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

CSE 317
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)

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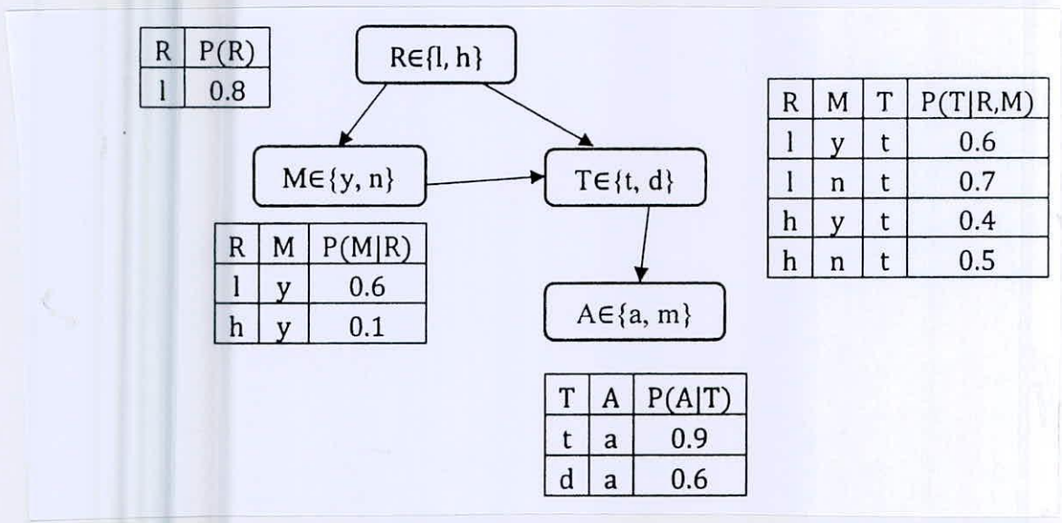
Contd... Q. No. 5

(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

CSE 317

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).**

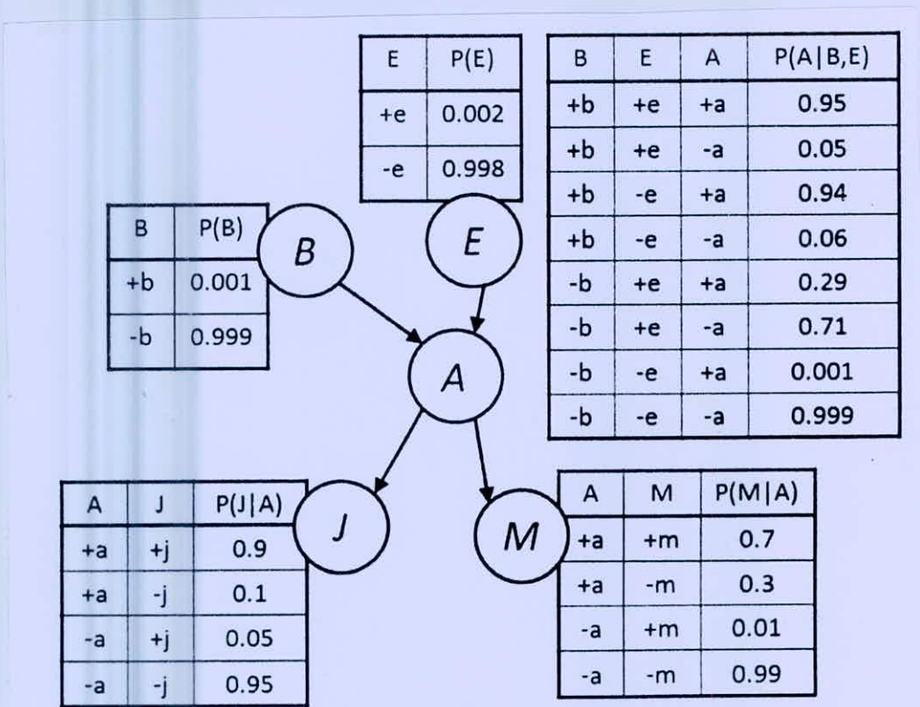
W	P(W)
sun	0.85
rain	0.15

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

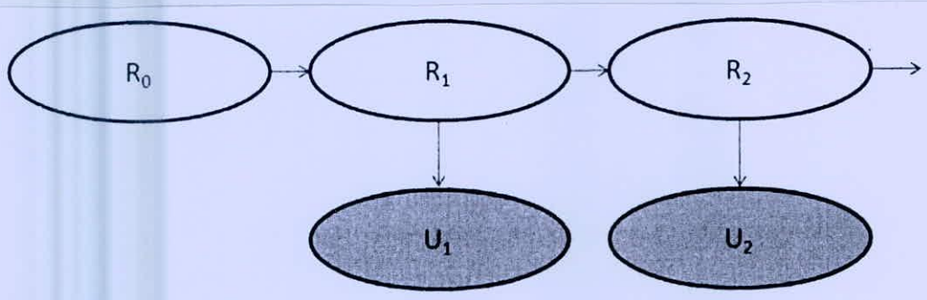
Contd...Q. No. 6

(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)

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 (10)

i. bidding on an item at an auction and

ii. automated taxi driving.

(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: (21)

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.

(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

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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

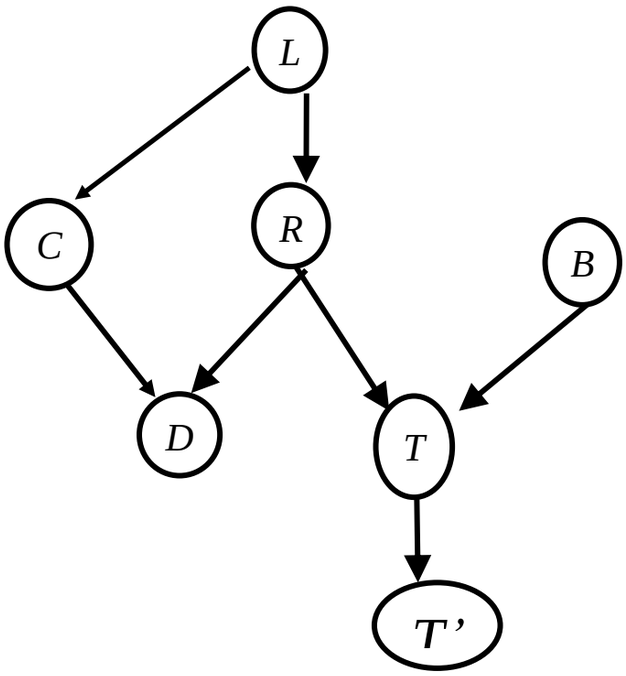
< (A=1,B=1), + >: 100 examples

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].

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 401** (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) How do you answer $P(Q|e_1 \ldots e_k)$ by using inference by enumeration, where you have r hidden variables $H_1 \ldots H_r$? **(10)**

   (b) Brendan and Selen play a coin toss game to illustrate how we can use HMMs for sequence analysis problems. Brendan starts tossing first, and they take turns. The game finishes when "THT" appears, and the winner is the one who last flips the coin. At each timestep, they can flip the coin many times, and the stopping rules are as follows: **(10)**

   (i) At his turn, each time Brendan flips the coin, he also flips an extra biased coin (P(H) = 0.4.) He stops only if the extra coin lands H, otherwise he keeps flipping the fair and extra coins. The flips of the extra biased coin are not recorded.

   (ii) At her turn, Selen flips the (fair) coin until T appears (all of her flips are recorded). You are given a sequence of recorded coin flips, you would like to infer the winner and the flips of each player. Describe an HMM to model this game.

   (c) What's the degree of freedom of a car? Why it is difficult to build a robot with high degree of freedom? **(2+3)**

   (d) How does Gibbs sampling work? **(10)**

2. Consider a two-bit register. The register has four possible states: 00, 01, 10 and 11. Initially, at time 0, the contents of the register is chosen at random to be one of these four states, each with equal probability. At each time step, beginning at time 1, the register is randomly manipulated as follows: with probability ½, the register is left unchanged; with probability ¼, the two bits of the register are exchanged (e.g., 01) becomes 10); and with probability ¼, the *right* bit is flipped (e.g. 01 becomes 00). After the register has been manipulated in this fashion, the *left* bit is observed. Suppose that on the first three time steps, we observe 0, 0, 1. **(35)**

   (a) Show how the register can be formulated as an HMM. What is the probability of transitioning from every state to every other state? What is the probability of observing each output (0 or 1) in each state?

   (b) Use the filtering algorithm to determine the probability of being in each state at time *t* after observing only the first t bits, for t=1,2,3.

Contd P/2

CSE 401

Contd ... Q. No. 2

(c) Use the forward-backward algorithm to determine the probability of being in each state at time k given all three observed bits, for k=0,1,2,3.

(d) What is the most likely sequence of states given all three observed bits? (Be sure to include the initial state at time 0 in your sequence.)

3. (a) You want to design your own ranking function to re-rank the Google provided search results. How do you update your weights for the Perceptron based ranking function? **(10)**

(b) How does bag-of-words model of Naïve Bayes classifier work for spam/non-spam classification, and how do you handle words with zero probabilities? **(5+5)**

(c) What's D-separation rule of conditional independence? How do you determine whether a path is active or not? **(8+7)**

4. (a)

	O	T	H	W	Play?
1	S	H	H	W	-
2	S	H	H	S	-
3	O	H	H	W	+
4	R	M	H	W	+
5	R	C	N	W	+
6	R	C	N	S	-
7	O	C	N	S	+
8	S	M	H	W	-
9	S	C	N	W	+
10	R	M	N	W	+
11	S	M	N	S	+
12	O	M	H	S	+
13	O	H	N	W	+
14	R	M	H	S	+

Consider the above dataset of 14 examples. In this example, we have four input attributes representing four columns O, T, H, and W to mean the following: **(20)**

Outlook: S(unny), O(vercast), R(ainy)

Temperature: H(ot), M(edium), C(ool)

Humidity: H(igh),N(ormal), L(ow)

Wind: S(trong), W(eak)

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Contd ... Q. No. 4(a)

Based on the values of different attributes, you will decide whether one should play (Yes (+) /No (-)) the basketball. In the above examples, real outcomes of 14 instances for Play is labeled as + or – in the rightmost column. Now you need to build a decision tree based on the concept of information gain, where four columns O, T, H, and W are input variables and the Play column is considered as output. Show the calculation at each step of the tree construction.

(b) How does nearest neighbor based classifier work? **(10)**

(c) What is the concept of deep-learning based image classification? **(5)**

SECTION – B

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

5. (a) Briefly describe the Turning Test. What advances do you think need to be made in order for the Turing Test to be passed? **(10)**

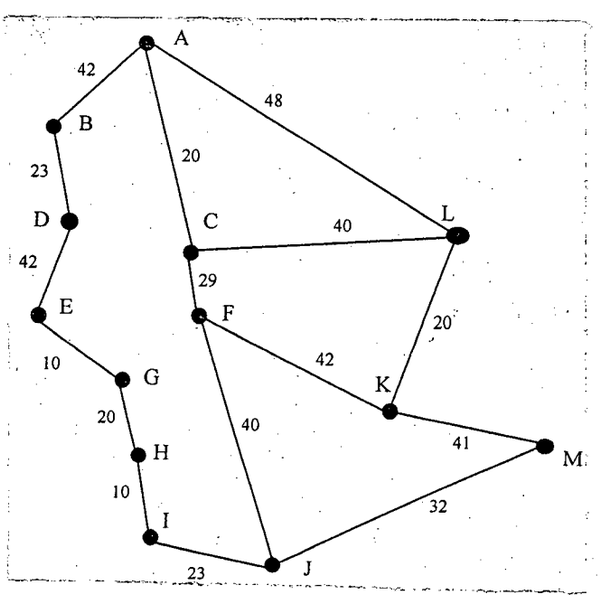
(b) What are the four approaches to AI? Briefly describe the rational agent approach to AI. How can you define rationality? What is a rational agent? Why should a rational agent be autonomous? **(16)**

(c) What is the PEAS description of a task environment? Provide two examples of agent types and their PEAS descriptions. **(9)**

6. (a) For the following map, using the A* algorithm, find a route from town A to town M. Show the search for your solution, showing the order in which the nodes were expanded and cost at each node. Assume previously visited states will not be re-visited. The Straight Line Distances between any town and town M are shown in the table below. Use it as a measure of the straight line distance heuristic. **(15)**

Straight Line Distance to M

A	51
B	50
C	32
D	28
E	42
F	14
G	33
H	43
I	50
J	32
K	41
L	56
M	0



Contd P/4

CSE 401

Contd ... Q. No. 6

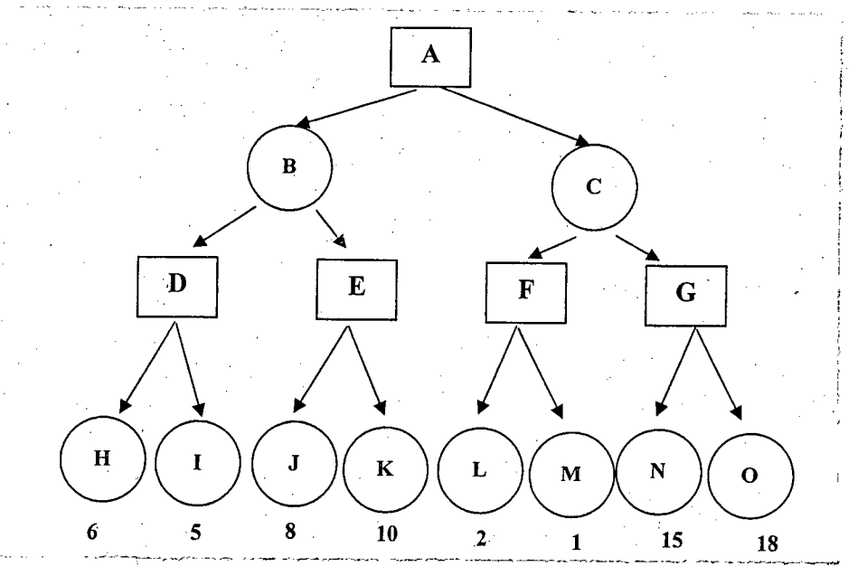
(b) State the conditions under which the optimality of the A* search algorithm is guaranteed. Briefly explain pruning and cost contours in the context of A* search done in Q. No. 6(a). **(10)**

(c) Find a route from town A to town M for the problem given in Q. No. 6(a) using the greedy best-first search algorithm. Is this solution optional? **(10)**

7. (a) How can a game be formally defined as a kind of search problem? Consider a two-player game with the rules given below. The game starts with a single stack of 5 tokens. At each move, a player selects one stack and divides it into two non-empty, non-equal stacks. A player who is unable to move loses the game. **(5+20)**

Assume two players, min and max, play it. Min plays first. If a terminal state in the search tree developed above is a win for min, a utility function of zero is assigned to that state. A utility function of 1 is assigned to a state if max wins the game. Draw the complete search tree. Apply the minimax algorithm to the search tree to assign utility functions to all states in the search tree. If both min and max play a perfect game, who will win? Explain your answer.

(b) Given the following search tree, apply the alpha-beta pruning algorithm and show the search tree that would be obtained. Make sure that you show where the cuts are applied and which parts of the search tree are pruned as a result. **(10)**



CSE 401

8. (a) Describe the terms complete and optimal with regards to evaluating search strategies. Is either depth-first-search or breadth-first-search complete? Is either of them optimal? What is the worst-case time and space complexity of these two algorithms? **(10)**

   (b) How can you learn heuristics from experience? Provide an illustrative example for the sliding puzzle domain. What is a relaxed problem? **(10)**

   (c) Why does a hill-climbing search often fail to find the global optimal solution? What is the random-restart hill-climbing search? Briefly explain how you can perform hill-climbing search for the Traveling Salesman Problem (TSP) using both construction and improvement heuristics. **(15)**

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

Contd. P/2

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Contd ... Q. No. 4(c)

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)**

L-4/T-1/CSE **Date: 05/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: **CSE 401** (Artificial Intelligence)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

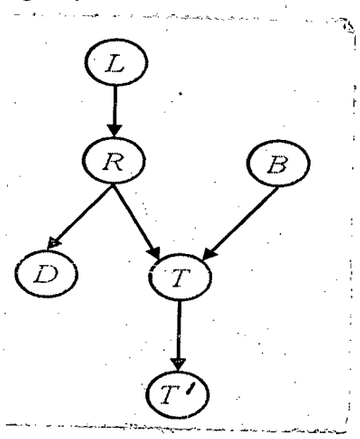
There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) How do you model a machine translation program to translate a Bangla sentence to an English sentence using HMM? **(10)**

(b) What are the different types of sensor used in an autonomous vehicle? How can you use Laser and Camera sensors to improve the driving experience? **(5+5)**

(c) What do you mean by degree of freedom of a robot? When you plan a robot to perform a task, why do you switch between configuration space and coordinate space to perform the task? **(2+3)**

(d) Given the following Bayes Net: **(10)**



Answer whether the following independence statements are true.

(i) $L \perp\!\!\!\perp T' \mid T$ (ii) $L \perp\!\!\!\perp B$ (iii) $L \perp\!\!\!\perp B \mid T$ (iv) $L \perp\!\!\!\perp B \mid T'$ (v) $L \perp\!\!\!\perp B \mid T, R$

2. (a) How do you update your weights for the Perceptron based binary classification? **(5)**

(b) For a bag-of-words model based spam-nonspam email naive Bayes classification problem, what are the parameters you need to learn and how do you answer the spam/nonspam query? **(10)**

(c) What is Laplace smoothing and how do you determine the smooth parameter (k) while designing your leaning algorithm? **(8)**

Contd P/2

CSE 401

Contd... Q. No. 2

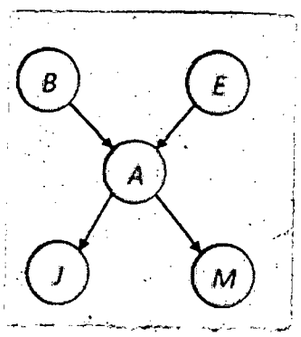
(d) Consider a dataset with two Boolean attributes (A,B). The dataset consists of 203 examples labeled with + and – outputs. **(12)**

$<(A=0,B=0),->$: 50 examples
$<(A=0,B=1),->$: 50 examples
$<(A=1,B=0),->$: 3 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.

3. (a) How do you compute the posterior probability $P(X_k \mid e_{1...t})$ of a past state X_k for a given set of evidence $e_1, e_2, ..., e_t$, where t>k? **(5+5)**

(b) How do you compute P(E | j, m) by using variable elimination method for the following Bayes Net? **(10+5)**



(c) What is the purpose of sampling in Bayesian networks? How does likelihood weighting sampling work? How do you overcome the limitation of likelihood weighting by using Gibbs sampling? **(2+3+5)**

4. (a) A conditional probability distribution P(X|e) can be expressed as α P(X,e). What is α in the above expression? If you have a third variable y, and you are given a joint distribution of P(X,e,y), how do you express P(X|e)? **(5+5)**

(b) Consider a scenario, where 5% of the populations have some sort 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 chromic 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)**

(c) How does Viterbi algorithm work to find the most likely sequence of states for a given sequence of observations? **(15)**

Contd P/3

CSE 401

SECTION – B

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

5. (a) What are the four approaches of Artificial Intelligence (AI)? What is the "laws of thought" approach? What are the main obstacles to this approach? **(4+4+4=12)**

(b) Distinguish between the Turning test and the total Turning test. Show how the skills needed to pass the Turning test allow an agent to act rationally. What are the main advantages of the rational agent approach of AI? **(6+4+4=14)**

(c) How can you relate the following disciplines to the foundations of AI? **(9)**

(i) Mathematics (ii) Economics (iii) Control theory and cybernetics

6. (a) Why is the iterative deepening search the preferred uninformed search method when the search space is large and the depth of the solution is unknown? What is the main difference between the informed search and the uninformed search strategies? **(10)**

(b) Prove each of the following statements: **(12)**

(i) Breadth-first search is a special case of uniform-cost search.

(ii) Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search.

(iii) Uniform-cost search is a special case of A* search.

(c) The heuristic path algorithm is a best-first search in which the evaluation function is $f(n)=(2-w)g(n)+wh(n)$. For what values of w, this algorithm is guaranteed to be optimal (you may assume that h is admissible). What kind of search does this perform for the following cases: **(13)**

(i) w = 0 (ii) w = 1 (iii) w = 2

7. (a) Prove that the A* search is optimal. **(10)**

(b) Explain how admissible heuristics can be generated from relaxed problems for the 8-puzzle problem. Can you generate an admissible heuristic from each of the relaxed problems which you have described? **(10)**

(c) Describe the algorithm to calculate the Linear Conflict (LC) heuristic for the 15-puzzle problem using pseudocode. What is the LC heuristic value for the following puzzle (assuming the standard goal state)? **(15)**

3	2	1	*B*
10	9	7	13
8	5	11	15
6	12	14	4

Here 'B' refers to the blank tile.

Contd P/4

CSE 401

8. (a) Distinguish between the variable and value ordering heuristic by providing one illustrative example for each case for the map coloring problem. **(10)**

(b) How can you formally define a game as a kind of search problem? What is a game tree? **(6)**

(c) Why is move-ordering significant for the effectiveness of α-β pruning? What is a Killer move? **(8)**

(b) What are the reasons for the hill-climbing search to get stuck or face difficulty in obtaining the global optimum solution? What is a sideways move? **(11)**

L-4/T-1/CSE **Date : 15/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **CSE 401** (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) How can you organize the definitions of Artificial Intelligence (AI) along two dimensions and into four categories? What is a rational agent? **(10)**

   (b) Describe the role of Computer Engineering as one of the foundations of AI . **(6)**

   (c) Briefly describe the working principle of the subsumption robotic software architecture. What is an Augmented Finite State Machine (AFSM)? Draw an AFSM for the control of a single leg of a hexapod robot. **(12)**

   (d) What is the major difference between the AI robotics and the industrial robotics? Briefly describe the recent applications of any one of the following domains for robotic technology: (i) Robotic cars (ii) Health care (iii) Human augmentation. **(7)**

2. (a) What are the steps of the knowledge-engineering process? Explain the ontology of a domain by means of illustrative examples from the standard Wumpus world domain. **(10)**

   (b) What is a model of a logical language? Explain if the following two sentences are true or false: (i) $\exists$ x, y x = y valid? (ii) $\forall$ x, y x = y satisfiable? Justify your answer in terms of models for first-order logic. **(9)**

   (c) For the following description, construct a Datalog knowledge base and prove by forward-chaining that (i) Fred is Tom's grandfather (ii) Bill is Tom's uncle: "Fred is the father of Harry and Bill. On the other hand, Harry is the father of Tom and John." **(11)**

   (d) How can you distinguish between the propositional logic and the first-order logic in terms of the ontological commitment and the epistemological commitment? **(5)**

3. (a) What is the major difference between (i) special-purpose logics and higher-order logics (ii) the database semantics and the standard semantics of the first-order logic? **(2+4=6)**

   (b) State the Deduction theorem. Prove that the resolution inference algorithm is complete in the propositional logic. **(12)**

   (c) Why is the entailment for the first-order logic semi-decidable? Show that the forward chaining in the propositional logic is both sound and complete. **(8+9=17)**

Contd P/2

CSE 401

4. (a) What are major improvements of the DPLL model checking algorithm over the simple model checking algorithm? Also, explain how the DPLL algorithm achieves the required scale-up for solving large problems. **(14)**

(b) How can you make plans by proportional inference? Why do we need the pre-condition axioms and the action-exclusion axioms? **(12)**

(c) What is the frame problem in AI? Distinguish between the representational frame problem and the inferential frame problem. **(9)**

SECTION-B

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

5. (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? **(15)**

(b) What is the aim of Turing test towards understanding intelligence? Why is the concept of this test important in the field of Artificial Intelligence? **(10)**

(c) Explain the advantages and pitfalls of greedy search. **(10)**

6. (a) Explain why problem formulation must follow goal formulation. Define the terms: agent, agent program, autonomy, and learning agent. **(10)**

(b) Give a PEAS description for each of the following activities: **(15)**

(i) Shopping for used AI books on the Internet

(ii) Bidding on an item at an auction

(iii) Playing soccer

(c) Assume two heuristic functions h_1 and h_2, both of which are admissible and applicable to your problem. It has been recommended that you should try to combine them to make a more general heuristic function h, which can be defined as **(10)**

$$h(s) = \alpha_1 h_1(s) + \alpha_2 h_2(s)$$

Here s denotes any state in the search problem, and the constants α_1 and α_2 are constrained such that they are non-negative and $\alpha_1 + \alpha_2 = 1$. Is the function h always admissible? Justify your answer with a specific example.

7. (a) Give a complete problem formulation for each of the following. Choose a formulation that is precise enough to be implemented. **(10)**

(i) Using only four colors, you have to color a planar map in such a way that no two adjacent regions have the same color.

Contd P/3

CSE 401

Contd... Q. No. 7(a)

(ii) A 3-foot-tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. the monkey would like to get the bananas. the room contains two stackable, movable, and climbable 3-foot-high crates.

(b) Describe Iterative Deepening A*(IDA*) search algorithm in detail. Your answer should include the algorithm's pseudo-code and a general description of how it works. **(15)**

(c) Give two reasons why the IDA* algorithm might prove unsuitable as a solution to a search problem. In each case, give a brief explanation of why this is the case and suggest one potential solution for each of them. **(10)**

8. (a) Why chronological backtracking might be sub-optimal in solving Constraint Satisfaction Problems (CSPs). Discuss this fact with a specific example. **(5)**

(b) Describe the necessity of alpha-beta pruning in the context of adversarial search. how genetic algorithm and simulated annealing are able to solve the local optima problem of greedy search algorithm. **(15)**

(c) A binary CSP has a set $X = \{x_1, ..., x_n\}$ of variables, each having a domain $D_i = \{v_{1i}, ..., v_{ni}\}$ of values. In addition, a CSP has a set $C = \{C1, ..., Cm\}$ of constraints, each relating to a subset of X and specifying the allowable combinations of assignments to the variables in that subset. **(15)**

(i) Given a binary CSP, define what it means for a directed arc x_i $x_i \rightarrow x_j$ between variables x_i and x_j to be arc consistent. Discuss how $x_i \rightarrow x_j$ can fail to be arc consistent. Explain how this can be solved.

(ii) Describe the AC-3 algorithm for enforcing arc consistency.

(iii) Prove that the time complexity of the AC-3 algorithm is $O(n^2 d^3)$, where d is the size of the largest domain.

L-4/T-1/CSE **Date : 16/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 401** (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 AI agent, rationality of an agent and the autonomy of an agent. **(6)**

   (b) Develop a PEAS description of a chess player agent. Comment on the environment of such an agent. **(10)**

   (c) Compare goal-based agents with learning agents. **(10)**

   (d) Give suitable examples of the following environment types (i) stochastic (ii) strategic (iii) discrete (iv) semi-dynamic (v) partially observable (vi) sequential. **(9)**

2. (a) Give the initial state, goal test, successor function and cost function for each of the following (choose a formulation that is precise enough to be implemented):

   (i) You have to color a planar map using only four colors, in such a way that no two adjacent regions have the same color. **(7)**

   (ii) A 3-foot-tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. He would like to get the bananas. The room contains two stackable, movable, climbable 3-foot-high crates. **(8)**

   (b) Why is abstraction needed in problem solving? Give an example. **(5)**

   (c) Compare BFS, DFS, uniform cost search, IDS with respect to completeness, time complexity, space complexity and optimality. Show necessary calculations. **(15)**

3. (a) Prove the following assertion: for every game tree, the utility obtained by MAX using minimax decisions against a suboptimal MIN will never be lower than the utility obtained playing against an optimal MIN. Can you come up with a game tree in which MAX can do still better using a suboptimal strategy against a suboptimal MIN? **(15)**

   (b) Prove the completeness and optimality of uniform cost search. **(6)**

   (c) Give an example of a contingency problem. Does it require less steps than original problem? Justify your answer. **(8)**

   (d) How can you use a relaxed problem in finding heuristics? Give examples to explain your answer. **(6)**

Contd P/2

CSE 401

4. (a) Prove that A* search is optimal if h(n) is consistent and admissible. **(7)**

   (b) "A* search runs out of memory before it runs out of time" – Justify the statement. **(6)**

   (c) Give the name of the algorithm that results from each of the following special cases: **(12)**

   (i) Local beam search with k = 1.

   (ii) Local beam search with k = ∞ (infinity).

   (iii) Simulated annealing with T = 0 at all times.

   (iv) Genetic algorithm with population size N = 1.

   Explain your choice with suitable example.

   (d) Compare three variations of hill climbing search. Which one is the best and why? **(10)**

SECTION – B

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

5. (a) Prune the game tree shown in Figure for Q. 5(a) with alpha-beta pruning. The up-directed-triangle and down-directed-triangle denote MAX and MIN, respectively. Clearly show which branches are pruned by striking through the edges of the tree. Also show the values of alpha and beta at each node clearly. **(18+2=20)**

   Which move will be taken by MAX at root?

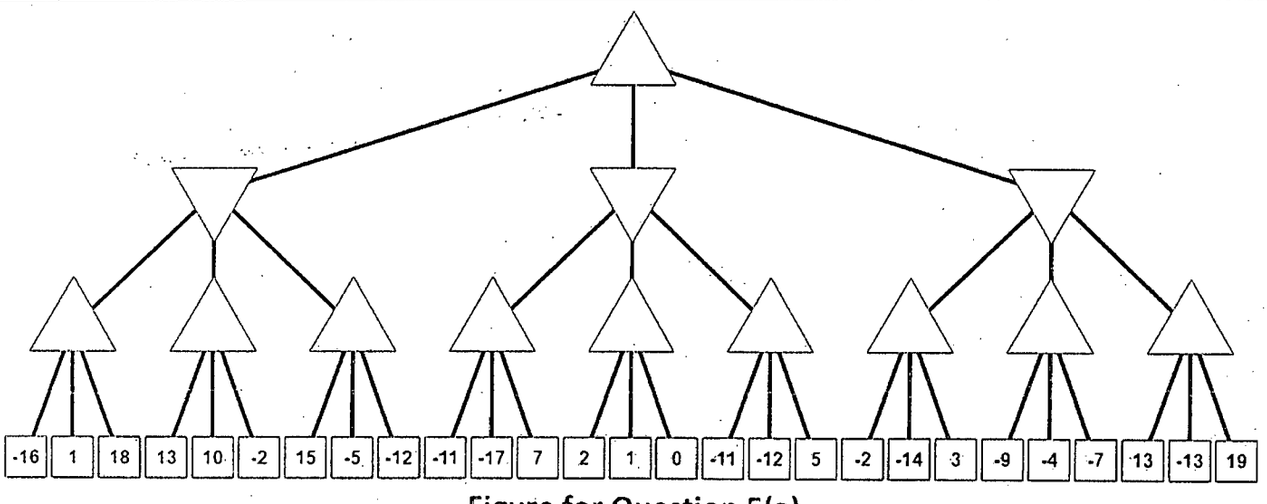


Figure for Question 5(a)

Note: The rectangular nodes represent terminal states and their labels indicate the utility values with respect to MAX.

   (b) Briefly explain the gradient descent algorithm in the context of univariate linear regression. You do not need to calculate the derivatives. How does the step size impact its performance? **(15)**

Contd P/3

CSE 401

6. (a) Suppose, the current Knowledge Base (KB) of a logical agent contains the following sentences: **(20)**

   (i) $P \vee R$

   (ii) $R \Rightarrow Q$

   (iii) $P \Rightarrow T$

   (iv) $\neg S$

   (v) $T \Rightarrow S$

   Use PL-Resolution algorithm to determine whether the KB entails "Q" or not. Clearly show the set of clauses derived after each iteration of the algorithm.

   (b) Briefly explain the Forward Checking algorithm with an example. How can it help the backtracking search? **(10+5=15)**

7. (a) Consider the following points in a 1-dimensional space: 1, 2, 3, 4, 7, 8, 10 and 12. Use K-means clustering algorithm with K = 2 to separate the points into two separate clusters. Clearly show, after each iteration of the algorithm, which points fall into the same clusters and the new **centroids (mean of the points in a cluster). Use 7 and 8 as initial centroids**. **(15)**

   Use the absolute difference of two points as the distance measure, i.e., distance between 3 and 7 is $|3 - 7| = 4$.

   (b) How does the ID3 algorithm for decision tree learning select attributes for partitioning the training set? **(10)**

   (c) Briefly explain Minimum Remaining Values and Least Constraining Value heuristics in the context of Constraint Satisfaction Problem (CSP) with examples. **(5+5=10)**

8. (a) Suppose, the current Knowledge Base (KB) of a logical agent contains the following sentences: **(15)**

   $A \wedge B \Rightarrow C$, $A \wedge D \Rightarrow C$, $B \wedge C \Rightarrow E$, $C \wedge E \Rightarrow D$, $A \wedge C \Rightarrow P$, $D \Rightarrow E$, $D \wedge P \Rightarrow Q$, $P \wedge Q \Rightarrow R$, $A \wedge D \wedge R \Rightarrow S$, A, and B

   Use Forward Chaining algorithm (PL-FC-Entails?) to determine whether the KB entails "S" or not. Clearly show the states of the associated data structures at each iteration of the algorithm.

   (b) What is a strongly k-consistent CSP? Suppose you are given a strongly n-consistent CSP with n variables. How can you devise an algorithm that can solve it in polynomial time, without involving any backtracking? **(3+7=10)**

   (c) What is a naive Baysian model? Briefly explain with an appropriate example. **(10)**

L-4/T-1/CSE **Date : 30/06/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2013-2014

Sub . **CSE 401** (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) Compare simple reflex agent, table-driven agent and agents with memory **(9)**

   (b) Define omniscience, autonomy and rationality of an agent. Give examples. **(6)**

   (c) Consider a modified version of the vacuum cleaner environment in which the agent is penalized one point for each movement. Can a simple reflex agent be perfectly rational for this environment? Why? How will a reflex agent with state perform in this environment? **(15)**

   (d) Develop a PEAS description of a robot soccer player. **(5)**

2. (a) Give examples of the following types of environments (i) Fully observable, (ii) episodic (iii) dynamic (iv) stochastic, (v) multi-agent. **(7)**

   (b) Derive the state space size of n-queens problem. Show your calculations. **(8)**

   (c) Give the initial state, goal test, successor function and cost function for the following problem. **(15)**

   You have three jugs, measuring 12 gallons, 8 gallons and 3 gallons and a water faucet. You can fill the jugs up or empty them out from one to another or onto the ground. You need to measure out exactly one gallon.

   (d) Find out a solution for the problem in Ques. No. 2(c) using your own formulation. **(5)**

3. (a) Consider a state space where the start state is number 1 and successor function for state n returns two states: numbers 2n and 2n+1. **(3+7+3+7=20)**

   (i) Draw the portion of the state space for states 1 to 25.

   (ii) Suppose the goal state is 19. List the order in which nodes will be visited for breadth-first search, depth-first search, depth-limited search with limit 4 and iterative deepening search.

   (iii) Which of the search approach finds the goal state in least time?

   (iv) How would bi-directional search work in this problem? What is the branching factor in each direction?

Contd P/2

CSE 401/CSE

Contd... Q. No. 3

(b) Consider the sensorless two-location vacuum cleaner world. Draw the belief state space reachable from the initial belief state. Is the problem solvable or not? Justify your answer. **(7)**

(c) What are the main problems of hill climbing search? How does simulated annealing solve the problems? **(8)**

4 (a) When is A* search optimal? Explain its necessary condition with an example. **(7)**

(b) How does Recursive Best-First Search (RBFS) solve the main problem of A* search? Give suitable example. **(10)**

(c) How can you use genetic algorithm to solve 8-queens problem? Explain using an example. You must explain each step of the genetic algorithm including the design of each individual of your example. **(12)**

(d) Explain how local beam search works. What is the main difference with random-restart search? **(6)**

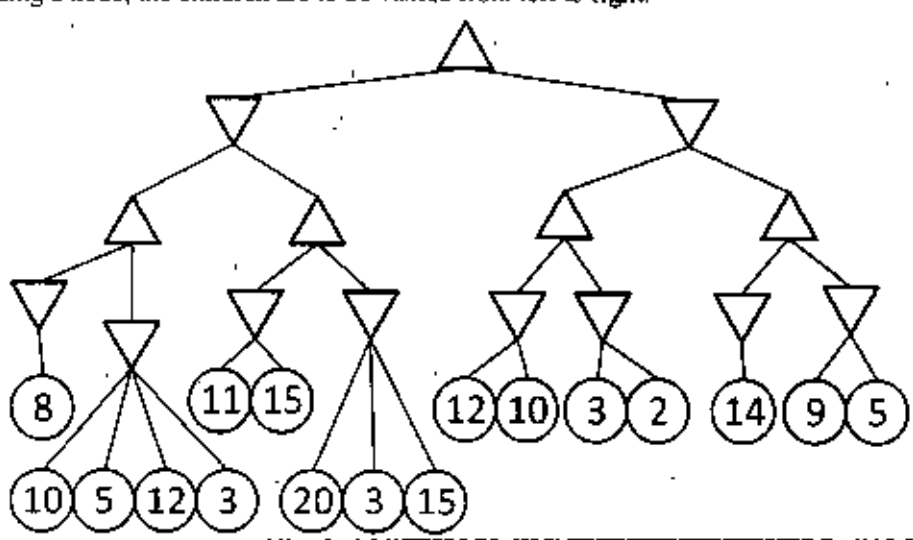
SECTION – B

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

5. (a) 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. **(7)**

(b) Consider a scenario where for solving a CSP problem you have run the arc consistency algorithm. The algorithm reduced domains of some variables. Some of the variables have multiple values in their domains after the algorithm is run and no domain is empty. Is there a guaranteed solution? Justify your answer briefly with suitable examples. **(8)**

(c) Consider the game tree below. Use Alpha-Beta pruning to determine the value for the root node. Clearly show which branches are pruned by the algorithm. While expanding a node, the children are to be visited from left to right. **(20)**



CSE 401/CSE

6. (a) Consider the problem of magic sequence. Given a finite integer n, the problem consists of finding a sequence of integers, $S = (s_0, s_1, ..., s_n)$, such that s_i represents the number of occurrences of i in S. As an example, when n = 4, one magic sequence is (2, 0, 2, 0), here $s_0 = 2$, $s_2 = 2$ as there are two 0s and two 2s in the sequence and $s_1 = 0$, $s_3 = 0$ as there are no 1s and 3s. Another example is (1, 2, 1, 0). Formulate the magic sequence problem as a formal Constraint Satisfaction Problem (CSP) with proper mathematical notations. **(7)**

(b) Consider the problem of "Wumpus World". Wumpus world is represented by 4×4 grid. Initially the agent is at [1,1]. There is one Wumpus is one of the 16 squares except [1,1]. There are four pits in the squares except [1,1]. The position of Wumpus and Pits are randomly distributed, but Wumpus cannot live in a square containing pit. Squares adjacent to Wumpus are smelly and adjacent to pits are breezy. The grid is shown below. **(18)**

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2	2,2	3,2	4,2
1,1	2,1	3,1	4,1

At [1,1], the agent perceives neither breeze nor stench. Then the agent moves to [2. 1] where it perceives only breeze but no stench. Then the agent moves to [1,2] (via [1,1]) where it perceive neither breeze nor stench. Then the agent moves to [1,3] where it perceives both stench and breeze.

Now can you proof the following propositions using the resolution algorithm? You only need to incorporate the clauses that you need to proof the following proposition.

(i) [2,2] contains no pit.

(ii) [3,1] contains a pit

(iii) [1,4] contains the Wumpus.

(c) After a yearly checkup, your friends is informed by his doctor that he has been tested positive for a very serious disease. The accuracy of the test is 99% (i.e. the probability of testing positive when indeed on has the disease is 0.99, as is the probability of testing negative when one does not have the disease). The disease is also very rare, only 1 out of 100,000 people gets affected by it. Now, given the above scenario, find out the actual probability of your friend having (and not having) the disease. **(10)**

Contd P/4

CSE 401/CSE

7. (a) Consider the following scenario and answer the following questions. **(17)**

"Mary goes swimming if and only if it is sunny or Friday, if Mary does not go swimming, then she goes to the library to study Artificial Intelligence (AI). Mary finds it difficult to study AI and this causes her headache The days Mary does not go to swimming and also has a headache, she goes to consult Dr. Barry. If Mary consults Dr. Barry on Friday, Dr Barry kills Mary. If Mary consults Dr. Barry on any other days, Dr. Barry gives Mary Ice Cream. If Mary goes to library, then she does not return home by sunset. Today is not sunny and not Friday either"

(i) Define the symbols you need to construct a Knowledge base using propositional logic. State the definitions clearly in a tabular format. One is done for you.

Definition	Symbol
Mary goes swimming	Swim
..	..

(ii) What are definite clauses? Build up a knowledge base for the given scenario. Every sentence must be a definite clause. You can declare new symbols too if needed.

(iii) Apply "Forward Chaining" algorithm to proof that— "Dr. Barry gives Mary Ice Cream". Clearly show the algorithm steps.

(b) Translate the following sentences into First Order Logic: **(5)**

(i) Every Student who take AI is brilliant

(ii) There is at least one student who took AI

(iii) There is at least one student who took AI is nerd

(iv) There is a person who loves everyone in the world

(v) Everyone in the world is loved by at least one person.

(c) What is Markov Blanket? Explain with an example. **(5)**

(d) Is alpha-beta pruning better than the mini-max algorithm? If yes, in which criteria? Is it guaranteed that alpha-beta pruning will always be better than mini-max algorithm? Justify your answer with example. **(8)**

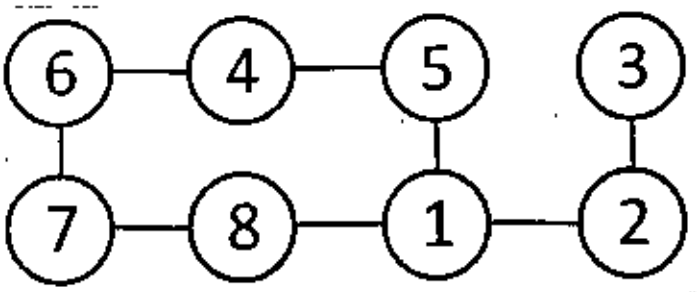
8. (a) Consider the following constraint graph for the map coloring problem. Each node can be colored either with red or blue (except node 3). **Node 3 can only be colored with blue.** **(15)**

Run backtracking algorithm with forward checking on this graph. And tabulate the assigned values and domains of different nodes as shown in the sample. The first 2 rows are already done for you. **Also indicate when the algorithm backtracks**. While coloring the graph, take nodes in increasing order of their label. That is, the algorithm will assign a value for node 1 first, then node 2, 3 and so on. You need to assign colors in the following order, **first red and then blue**. Mark the assigned values with circle.

Contd P/5

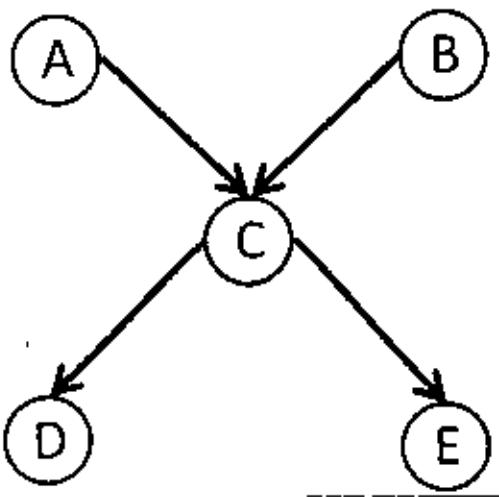
CSE 401/CSE

Contd... Q. No. 8(a)



	1	2	3	4	5	6	7	8
Initial Domains	RB	RB	B	RB	RB	RB	RB	RB
I: R	R	B	B	RB	B	RB	RB	B
...								

(b) Consider the following Bayesian Network. Find out the probability of the following query: P(B|D = True, E = False) **(20)**



The CPT (Conditional Probability Tables) are given below:

P(B)
0.3

P(A)
0.1

A	B	P(C)
T	T	0.95
T	F	0.94
F	T	0.29
F	F	0.01

C	P(D)
T	0.90
F	0.05

C	P(E)
T	0.7
F	0.01

L-4/T-1/CSE **Date : 07/12/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **CSE 401** (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 CSP has a set $X = \{x_1 \ldots, x_n\}$ of variables, each having a domain $D = \{d_1 \ldots, d_n\}$ of values. In addition, the CSP has a set $C = \{C_1 \ldots, C_m\}$ of constraints, each relating to a subset of X and specifying the allowable combinations of assignments to the variables in that subset.

   a) Give a general definition of a solution to the CSP. Given a binary CSP, define what it means for a directed arc $x_i \rightarrow x_j$ between variables x_i and x_j to be arc consistent. 3+3

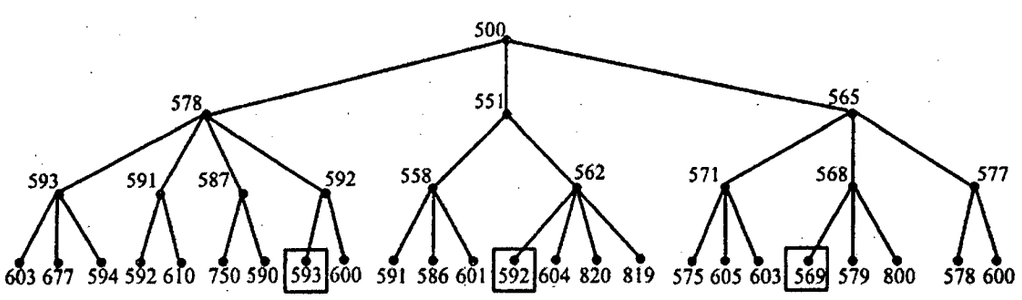
   b) Give an example of how a directed arc $x_i \rightarrow x_j$ can fail to be arc consistent. Explain how this can be fixed. 5

   c) Describe the *AC*-3 algorithm for enforcing arc consistency. Prove that the time complexity of the *AC-3* algorithm is $O(n^2d^3)$, where d is the size of the largest domain. 7+7

   d) 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. In the remainder of the question we refer to this as 3-consistency. Give an example of how a set of three variables might fail to be 3-consistent, and show how 3-consistency might then be imposed. 5+5

2. a) With the help of a pseudo code give a general description of the operation of the Recursive Best-First Search (RBFS) algorithm. Explain why RBF might be used in preference to the A^* search algorithm. 12+3

   b) Consider the following search tree. 14



The numbers by the nodes denote the sum of some path cost and heuristic. The boxed nodes are goals. Describe in detail the way in which the RBFS algorithm searches this tree. Your answer should indicate the order in which nodes are expanded, the reason that this order is used, and should state which of the three goals is found and why. Note that smaller numbers represent more desirable nodes.

   c) What are the problems associated with the Depth First Search algorithm? Describe how the Iterative Deepening Search (IDS) algorithm addresses some of these problems. 6

Contd P/2

CSE 401/CSE

3. a) Discuss the facilities and problems of a greedy search algorithm. Discuss how simulated annealing addresses the main problem of this algorithm. **8+4**

b) How do evolutionary algorithms work? Define the term *self adaptation* in the context of evolutionary algorithms. **8+4**

c) What are the differences between a search tree used for a adversarial search versus a tree for classical single-agent search problems? Why do we use Depth First Search to solve adversarial search problems? Describe the operation of alpha-beta pruning. **3+3+5**

4. a) Define in your own words: intelligence, artificial intelligence, agent, rationality, and logical reasoning. Explain how a model based reflex agent operates. Also write the pseudo code of the agent. 5+3+3

b) Four additional features that can be built into AI agents are: internal states, goals, utility functions, and learning. Explain how each of these can enable an agent to act more intelligently. Illustrate your answer with some simple examples. 8

c) For each of the following activities, give a PEAS description of the task environment. 8

(i) Playing soccer

(ii) Exploring the subsurface oceans of Titan

(iii) Playing a tennis match

(iv) Performing a high jump

d) "Surely animals, humans, and computers cannot be intelligent—they can do only what their constituent atoms are told to do by the laws of physics." Is the latter statement true, and does it imply the former? Justify. 8

SECTION – B

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

5. a) Climactic data shows that, both oceanic temperature and atmospheric pressure contribute to the formation of a low pressure zone in offshore regions. The probabilities that the oceanic surface temperature is greater than 25^0 C (condition known as T-kick) and that the atmospheric pressure is less than 92 kilo-Pascal (condition known as P-kick) are 65% and 60% respectively for any instant of time. The probabilities that a low zone will be formed due to both T-kick and P-kick, due to T-kick only, due to P-kick only and due to reasons other than T-kick and P-kick are 80%, 35%, 45% and 10% respectively. There is a 48% probability that the low zone will result in moderate rain-fall. However, if Coriolis force, a peculiar tropical wind pattern, is present, then the low zone may result in tropical cyclone. There is a 25% prior probability of the presence of Coriolis force (known as C-force). The probabilities that a cyclone will build up due to both C-force and low zone, due to C-force only, due to low zone only and due to none of them are 95%, 22%, 24% and 8% respectively. **8+12+8 =28**

Contd P/3

CSE 401/CSE

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

i) Draw a Bayesian Network that represent the above scenario correctly.

ii) Using Variable Elimination algorithm, find the probability of P-kick if a cyclone has already formed.

iii) If both T-kick and P-kick are present in the environment, what is the probability that a tropical cyclone will be formed?

b) Write short note on: **4+3=7**
i) Markov Blanket.
ii) Clustering.

6. a) Convert the following sentences into predicate form and then, into clause form and hence build a knowledge base: **5+10+5 +5 =25**

i) Anything that is played by any student is tennis, soccer, or chess.
ii) Anything that is chess is not vigorous.
iii) Anyone who is healthy plays something that is vigorous.
iv) Anyone who plays any chess does not play any soccer.

(Conclusion) If every student is healthy, then every student who plays any chess plays some tennis.

Using the above knowledge base, prove the following by the method of resolution:-
Anyone who is healthy plays something that is vigorous.

b) Is there any problem with the following unification? Explain. **5**
(1) President (Obama, 2014, X1).
(2) President(X2, T1, Senator(X1, Illinois)).
Substitute: {Senator(X1, Illinois)/X1}{2014/T1}{Obama/X2}

c) What are the limitations of Resolution of *Predicate Logic*? **5**

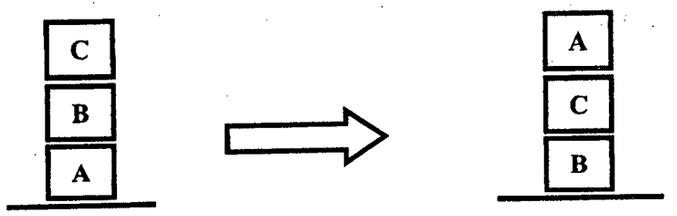
7. a) Suppose following predicates describe the environment of blocks completely having two agents in that environment. These two agents are Agent1 and Agent2. **10**
ON(A,B) – Block A is on block B.
ONTABLE(A) – Block A is on the table.
CLEAR(A) – There is nothing on top of block A.
HOLDING(A, 1) – The Agent1's arm is holding block A.
HOLDING(A, 2) – The Agent2's arm is holding block A.
ARMEMPTY(1) – The Agent1's arm is holding nothing.
ARMEMPTY(2) – The Agent2's arm is holding nothing.
Now define the precondition, add-list and delete-list for the following action as a precursor to goal stack planning:-
i) STACK(X, Y, 1) and STACK(X, Y, 2).
ii) UNSTACK (X, Y, 1) and UNSTACK (X, Y, 2).
iii) PICKUP (X, 1) and PICKUP (X, 2).
iv) PUTDOWN (X, 1) and PUTDOWN (X, 2).

Contd P/4

CSE 401/CSE

Contd... Q. No. 7

b) Using the goal stack planning and the actions defined in 7(a), attain the goal state from the initial state as shown in Figure for 7(b) (Consider that, both Agent1 and Agent2 work equally). **18**



(initial state) **(goal state)**

Figure for 7(b)

c) What are the differences between linear and non-linear planning? State modal truth criterion. **5 + 2 = 7**

8. **a)** Define de Finetti's theorem. Apply the theorem to show that there is a bet for Agent 1 for the events x and y such that the outcomes are always in favor of Agent 1 if Agent 2 believes that the event x, y and $(x \vee y)$ happen with probabilities 40%, 35% and 80% respectively. **2 + 5 = 7**

b) Three prisoners, A, B, and C, are locked in their cells. It is common knowledge that one of them will be executed the next day and the others pardoned. Only the governor knows which one will be executed. Prisoner A asks the guard a favor: "Please ask the governor who will be executed, and then take a message to one of my friends B and C to let him know that he will be pardoned in the morning." The guard agrees, and comes back later and tells A that he gave the pardon message to B. What are As chances of being executed, given this information? (Answer this mathematically, not by energetic waving of hands.) **12**

c) With suitable examples, explain the five steps of TWEAK planning framework. **10**

d) Define singly connected tree (poly tree) and multiply connected tree with suitable examples. **6**

Shubhra Kanti
09/09/13

L-4/T-1/CSE **Date : 06/07/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **CSE 401** (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) There are some predicates describe the block-world as follows. **(07)**

on (A, B) - Block A is on block B.

on table (A) - Block A is on the table.

clear (A) - There is no block on top of block A.

holding (A) - The robot's arm is holding block A.

armempty - The robot's arm is holding nothing.

There are some actions: stack (x, y), unstuck (x, y), pickup (x) and putdown (x)

Define the preconditions and effects for the actions using the predicates.

(b) What are the differences between "forward state-space-search" and the "backward state-space-search"? Discuss using the following block-world problem. (Use actions and predicates of 1.(a)) **(10)**

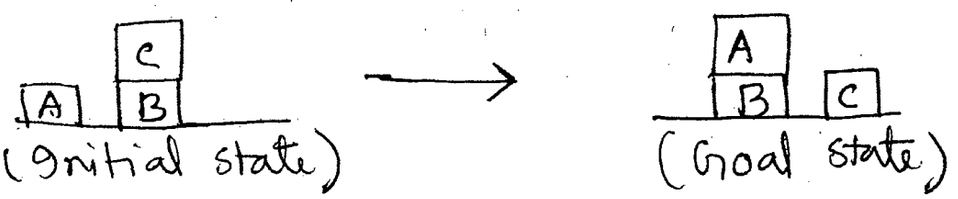


Figure for 1(b)

(c) A flat tire problem is defined by the following predicates and actions. **(18)**

Initial state - at (flat, axle) Λ at (spare, trunk)

Goal state - at (spare, axle).

Actions:

(i) remove (spare, trunk) means spare tire is taken out from trunk and put on ground.

(ii) remove (flat, axle) means flat tire is taken out from axle and put on ground.

(iii) puton (spare, axle) means spare tire is taken out from ground and put on axle.

(iv) leaveovernight means neither flat nor spare tire is on ground or on axle or in trunk. How can a partial-order-planning help to achieve the goal state from the initial state for the "flat-tire" problem?

Contd P/2

CSE 401

2. (a) **(12)**

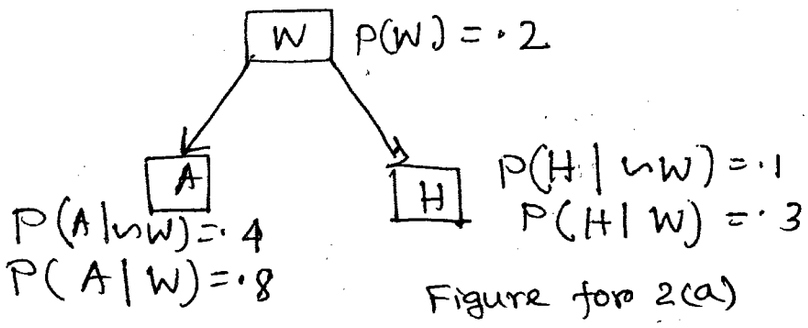


Figure for 2(a)

For the above Bayesian Network compute (i) P(¬A, W, H) and (ii) P(¬A | H) where variables are W, A and H and these are all Boolean valued.

(b) What is "Markov blanket" in a Bayesian network? Explain with an example. **(05)**

(c) For the given Bayesian Network find the correctness of the following query, **(13)**

P(B | J = true, M = true) using variable elimination method. (Show the calculations).

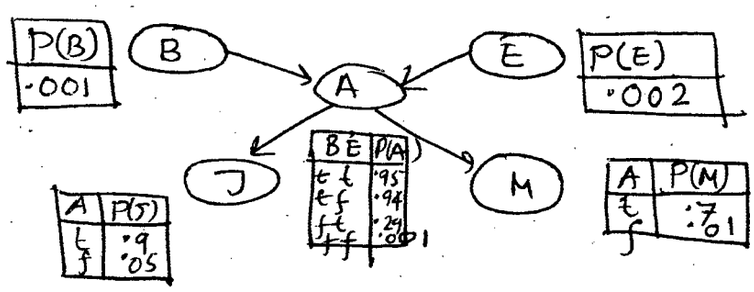


Figure for 2(c)

(d) What is the role of clustering in "Bayesian Network"? **(05)**

3. (a) **(12)**

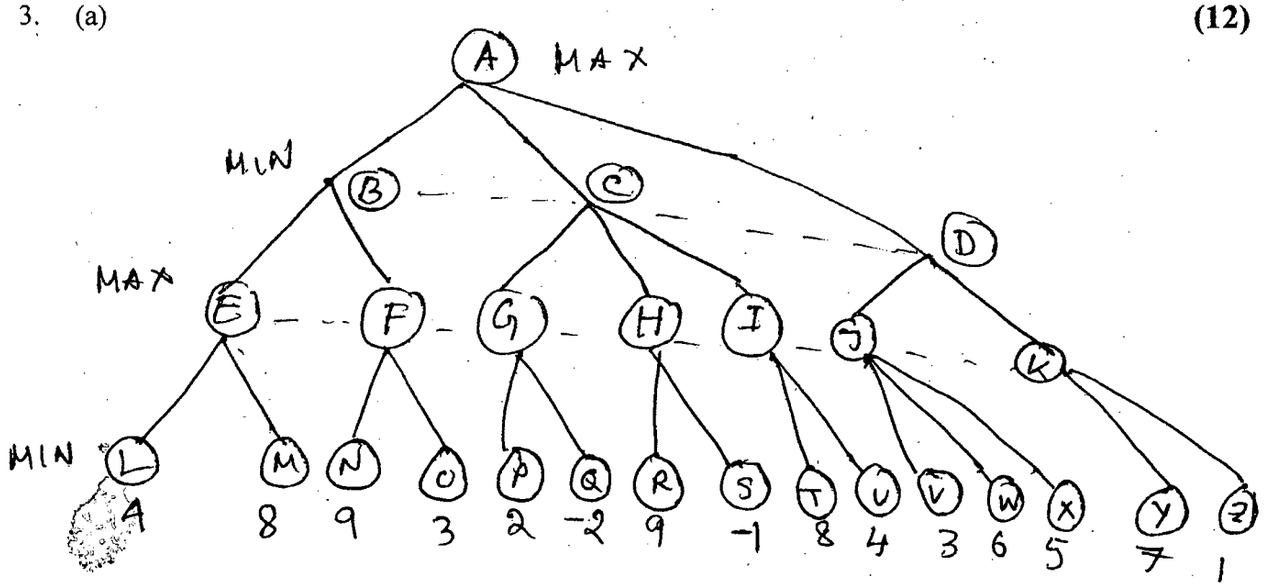


Figure for 3(a)

Contd P/3

CSE 401

Contd... Q. No. 3(a)

For the above game tree using "α–β" pruning determine the value for the root node. Find the branches to be pruned while children are visited from the left to right. (Show the steps).

(b) Consider the problem of "wumpus world". Wumpus world is represented by a 4×4 grid. Initially the agent is at [1, 1]. There is one wumpus in one of the 16 squares except [1, 1]. Three of the squares except [1, 1] contain three pits. The positions of wumpus and pits are randomly distributed, however wumpus does not live in a square where there is a pit. Squares adjacent to wumpus are smelly and adjacent to pits are breezy. **(18)**

At [1, 1], the agent perceives neither stench nor breeze. Agent moves to [2, 1] where it perceives both stench and breeze. When it returns to [1, 1] and thereafter moves to [1, 2], it perceives both stench and breeze.

From the initial knowledge base entail the following conclusions with the help of propositional logic.

(i) whether [2, 2] labelled square contains the wumpus.

(ii) whether [1, 3], [2, 2] and [3, 1] labeled squares contain pit.

(The grid of the problem is given as follows)

1, 4	2, 4	3, 4	4, 4
1, 3	2, 3	3, 3	4, 3
1, 2	2, 2	3, 2	4, 2
1, 1	2, 1	3, 1	4, 1

(c) What are the advantages of "α–β pruning" over "mini-max" search algorithm? **(05)**

4. (a) Tony, Michael and Ellen belong to the Hoofers Club. Every member of the club is either skier or a mountain climber or both. No mountain climber likes rain, and all skiers like snow. Ellen dislikes whatever Tony likes and likes whatever Tony dislikes. Tony likes rain and snow. **(20)**

(i) Represent the problem using first-order logic.

(ii) Convert the sentences to CNF.

(iii) Find the member who is a mountain climber but not a skier.

(b) What are "unification" and "lifting lemma"? **(10)**

(c) Explain "skolemization" with an example. **(05)**

Contd P/4

CSE 401

SECTION – B

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

Assume if any missing value.

5. (a) Define in your own words: intelligence, artificial intelligence, and agent. **(05)**

(b) Surely animals, humans, and computers cannot be intelligent-they can do only what their constituent atoms are told to do by the laws of physics. Is the later statement true, and does it imply the former? **(15)**

(c) Briefly describe the Turing Test. If the Turning Test is passed does this show that computers exhibit intelligence? State your reasons. **(15)**

6. (a) Consider the following map (not drawn to scale)

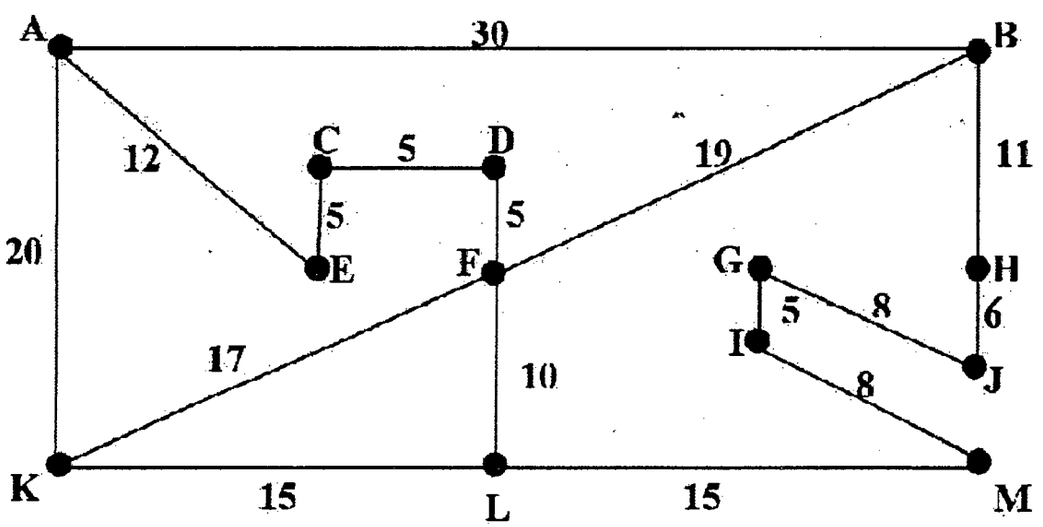


Figure for 6(a)

Use the A* algorithm to work out a route from town **A** to town **M**. The straight line distance between any town and town **M** is given in the following table.

Town	Distance	Town	Distance
A	56	H	10
B	22	I	8
C	30	J	5
D	29	K	30
E	29	L	15
F	30	M	0
G	14		

(i) Provide the search tree for your solution, showing the order in which the nodes were expanded and the cost at each node. You should not re-visit a town that you have just come from. **(10)**

Contd P/5

CSE 401

Contd... Q. No. 6(a)

(ii) State the route you would take and the cost of that route. **(05)**

(iii) Is your chosen route optimal? State your reasons. **(05)**

(b) What are the differences between informed search and uninformed search algorithms? **(05)**

(c) Briefly discuss the problems of greedy search algorithms. **(10)**

7. (a) Describe the idea behind simulated annealing and define the acceptance function used by this algorithm. **(06)**

(b) Outline the simulated annealing cooling schedule and describe its various components. **(15)**

(c) How do evolutionary algorithms work? Explain the term self adaptation and its necessity in the context of artificial intelligence. **(14)**

8. (a) What is CSP? Is there a standard representation for CSP problems? Justify your answer. **(09)**

(b) How do you apply CSP to the 8 queens problem? **(06)**

(c) Propose an approach to building an agent that plays chess. Within this approach, what are some different strategies one can exploit? **(20)**

L-4/T-1/CSE **Date : 18/03/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **CSE 401** (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) What are the differences between supervised and unsupervised learning? Define reinforcement learning. **(5)**

(b) The accuracy of an opinion poll is 98.5%. The poll is used to determine the popularity of a certain candidate X for the national election. Collected data shows that 3 in 5 people are in favor of the candidate. Find the followings– **(10)**

(i) probability that the candidate is elected given the opinion poll is against the candidate.

(ii) probability that the candidate is defeated given the opinion poll is in favor of the candidate.

(c) State Ockham's razor. Show that for any PAC-learning algorithm $N \geq \frac{1}{\epsilon}(\ln|H| + \ln|\frac{1}{\delta}|)$ where symbols have their usual meanings. **(10)**

(d) Describe the steps of a decision-theoretic agent. How is a poly-tree in a Bayesian Network converted into a singly-connected tree? Give an example. **(10)**

2. (a) Describe two strategies to speed up the resolution process of predicate logic. **(6)**

(b) Explain the problem with the following unification. **(5)**

(i) SpringRevolution (2011, egypt, X1)

(ii) SpringRevolution(T1, C1, President(X1, Since(T2))).

Substitute: {President(X1, Since(T2))/X1} {egypt/C1} {2011/T1}

(c) Convert the following sentences into predicate form and then, into clause form and hence build a knowledge base: **(16+8=24)**

(i) If a category 5 cyclone hits a country's coastline in any time, high waves submerge area within 5 kilometers of the coastline and high velocity wind knocks down every house within 5 kilometers of the coastline at that time.

(ii) If high waves submerge an area in any time, any person living in that area who does not go to the cyclone shelter will drown at that time.

(iii) If high velocity wind knocks down a house in any time, any person living in that house is crushed at that time.

Contd P/2

CSE 401

Contd ... Q. No. 2(c)

(iv) Any person who is drowned or crushed in any time dies at that time.

(v) A category 5 cyclone hit the coastline of Bangladesh on April 29, 1991.

(vi) Hamidur Rahman lived in Patenga on April 29, 1991.

(vii) Patenga is within 5 kilometers of coastline.

(viii)Hamidur Rahman did not go to the cyclone center.

Using the above knowledge base, answer the following query by the method of resolution:

When did Hamidur Rahman die?

3. (a) Studies about the migratory behavior of Siberian crane (bird) found the following: **(8+12+8=28)**

Two factors mainly control the success of Siberian cranes in crossing the Himalayan mountains - weather condition of the mountain and the birds' timely arrival in the mountain regions. The probabilities that the cranes will cross the Himalayan mountains successfully are 90%, 80%, 75% and 45% respectively if both the weather condition in the Himalayas is good and the birds have arrived in time, if only the weather condition in the Himalayas is good, if only the birds have arrived in time and if both of the causes are absent. The probabilities that the weather condition is good during the migration and that the birds arrive there in time are 50% and 95% respectively. Whether the birds will reach our country depends on two factors- their successful crossing of the Himalayan region and sunny weather in our country during the migration. The prior probability of sunny weather in our country during migration is 55%. The probabilities that the bird will reach our country 84%, 78%, 52% and 45% respectively if both the birds crossed the Himalayas successfully and the weather here is sunny, if only the birds crossed the Himalayas successfully, if only the weather is sunny and if none of the factors are true.

The probabilities that the bird flu will spread in our country are 30% and 24% respectively due to the presence of Siberian crane and due to other causes.

(i) Draw a Bayesian Network that represent the above scenario correctly.

(ii) Using Variable Elimination algorithm, find the probability that Siberian cranes have reached the Himalayas in time if bird flue has spread in our country.

(iii) Using variable elimination algorithm, find the probability that Siberian cranes will reach our country if the birds fail to reach the Himalayas in time and if the weather of the Himalayan region is bad.

(b) What are the underlying assumptions of Bayesian network? Define Markov blanket for a node in Bayesian network. **(4+3=7)**

Contd P/3

CSE 401

4. (a) Suppose following predicates describe the environment of blocks completely. **(8)**

ON(A,B) – Block A is on block B.
ONTABLE(A) – Block A is on the table.
CLEAR(A) – There is nothing on top of block A.
HOLDING(A) – The arm is holding block A.
ARMEMPTY – The arm is holding nothing.

Now define the precondition, add-list and delete-list for the following action as a precursor to goal stack planning;

(i) STACK(X, Y).
(ii) UNSTACK (X, Y).
(iii) PICKUP (X)
(iv) PUTDOWN (X).

(b) Using the goal stack planning and the actions defined in 4(a), attain the goal state from the initial state as shown in Figure for 4(b). **(15)**

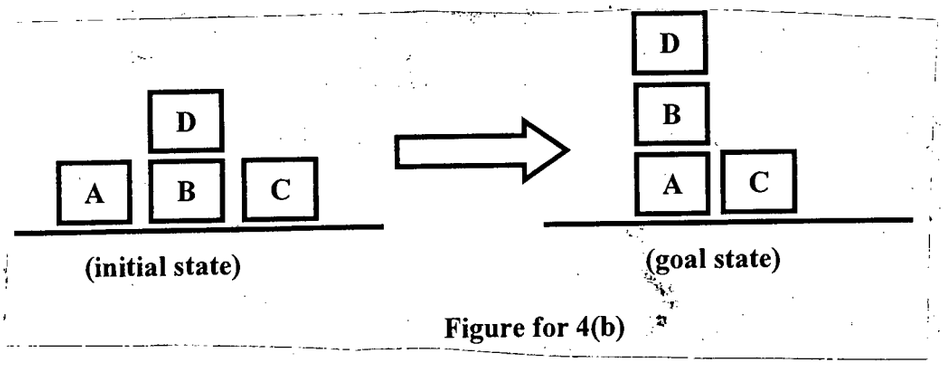


Figure for 4(b)

(c) What are the five operations involved in TWEAK planning framework. **(10)**

(d) What is the difference between linear and non-linear planning? **(2)**

SECTION – B

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

5. (a) Consider the problem of sorting four numbers in ascending order. You are only allowed to swap two adjacent elements. You are to solve this problem in minimum number of swaps. **(4×5=20)**

(i) Write down- State representation, Initial state, Goal state, Operations and Path Cost.
(ii) How many states are there in your representation?
(iii) For this problem let the heuristic be-sum of the distance between original and correct place of a number. If the starting state is "4, 1, 3, 2", draw the search tree for A* algorithm.
(iv) Is the heuristic described in (iii) admissible? If yes, explain why; if not, propose an admissible heuristic.

(b) Consider the game tree in Figure 5b. Using ALPHA-BETA pruning determine the value for the root node. Also specify which branches are pruned by the algorithm. While expanding a node, children should be visited from left to right. **(15)**

Contd P/4

CSE 401

6. (a) Consider the problem of assigning Red(R) and Green(G) colors to five squares on board in Figure 6a such that horizontally or vertically adjacent squares do not have the same color. **(3×6=18)**

   (i) State the variables, domains and constraints for this problem.

   (ii) If initially Red color is assigned to square 1, what is the result of "Forward Checking" algorithm?

   (iii) If initially Green color is assigned to square 5, what is the result of "Arc Consistency Checking" algorithm?

   (b) Initially you are given a number X inclusively between 1 and 7. At each turn you can perform one of these three moves: **(17)**

   (i) Multiply by 2.

   (ii) Multiply by 2 and then add 1.

   (iii) Divide by 2 and keep the integer part.

   If the resulting number is not between 1 and 7 inclusive, the number remains the same. If some one wants to get 6, what will be the operation sequence? Draw the corresponding belief state diagram.

7. (a) Perform Recursive Best First Search (RBFS) and Iterative Deepening A* Search (IDA*) algorithm to reach the goal state G from the initial state S for the graph and the heuristic values in Figure 7a. **(12½×2=25)**

   (b) There are two types of Ludo. Traditional Ludo and Snake ludo. You are asked to analyze their environments. Describe the environments of both Ludo with explanation. **(10)**

8. (a) Perform the following searching algorithm in Figure 8a from initial state S to Goal State G. **(20)**

   (i) Breadth First Search (Right move has higher priority than Down)

   (ii) Depth First Search (Right move has higher priority than Down)

   (iii) Depth First Search (Down move has higher priority than Right)

   (b) What is the advantage of Breadth First Search (BFS) over Depth First Search (DFS)? Also state the advantage of DFS over BFS. **(8)**

   (c) What is the meaning of completeness and optimality of a searching algorithm? **(7)**

Contd.....P/5

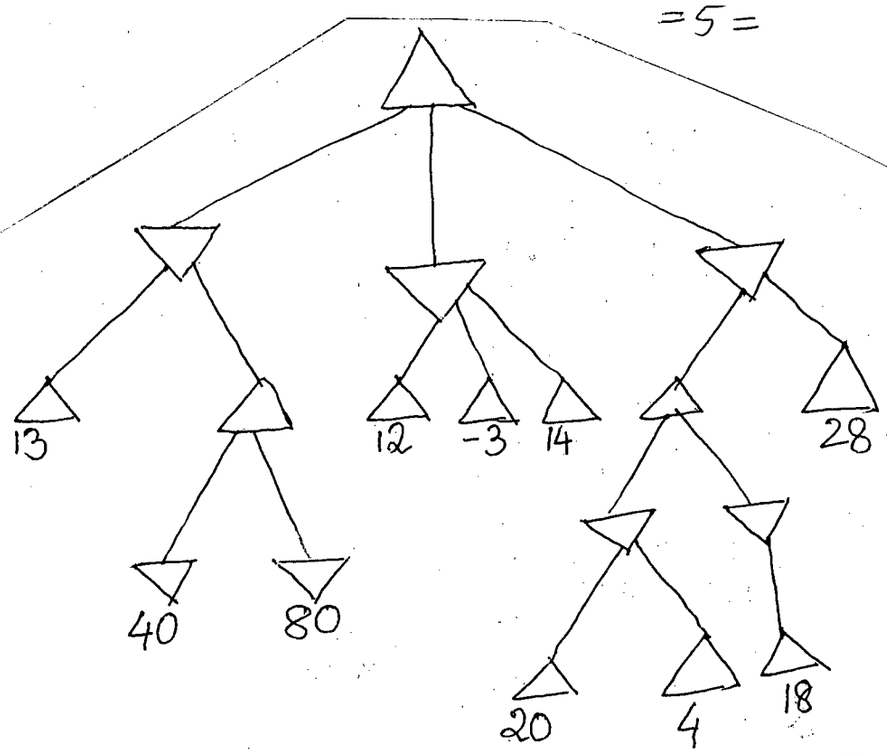
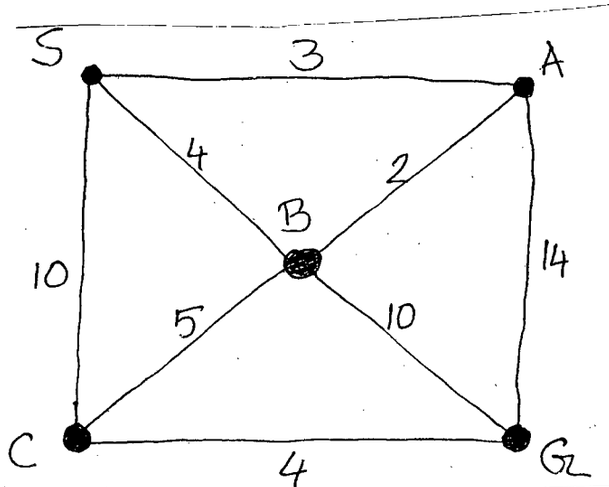


figure 5b

1	2	3
4	5	

figure 6a



Heuristic values

h(S) = 10
h(A) = 7
h(G) = 0
h(C) = 2
h(B) = 7

figure 7a

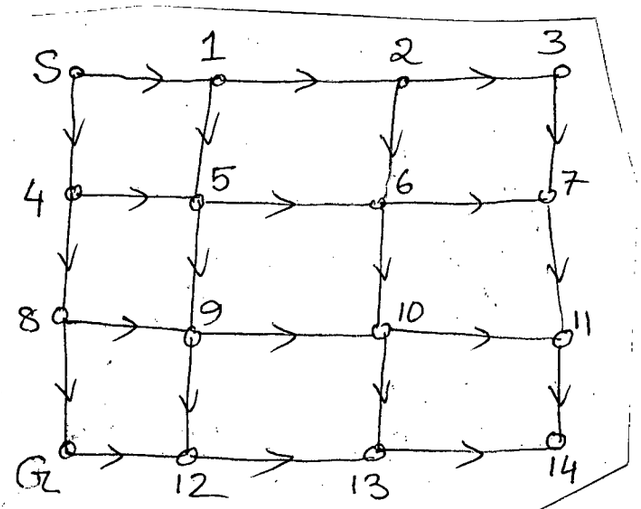


figure 8a

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2009-2010

Sub : **CSE 401** (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) Climactic data shows that, both oceanic temperature and atmospheric pressure contribute to the formation of a low pressure zone in offshore regions. The probabilities that the oceanic surface temperature is greater than 25°C (condition known as T-kick) and that the atmospheric pressure is less than 92 kilo-Pascal (condition known a P-kick) are 65% and 60% respectively for any instant of time. The probabilities that a low zone will be formed due to both T-kick and P-kick, due to T-kick only, due to P-kick only and due to reasons other than T-kick and P-kick are 80%, 35%, 45% and 10% respectively. There is a 48% probability that the low zone will result in moderate rain-fall. However, if Coriolis force, a peculiar tropical wind pattern, is present, then the low zone may result in tropical cyclone. There is a 25% prior probability of the presence of Coriolis force (known as C-force). The probabilities that a cyclone will build up due to both C-force and low zone, due to C-force only, due to low zone only and due to none of them are 95%, 22%, 24% and 8% respectively. **(8+12+8)**

i) Draw a Bayesian Network that represent the above scenario correctly.

ii) Using Variable Elimination algorithm, find the probability of T-kick if a cyclone has already formed.

iii) If both T-kick and P-kick are present in the environment, what is the probability that a tropical cyclone will not be formed?

(b) Define Markov Blanket, "Exact inference in Bayesian Network by enumeration is computationally redundant"-explain. **(4+3=7)**

2. (a) Convert the following sentences into predicate form and then, into clause form and hence build a knowledge base: **(10+5 = 15)**

i) Anyone who loves any lottery is a gambler.

ii) Everyone who favors the lottery proposition loves some lottery.\

iii) Everyone favors the lottery proposition or opposes the lottery proposition.

iv) If every Baptist votes and opposes the lottery proposition, then the lottery proposition does not win.

v) Every Baptist who is faithful is not a gambler.

Using the above knowledge base, prove the following by the method of resolution:- "If every Baptist votes and the lottery proposition wins, then some Baptist is not faithful".

(b) "The resolution algorithm is sound and complete" - Explain. What are the set of support strategy and the unit-preference strategy for the speed-up of resolution process? **(4+4=8)**

(c) Convert the following sentences into predicate form and then, into clause form and hence build a knowledge base: **(8+4=12)**

i) All intellectuals were in the hit-list created by the traitors.

ii) All persons who were in the hit-list created by the traitors and did not go into hiding were captured by the traitors.

iii) All persons captured by the traitors were murdered by the traitors on December 14, 1971.

iv) Selina Parvin was an intellectual.

v) Selina Parvin did not go into hiding.

Using the above knowledge base, answer the following query by the method of resolution:- When was Selina Parvin murdered?

3. (a) Suppose following predicates describe the environment of blocks completely. **(8)**

ON(A,B) - Block A is on block B.

ONTABLE(A) - Block A is on the table.

CLEAR(A) - There is nothing on top of block A.

HOLDING(A) - The arm is holding block A.

ARMEMPTY- The arm is holding nothing.

Now define the precondition, add-list and delete-list for the following action as a precursor to goal stack planning:-

i) STACK (X, Y).

ii) UNSTACK (X, Y).

iii) PICKUP (X).

iv) PUTDOWN (X).

(b) Using the goal stack planning and the actions defined in 3(a), attain the goal state from the initial state as shown in Figure for 3(b). **(12)**

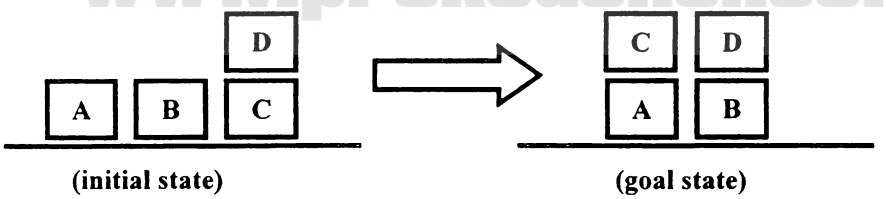


Figure for 3(b)

(c) With suitable examples, explain the five steps of TWEAK planning framework. **(10)**

(d) What are the differences between linear and non-linear planning? State " modal truth criterion." **(5)**

Contd P/3

4. (a) Apply de Finetti's theorem to show that there is a bet for Agent 1 for the events x and y such that the outcomes are always i favor of Agent 1 if Agent 2 believes that the event x, y and (x v y) happen with probabilities 40%, 35% and 80% respectively. **(7)**

(b) A diagnostic test has an accuracy of 97.5%. Statistics show that 1 in 50,000 has the disease. Find the followings:-

i) probability that you do not have the disease given that the test result is positive.

ii) probability that you have the disease given the test result is negative. **(8)**

(c) What is a hybrid Bayesian network? With a suitable example, illustrate how continuous distributions are handled alongside with discrete ones in such a network. **(10)**

(d) Define singly connected tree (poly tree) and multiply connected tree. Prove that the complexity of running variable elimination algorithm on a poly tree network is linear in the size of the tree for any variable ordering consistent with the network structure. **(10)**

SECTION – B

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

5. (a) What is the difference between rationality and omniscience? Explain. **(3)**

(b) What is an agent? Briefly describe various components of a Learning Agent and compare those with components of a Human Being. **(3)**

(c) What is a PEAS description? Suppose you are playing FIFA 2011 (Football Game) on your PC. There are 22 agents. At any time, you can control exactly one of the 11 players of your team. And, all other 21 players are controlled by the PC according to some rules. Both teams optimize their actions with a goal to win the match. For this Task Environment describe its Characteristics (i.e. whether Fully-observable/Partially-observable, deterministic/stochastic, episodic/ strategic/sequential, static/dynamic, discrete/continuous, single agent/ multi-agent, competitive/cooperative). **(10)**

(d) What is a Consistent Heuristic? Prove that A* using GRAPH-SEARCH (i.e. not revisiting a state twice) is optimal if h(n) is consistent. Here, terms carry their usual meaning. **(15)**

(e) Suppose you are playing Crysis 2 on PC. You are controlling the protagonist (main character of the game). There are some hostile agents (hostile to you) searching for you. You have taken HIT-AND-RUN strategy, which means you shoot some hostile agent with your gun, then become invisible (yes you have that power!), and change places in the stealth mode (others cannot notice). Suggest some heuristics for the hostile agents as to how to search for you. It is given that, when you attack someone, everyone can hear the gun-shot and knows the location of the sound's source. **(4)**

6. (a)What are the four components of a formal problem? What is abstraction? How do we use abstraction in formulating problems? Explain. **(7)**

Contd P/4

(b) What is MATERIAL-VALUE? Suppose you and your friend are playing Ludo game (2 players). Both of you have 4 pieces (i.e., "guti"). Design a scheme to assign a MATERIAL-VALUE to each of the pieces. You should provide a weight of each piece based on its maturity (i.e., whether it is "kacha guti" or "paka guti"). You should also consider safety of pieces (i.e., safe cells). **(8)**

(c) For the search tree (see figure 6(c)), perform an ITERATIVE DEEPENING SEARCH. Node M contains the GOAL STATE. You only need to show 5 trees for 5 limits. **(8)**

(d) You have to place 5 pieces on a 5 by 5 grid. Your target is to maximize the minimum distance (measured by EUCLIDEAN distance) among all pairs of pieces. Formulate this problem with Genetic Algorithm. Also, describe a CROSSOVER operation, a MUTATION operation, and a FITNESS FUNCTION for this problem. **(12)**

7. (a) Consider a 3 by 1 grid (refer to the figure). Initially, the agent is situated in the middle. At any time, X denotes the current position of the agent. All other visited cells are denoted by V, and all other unvisited cells are denoted by a dot ("."). The goal of the agent is to visit all cells. It can move left or right by one cell. Moving left while in the leftmost cell and moving right while in rightmost cell do nothing. Determine all the valid States. Draw the STATE TRANSITION DIAGRAM. Note that the agent can revisit a visited state. See Figure 7(a) for details. **(10)**

(b) What are BELIEF STATES in Sensorless problems? "In general, if the physical state space has S states, the belief state space has 2^S belief states." - Explain. **(5)**

(c) Consider the problem of question no. 7(a) again. Now, the agent is sensorless, and the grid is 2 by 1. Draw the reachable portion of Belief-State-Transition-Diagram. Recall meaning of X, V, Dot and See Fig. 7(c), for possible initial states. **(12)**

(d) Differentiate between Node and State. Briefly describe the five components of a node. **(5)**

(e) What is a SEARCH TREE? Can multiple Nodes in a SEARCH TREE correspond to the same State? **(3)**

8. (a) What is an Admissible Heuristic? Prove that A* using TREE-SEARCH (i.e. revisiting same states) is optimal if h(n) is admissible. Here, terms carry their usual meaning. **(10)**

(b) Suppose for a problem, two solutions are written using A* following two different heuristic h1 and h2. In one instance, both A* (h1) and A* (h2) find solutions in depth 3. A*(h1) has created 100 nodes, and A*(h2) has created 80 nodes. Find the effective branching factors of both of them and say which heuristic is better. **(7)**

(c) Consider the following CRYPTARITHMETIC puzzle.

```
FORTY
   TEN
+ TEN
--------
SIXTY
```

For this CSP (Constraint Satisfaction Problem), Write the addition constraints. Show the CONSTRAINT HYPERGRAPH. Do not forget to consider All-different constraints (Inequality of different symbols). Note, you do NOT need to find the solution. **(8)**

(d) Using ALPHA-BETA Pruning, determine the MINIMAX value for the root node. Also, write which nodes will be pruned. See Figure 8(d) for the game-tree. All leaf nodes are terminal states, for which utility values are given. Child nodes are visited from the left to right. **(10)**

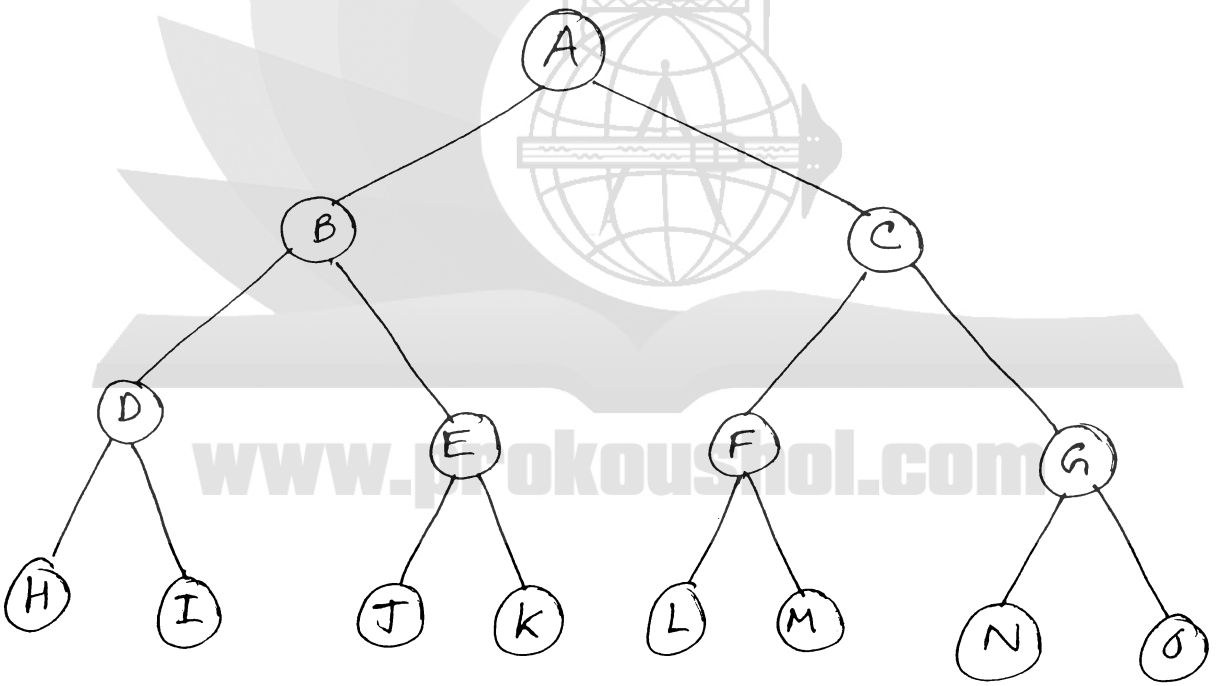


Figure for
Question No. 6(c)

"আল্লাহর ভয়কে পাথেয় আর আখিরাতকে গন্তব্য বানিয়ে পথ চলো।"

-ইমাম আহমাদ ইবনে হাম্বল রহ.:

Figure for Question 7(a)

Possible Initial States 

Figure for Question 7(c)

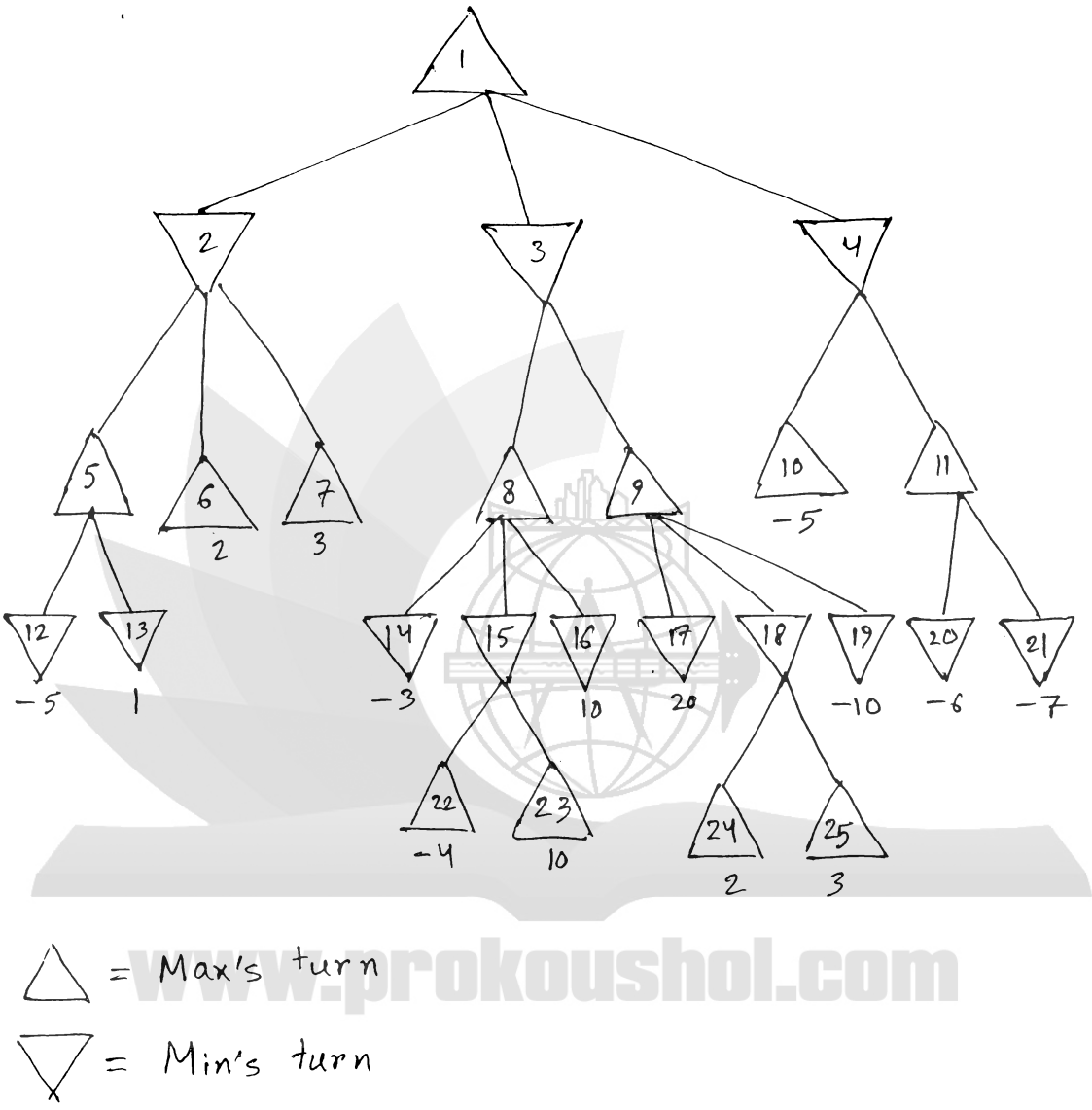


Figure for Question 8(d)

L–4/T–1/CSE Date: 28/02/2010

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L–4/T–1 B. Sc. Engineering Examinations, 2008-2009

Sub : **CSE 401** (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) What is an omniscient agent? Is it a rational agent? Justify. **(5)**

   (b) Describe the information needed to define a problem to be solved by an intelligent agent. Briefly describe different types of search problems. **(25)**

   (c) How does the iterative deepening search algorithm address the pitfalls of the depth first search and the depth limited search algorithms? **(5)**

2. (a) Describe the principle of α–β pruning technique. With an example, show when α–β pruning technique does not improve the search cost. **(10)**

   (b) Describe the 'gain' criterion of attribute selection of a decision tree. Interpret its physical meaning. Show how the 'gain ratio' criterion resolves the problem of 'gain' criterion. **(20)**

   (c) Briefly describe pre-pruning and post-pruning of a decision tree. **(5)**

3. (a) What is a polyhedral region? Can a 2-layer neural network (NN) classify any union of polyhedral regions of training samples? Justify with an example. **(15)**

   (b) Describe why an NN architecture produced by the tiling algorithm correctly classify all training samples. **(15)**

   (c) What is the problem of a discontinuous activation function in an NN? How can it be solved? **(5)**

4. (a) Prove the optimality of A* search algorithm assuming the optimality condition is satisfied. **(10)**

   (b) Briefly describe the problems of hill climbing algorithm. **(5)**

   (c) What are the characteristics of SMA* algorithm? Find the solution of the following graph using SMA* with a memory size of three nodes. Symbols carry the usual meanings. Justify your findings. **(20)**

Contd P/2

CSE 401

Contd ... Q. No. 4(c)

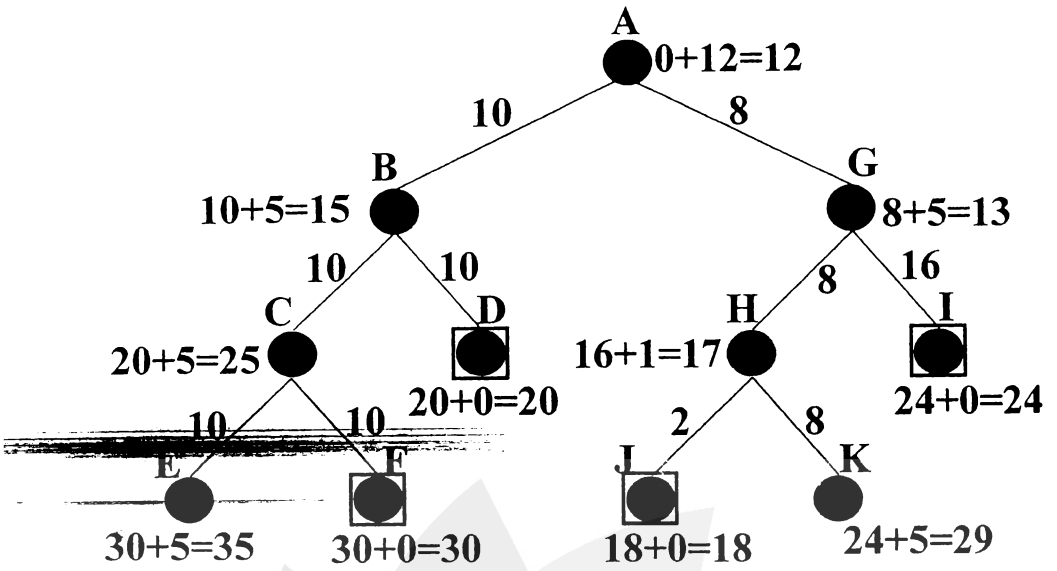


Figure for Q. No. 4(c)

SECTION–B

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

5. (a) Convert the following English statements into first order logic statements: **(10+10=20)**

(i) Every boy or girl is a child.

(ii) Every child gets a doll or a train or a bi-cycle.

(iii) No boy gets a doll.

(iv) No child who is good gets bi-cycle.

(v) Jack is a boy.

Using above five axioms, construct a proof by resolution of the following statement:

"If Jack does not get a train, than Jack is not a good boy."

(b) Write down the steps of converting first-order-logic statements into conjunctive normal form (CNF). Using these steps, convert the following first-order-logic statement into CNF: **(15)**

$$\forall x \exists y \left(\forall z \; loves(x,z) \Rightarrow loves(y,z) \right) \wedge loves(x,y)$$

6. (a) 1% of woman over age forty who are screened have breast cancer. 80% of woman, who really do have breast cancer will have a positive mammography, (meaning test is positive). 9.6% of woman who don't actually have breast cancer will also have a positive mammography. Now, answer the following questions:

Contd P/3

CSE 401

Contd ... Q. No. 6(a)

(i) If a woman in this age group gets a positive mammography, what is the probability that, she actually has the breast cancer? **(10)**

(ii) Say, a woman gets a positive mammography test M1, goes back and gets a second mammography M2, which is also positive. Use the naive Bayes assumption to calculate the probability that she has breast cancer given the results from these two tests. **(10)**

(b) Consider the Bayesian network as shown in fig. for Q. 6(b). The network shows 3 boolean random variables and the conditional probability tables. **(15)**

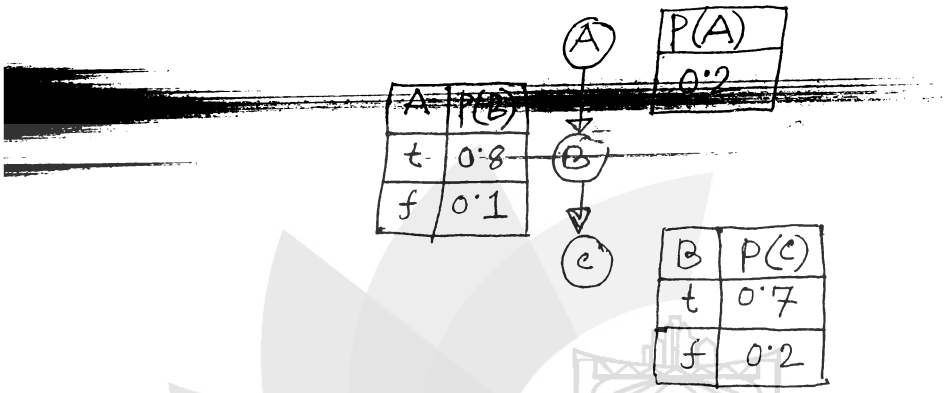


fig. for Q. 6(b)

Now, compute the probability: P (A = t | C = f).

7. (a) Consider an instance of the Blocks World Problem where the initial state and goal state are as shown in fig. for Q. 7(a). Now answer the following Questions:

(i) Write down STRIPS representation for initial state and goal state using appropriate literals. **(2×2=4)**

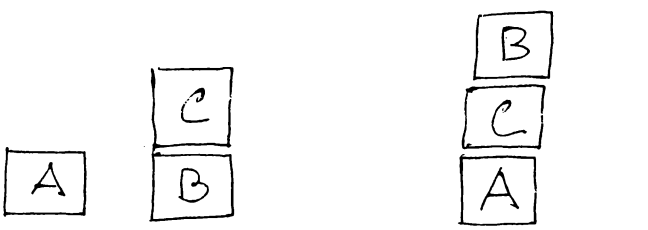
(ii) Write down STRIPS representation for the following four actions: **(4×2=8)**

(a) pickup(x): picks up a block x from top of table.

(b) putdown(x): puts down a block x on the table.

(c) Unstack(x,y): picks up a block x from top of another block y.

(d) stack(x,y): puts down a block x on top of another block y.



Initial State Goal State

fig. for Q. 7(a).

CSE 401

Contd ... Q. No. 7

(b) Show, how regression planning algorithm generates the plan for solving the problem of Q. 7(a). For each step of the algorithm, show only, which literals are added to the goal stack and removed from the goal stack. **(23)**

8. (a) Formally define constraint satisfaction problem. Write names of four such problems. **(3+4=7)**

(b) Suppose, the constraint graph for the map-coloring problem is as shown in fig. for Q. 8(b). We have to color the map using 3 colors Red (R), Green (G) and Blue (B). Show, how the following three algorithms will solve the problem. For each algorithm, show only **(3×6=18)**

(i) Simple DFS, choose the variables in alphabetical order.

(ii) Forward Pruning DFS, use degree heuristic for variable ordering.

(iii) Forward Pruning DFS, use MRV (Minimum Remaining Value) heuristic for variable ordering.

For each algorithm, consider the color values in the order R, G, B.

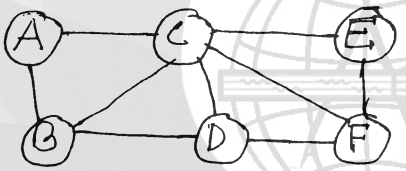


fig. for Q. 8(b): constraint graph for a Map coloring problem.

(c) Describe, using a suitable example, how MIN-CONFLICTS algorithm can be used to solve constrained satisfaction problem. **(10)**

হ্যাঁ, আল্লাহ তো রহমত সহকারে তোমাদের প্রতি দৃষ্টিপাত করতে চান। কিন্তু যারা নিজেদের প্রবৃত্তির লালসার অনুসরণ করছে তারা চায় তোমরা ন্যায় ও সত্যের পথ থেকে বিচ্যুত হয়ে দূরে চলে যাও। (নিসাঃ ২৭)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L–3/T–2 B. Sc. Engineering Examinations 2006-2007

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

Full Marks : 210 Time : 3 Hours

The questions are of equal value.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) "Problem formulation should follow goal formulation'' – Explain. **(5)**

   (b) Define the following terms – **(6)**

   (i) Rationality (ii) Turing Test

   (c) Briefly explain Strategic and Episodic task environment with examples. **(6)**

   (d) "An agent that communicates using natural language is usually operating in a partially observable environment" — is this statement true? Explain in brief. **(3)**

   (e) Describe and compare between Goal based agent and Utility based agent. **(15)**

2. (a) Prove the optimality of A* search. **(8)**

   (b) What is contingency problem? **(7)**

   (c) Consider the state space graph as shown in figure 2(c). All arcs are bidirectional. Arcs are labelled with the cost of traversing them and the value of an admissible heuristic function h, is shown along side each node. The start state is S and the goal is G. For each of the following search strategies, list, in order, all the states popped of the OPEN list. When everything else is equal, nodes should be removed from the OPEN list in alphabetic order. **(20)**

   (i) Iterative deepening depth first search

   (ii) UCS

   (iii) A*

   (iv) Greedy best first search

3. (a) Suppose A* known to generate K nodes on a given problem, and every node has a distinct F value. Roughly how many nodes will IDA* generate on the same problem? **(10)**

   (b) How can admissible heuristic function be invented? **(8)**

   (c) Can iterative deepening search ever expand fewer total nodes than BFS does? **(5)**

   (d) Assume, you are trying to find the values for X_1 through X_4 that maximize the following function--- **(12)**

$f = 5X_1 - 3X_2X_3 + X_3 - 2X_4$

you decide to use a genetic algorithm and create the initial population:

	X_1	X_2	X_3	X_4
Parent 1 :	0	1	1	0
Parent 2 :	1	1	0	0
Parent 3 :	1	0	1	1
Parent 4 :	0	0	0	1

Briefly explain how you might create the next generation of the population.

4. (a) What is quiescence search? **(5)**

(b) Briefly discuss Backtracking search for constraint satisfaction problem. What heuristics may be used to improve its performance? **(9+6=15)**

(c) Consider the game tree as shown in figure 4(c). The root corresponds to a MAX node and the value of an evaluation function, if applied, are given at the leaves. **(15)**

(i) What is the minimax value computed at the root mode for this tree?

(ii) What move should MAX choose?

(iii) Which nodes are not examined when Alpha-Beta pruning is performed? Assume children are visited from left to right.

SECTION – B

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

5. (a) Consider the following English sentences: **(10+5+10=25)**

Tony, Michael and Ellen belong to the Hoofers Club. Every member of the Hoofers club is either a skier or a mountain climber or both. No mountain climber likes rain, and all skiers like snow. Ellen dislikes whatever Tony likes and likes whatever Tony dislikes. Tony likes rain and snow.

(i) Represent the sentences in first-order logic.

(ii) Convert the sentences to conjunctive Normal Form (CNF).

(iii) Applying resolution refutation answer the following query:

"Is there a member of the Hoofers Club who is a mountain climber but not a skier?"

(b) For each of the following sentences, is the accompanying sentence in First-Order Logic a good translation? If yes, answer "yes". If no, explain why not and then give a correct answer. **(10)**

(i) No two people have the same social security number. $\neg \exists x,y,n$ (Person (x) $\wedge$ Person (y)) $\Rightarrow$ (HasSSN (x, n) $\wedge$ HasSSN (y, n))

Contd P/3

(ii) Every one's social security number has nine digits.

$\forall x,n \quad Person(x) \Rightarrow (HasSSN(x, n) \wedge NumDigits(n, g))$

6. (a) Consider the following knowledge-base which describes the rules to identify when the car should brake? **(8)**

PersonInFrontofCar $\Rightarrow$ Brake

(YellowLight $\wedge$ Policeman $\wedge \neg$ Slippery) $\Rightarrow$ Brake

Policecar $\Rightarrow$ Policeman

Snow $\Rightarrow$ Slippery

Slippery $\Rightarrow \neg$ Dry

RedLight $\Rightarrow$ Brake

Winter $\Rightarrow$ Snow

Observation from sensors:

YellowLight $\wedge$ RedLight $\wedge$ Dry $\wedge$ Policecar $\wedge \neg$PersonInFrontofCar

Using the Backward chaining inference strategy can the agent infer "Brake"?

(b) Soundness of an inference rule (procedure) i is defined as: **(8)**

Whenever $KB \vdash_i \alpha$ for any sentence α, it is also true that $KB \models \alpha$. Consider the following inference rule in propositional logic where J, H and P are proposition symbols. Prove whether or not it is a sound rule of inference.

$$\frac{(J \wedge H) \Rightarrow P, \quad \neg P}{\neg J \vee \neg H}$$

(c) Given the following decision tree (in figure 6(c), for making a binary decision about whether or not to go on a bike ride, write a single sentence in propositional logic that expresses the same information, i.e. when to go on a bike ride. **(4)**

(d) Why information gain ratio is used as the metric to choose the best attribute in Decision Tree Learning Algorithm, when the attributes are multi-valued? Explain with a suitable example. **(9)**

(e) What are the two restrictions to circuit-based agent design? Explain briefly. **(6)**

7. (a) Consider the following description of wumpus world problem: **(18)**

Wumpus world is a 4×4 grid. Initially the Agent is at [1, 1]. There is one wumpus in one of the 16 squares except [1, 1]. Three of the squares except [1, 1] contain three pits. The positions of wumpus and pits are randomly distributed, however wumpus doesn't live in a square where there is a pit. Squares adjacent to wumpus are smelly and adjacent to pits are breezy.

At [1, 1] the Agent perceives neither Stench nor Breeze perception. Now the Agent moves to [2, 1] where it perceives both Stench and Breeze perceptions. Then it returns to [1, 1], and thereafter moves to [1, 2] where it perceives both Stench and Breeze perceptions.

From the initial Knowledge Base and observed perceptions, entail the following conclusions with the help of propositional logic:

(i) whether [2, 2] labelled square contains the wumpus.

(ii) whether [1, 3], [2, 2] and [3, 1] labeled squares contain pit.

(The labelling of the square is shown in figure 7(a)).

(b) Why does ensemble learning outperform the general learning method, in which a single hypothesis is chosen from the hypotheses space? **(5)**

(c) Consider the Bayesian Network shown in figure 7(c). Where variables W, A and H are all Boolean - valued. **(4+8=12)**

(i) compute $P(\neg A, W, H)$

(ii) compute $P(\neg A \mid H)$

8. (a) Consider the set of training examples given in figure 8(a) each indicating whether or not a person played tennis denoted by the Boolean classification variable PlayTennis, given four attributes: Outlook, Temperature, Humidity and Wind. **(28)**

Find the information gain of each attribute. Based on the calculated information gains, select the attribute for the root of the decision tree. Using the information gain criterion choose the best attribute to classify the examples at each subsequent steps. Draw the complete decision tree learned from this set of examples.

(b) Consider the following cell phone domain. Having a charged battery (CB) enables a cell phone to be operational (OP). Having an operational cell phone, being in the coverage area (CA), and knowing the number to call (KN) enables the placing of a call (PC). Assume there are no other dependencies. All random variables are Boolean. Draw a Bayesian Network for this domain, including nodes, arcs and the form of each conditional probability table (CPT) at each node. **(7)**

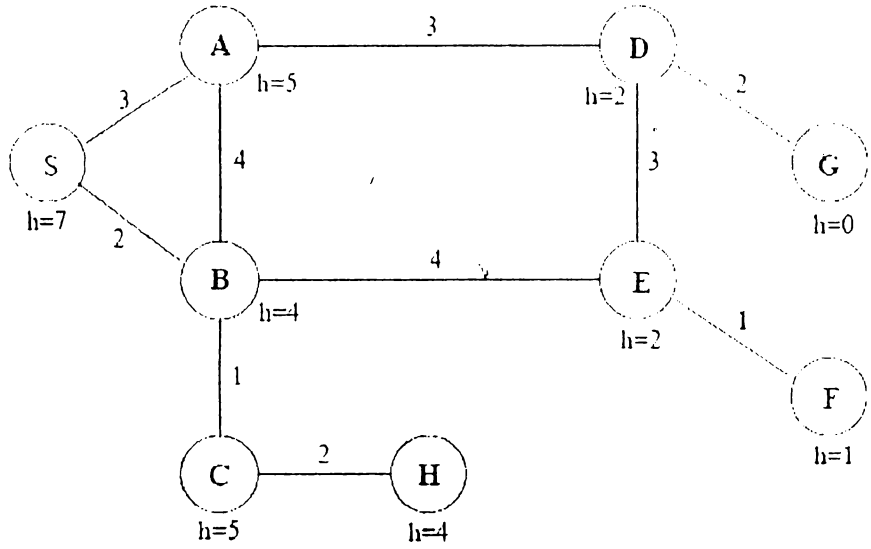


Figure: 2(c)

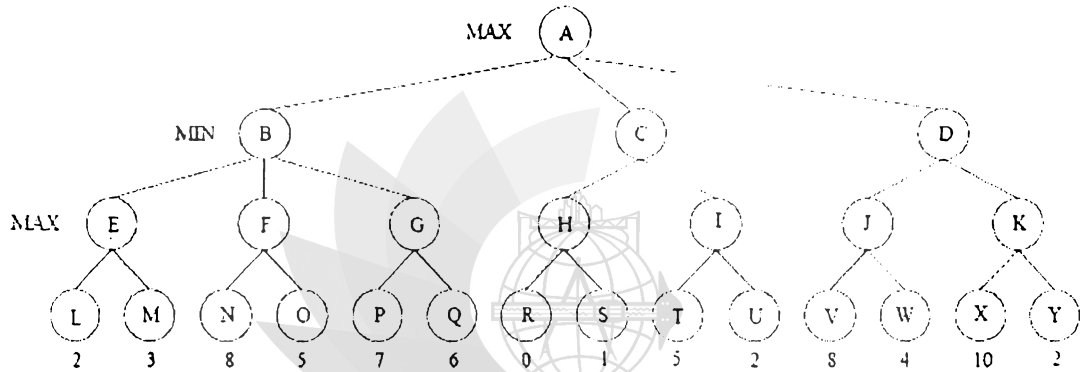
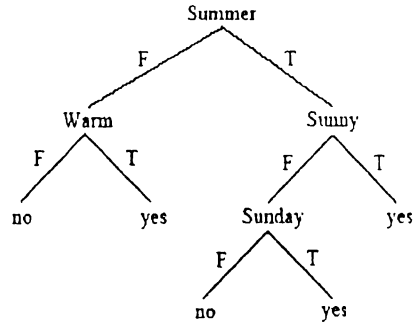


Figure: 4(b)



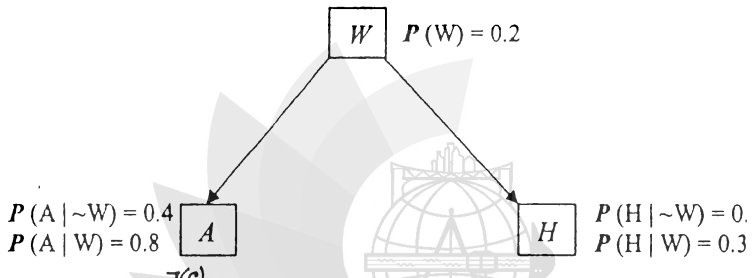
6(c)

Figure 4: The decision tree for bike riding [for question# 6(c)]

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2	2,2	3,2	4,2
1,1	2,1	3,1	4,1

7(a)

Figure 5: The labeling of the squares of the Wumpus World [for question# 7(a)]



7(c)

Figure 6: A Bayesian network showing the topology and the conditional probability tables (CPTs) [for question# 7(c)]

Day	Outlook	Temperature	Humidity	Wind	PlayTennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	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	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

8(a)

Figure 7: Examples for the *PlayTennis* domain [for question# 8(a)]