LNMIIT/B.Tech./CSE/CORE/2018-19/ODD/AI/EndTerm

LNMIIT
The LNM Institute of Information Technology

# Artificial Intelligence (AI)

End Term

Date: December 5, 2018

Max. Marks: 50

Time: 3 Hours

16UCS126

*NOTE:*

- *There are 15 questions printed on 4 pages*
- *In case of any doubt, write your assumptions, write it clearly and continue.*
- *No marks for providing just expressions/answers unless accompanied with correct justification and/or derivation.*
- ***Attempt all the part of Q1 first and then other questions.***

Q 1. Consider the game provided in figure 1. It is a variant of chess but the rules of chess are followed except those mentioned here. The game is won by a player if the other player looses all the pieces.

A. Provide an evaluation function for the above game. You need to justify this evaluation function.
B. Draw for the first two levels of tree (excluding the root node) and mark those states that can be pruned.
C. Now consider a single player version of the game. In this game, your goal is to make moves such that the players on the board switch, i.e., row 2 becomes row 7 and vice versa. All the pieces of row 1 should occupy places in row 8 and vice versa. However, their order need not be preserved. For example, a bishop may take place of a rook, knight or queen. Note: Be precise. You already knew what is coming so don't write irrelevant things. design algo that accomplish this.

**[4+2+4 Marks]**

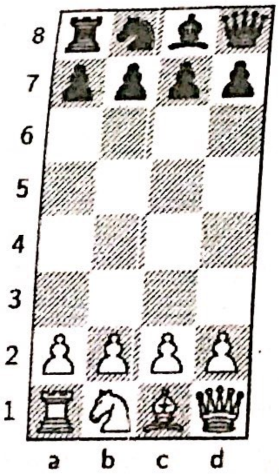

Figure 1: Chess board for this problem

Q 2. Show that the statement of conditional independence **[1 mark]**

$$P(X,Y|Z)=P(X|Z)P(Y|Z)$$

is equivalent to the statement $P(X|Y,Z)=P(X|Z)$?

Q3. In an oral exam, you have to solve exactly one problem, which might be one of three type, A, B, and C, which will come up with probability 30%, 20%, and 50% respectively. During your preparation, you have solved 9 of 10 problems of type A, 2 of 10 problems of type B, and 6 of 10 problems of type of C.

A. What is the probability that you will solve the problem of the exam? **[1 mark]**
B. Given, you have solved the problem, what is the probability that it was type A? **[1 mark]**

Q4. Consider two medical tests, A and B, for a virus. Test A is 95% effective at recognizing the virus when it is present, but has a 10% false positive rate (indicating that the virus is present, when it is not). Test B is 90% effective at recognizing the virus, but has a 5% false positive rate. The two tests use independent methods of identifying the virus. The virus is carried by 1% of all people. Say that a person is tested for the virus using only one of the tests, and that test comes back positive for carrying the virus. Which test returning positive is more indicative of someone really carrying the virus? **[2 marks]**

Q5. Assume you have three boxes, each containing a certain number of apples and oranges. At any point in time, you select a box at random, and then a fruit from that box (i.e., an apple or orange) and record your finding (*A* for apple and *o* for orange). You immediately replace the fruit so that the total number of apples and oranges stays the same over time, and repeat the process. Unfortunately, you forgot to write down the boxes you chose and simply have an account of apples and oranges. Assume the following quantity of fruits:

- **Box 1**: 2 apples, 2 oranges
- **Box 2**: 3 apples, 1 orange
- **Box 3**: 1 apple, 3 oranges

A. Draw a hidden Markov model to represent this problem. Show a state diagram in addition to two-dimensional parameter arrays *T* (for transitions) and *E* (for emission probabilities). **[2 marks]**

B. Compute the probability of seeing box sequence $\pi = (1,1,3,3,2)$ and fruit sequence x = (A,A,O,O,A). Show your work. **[1 mark]**

C. Use the Viterbi algorithm to compute the most probable state sequence for the string A, A, O, O, A. Show your work, and report both the state sequence and its probability. **[4 marks]**

Q6. In HMM, exact inference is not efficient in terms of computation cost for the models where the domain space of random variable is very large or continuous. Explain an approach to perform approximate inference in such type of models. **[3 marks]**

Q 7. In case of markov model, influence of the initial distribution gets less and less over time. Explain with an example, how this property helps in real-life applications? **[2 marks]**

Q8. Draw the corresponding Bayesian network for the below joint distribution probability equation
$P(A,B,C,D,E,F,G)=P(G|E)P(E|B)P(F|C,D)P(C)P(D|A,B)P(B)P(A)$ **[1 mark]**

Q9. Consider the following scenario:

Imagine you are at a birthday party of a friend on Sunday and you have an exam on Monday. If you drink so much alcohol at the birthday party, you most likely have problems concentrating the next day, which would reduce the probability that you pass the exam. Another consequence of the reduced concentration might be increased stress with your flatmates, because, e. g, you forget to turn off the radio or the stove. Lack of concentration might also be caused by your pollen allergy, which you suffer from on some summer days.

Consider the following random variables that can assume values "TRUE" or "FALSE": A: drinking too much alcohol on Sunday, P: Pollen allergy strikes, C: reduced concentration on Monday, E: you pass the exam, S: stress with your flatmates.

A. Draw the Bayesian Network. **[1 mark]**

B. Write all the condition independencies asserted by the network. **[2 marks]**

Q 10. For the given Bayesian Network in figure 2, show P(D|CEG) = P(D|C) or not? **[1 mark]**

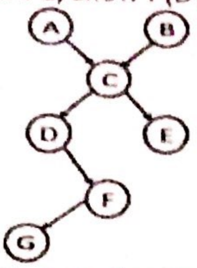


Figure 2: Bayesian Network

Q 11. In the triplet of random variable having causal chain relationship (X and Z have common cause Y), prove that X and Z are independent given Y. **[1 mark]**

Q 12. For the given Bayesian Network in figure 3 and query P(J), compute the complexity of inference for the following two orders while performing the variable elimination technique? **[1.5X2=3 marks]**

A. G,I,S,L,H,C,D
B. C,D,I,H,G,S,L

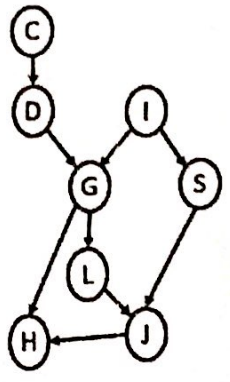


Figure 3: Bayesian Network

Q 13. *For the network given below in figure 4,* calculate the conditional probability P(p1|+p2,-p3) using

A. *Exact inference applying the method of enumeration.*
B. Approximate inference applying direct sampling method (generate at least 5 samples)
C. Approximate inference applying rejection sampling method (generate at least 5 samples)

**[2+2+2= 6 marks]**

| $P(+p_1)$ |
|---|
| 0.4 |

| $P(+p_2 \mid p_1)$ | | |
|---|---|---|
| $p_2$ | $+p_1$ | 0.8 |
| $p_2$ | $-p_1$ | 0.5 |

| $P(+p_3 \mid p_2)$ | | |
|---|---|---|
| $p_3$ | $+p_2$ | 0.2 |
| $p_3$ | $-p_2$ | 0.3 |

| $P(+p_4 \mid p_2)$ | | |
|---|---|---|
| $p_4$ | $+p_2$ | 0.8 |
| $p_4$ | $-p_2$ | 0.5 |

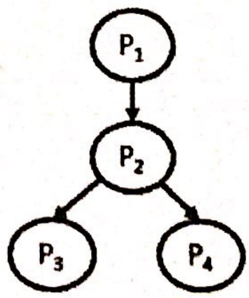


**Figure 4: Bayesian Network**

| r1 | r2 | r3 | r4 | r5 | r6 | r7 | r8 | r9 | r10 | r11 | r12 | r13 | r14 | r15 | r16 | r17 | r18 | r19 | r20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.25 | 0.50 | 0.69 | 0.89 | 0.95 | 0.54 | 0.13 | 0.14 | 0.25 | 0.84 | 0.08 | 0.90 | 0.76 | 0.14 | 0.58 | 0.63 | 0.50 | 0.80 | 0.01 | 0.69 |

**The above table gives an output of a uniform random number generator on the interval (0, 1), Use the table to generate samples.**

Q 14. Discuss pros and cons of rejection sampling, likelihood weighting and Gibbs sampling, with example. **[4 marks]**

Q 15. A tennis player will play or not on a particular day depends on the four parameters namely Outlook (O), Temperature (T), Humidity (H), and Wind (W). Let's consider the following table which provides the value of parameters for few days with the outcome for playing a match or not. The table have been used for the training purpose of the Bayesian network.

**A.** Explain, what will happen if during the testing, the observed values are O=Overcast, T=Cool, H=High and W=Strong?

**B.** Describe one approach to address the issue. **[1+ 3 marks]**

| Day | Outlook | Temperature | Humidity | Wind | Play Tennis |
|---|---|---|---|---|---|
| D1 | Sunny | Hot | High | Weak | No |
| D2 | Sunny | Hot | High | Strong | No |
| D3 | Sunny | Hot | High | Weak | Yes |
| D4 | Rain | Mild | High | Weak | Yes |
| D5 | Rain | Cool | Normal | Weak | Yes |
| D6 | Rain | Cool | Normal | Strong | No |
| D7 | Overcast | Cool | Normal | Weak | No |
| D8 | Sunny | Mild | High | Strong | No |
| D9 | Sunny | Cool | Normal | Weak | Yes |
| D10 | Rain | Mild | Normal | Weak | Yes |