L-3/T-2/CSE **Date : 18/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2021-2022

Sub : **CSE 317** (Artificial Intelligence)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) "Surely computers cannot be intelligent – they can do only what their programmers tell them." Is the latter statement true, and does it imply the former? Describe it in detail using the concepts of evolutionary algorithm. **(20)**

   (b) For each of the following activities, give a PEAS description of the task environment **(15)**

   (i) Bidding on an item at an auction

   (ii) Medical diagnosis system

   (iii) Interactive English tutor

2. (a) Explain why problem formulation must follow goal formulation. **(10)**

   (b) The traveling salesman problem (TSP) is described as follows: **(25)**

   "Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly one time and returns to the origin city?" Describe in detail how we can solve TSP by applying genetic algorithm with appropriate representation scheme and operators.

3. (a) Describe simulated annealing algorithm with the help of its pseudo code. Explain how this algorithm can avoid local optima problem of a greedy search algorithm. **(20)**

   (b) Show that A* search algorithm is optimal if the heuristic used in it is admissible and/or consistent. **(15)**

4. (a) Describe the main challenges of adversarial search as contrasted with single-agent search. Explain why it is a good heuristic to choose the variable that is the most constrained but the value that is the least constraining in a CSP search. **(15)**

   (b) Show that the worst case time complexity the arc-consistency algorithm AC-3 is in cubic order. **(20)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) We have a bag of three biased coins *a, b,* and *c* with probabilities of coming up heads of 20%, 60%, and 80%, respectively. One coin is drawn randomly from the bag (with equal chance of drawing each of the three coins), and then the coin is flipped three times to generate the outcomes X_1, X_2, and X_3. **(6+12=18)**

Contd P/2

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Contd ... Q. No. 5(a)

(i) Construct a Bayesian network corresponding to this setup and state the necessary conditional probability tables (CPTs).

(ii) Compute which coin was most likely to have been drawn from the bag if the observed flips come out as X_1 = head, X_2 = head, and X_3 = tail.

(b) Let H_x be a random variable denoting the handedness of an individual x, with possible values l or r. A common hypothesis is that left- or right-handedness is inherited by a simple mechanism; that is, perhaps there is a gene G_x, also with values l or r, and perhaps actual handedness turns out mostly the same (with some probability s) as the gene an individual possesses. Furthermore, perhaps the gene itself is equally likely to be inherited from either of an individual's parents, with a small nonzero probability m of a random mutation flipping the handedness. **(5+6+6=17)**

(i) Show which of the three networks shown in Figure 5 satisfy the following equation:

$$\boldsymbol{P}(G_{father}, G_{mother}, G_{child}) = \boldsymbol{P}(G_{father})\boldsymbol{P}(G_{mother})\boldsymbol{P}(G_{child})$$

(ii) Compute the conditional probability table (CPT) for the G_{child} node in network (a) (of Figure 5), in terms of s and m.

(iii) Suppose the $P(G_{father} = l) = P(G_{mother} = l) = q$. in the given network (a) (of Figure 5), compute an expression for $P(G_{child} = l)$ in terms of m and q only, by conditioning on its parent nodes.

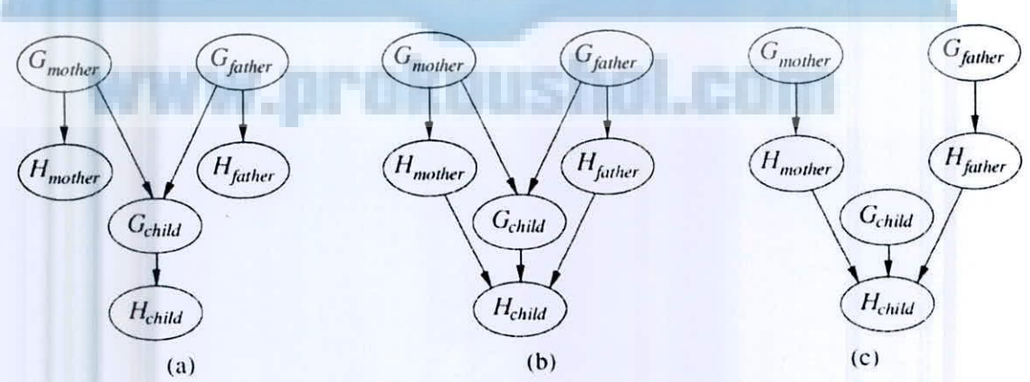

Figure 5

6. (a) Discuss why overfitting is bad in machine learning. Briefly explain How you would prevent overfitting in decision tree learning. **(7)**

(b) Why is a complex hypotheses space not always preferred in machine learning? Justify with respect to Occam's razor principle. **(5)**

Contd P/3

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Contd ... Q. No. 6

(c) A professor wants to know if students are getting enough sleep. Each day, the professor observes whether the students in the class have red eyes. The professor has the following domain theory: The prior probability of getting enough sleep, with no observations, is 0.7. The probability of getting enough sleep on night t is 0.8 given that the student got enough sleep the previous night, and 0.3 if not. The probability of having red eyes is 0.2 if the student got enough sleep, and 0.7 if not. Answer the following questions. **(8+15=23)**

(i) Build a hidden Markov model (HMM) to formulate the above problem that the professor could use to filter or predict from a sequence of observations. Show the state transition probabilities (transition model) and observation probabilities (sensor model).

(ii) Let the state variable be X_t = $EnoughSleep_t$. Given the evidence values $\boldsymbol{e}_1$ = not red eyes, $\boldsymbol{e}_2$ = red eyes, and $\boldsymbol{e}_3$ = red eyes for the first three days, compute the filtered estimates $P(X_t|\boldsymbol{e}_{1:t})$ for each of t = 1,2,3 using filtering algorithm. Using the filtered estimate, compute smoothed probability estimates $P(X_t|\boldsymbol{e}_{1:3})$ for each of t = 1,2,3 using forward-backward algorithm.

7. (a) Sometimes Markov decision processes (MDPs) are formulated with a reward function $R(s, a)$ that depends on the action a taken on state s or with a reward function $R(s, a, s')$ that also depends on the outcome state s'. Express the Bellman equations for these formulations. **(7)**

(b) Figure 7 shows an instance of a grid world Markov decision process (MDP). Shaded cells represent walls. In all states, the agent has available actions UP (↑), Down (↓), Left (←), and Right (→). Performing an action that would transition to an invalid state (outside the grid or into a wall) results in the agent remaining in its original state. In states with an arrow coming out, the agent has an additional action *EXIT*. In the event that the *EXIT* action is taken, the agent receives the labeled reward and ends the game in the terminal state *T*. Unless otherwise stated, all other states generate no reward, and all transitions are deterministic (not stochastic). Let the discount factor be $\gamma = ½$. **(16)**

Suppose that we are performing value iteration algorithm on the given grid world MDP. Assume that value iteration begins with all states initialized to zero, i. e., $U(s) = 0 \forall s$. Compute the optimal utility values $U(s)$ for states (i.e., cells in the grid) A and B. Show the utility values $U(s)$ for all states after every iteration of the value iteration algorithm. Show the optimal policy.

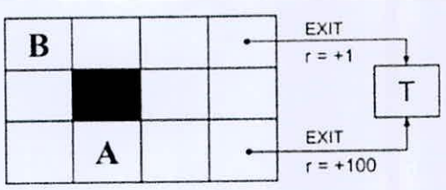

Figure 7

Contd P/4

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Contd ... Q. No. 7

(c) Consider the following random process. A magician has three coins, each of which has a distinct type. One is a fair coin (50/50 odds of heads vs tails). The other two are tricky coins: one has heads on both sides and the other has tails on both sides. At every time step, the magician picks a coin randomly with the exception that a fair coin is not picked at two successive time steps (in which case remaining coins are equally likely to be chosen). After picking a coin (without actually showing you which coin was picked), the magician flips (toss) it, and shows you the result, However, unfortunately, the magician only shows you the coin very briefly, and 10% of the time you make a mistake when you observe the true side of the coin (e.g., you see heads when it was actually tails). Construct a hidden Markov model (HMM) to formulate the problem. Show the state transition probabilities (transition model) and observation probabilities (sensor model). **(12)**

8. (a) Consider the following data set comprised of three binary input attributes (A_1,A_2, and A_3) and one binary output y: **(16)**

Example	A_1	A_2	A_3	Output y
x_1	1	0	0	0
x_2	1	0	1	0
x_3	0	1	0	0
x_4	1	1	1	1
x_5	1	1	0	1

Construct a decision tree for these data. Show the entropy and information-gain computations made to determine the attribute to split at each node.

(b) Discuss how would you handle the following cases in decision tree learning? (i) No examples left at a child node, (ii) No attributes are left, but both positive and negative examples remain at a child node, and (iii) Missing values in an attribute. **(6)**

(c) Consider the Bayes net shown in Figure 8 with Boolean variables B = *BrokeElectionLaw*, I = *Indicted*, M = *PoliticallyMotivatedProsecutor*, G = *FoundGuilty*, J = *Jailed*. Using variable elimination algorithm, compute the probability that someone goes to jail given that they broke the law, have been indicted, and face a politically motivated prosecutor. **(13)**

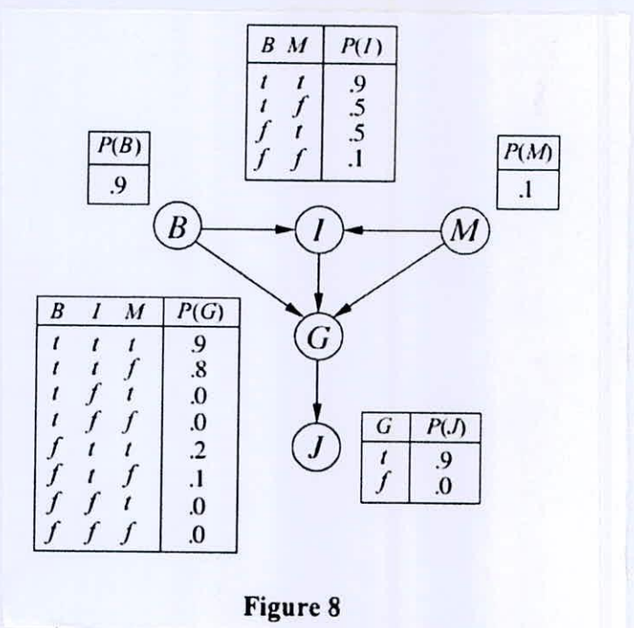

Figure 8

L-3/T-2/CSE Date: 05/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CSE 317** (Artificial Intelligence)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Define the terms intelligent and rationality. Why would evolution tend to result in systems that act rationally? Which goals are such systems designed to achieve? (Use the concepts of evolutionary algorithm in answering the second and third parts of this question). **(20)**

   (b) Discuss Turing test in detail. In a Turing test which question would you ask an AI system to verify that it is really intelligent and is not just imitating what it thinks a human would do? **(15)**

2. (a) Draw the block diagram of a general learning agent and discuss each component of the diagram in detail. Explain how the learning agent differs from a model based agent. **(20)**

   (b) Write pseudo code of a simple problem-solving agent that first formulates a goal and a problem, searches for a sequence of actions that would solve the problem, and then executes the actions one at a time. **(15)**

3. (a) The missionaries and cannibals problem is usually stated as follows. Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place. **(22)**

   i. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution. Draw a diagram of the complete state space.

   ii. Describe an appropriate search algorithm to solve the problem optimally. Is it good idea to check for repeated states?

   (b) Describe a state space in which iterative deepening search performs much worse than depth-first search. **(13)**

4. (a) Describe how the minimax and alpha-beta algorithms change for two-player, nonzero-sum games in which each player has a distinct utility function and both utility functions are known to both the players. If there are no constraints on the two terminal utilities, is it possible for any node to be pruned by alpha-beta? What if the player's utility functions on any state differ by at most a constant k, making the game almost cooperative? **(23)**

Contd P/2

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Contd... Q. No. 4

(b) Compare simulated annealing and greedy search algorithms based on their advantages and pitfalls. **(12)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

If you find any information missing in the question. Just assume a value of your choice and clearly mention your assumption.

5. (a) Consider the function named *check_all*, shown in Figure for Q.5(a), used for implementing the Model Checking inference algorithm for propositional logic. Its parameters are **(15)**

- knowledge: knowledge base used to draw inferences
- query: a query, or the proportion that we are interested in whether it is entailed by the knowledge base
- symbols: a list of all the symbols (or atomic propositions) used
- model: an assignment of truth and false values to symbols

Can this *check_all* function correctly implement the Model Checking algorithm? If not, explain why this function fails to correctly implement the Model Checking algorithm by referring to the relevant lines of code.

```
1   def check_all(knowledge, query, symbols, model):
2       """Checks if knowledge base entails query, given a particular model."""
3
4       # If model has an assignment for each symbol
5       if not symbols:
6
7       # If knowledge base is true in model, then query must also be true
8           if knowledge.evaluate(model):
9               return query.evaluate(model)
10          return True
11      else:
12
13          # Choose one of the remaining unused symbols
14          remaining = symbols.copy()
15          p = remaining.pop()
16
17          # Create a model where the symbol is true
18          model_true = model.copy()
19          model_true[p] = True
20
21          # Create a model where the symbol is false
22          model_false = model.copy()
23          model_false[p] = False
24
25          # Ensure entailment holds in both models
26          return (check_all(knowledge, query, remaining, model_true) or
27                  check_all(knowledge, query, remaining, model_false))
28
```

Figure for Q.5(a)

Contd P/3

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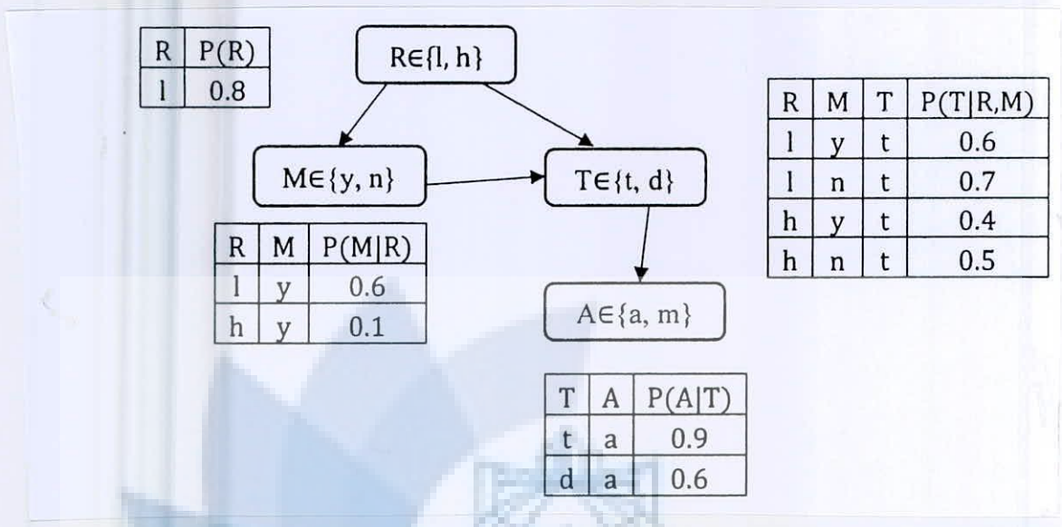
Contd... Q. No. 5

(b) Consider the Bayesian Network and corresponding probability tables shown in Figure for Q.5(b). Now based on the observation T = d, calculate the updated probability distribution of M and R using inference by enumeration. **(20)**



R	P(R)
l	0.8

R	M	P(M|R)
l	y	0.6
h	y	0.1

R	M	T	P(T|R,M)
l	y	t	0.6
l	n	t	0.7
h	y	t	0.4
h	n	t	0.5

T	A	P(A|T)
t	a	0.9
d	a	0.6

Figure for Q.5(b)

6. (a) Consider the knowledge base (KB) comprising eigth First-Order Logic sentences each converted into Conjunctive Normal Form shown in Figure for Q.6(a). Here **(20)**

- A, B, C, D, E, F, G, H are predicates
- x, y, z, are variables
- M_1, M_2, M_3, M_4, are constants

Using Resolution, prove that KB ⊨ E (M_2).

1. $\neg F(M_1, x) \vee \neg G(x) \vee D(M_2, x, M_1)$
2. $\neg H(x, M_3) \vee C(x)$
3. $\neg G(x) \vee B(x)$
4. $F(M_1, M_4)$
5. $\neg A(x) \vee \neg B(y) \vee \neg C(z) \vee \neg D(x, y, z) \vee E(x)$
6. $G(M_4)$
7. $A(M_2)$
8. $H(M_1, M_3)$

Figure for Q.6(a)

Contd P/4

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Contd... Q. No. 6

(b) Suppose you want to keep track of an animal in a triangular enclosure using sound. You hav 3 microphones that provide unreliable (noisy) binary information at each time step. The animal is either close to one of the 3 points of the triangle or in the middle of the triangle. If the animal is in a cornet, it will be detected by the microphone at that corner with probability 0.6, and will be independently detected by each of the other microphones with a probability of 0.1. If the animal is in the middle, it will be detected by each microphone with probability of 0.4. If the animal is in a corner it stays in the same corner with probability 0.8, goes to the middle with probability 0.1 or goes to one of the other corners with probability 0.05 each. If it is the middle, it stays in the middle with probability 0.7, otherwise it moves to one the corners, each with probability 0.1. Initially the animal is in one of the four states, with equal probability. **(15)**

Now you have to formulate the above scenario using a Hidden Markov Model. What are the hidden states? List the possible observations at any time step? Construct the appropriate observation model and transition model in tabular format.

7. (a) Suppose we want our AI agent to learn the meaning of 10 words based on valid sentences composed only of those words stored in a document. To accomplish this, we want to semantically represent each word as a 3-D vector of real values between -1.0 to 1.0. Also we want to use the Skip-Gram Architecture which is a neural network architecture for predicting context given a target word. Draw the required neural network architecture clearly showing the number of neurons in each layer. Discuss which layer of this architecture represents the target, meaning, and context respectively. **(20)**

(b) Q-Learning is a model of reinforcement learning, where a function Q(s, a) outputs an estimate of the utility value of taking action a in state s. Every time we take an action a in state s to reach a new state s' and observe a reward r, we update Q(s, a) based on the following mechanism. **(15)**

$$Q(s, a) \leftarrow Q(s, a) + \alpha((r + \gamma \max_{a'} Q(s', a')) - Q(s, a))$$

Explain the intuitions behind the components of this update mechanism. You must discuss the effect of increasing/decreasing the values of α and γ.

8. (a) Explain the Perceptron learning rule for binary classification task using necessary equation. **(15)**

Contd P/5

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Contd... Q. No. 8

(b) Consider the program (Figure for Q.8(b)) that parses a given English sentence using the syntax defined by a Contest-Free Grammar, Show the output of this program for the input 'she saw car on street with dog'. **(20)**

```
import nltk

grammar = nltk.CFG.fromstring("""
    S -> NP VP

    AP -> A | A AP
    NP -> N | D NP | AP NP | N PP
    PP -> P NP
    VP -> V | V NP | V NP PP

    A -> "big" | "blue" | "small" | "dry" | "wide"
    D -> "the" | "a" | "an"
    N -> "she" | "city" | "car" | "street" | "dog" | "binoculars"
    P -> "on" | "over" | "before" | "below" | "with"
    V -> "saw" | "walked"
""")

parser = nltk.ChartParser(grammar)

sentence = input("Sentence: ").split()
try:
    for tree in parser.parse(sentence):
        tree.pretty_print()
except ValueError:
    print("No parse tree possible.")
```


Figure for Q.8(b)

L-3/T-2/CSE **Date : 28/03/2020**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2019-2020

Sub : **CSE 317** (Artificial Intelligence)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Why would evolution tend to result in systems that act rationally? What goals are designed to achieve for such systems? **(15)**

   (b) What is Turing Test in the context of artificial intelligence? Explain what kind of capacities computer would need to possess for passing Turing test. **(20)**

2. (a) Define in your own words the following terms: agent, agent program, rationality and autonomy. **(10)**

   (b) Write agent programs (in pseudocode form) for the goal-based and utility-based agents. **(15)**

   (c) Discuss various parameters used for measuring problem-solving performance of search algorithms. **(10)**

3. (a) What are the main bottlenecks of depth first search and depth limited search algorithm? Using an appropriate example, explain how IDS (Iterative Deepening Search) algorithm solves those problems. **(13)**

   (b) What is the main pitfall of greedy algorithms? Discuss this pitfall in detail. Explain how an evolutionary algorithm can solve it. What evolutionary operator is more suitable for avoiding such a pitfall? Justify your answer using an appropriate example? **(22)**

4. (a) Explain why it is a good heuristic to choose the variable that is most constrained but the value that is least constraining in a CSP search. Discuss AC-3 algorithm with the help of its pseudo code. What is the worst-case complexity of running AC-3? **(17)**

   (b) Describe how the minimax and alpha-beta algorithms are to be changed for two-player, non-zero-sum games in which each player has a distinct utility function and both utility functions are known to both players. If there are no constraints on the two terminal utilities, is it possible for any node to be pruned by alpha-beta? **(18)**

Contd P/2

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Suppose two pathological tests, A and B, can identify the presence of a virus in a person's body. If the virus is present, Test A is 95% effective in recognizing it. But the false positive (i.e. recognizing the virus if it is absent) rate of Test A is 10%. On the other hand, Test B is 90% effective in recognizing the virus if it is present, but it has a false positive rate of 5%. You can assume that the tests are independent of each other. Say that a person is tested for a virus using only one of the tests, and that test comes back positive for carrying the virus. If the virus is carried by 0.1% of all people, calculate the appropriate probabilities to determine which test returning positive is more indicative of someone really carrying the virus. **(15)**

(b) Calculate P(W | dry) given the probability distributions in the **Tables for Q. 5(b).**

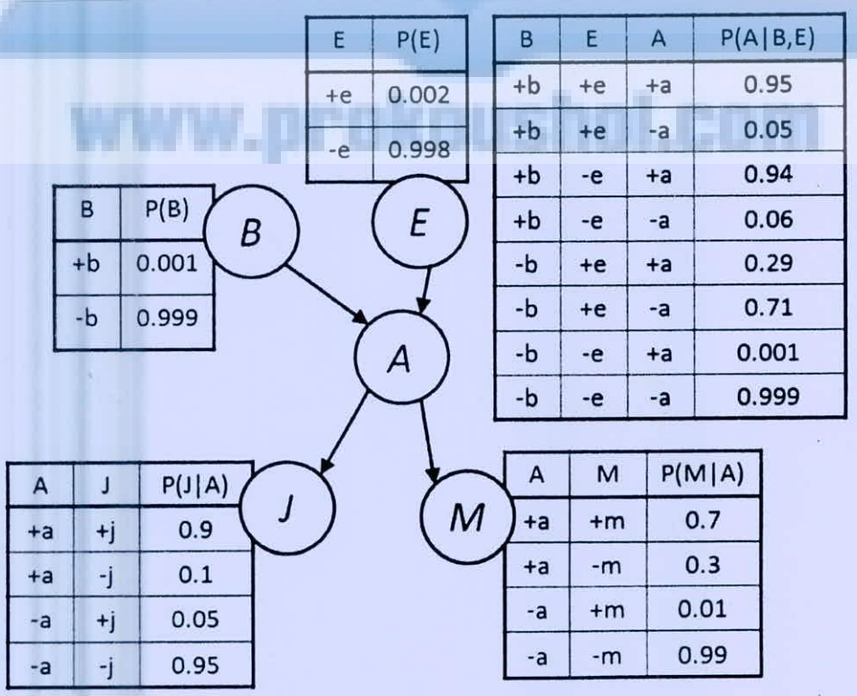
W	P(W)
sun	0.85
rain	0.15

D	W	P(D | W)
wet	sun	0.1
dry	sun	0.9
wet	rain	0.75
wet	rain	0.25

Tables for Q. 5(b)

(c) What are the problems of Rejection Sampling in Bayesian networks? How does Likelihood Weighting solve them? Explain with an example. **(10)**

6. (a) Calculate P(B | –e, +j) from the Bayesian network shown in the **Figure for Q.6**. **(15)**



E	P(E)
+e	0.002
-e	0.998

B	P(B)
+b	0.001
-b	0.999

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 for Q.6

Contd P/3

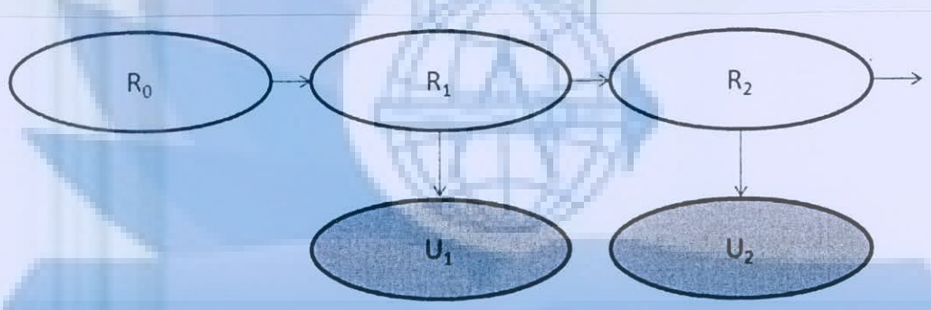
Contd...Q. No. 6

(b) Calculate P(+e | +m, +j) from the Bayesian network shown in the **Figure for Q. 6**, using the method of inference by Variable Elimination. **(20)**

7. (a) Mathematically express the conditions of stationary distribution for a first order Markov chain. If any state at time t, X_t can attain one of only two values, x_1 and x_2, show that $P(X_\infty)$ depends on transition probability but is independent of initial probability distribution. **(15)**

(b) Consider the Hidden Markov Model shown in the **Figure for Q. 7(b).** Calculate the belief state at time step = 2, given the following information. Also, justify the statement, "Uncertainty accumulates as time passes and decreases as we get observations", from your calculation. **(20)**

- Initial belief state: $B(R_0) = 0.6$ when $R_0 = +r$ and 0.4 when $R_0 = -r$.
- Observation at time step = 1: $U_1 = +u$
- Observation at time step = 2: $U_2 = -u$



R_t	R_{t+1}	$P(R_{t+1} \mid R_t)$
+r	+r	0.7
+r	-r	0.3
-r	+r	0.3
-r	-r	0.7

R_t	U_t	$P(U_t \mid R_t)$
+r	+u	0.9
+r	-u	0.1
-r	+u	0.2
-r	-u	0.8

Figure for Q.7(b)

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8. (a) Consider the following dataset, shown in the **Table for Q. 8(a)**, comprised of three binary input attributes (A_1, A_2, A_3) and one binary output (y). **(12+3=15)**

A_1	A_2	A_3	y
1	0	0	0
1	0	1	0
0	1	0	0
1	1	1	1
1	1	0	1

Table for Q.8(a)

(i) Construct a decision tree based on the information gain heuristic for these data. Show the calculations in detail.

(ii) How will your decision tree classify the instance (0, 1, 1)?

(b) Draw the Bayesian network topology of a Naive Bayes classifier assuming there are three features. What are the parameters that need to be learnt in this model? **(10)**

(c) Write short notes on the following. **(5+5=10)**

(i) Supervised Learning

(ii) Overfitting

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations (January 2020 Semester)

Sub: **CSE 317** (Artificial Intelligence)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1(a)	Are reflex actions (such as flinching from a hot stove) rational? Are they intelligent?	(5)
(b)	Why would evolution tend to result in systems that act rationally? What goals are such systems designed to achieve?	(10)
(c)	Explain the differences among genetic algorithms, evolutionary programming and genetic programming.	(15)
2(a)	For each of the following activities, give a PEAS description of the task environment and characterize it in terms of the properties of i. bidding on an item at an auction and ii. automated taxi driving.	(10)
(b)	Explain why problem formulation must follow goal formulation.	(05)
(c)	How does a simple reflex agent differ from a goal based agent? "Learning agent is suitable for dynamic environment" – Justify this statement with an appropriate example.	(15)
3(a)	Prove each of the following statements, or give a counterexample: i. Breadth-first search is a special case of uniform-cost search. ii. Depth-first search is a special case of best-first tree search. iii. Uniform-cost search is a special case of A^* search.	(21)
(b)	Explain how uninformed search algorithm differs from informed search algorithm. Discuss an environment where informed search algorithm can perform better than uninformed search algorithm.	(9)
4(a)	What is the main problem of a greedy algorithm? How can the incorporation of simulated annealing algorithm solve this problem? Write the pseudocode of this hybrid (greedy + simulated annealing) algorithm that will utilize the complementary strengths of these two algorithms.	(15)
(b)	Explain why it is a good heuristic to choose the variable that is *most* constrained but the value that is *least* constraining in a CSP search.	(7)
(c)	Explain the functions of inference engine and knowledge-base of a logical agent. Explain why the use of entailment is necessary for such an agent.	(8)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations (January 2020 Term)

Sub: **CSE 317** (Artificial Intelligence)

Full Marks: 180 Section Marks: 90 Time: 2 Hours (Sections A + B)

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5 (a) Given the following joint probability distribution P(X,Y), compute the following conditional probabilities: i) P(+x|-y), ii) P(-y|+x), iii) P(+x|+y), and iv) P(-x|+y). **(12)**

X	Y	P
+x	+y	0.2
+x	-y	0.3
-x	+y	0.4
-x	-y	0.1

(b) Given the following three random variables S, T, and W and their joint probability distributions, compute P(W|summer) by using the variable elimination method. **(8)**

S	T	W	P
summer	hot	sun	0.20
summer	hot	rain	0.15
summer	cold	sun	0.10
summer	cold	rain	0.05
winter	hot	sun	0.10
winter	hot	rain	0.05
winter	cold	sun	0.25
winter	cold	rain	0.10

(c) How big is an N-node Bayes net if nodes have up to k parents? Assume that each variable domain size is n, where n is calculated as (the last digit of your roll number + 1) mode 3. **(10)**

6 (a) Consider a dataset with two Boolean attributes A and B. The dataset consists of 185 examples labeled with + and - outputs. **(20)**

< (A=0,B=0), - >: 50 examples

< (A=0,B=1), - >: 25 examples

< (A=1,B=0), - >: 10 examples

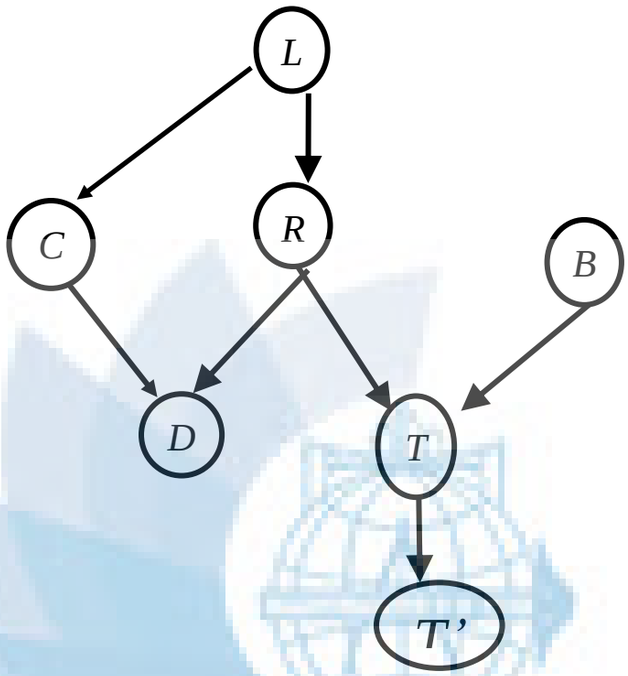
< (A=1,B=1), + >: 100 examples

Based on the information gain concept, draw the decision tree. Also show the calculation of information gain at each step of the tree construction.

(b) Consider a scenario, where 10% of the population have some variants of cancer (cr) diseases. Among the cancerous population, 40% of them have chronic cough (cc) as one of their symptoms. There are many other reasons for chronic cough, and among all chronic cough patients, 9 out 10 people are non-cancerous. If you have a symptom of chronic cough, what will be the probability that you will be diagnosed with cancer? (10)

7(a) You have to build a machine translator that can translate a Bangla sentence into an English sentence. Use HMM to show the high level diagram of such a model. Discuss briefly how you will answer a query of a Bangla sentence. (12)

(b) (10)



Given the above Bayes net, answer whether the following independence statements are true.

(i) $L \perp\!\!\!\perp T' | T$ (ii) $L \perp\!\!\!\perp B | T$ (iii) $L \perp\!\!\!\perp B | T, R$,

(iv) $L \perp\!\!\!\perp D$ (v) $L \perp\!\!\!\perp D \mid C$

(c) In a machine learning model, accuracy is not always a good measure, why? Explain the intuition of using precision and recall in various scenarios. Discuss which measure is more important in customer support email automation and which one is more important in airport face recognition. (8)

8(a) You are given a task of identifying a Bangla character from an image. Design a solution using Naïve Bayes. Also discuss possible optimizations so that your model does not overfit. (12)

(18)

(b) You are given some tasks of text classification, where from the given text input you need to predict whether the text is written by a kid or an adult. Consider the following labeled text SAMPLE,
"like to travel" - Adult
"love rhymes" - Kid
"love to play" - Kid
"love to read" – Adult

Design a multilevel perceptron classification approach to learn the weight vector from the above text SAMPLE. Assume the following initial weight vector, **w** [BIAS, like, love, travel, rhymes, play, read] as [1, 0, 0, 0, 0, 0, 0].

L-3/T-2/CSE **Date : 06/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-II B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 317** (Artificial Intelligence)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Define model and entailment for propositional logic sentences with illustrative examples. What is a Horn clause? **(9)**

   (b) What is a unit clause and the full resolution rule? Briefly explain the soundness of the resolution rule. What are the rules for converting a propositional logic sentence to Conjunctive Normal Form (CNF)? Show how the half-adder circuit can be described by a CNF sentence. **(18)**

   (c) Define validity and satisfiability in propositional logic. How are they closely related to each other? **(8)**

2. (a) What is an intended interpretation in First-Order Logic (FOL)? Show how alternative interpretations are possible by using an illustrative example. What is the database semantics? **(9)**

   (b) What is a planning graph? What are the three conditions for mutex relations between two actions at a given level? **(12)**

   (c) Prove that the GraphPlan algorithm is complete by showing that it terminates and return failure if there is no possible solution. **(14)**

3. (a) What is a relaxed problem in the context of planning heuristics? Explain the ignore-pre-conditions and the ignore-delete-list heuristics for the blocksworld problem domain. **(10)**

   (b) What is the subgoal independence assumption? How does the state abstraction technique make it easier to find a solution plan in the air cargo problem domain? **(10)**

   (c) Find out the max-level, the level-sum, and the set-level heuristic value for the problem "have cake and eat cake too" in the cake domain by using a planning graph. What is a serial planning graph? **(15)**

4. (a) Briefly explain how you can represent temporal and resource constraints for the job shop scheduling problem. How does aggregation technique help in the representation? **(9)**

   (b) Why is the problem of finding a schedule with resource conflicts harder than the critical path problems? **(8)**

   (c) Consider a job shop scheduling problem where you have two jobs, each of the form [AddEngine, Addwheels, Inspect]. For the first job J1, the durations of three activities are

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30, 30, and 10, respectively. Also, for the second job J2, the durations of three activities are 60, 15, and 10, respectively. Assume, you have one engine hoist, one wheel station, two inspectors, and 500 nuts. Find out the makespan by minimum slack algorithm. What is the makespan, if you have two engine hoists, one wheel station, one inspector, 500 nuts with the duration of the activities of second job J2 being 40, 15, and 10, respectively. **(18)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Explain, giving a specific example, why chronological backtraking might be sub-optimal in solving Constraint Satisfaction Problems (CSPs). **(05)**

(b) Describe the AC-3 algorithm with pseudo code for enforcing arc consistency in solving CSPs. Suggest a way in which the concept of arc consistency, (also known as 2-consistency) can be extended to sets of three, rather than two variables. Suggest a modified version of the AC-3 algorithm that can be used to enforce 3-consistency. **(25)**

(c) Using an appropriate example, describe how we can apply forward checking in the process of solving a CSP. **(05)**

6. (a) Define what it means for a search algorithm to be complete and optimal. Explain why these two criteria are important for a search algorithm. **(06)**

(b) Compare and contrast heuristic search and exhaustive search. Which compromises are accepted by a heuristic approach? Illustrate your answer with examples of heuristics. **(14)**

(c) Describe the operation of the A^* heuristic search algorithm. Prove that the A^* heuristic search algorithm is optimal when applied in conjunction with a monotonic heuristic. **(15)**

7. (a) Describe the Minimax Algorithm for searching game trees. Suggest the modifications required to this algorithm in order to apply it to realistic games. **(12)**

(b) Explain how the Alpha-Beta Algorithm is a better way than conventional algorithms to search game trees. The algorithm depends on certain assumptions about how the game is played. What are those? **(10)**

(c) Provide a detailed description of the Iterative Deepening A* (IDA*) algorithm. Your answer should include a clear statement of the algorithm in pseudo-code, and a general description of how it works. **(13)**

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8. (a) Using an appropriate figure, explain the pitfalls of greedy search algorithms. How can the main pitfall of this algorithm be solved by applying it in conjunction with simulated annealing. Your answer should include a clear statement of the algorithm in pseudo-code, and a general description of how it works. **(20)**

   (b) Describe the basic evolutionary algorithm with its all components. **(15)**
