LNMIIT
The LNM Institute of Information Technology

LNMIIT/B.Tech./CSE/CORE/2019-20/ODD/AI/ET

The LNM Institute of Information Technology

Computer Science and Engineering

Artificial Intelligence

End Term

Time: 3 hours | Date: December 09, 2019 | Max. Marks: 50

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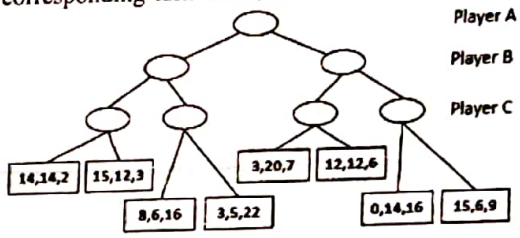
Read the following instructions carefully:

- *There are 10 questions printed on both sides of the paper.*
- **No marks** *for providing just expressions/answers unless accompanied with correct justification and/or derivation.*
- *In case of any doubt, make your assumption, write it clearly and continue.*
- *Unnecessary text will attract negative marking. So think before you write.*

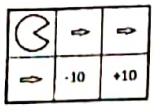
1. Which of the following are true or false? Justify. [4×1]
   (a) In a finite state space, BFS is complete even if zero and negative step costs are allowed.
   (b) DFS always expands at least as many nodes as A* search with an admissible heuristic.
   (c) Uniform-cost search is a special case of A* search.
   (d) Time and space complexity of backtracking will be greater than the DFS tree approach.

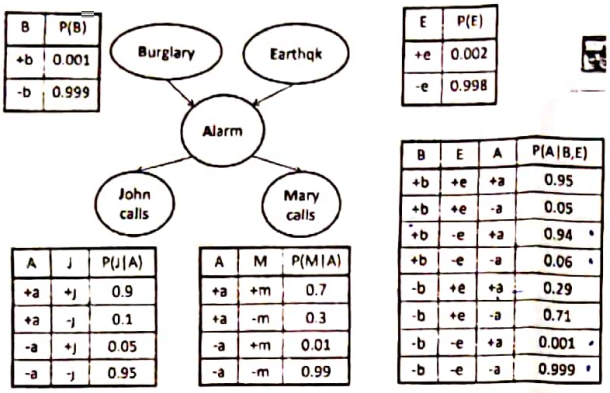
2. Three players A, B and C are playing a game where they want to maximize their individual score. A got first turn then, B and then C. The achievable score by every player is mentioned at the leaves in their corresponding turn order, as shown in figure below.



   (a) What will be the score achieved by each of the player considering each one is perfect player?
   (b) Is pruning possible in this game? If yes, cross out all nodes (explaining the intermediate nodes values) that get pruned. Assume the tree traversal goes from left to right. [1+2]

3. The figure is showing a 3x2 grid where Pacmans wants to maximize the reward. There are two rewards, -10 an +10 as shown and they are also exit points. Whatever move the Pacman takes, he succeeds with 80% in that direction, 10% left, and 10% right. Considering the arrows the initial policy and discount factor 1, explain how the policy iteration works to achieve the optimal policy. Explain at least two iteration of improvements. [3]





B	P(B)
+b	0.001
-b	0.999

E	P(E)
+e	0.002
-e	0.998

B	E	A	P(A|B,E)
+b	+e	+a	0.95
+b	+e	-a	0.05
+b	-e	+a	0.94
+b	-e	-a	0.06
-b	+e	+a	0.29
-b	+e	-a	0.71
-b	-e	+a	0.001
-b	-e	-a	0.999

A	J	P(J|A)
+a	+j	0.9
+a	-j	0.1
-a	+j	0.05
-a	-j	0.95

A	M	P(M|A)
+a	+m	0.7
+a	-m	0.3
-a	+m	0.01
-a	-m	0.99

Figure 1: This is our default Bayes' Net (BN), unless stated otherwise in a question. The story remains as discussed in classes.

4. (a) Model a scenario in which a coin toss has three possible outcomes, HEADS, TAILS, and UP-RIGHT. Define an appropriate random variable and give its marginal distribution.
   (b) Compute $P(A|A \wedge B)$ and $P(A|A \vee B)$ [2+2]

5. (a) Convert the default BN, possibly altering CPTs at each node, to effectively making all the five nodes absolutely independent.
   (b) Assume we have added two more nodes in the default BN, i.e., Richness (R) → Burglary and Tectonic Plates (T) → Earthquake. Reason for
      i. R⫫M|A
      ii. R⫫E|A
      iii. R⫫T|A
   (c) Draw a Bayes' Net corresponding to the chain rule for the default Bayes' Net. Show that subject to the some conditional independencies (write them), it can be reduced to the Bayes' Net provided in Figure 1. [2+3*1+2]

6. In the Bayes' Net given in Figure 1, using inference by enumeration,
   (a) compute $P(+b, +e, -a, +j, +m)$
   (b) compute $P(M|-j, +e)$ [1+4]

7. (a) In the Bayes' Net given in Figure 1, using variable elimination, compute $P(B|+e, +j)$.
   (b) How does it compare with computing the same using inference by enumeration?
   (c) Also compare the computational complexity of considering the following orderings on joining and elimination of variables given that query is B and evidence is +e.
      i. A,M,J
      ii. J,M,A [4+1+(1+1)]

8. (a) The algorithm for likelihood weighting is provided below. Show that it is consistent with prior distribution.

   - Input: evidence instantiation
   - w = 1.0
   - for i = 1, 2, ..., n
     - if X_i is an evidence variable
       - X_i = observation x_i for X_i
       - Set w = w * $P(x_i \mid Parents(X_i))$
     - else
       - Sample x_i from $P(X_i \mid Parents(X_i))$
   - return $(x_1, x_2, ..., x_n)$, w

   (b) In the default BN, if +j,+m are the evidences, discuss the limitation of sampling through likelihood weighting. What happens if +b and +e are the evidences instead? [2+(1+1)]

9. (a) With the help of proper diagram, formulate a reinforcement learning problem as an MDP.
   (b) What is the difference between model based and model free reinforcement learning?
   (c) Write update equations for T-D value learning.
   (d) What are the problems with T-D value learning? [2+2+1+1]

10. (a) Write equation for Q-value iteration.
    (b) Discuss an important property of Q-learning.
    (c) What is exploration vs exploitation tradeoff?
    (d) Discuss the main difference between exploration of $\mathcal{E}$-greedy and exploration functions. [2+1+2+2]