BITS, PILANI – DUBAI
Academic City, Dubai
BE (Hons) CS IV Year - 2nd Sem

ARTIFICIAL INTELLIGENCE – EA C461
COMPREHENSIVE EXAMINATION (Closed Book)

Date: 21 May 2009
Time: 3 hrs **Max Marks: 80**

Answer all questions

1. (a). For a general search problem, state which of breadth-first search (BFS) or depth-first search (DFS) is preferred under the following condition and why: "Very large memory space to store the search tree (or the queue) is available." 2 mks

(b). Consider the search space below, where "start" is the start node and "goal1" and "goal2" are goal nodes. Arcs are labeled with the value of a cost function; the number gives the cost of traversing the arc. Inside each node is the value of a heuristic function; the number gives the estimate of the distance to the goal. Assume that uninformed search algorithms always choose the left branch first when there is a choice. Assume that the algorithms do not keep track of and recognize repeated states. For each of the following search strategies, list in order, all the states that are removed from the OPEN list. Stop as soon as any one goal state is reached.

(i) Depth first iterative deepening 4 mks

(ii) A* 6 mks

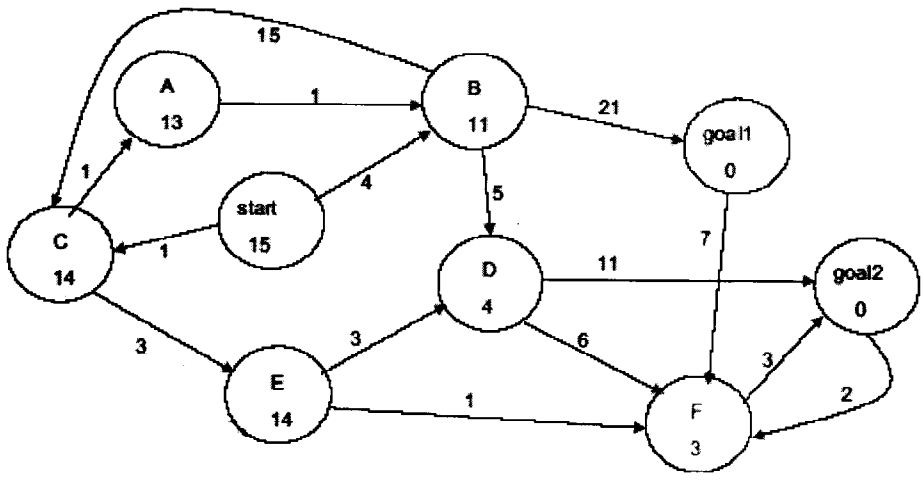


Fig 1: Graph

2. Consider the game tree given in Fig 2, in which the root corresponds to a MAX node and the values of a static evaluation function, if applied, are given at the leaves.

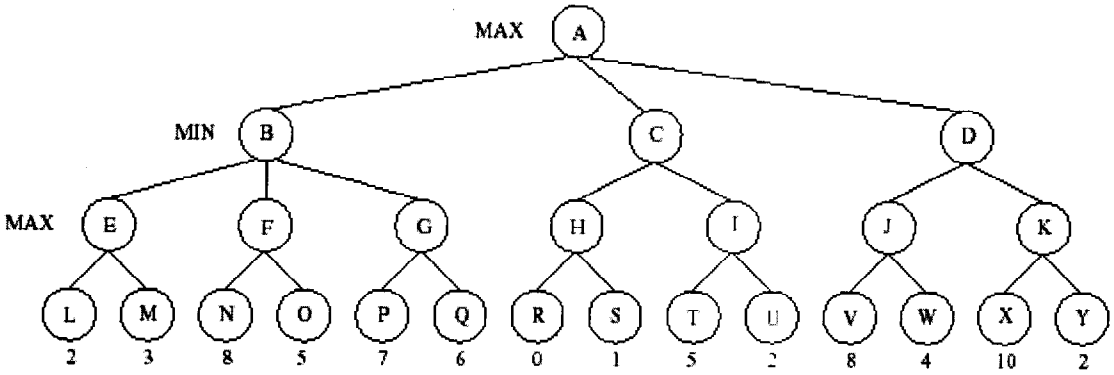


Fig 2: Game tree

(a) What is the minimax value computed at the root node for this tree? What move should MAX choose? Show all intermediate values at each node as they get updated. 4 mks

(b) Which nodes are not examined when Alpha-Beta Pruning is performed? Assume children are visited left to right. Show all intermediate values at each node as they get updated. 6 mks

(c) Is there a different ordering for the children of the root for which more pruning would result by Alpha-Beta? If so, state the order. If not, say why not. 2 mks

3. (a) Translate the following sentences into first-order predicate logic. Use the following predicates in the translation: 8 mks

T(x) - x subscribes to "The Times".
E(x) - x is well-educated.
H(x) - x is a hedgehog.
L(x) - x is literate.

(i) No one subscribes to "The Times" unless he is well-educated.
(ii) There are no literate hedgehogs.
(iii) Illiterates are not well-educated.
(iv) No hedgehog subscribes to The Times.

(b) Consider the following sentence in Propositional Logic: 6 mks

$(P \rightarrow (Q \rightarrow R)) \rightarrow ((P \rightarrow Q) \rightarrow (P \rightarrow R))$

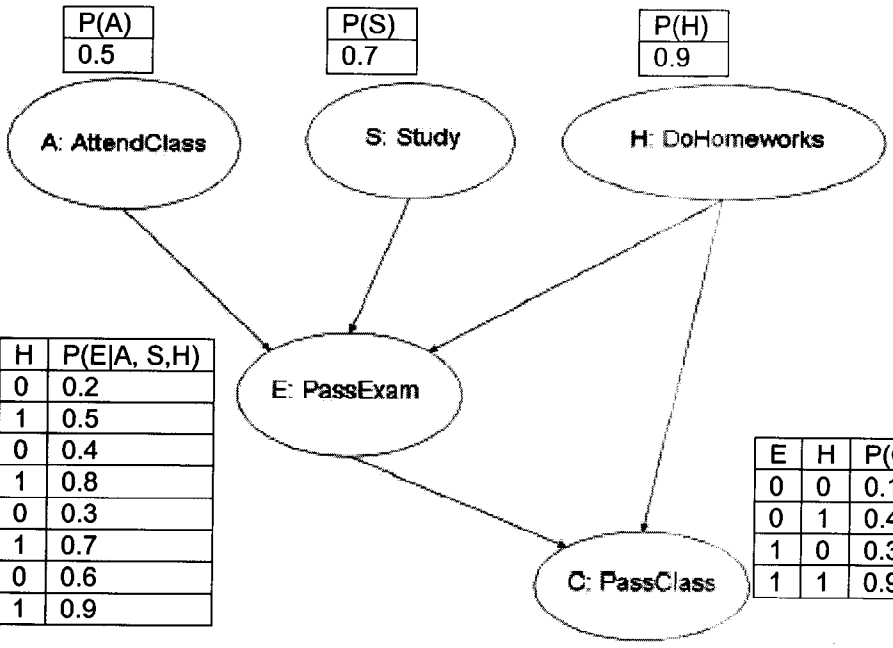
Prove that the given sentence is valid using the Resolution Refutation algorithm.

4. A Bayesian network along with the conditional probability tables is given in Fig 3.

(a) How many independent values are required to store the full joint probability distribution for this problem? 2 mks

(b) Compute the value of P(A, S,H,E,C). 2 mks

(c) Compute the value of P(C|A, S,¬H). 6 mks



A	S	H	P(E|A, S,H)
0	0	0	0.2
0	0	1	0.5
0	1	0	0.4
0	1	1	0.8
1	0	0	0.3
1	0	1	0.7
1	1	0	0.6
1	1	1	0.9

E	H	P(C|E,H)
0	0	0.1
0	1	0.4
1	0	0.3
1	1	0.9

Fig 3: Bayesian Network

5. (a) Assume a domain with three attributes A, B, and C. Each attribute has two possible values T and F. Given below is a set of instances.

A	B	C	Target
T	T	T	Yes
T	T	F	No
T	F	T	Yes
F	T	T	Yes
F	T	F	No
F	F	F	Yes

Calculate the information gain for the attributes A, B, and C. Which attribute would be selected by the standard ID3 algorithm? 8 mks

(b) Consider the following data set. A and B are numerical attributes and Z is a Boolean classification.

A	B	Z
1	2	T
2	1	F
3	2	T
1	1	F

Let P be the perceptron with weights $w_A = 2$, $w_B = 1$, and threshold $T = 4.5$. Without tuning the weights and threshold, show how many of the instances are misclassified. Show your work neatly. 4 mks

6. (a) What is syntactic ambiguity and what is semantic ambiguity? Do you find examples of syntactic ambiguity in the paragraph below? If so, which one(s), and why?

"The population of bears has decreased this season. Most of them hibernate in dens all winter long. There are a lot of plants in and around where bears live. Bears can be friendly or can be wild. We can never bank on them." 6 mks

(b) Assume the following is typed to a newly started LISP: 4 mks

```
(setq a '(* 1 3 9))
(setq b '(+ 3 (car (cdr a))))
```

What does each of the following return:

i) `b`

ii) `(cons 'a a)`

7. Write short notes on any **two** of the following: 10 mks

(a) Sussman Anomaly

(b) Hill climbing

(c) Applications of AI

BITS, PILANI – DUBAI
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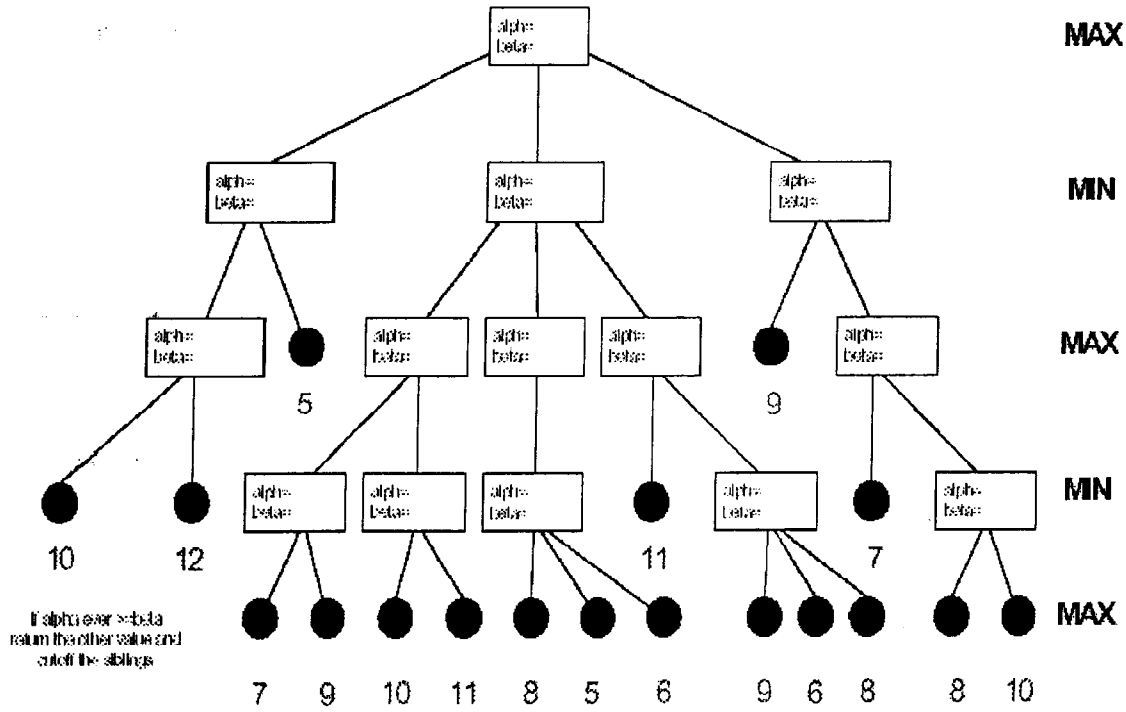
BE (Hons) CS IV Year - 2nd Sem

Course No: EA C461
Course Title: Artificial Intelligence
Test -2 (Open Book)

Date: 12 April 2009 **Time: 50 min** **`Max Marks: 20**

Note: Answer all questions.

1. Do the alpha-beta analysis for the figure below. Cross out the node(s) that are pruned during the analysis. For all other nodes, indicate their alpha and beta values as determined by the alpha-beta algorithm. A game lost by the MAX player scores 0 while a game won by the MAX player scores 100 (i.e. alpha starts out at 0, beta starts out at 100). 5 mks mks



2. Symbolize the following, using the interpretation provided (Universe = people)
W(x): x is wise
N(x,y): x is a neighbour of y
L(x,y,z) = x loves y more than x loves z

a) The wise love some of their neighbours more than they love themselves. 2mks
b) Every neighbour of a wise person loves that person more than anyone else. 3 mks

3. Given the following English statements: 6 mks

a. No software is guaranteed

b. All programs are software

Infer the following using resolution refutation.

c. No programs are guaranteed

Show all the steps to get full marks

4. Describe the evident purpose of the following procedure 4 mks

```
(DEFUN STRANGE (L)
        (COND ((NULL L) NIL)
                ((ATOM L) L)
                (T  (CONS   (STRANGE (CAR L))    (STRANGE (CDR L)) ))
        )
)
```

Take two different lists and show the result. From this infer the purpose.

BITS, PILANI – DUBAI
Academic City, Dubai
BE (Hons) CS IV Year - 2nd Sem

Course No: EA C461
Course Title: Artificial Intelligence
Test -1 (Closed book)

Date: 1 March 2009 **Time: 50 min** **Max Marks: 25**

Note: Answer all questions.

1. Consider the 3-puzzle problem, which is a simpler version of the 8-puzzle where the board is 2 × 2 and there are three tiles, numbered 1, 2, and 3. There are four moves: move the blank up, right, down, and left. The start and goal states are

Start

2	
1	3

Goal

1	2
3	

(a) How many possible states are there, either reachable or unreachable, from the given start state. 2 mks

(b) If we treated the search space as a tree, what would be the result of a 6 mks
i) breadth-first search
ii) depth-first search.
Assume that we always try moving the blank first down, then up, then left and then right. Draw the complete search space reachable from the given start state to the goal state making sure that a given state occurs only once.

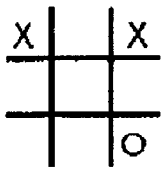
(c) Suppose we use a hill climbing search algorithm on this problem with an evaluation function which counts the number of tiles "out of place" with respect to the goal. Assuming there is no checking for repeated states of any kind, draw the search tree produced labeling nodes and arcs clearly using hill climbing search. Will this lead to a solution? 5 mks

2. Assign a list (a b c d e f) to a variable x. Build expressions using any of the following operations: car, cdr, cons, list, append, reverse, in different sequences along with the variable x, so as to return the following lists: 6 mks
(a) (b c d e f)
(b) (b c d e)
(c) ((a) b c d e f)
Note: Put the brackets properly and evaluate the expression and show the result, so as to get full credit

3. In the game of Tic-Tac-Toe, your goal is to get three O's in a row, either horizontally, vertically, or diagonally. Players alternate placing X's and 0 ' s on the board. If the opponent places three X's in a row, you lose. You decide to use minimax to determine which moves you should make. You use the following heuristic to perform static evaluation:

heuristic(state) = -5 if there are three X's in a row
5 if there are three O ' s in a row
the maximum number of O's in a diagonal, row or column with no X's.
0 otherwise

Suppose the game board looks like this:



The six possible places that you can place an O are indicated in the diagram, labeled **1** , 2, 3,4, 5, and 6.

X	1	X
2	3	4
5	6	O

(a) Where would you place an 0 given the static values associated with each choice and no further search? (In case of a tie, enter the lower/lowest number) 3 mks

(b) If you place the next 0 in cell 1, which spot on the tic-tac-toe board does the opponent place the next X, given the static values produced by the heuristic. (In case of a tie enter the lower/lowest number) 3 mks

To get full credit show the calculations of the static values clearly at each step

BITS, PILANI – DUBAI
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BE (Hons) CS IV Year - 2nd Sem

Artificial Intelligence (AI) : EA C461
Quiz -3-A

Date: 26 March 2009 **Time: 15 min** **Max Marks: 10**

ID NO:_____ **NAME:**_____

We want to design a troubleshooting advisor for PCs. Let CF be a Boolean random variable representing whether the Computer Fails (CF = true) or not. Assume there are two possible causes of failure: Electricity-Failure and Malfunction-of-the-Computer, represented using the Boolean random variables EF and MC, respectively.

Let P(EF) = 0.1, P(MC) = 0.2, P(CF | ~EF, ~MC) = 0.0, P(CF | ~EF, MC) = 0.5, P(CF | EF, ~MC) = 1.0, and P(CF | EF, MC) = 1.0.

(1) Draw the Bayesian Network (with CPTs) for this problem. 2 mks

(2) Compute P(MC | EF) 2 mks

(3) Compute P(CF, ~EF, MC) 3 mks

(4) Compute P(EF | CF) 3 mks

BITS, PILANI – DUBAI
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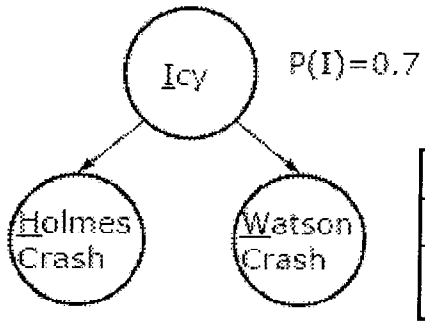
BE (Hons) CS IV Year - 2nd Sem

Artificial Intelligence (AI) : EA C461
Quiz -3- B

Date: 26 March 2009 **Time: 15 min** **Max Marks: 10**

ID NO:_____ **NAME:**_____

Given the following Bayesian Network (with CPTs)



	P(H| I)
I	0.8
¬I	0.1

	P(W| I)
I	0.8
¬I	0.1

(1) Compute P(H|W, ¬I) 2 mks

(2) Compute P(W) 2 mks

(2) Compute P(I | W) 3 mks

4) Compute P(H|W) 3 mks

BITS, PILANI – DUBAI
Academic City, Dubai
BE (Hons) CS IV Year - 1st Sem

Course No: EA C461
Course Title: Artificial Intelligence
Quiz -2 A

Date: 29 October 2008 **Time: 15 min** **Max Marks: 10**

ID NO:_____ **NAME:**_____

I. Multiple choice (5 mks)

1. A* becomes best-first search when ( )
   a. f(n) = g(n) b. f(n) = h(n)
   c. f(n) < g(n) d. f(n) < h(n)

2. Breadth first search (in the worst case) takes ( )
   a. more time than Depth First Search b. less time than Depth First Search
   c. same time as Depth First Search d. None of the above

3. Assume the following is typed to a newly-started LISP:
   ```
   (setq b '(8 (9)))
   (setq c '(cons b c))
   ```
   What does the following return ( )
   ```
   (cons b c)
   ```
   a. (8 (9) b c) b. ((8 (9)) b c)
   c. (8 (9) (b c)) d. None of the above

4. Which of the following first-order logic statements closely correspond to the English sentence: "Tom hit somebody with a hammer" ( )
   a. $\exists x : hit(Tom, x) \Lambda had(Tom, hammer)$ b. $\exists x : hit(Tom, x) \Lambda had(x, hammer)$
   c. $\exists x : hit(Tom, x, hammer)$ d. $\exists x : hit(x) \Lambda had(Tom, hammer)$

5. Use predicate F(x,y) to state that "x can fool y". The translation of the following sentence into predicate logic. "There is no one who can fool everybody" ( )
   a. $\neg\forall x\ \exists y\ F(x,y)$ b. $\neg\exists x\ \forall y\ F(x,y)$
   c. $\neg\forall x\ \exists y\ F(y,x)$ d. None of the above

II. Short Answer: (5mks)

1. Given p → q and q → r, prove by resolution refutation the fact p → r (Show all the steps to get full credit)

BITS, PILANI – DUBAI
Academic City, Dubai
BE (Hons) CS IV Year - 1st Sem

Course No: EA C461
Course Title: Artificial Intelligence
Quiz -2 B

Date: 29 October 2008 **Time: 15 min** **Max Marks: 10**

ID NO:_____ **NAME:**_____

I. Multiple choice (5 mks)

1. Breadth first search is uniform-cost search with ( )
   a. h(n) = 1 b. g(n) = h(n)
   c. g(n) = 1 d. g(n) < h(n)

2. Depth first search (in the worst case) takes ( )
   a. more space than Breadth First Search b. less time than Breadth First Search
   c. less space than Breadth First Search d. more time than Breadth First Search

3. Assume the following is typed to a newly-started LISP:
   ```
   (setq b '(8 (9)))
   (setq c '(list b c))
   ```
   What does the following return ( )
   ```
   (cons b c)
   ```
   a. (8 (9) b c) b. ((8 (9)) b c)
   c. (8 (9) (b c)) d. None of the above

4. Which of the following first-order logic statements closely correspond to the English sentence: "Paul hit somebody with a stone" ( )
   a. $\exists x : hit(Paul, x) \Lambda had(Paul, Stone)$ b. $\exists x : hit(Paul, x) \Lambda had(x, Stone)$
   c. $\exists x : hit(Paul, x, Stone)$ d. $\exists x : hit(x) \Lambda had(Paul, Stone)$

5. Use predicate P(x,y) to state that "x can praise y". The translation of the following sentence into predicate logic. "There is no one who can praise everybody" ( )
   a. $\neg\exists x \forall y$ P(x,y) b. $\neg\forall x \exists y$ P(x,y)
   c. $\neg\forall x \exists y$ P(y,x) d. None of the above

II. Short Answer: (5mks)

Given
~A
~A => ~B Λ ~C
~B => ~D Λ ~E
~C => D V E V F
prove by resolution refutation the fact F (Show all the steps to get full credit)

BITS, PILANI – DUBAI
Academic City, Dubai
BE (Hons) CS IV Year - 2nd Sem

Course No: EA C461
Course Title: Artificial intelligence (AI)
Quiz -1-A

Date: 1 March 2009 **Time: 15 min** **Max Marks: 10**

ID NO:_____ **NAME:**_____

Note: Answer all questions. All questions carry equal marks

1. When comparing tree-search algorithms, we measure the number of nodes expanded. How many nodes are expanded (in the worst case) by each of the following search techniques when searching a tree with branching factor *b* to find a goal at a depth of h? Do not use big Oh notation.

a) Breadth-first search: 5 mks

b) Iterative deepening depth-first search: 5 mks

BITS, PILANI – DUBAI
Academic City, Dubai
BE (Hons) CS IV Year - 2nd Sem

Course No: EA C461
Course Title: Artificial intelligence (AI)
Quiz -1-B

Date: 1 March 2009 **Time: 15 min** **Max Marks: 10**

ID NO:_____ **NAME:**_____

Note: Answer all questions. All questions carry equal marks

1. When comparing tree-search algorithms, we measure the number of nodes expanded. How many nodes are expanded (in the worst case) by each of the following search techniques when searching a tree with branching factor *b* to find a goal at a depth of k? Do not use big Oh notation.

a) Depth-first search: 5 mks

b) Iterative deepening depth-first search: 5 mks