0\}$, where h^* is the actual cost to the closest goal and k is a non-negative constant unknown to the search algorithm. Prove with justification that
- h is admissible [3]
 - h is monotone [3]
 - A* search without closed list will be optimal [3]

- 3) Consider the following graph all the path costs as 1. Solve the graph and show step by step improvement using AO* algorithm. [6]



4) Consider the following axioms:

1. Anyone who buys carrots by the bushel owns either a rabbit or a grocery store.
2. Every dog chases some rabbit.
3. Mary buys carrots by the bushel.
4. Anyone who owns a rabbit hates anything that chases any rabbit.
5. John owns a dog.
6. Someone who hates something owned by another person will not date that person.

Conclusion: If Mary does not own a grocery store, she will not date John.

Represent these clauses in predicate calculus, Skolemize as necessary. Prove the set of clauses by resolution refutation. [10]

Use the following to form your clauses:

- $BUY(x)$: x buys carrots by the bushel
- $DOG(x)$: x is dog
- $RABBIT(x)$: x is rabbit
- $GROCERY(x)$: x is a grocery store
- $DATE(x,y)$: x date y
- $OWNS(x,y)$: x owns y
- $CHASE(x,y)$: x chases y
- $HATES(x,y)$: x hates y

Constants: Mary, John

5) Represent the following sentences in first-order logic using the provided consistent vocabularies.

(a) Vocabulary:

Student(x): x is a student

takes(x, c, s): student x takes course c in semester s

Score(x, c, s): the score obtained by student x in course c in semester s

$x > y$: x is greater than y

List of sentences:

(i) Some students took AIFA in Autumn 2024.

(ii) The best score in StatAIML is always higher than the best score in AIFA.

[1 + 2 = 3]

(b) Vocabulary:

Man(x): x is a man

Barber(x): x is a barber

Shaves(x, y): person x shaves person y

Sentence: There is a barber who shaves all men in town who do not shave themselves.

[2]

(c) Vocabulary:

Person(x): x is a person •

Born(x, c): person x is born in country c

Parent(x, y): x is a parent of y

Citizen(x, c, r): x is a citizen of country c for reason r

Resident(x, c): x is a resident of country c

List of sentences:

(i) A person born in India, each of whose parents is an Indian citizen or an Indian resident, is an Indian citizen by birth.

(ii) A person born outside India, one of whose parents is an Indian citizen by birth, is an Indian citizen by descent.

[2.5 × 2 = 5]

6) Consider a list contains a set of integers. Write a prolog program to count number of times a given input number x appeared in the list. [5]