MAKERERE UNIVERSITY
FACULTY OF COMPUTING & IT

DEPARTMENT OF COMPUTER SCIENCE
CSC 2114 ARTIFICIAL INTELLIGENCE TEST 1

MARKING GUIDE

Question 1:

a) Define Artificial Intelligence as a discipline. (1 Mark)

The ability of a machine (device) to perform functions that are normally associated with human intelligence, such as reasoning, planning, recognition, perception, cognition, learning, understanding, and problem-solving. The ability of a machine (device) to perform functions that are normally associated with human intelligence, such as reasoning, planning, recognition, perception, cognition, learning, understanding, and problem-solving.

b) Define Artificial Intelligence as an ability (1 Mark)

A branch of the computer science that deals with the research, design and application of the intelligent computer. Its major objective is to develop and use a machine to imitate some intellectual capabilities of human brain and to develop the related theories and techniques.

c) Intelligent Machine (1 Mark)

A kind of machine that performs various anthropomorphic tasks in an environment by doing autonomously or interactively

d) Intelligent System (1 Mark)

A system that can drive (operate) an intelligent machine to reach its goal.

e) Intelligent Science (1 Mark)

A discipline that studies the essences of the human-being intelligent behavior, simulates the intelligence of human and living beings, and realizes various intelligent systems.

Question 2:

The hypothesis of intelligent information processing systems has got basic functions in its physical symbol operation in regards to Human Intelligence and AI.

a) State the six (6) functions (3 Marks)

(i) Input ;
(ii) Output;
(iii) Storage; {0.5 marks for @ correct one}
(iv) Copy;
(v) Construction of the symbol structure ;
(vi) Conditional transfer

FACULTY OF COMPUTING & IT

DEPARTMENT OF COMPUTER SCIENCE
CSC 2114 ARTIFICIAL INTELLIGENCE TEST I

MARKING GUIDE

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Data 1-5
Data Struc 1-5
Final 10-11

How can agent survive
- to built knowledge
- ability to learn

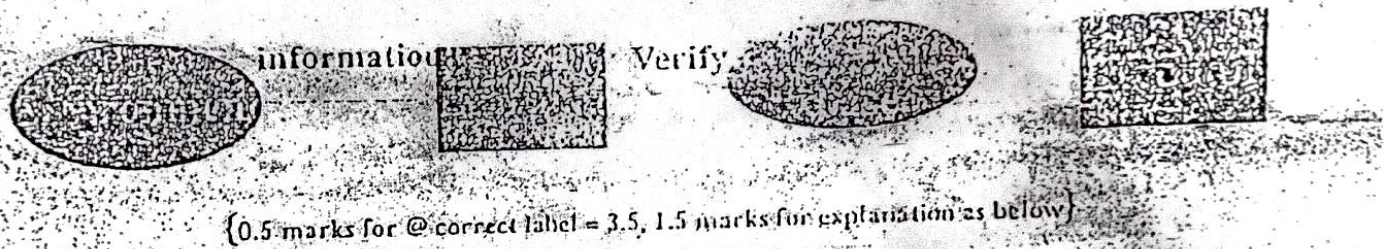
b) State the four (4) key divisions of the above information system. (2 Marks)

(i) Symbol Operating system Basic Functions
(ii) Human being
(iii) Hypotheses
(iv) Deductions

{0.5 marks for @ correct one}

Question 3: (5 Marks)

With the aid of a well-labeled diagram, explain the machine learning model



{0.5 marks for @ correct label = 3.5, 1.5 marks for explanation as below}

Extracting information from an environment (or a particular domain) is a learning process that after verification, one constructs or builds a knowledge base. There's constant execution and giving a feedback to bring machine learning to perfection is an iterative process model.

Question 4:

There is often a tradeoff between Artificial Intelligence and Natural Intelligence.

a) Explain three (3) advantages of Artificial Intelligence over Natural Intelligence (3 Marks)

- Ease of duplication and dissemination
- More permanent
- Less expensive
- Consistent and thorough
- Can be documented
- Can execute certain tasks much faster than a human
- Can perform certain tasks better than many or even most people

{1 mark for stating & explaining for @ correct one}

b) Explain three (3) advantages of Natural Intelligence over Artificial Intelligence (3 Marks)

- Natural intelligence is creative
- People use sensory experience directly
- Can use a wide context of experience in different situations

{1 mark for stating & explaining for @ correct one}

Question 5:

In AI, heuristic (s) can be defined as the study of problem solving methods and rules of discovery and invention (Often associated with searching (2 marks for stating & explaining for @ correct one)

a) State and Explain the two (2) search categories (4 Marks)
   Informed and Uninformed.

b) Explain four (4) search criteria that are normally followed while analyzing the performance of the various search strategies (8 Marks)

- Time complexity
- Completeness
- Space complexity
- Solution Optimality

(2 marks for stating & explaining for @ correct one)

Question 6:

By attempting to unify the following pairs of expressions, either show their most general unifiers or explain why they will not unify. (2Marks for @)

a) p(X,Y) and p(a,Z)
b) p(X,X) and p(a,b): **Failure: there are different constants that cannot match.**
c) ancestor(X,Y) and ancestor(bill,father(bill))
d) ancestor(X,father(X) and ancestor(david,george)
e) q(X) and ¬q(a)

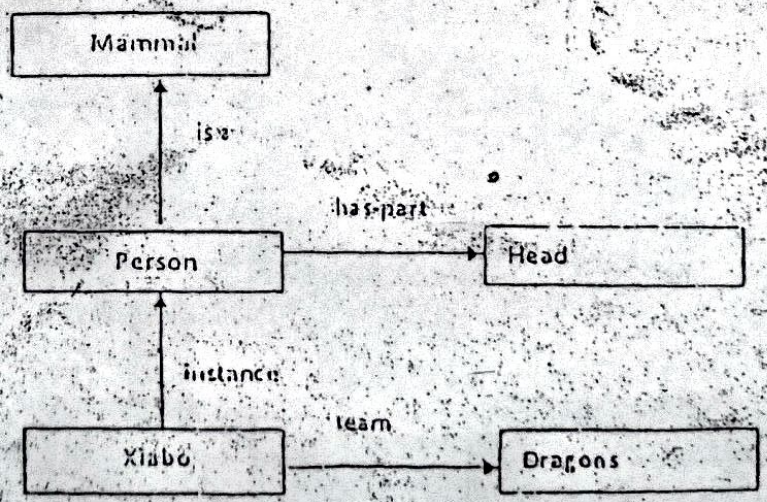
All the rest can, it's your challenge! Would accept any form despite asking for *most general form*

Question 7: Knowledge representation is the study of how knowledge about the world can be represented and what kinds of reasoning can be done with that knowledge. Draw a semantic network for the following logic statements:

(7 Marks)

isa(person,mammal),
has_part(person,head),
instance(Xiaobo,person),
team(Xiaobo,dragons)

5 Marks for all the 5 correctly labeled entities.
2 Marks for all the 4 correctly labeled relations



Makerere University

completeness
Time complexity
space complexity
optimality
solution

School of Computing and Informatics Technology
Department of Computer Science
Semester 1 Academic year: 2011/2012
CSC 2114: Artificial Inteiligence Test 1

Date: November, 12th, 2011 Time: 10 : 00 - 11 : 00

Answer All Questions

1. In Artificial Intelligence (AI), we aim at building computer systems which can think like human beings. AI has been categorized into a variety of branches depending on the applications involved. Using real life examples explain the following AI branches. (3 marks each)
   a) Logical AI
   b) Search
   c) Pattern recognition
   d) Representation
   e) Heuristics

2. Problem solving is concerned with building systems which can solve a particular problem. Explain the steps you would take to build a problem solving system. (10 Marks)

3. Heuristic search is one of the search control strategies used in Artificial Intelligence. Using examples explain the steps you take when performing a heuristic search (5 marks)

4. With a help of a tree structure explain how each of the following search strategies work (10 Marks)
   a) Breadth-First Search
   b) Depth-First Search

Define the problem precisely
Analyze the problem
Isolate and represent the task knowledge
Choose the best problem

d. Explain how Beyesian statistics provides reasoning under various kinds of uncertainty (4 Marks)

e. On 10th January is CSC2114 Exam. In recent months, each month it has rained only 4 times. The weatherman has predicted rain on the day of CSC2114 Exam. When it actually rains the weatherman correctly forecasts rain with 90% of the time. When it does not rain, the weatherman incorrectly forecasts rain 10% of the times. What is the probability that it will rain on the day of the Exam? (4 Marks)

Question Four

a. Define the term Knowledge as used in Artificial Intelligence. (1 Mark)

b. Using a well-labeled diagram explain how knowledge progresses in a Knowledge System. (5 Marks)

c. One of the key issues in developing an A.I system is Knowledge Representation which is done based on some framework. Explain this framework (5 Marks)

d. When designing a knowledge representation system, there are some properties one needs to consider. Explain these properties. (4 Marks)

e. Illustrate the use of predicate logic to represent knowledge with suitable examples. (5 Marks)

Question Five

a With the help of a tree structure explain how each of the following search strategies work. (4 Marks)

i. Breadth-First Search ii. Depth-First Search

b. Give an example of a problem for which breath first search would work better than depth first search. (2 Marks)

c. Explain the algorithm for steepest hill climbing. (5 Marks)

d. Explain the following search strategies. (4 Marks)

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SECTION A
ATTEMPT ALL QUESTIONS IN SECTION [40 Marks]

1. Define the following in relation to Artificial Intelligence (A.I) (1 Mark @)
   i. Heuristic Function
   ii. Unification Algorithm
   iii. Search space
   iv. Learning Agent

2. Explain the factors you would consider when evaluating the performance of a Search Algorithm (4 Marks)

3. Explain the five components of a well-defined problem in A.I (5 Marks)

4. Explain the purpose of the following inputs to a Learning Agent (1 Mark @)
   i. Agent Function
   ii. Percept Sequence

5. Define the term Game theory as applied to Artificial Intelligence and how how the MinMax algorithm is used in this theory (4 marks)

6. Explain a Constraint Satisfaction Problem (CSP) clearly stating the various variables involved (2 Marks)

7. With help of examples explain four things Artificial Intelligence can do in today's world (4 Marks)

8. Explain three causes of uncertainty in Knowledge for AI systems (6 Marks)

9. Explain the role of the following people in the development of an Expert system (1 Mark @)
   i. Domain Expert
   ii. Knowledge engineer
   iii. User

10. What are Frames,cts and Instances (2 Marks)

11. List any four schemes used in Knowledge representation (4 Marks)

SECTION B [60 MARKS]

ATTEMPT ANY THREE(03) QUESTIONS IN THIS SECTION

Question one

a. Using a well-labeled diagram explain the Components of a Learning Agent. (8 Marks)

b. Suppose you are in charge of developing an automated taxi for driving on Kampala roads, identify and explain the components of this learning Agent (taxi) (4 Marks)

c. Using examples explain the difference between the following learning paradigms

i. Rote learning and Induction learning (4 Marks)

ii. Clustering and Reinforcement learning (4 Marks)

Question Two

a. What is the difference between Forward Chaining Algorithm and Backward Chaining Algorithm? (2 Marks)

b. Given the following set of rules in a Knowledge base

Rule 1: if A and C Then F Rule 3: if B Then E

Rule 2: if A and E Then G Rule 4: if G Then D

Prove that if A and B are true Then D is true using Forward Chaining Algorithm (8 Marks)

c. Knowledge Acquisition is a key step in the development of an Expert system. Explain any five important issues a developer is concerned with during this step (5 Marks)

d. Construct a semantic network using the sentences given below (5 Marks)

1. A Car is Vehicle
2. A Vehicle has Wheels
3. A Car has an Engine
4. A Car has a Battery
5. A Car is a Nissan
6. A Nissan has a Power

Question Three

a. Differentiate between Monotonic and Non Monotonic Reasoning (2 Marks)

b. Artificial Intelligence is concerned with building system which can reason under uncertainty situations. Explain any three sources of these situations (3 Marks)

c. Explain the following types of Reasoning (2 Marks)

i. Default Reasoning

ii. Abductive

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Section A (Attempt all questions in this section)

1. Using real life examples explain any four applications of Artificial Intelligence [4 marks]
2. With the help of an example explain the difference between a goal-based agent and a utility based agent. [4 marks]
3. Define a search problem as applied to Artificial Intelligence [4 marks]
4. Explain the four properties of a search Algorithm [4 marks]
5. Define an Admissible Heuristics [2 marks]
6. Define a Constraint Satisfaction Problem [2 marks]
7. Using examples explain the following types constraints as applied to constraint satisfaction problem [2 marks]
   i. Unary constraints
   ii. Binary constraints.
8. What is Backtracking Search and explain how it can be used to enforce Arc Consistency in a constraint satisfaction problem [4 marks]
9. Define the term Game as used in Artificial intelligence and give any two deterministic single player games you know [2 marks]
10. Define the term knowledge base as used in Artificial Intelligence [2 marks]
11. From Schematic perspective define the term entilement [2 marks]
12. In relation to Inference Procedures what is meant by the statement that the Inference Procedure K is sound and complete [4 marks]
13. Differentiate between generative and Discriminative [2 marks]
14. Define a decision boundary [2 marks]

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Section B (Attempt any three questions in this section)

Question one

a) Define a rational Agent [2 marks]

b) Using examples explain the following concepts in relation to ration Agents [4 marks]

i. Agent function

ii. Agent program

c) In the design of rational agents we need to specify their task environments, Basis on the PEAS criteria, specify the task environment for each of the following agents [6 marks]

i. An automated taxi driver

ii. Internet Shopping Agent

iii. Spam Filtering Agent

d) Explain how the environment type influence the design of rational agent and state the environment types for the following rational agents [8 marks]

i. Crossword puzzle

ii. Back-gammon

Question two

a) Explain the term MinMax as used in game playing and state the properties of MinMax for an optimal perfect player game [6 marks]

b) Consider the MinMax tree given in figure: 1 what is the value of the root [2 marks]

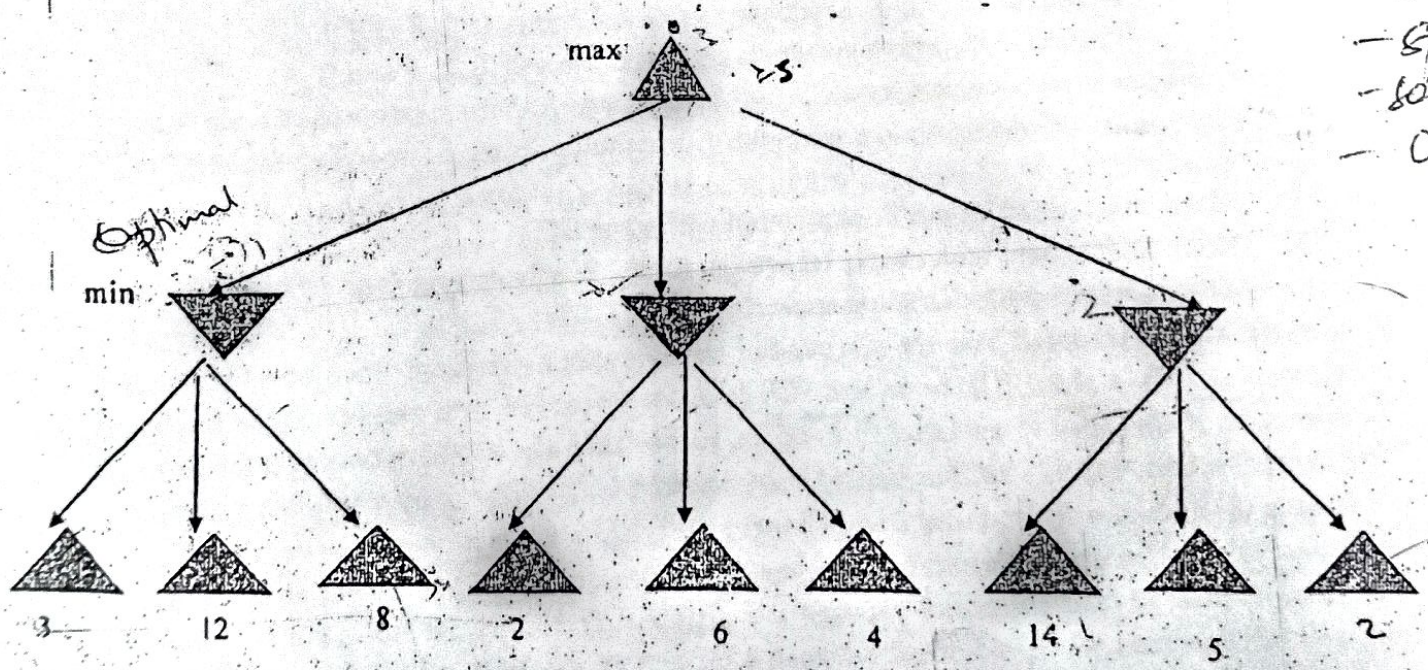

Figure:1

c) Using an example, explain the $\alpha-\beta$ – Pruning technique [4 marks]

d) Consider the MinMax tree given in figure: 1 indicates with an X the branches that will be pruned by the $\alpha-\beta$ Pruning technique [2 marks]

e) Define a Markov Decision process and show how it has been applied to model the card playing game [6 marks]

Question Three

a) You are in charge of scheduling computer science classes that meet Tuesdays, Wednesdays, Thursdays and Saturdays. There are 9 classes that meet on these days and 5 professors who will be teaching these classes. You are constrained by the fact that each professor can only teach one class at a time.

The classes are

Class 1 - Programming methodology 1: meets from 8:00-9:00am
Class 2 - Artificial Intelligence: meets from 8:30-9:30am
Class 3 - Selected topics in Computer Science: meets from 10:00-11:00am
Class 4 - Formal Methods: meets from 9:00-10:00am
Class 5- Computer Organization and Structure: meets from 9:00-10:00am
Class 6 - Communication Skills: meets from 10:30-11:30am
Class 7 - Data structures and algorithm: meets from 11:00-12:00am
Class 8- Calculus 1: meets from 9:30-10:30am
Class 9- Database systems: meets from 2:30-3:30pm

The professors are:

Professor Q, who is available to teach Classes 1, 2, 3 and 7
Professor R, who is available to teach Classes 2, 3, 4 and 5.
Professor C, who is available to teach Classes 1, 3, 4 and 6.
Professor A, who is available to teach Classes 1, 2, 8 and 9.
Professor M, who is available to teach Classes 1, 2, 5 and 9.

i. Formulate this problem as a CSP problem in which there is one variable per class, stating the domains, and constraints. Constraints should be specified formally and precisely [6 marks]

ii. Draw the constraint graph associated with your CSP [2 marks]

iii. Your CSP should look nearly tree-structured. Briefly explain (one sentence or less) why we might prefer to solve tree-structured CSPs [2 marks]

b) You have been trapped! You are surrounded by mysterious corridors, each of which leads to either a pit (P), a ghost (G), or an exit (E). In order to escape, you need to figure out which corridors, if any, lead to an exit and freedom, rather than the certain doom of a pit or a ghost. The one sign of what lies behind the corridors is the wind: a pit produces a strong breeze (S) and an exit produces a weak breeze (W), while a ghost doesn't produce any breeze at all. Unfortunately, you cannot measure the strength of the breeze at a specific corridor. Instead, you can stand between two adjacent corridors and feel the max of the two breezes. For example, if you stand between a pit and an exit you will sense a strong (S) breeze, while if you stand between an exit and a ghost, you will sense a weak (W) breeze. The measurements for all intersections are shown in the figure:2 below. Also, while the total number of exits might be zero, one, or more, you know that two neighboring squares will not both be exits

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S...tion A (40 Marks)

1. Highlight some examples where a search approach would be appropriate and where a CSP problem solving approach would be appropriate. In which way are search problems related to CSPs ? [3 marks]

2. Consider a state space where the start state is 1 and the successor function for state i returns two states: $2i$, $2i+1$.

   (a) Draw the corresponding search tree upto depth 3. [3 marks]

   (b) Suppose the goal state is 11. List the order in which nodes will be visited for:

      i. Breadth-first search [2 marks]

      ii. Depth-limited search with depth limit 3 [2 marks]

3. Consider the following CSP with 3 variables X, Y and Z with the following domains $X = \{1, 2, \ldots, 10\}$, $Y = \{5, 6, \ldots, 15\}$ and $Z = \{5, 6, \ldots, 20\}$. The constraints on 3 the variables are: $X > Y$, $Y + Z = 12$ and $X + Z = 16$.

   (a) Draw the constraint graph [2 marks]

   (b) Are the constraints arc consistent? If no, apply arc consistency method repeatedly so they become arc consistent. What is the updated domain of each variable? [3 marks]

4. You are designing an informed search algorithm to solve a problem of interest. Explain what a heuristic function is and why you might want to use one. [3 marks]

5. Consider a hypothetical case where emails are sent by Sam and Jane. Sam has sent the following emails with the following letters. Calculate P(Sam), P(Jane), P(a | Sam), P(f | Jane) [6 marks]

Sam: $[(a, b, a, a, b, b, c, c,), (d, e, e, f, d, a, t), (a, f), (e, d)]$

Jane: $[(b, b, a), (c, c, t, t, d), (e, f, a, b, e, e, f, g, s)]$

6. Consider the search graph in Figure 1.

   (a) What are the solutions to the graph for the UCS and A^* search algorithm if you break times alphabetically? [6 marks]

   (b) What are the corresponding costs for UCS and A^*? [2 marks]

7. If $P(A|B)$ is three times the value of $P(B|A)$, and P(A)=0.123, what is P(B)? [3 marks]

8. Consider points in 2D and binary labels. Given the following training data: $x_1 = (1,1), y_1 = 1, x_2 = (-1,1), y_2 = 0, x_3 = (-1,-1), y_3 = 1, x_4 = (1,-1), y_4 = 0$, and using Euclidean distance, how will Nearest Neighbor (NN) classify the data point A(0.5,0.5) in 2D? [5 marks]

9. Given $P(A|B)$=0.4, P(B)=0.2, P(A)=0.5, compute $P(B|A)$. [3 marks]

Section A (40 Marks)

1. Highlight some examples where a search approach would be appropriate and where a CSP problem solving approach would be appropriate. In which way are search problems related to CSPs ? [3 marks]

2. Consider a state space where the start state is 1 and the successor function for state i returns two states: $2i$, $2i+1$.

   (a) Draw the corresponding search tree upto depth 3. [3 marks]

   (b) Suppose the goal state is 11. List the order in which nodes will be visited for:

      i. Breadth-first search [2 marks]

      ii. Depth-limited search with depth limit 3 [2 marks]

3. Consider the following CSP with 3 variables X, Y and Z with the following domains $X = \{1, 2, \ldots, 10\}$, $Y = \{5, 6, \ldots, 15\}$ and $Z = \{5, 6, \ldots, 20\}$. The constraints on 3 the variables are: $X > Y$, $Y + Z = 12$ and $X + Z = 16$.

   (a) Draw the constraint graph [2 marks]

   (b) Are the constraints arc consistent? If no, apply arc consistency method repeatedly so they become arc consistent. What is the updated domain of each variable? [3 marks]

4. You are designing an informed search algorithm to solve a problem of interest. Explain what a heuristic function is and why you might want to use one. [3 marks]

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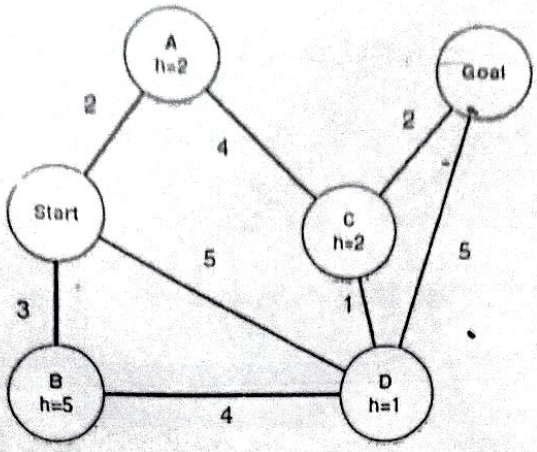


Figure 1: Search graph

Section B. Attempt any 3 questions (20 Marks each).

Question 1

As you get close to graduating from Makerere, you decide to do some career planning. You create a graph of your options where the start node is M =Makerere and your goal node is R=Retirement, with a bunch of options in between as shown in Figure 2. A =Wall Street, B =Grad School, C = Professor, D = Government and E = Entrepreneur. Your graph includes edge distances that represent roughly the cost of transition in years between these careers. You have also a heuristic (h) for the node-to-goal distances which represents your preconceptions about how many more years you have to work until you retire. For example, you think it will take 25 years to go from Makerere (M) to retirement (R), but only 2 years from Entrepreneur (E).

Suppose you want to retire after doing a certain number of jobs, the search for these jobs can proceed with a variety of algorithms, resulting in different search trees. Assume that children of a node are visited in alphabetical order. Provide the search order and the resulting path that would be generated when a graph search with a *closed/visited list* is performed on the graph using each of the following search strategies.

(a) Depth first search [3 marks]

(b) Breadth first search [3 marks]

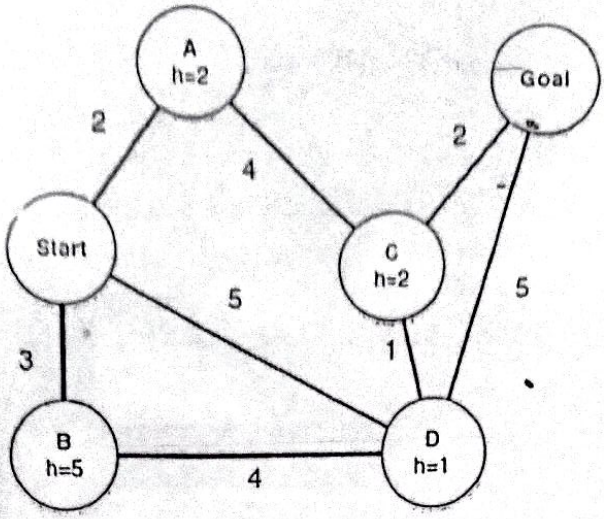
(c) Uniform cost search [5 marks]

(d) A^* search [7 marks]

(e) Best-first (greedy) search [2 marks]

Question 2

(a) Game playing as a concept in search tends to be adversarial in nature. What do you understand by adversarial search ? [2 marks]



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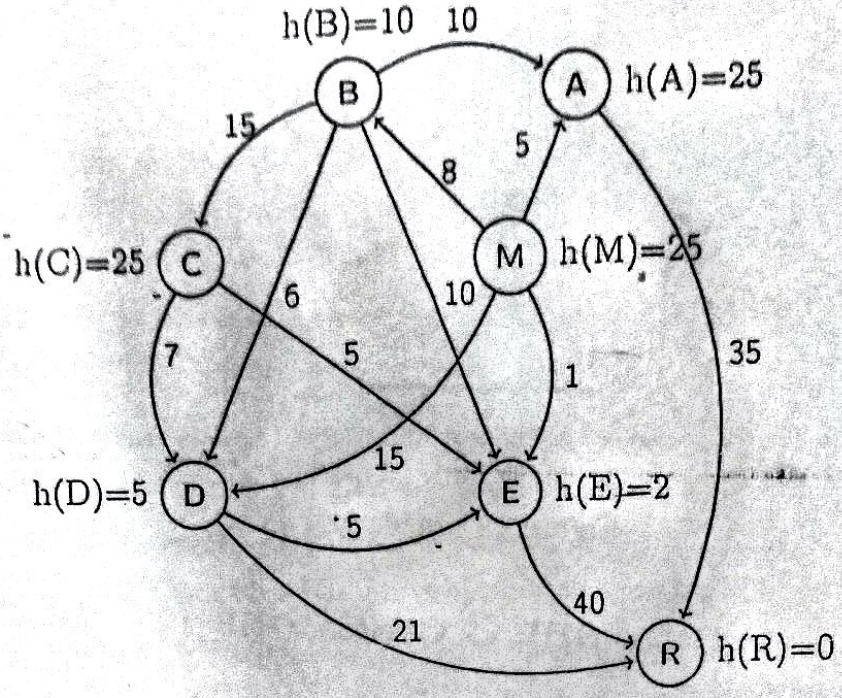

Figure 2: Career options graph

(b) One algorithm that can be used in this kind of search is the Minimax algorithm. Briefly explain how this algorithm works. [4 marks]

(c) Perform Minimax on the game tree provided in Figure 3. Write the minimax value associated with each letter, A, B, C, D, E, F, and G. [7 marks]

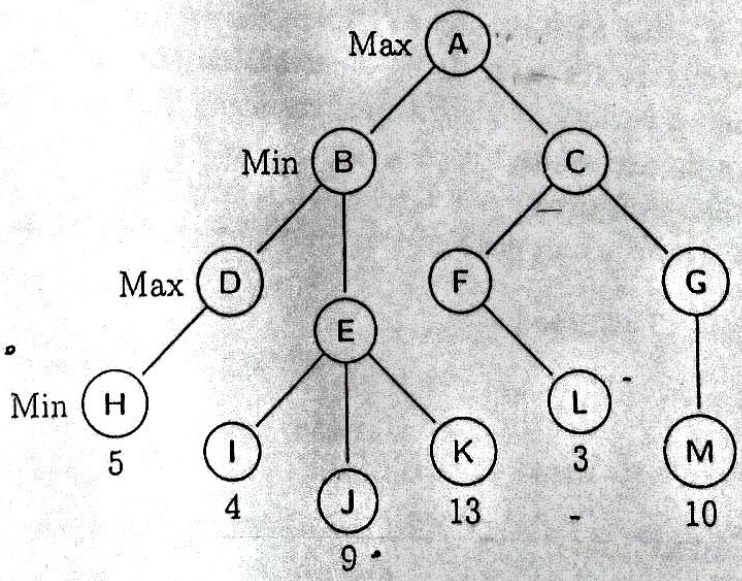

Figure 3: Game tree 1

(d) Perform Alpha-Beta pruning on the game tree provided in Figure 3. Indicate pruning by striking through the appropriate edge(s) and explain why the pruning that had to take place. [7 marks]

Question 3

You have been provided with examination timetables and a set of available rooms as indicated in Tables 1 and 2. Your task is to allocate rooms to the papers scheduled on the examination timetable adhering to the following set of rules by modeling the room allocation problem as a constraint satisfaction problem (CSP).

- **All students sitting for the same paper must sit in a single room.**
- **Examination papers running at the same time must not share rooms.**

Table 1: Test Schedule

Paper	Time	Number of Students
BIS2106	8:00AM-11:00AM	120
BIS2105	8:00AM-11:00AM	90
CSC2100	-12:00-3:00PM	350
BIS1104	4:00PM-7:00PM	170
CSC1100	4:00PM-7:00PM	450
CSC2114	12:00-3:00PM	360
BSE2106	4:00PM-7:00PM	300
MTH3105	12:00-3:00PM	250
CSC1107	8:00AM-11:00AM	500
BIT2110	12:00-3:00PM	100
BIS1100	8:00AM-11:00AM	100

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Table 2: Rooms Available

Room	Time Available	Sitting Capacity
R1	9:00AM-9:00PM	355
R2	7:00AM-1:00PM	600
R3	7:00AM-9:00PM	100
R4	7:30AM-8:00PM	95
R5	7:30AM-8:00PM	200
R6	10:00AM-8:00PM	500
R7	10:00AM-4:30PM	290
R8	7:00AM-1:00PM	120

CSC2
CSC

(a) Using examination papers as variables and rooms as the domain values, list legal domains for each of your variables. [5 marks] .

(b) Specify the binary constraints of your CSP. [5 marks]

(c) Draw constraint graph for your CSP indicating variables and their relationships.[3 marks]

(d) If you start by allocating $R6$ to CSC2100. Will your CSP have a solution? Explain your answer. [3 marks]

(e) By using the minimum remaining value (MRV) heuristics, which variable(s) should be assigned first. [2 marks]

(f) List one solution to this CSP or state that none exist. [2 marks]

Question 4

An outbreak of Cholera (C), Typhoid (T) and Ebola (E) diseases have been reported in Kisenyi. The Ministry of Healthy has sent a team of experts to Kisenyi to perform laboratory tests on patients suspected to be suffering from the three diseases. Table 3

provides a summary of results obtained after conducting laboratory tests on the suspected patients. In the table a positive indicates that the laboratory tests were positive for that disease while a negative indicates that the tests were negative for that disease. For example, +c indicate that the tests were positive for cholera disease and -c indicate that the tests were negative for cholera.

Table 3: Test Schedule

Cholera (C)	Typhoid (T)	Ebola (E)	Number of patients
+c	+t	+e	200
+c	+t	−e	70
+c	−t	+e	180
+c	−t	−e	80
−c	+t	+e	210
−c	+t	−e	60
−c	−t	+e	150
−c	−t	−e	50

(a). Using data provided in Table 3. Calculate the following probabilities: P(C = +c), P(C = −c), P(T = +t), P(T = −t), P(E = +e), P(E = −e). [8 marks]

(b) Based on the results obtained in (a) which disease is most prevailing in the Kisenyi. Explain your answer. [2 marks]

(c) Calculate the following probabilities: P(C = +c|T=+t), P(E = +e|T=+t), P(C = −c|E = −e), P(C = +c, E=−e|T = +t), P(E = −e,T = −t|C = +c). [5 marks]

(d) A patient suspected of having the three diseases has just left the laboratory, What is the probability that this patient tested positive for Cholera given that his tests for Typhoid and Ebola were negative? [5 marks]

Question 5

Jane has attempted all questions in the CSC 2114 examination. She wants to calculate her chances of getting a distinction in CSC 2114. She asked 120 students who have had distinctions in CSC 2114 in the past, and 70 of them said they had attempted all questions in the CSC 2114 exam. Then she asked 1080 students who didnot get distinctions in CSC 2114 in the past, only 430 of them said they had attempted all questions. Past experience shows that only 10% of students who take CSC 2114 get distinctions.

(a) Calculate the probability of not having a distinction given that you attempted all questions. [2 marks]

(b) What is the probability of not having a distinction given that you did not attempted all questions? [2 marks]

(c) What is the probability of someone attempting all questions? [4 Marks]

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(d) From the information provided, calculate using Bayes rule, the probability that Jane will get a distinction? (given she attempted all questions) [6 Marks]

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Question 6

(a) Differentiate a classification problem from a regression problem, highlighting some examples of each. [3 marks]

(b) You train a linear regression algorithm on some data and obtain a line of best fit as $4y + 10x - 5 = 0$.

(a) Derive the weights w0 and w1 from your line of best fit. [2 marks]

(b) Using my trained algorithm what would be the predictions for y for values of x given as [4,12,-3,-6] ? [3 marks]

(c) If you were told the real values of y for those values of x (ie. [4,12,25,6]) are actually [1.25, -20.0, 5.75, 16.25]. Calculate the mean square error (MSE) of your earlier predictions. [6 marks]

(c) Given a dataset of two classes 1 and 2. Points in class 1 are [(1.0,7.0), (1.5,8.9)] and points in class 2 are [(3.0,6.7),(4.0,7.5)]. Using K-NN with $K = 3$. Given a point $Z = (2.0,7.8)$. Give the euclidean distance of this point from all the other 4 points. Which class would you place the point Z ? [6 marks]

Question 7

(a) In your understanding what is Machine Learning ? Highlight some examples of where it would come in handy (or where you have experienced it) in your day to day life as a student. [2 marks]

(b) One of the basic machine learning algorithms is the K-NN classifier.

(a) What does the K mean and what contraints are imposed on it normally ? [2 marks]

(b) Briefly write down pseudo code for the K-NN algorithm. [4 marks]

(c) Why is the Naïve Bayes algorithm called *Naïve* ? [2 marks]

(d) Consider a hypothetical case of a spam detector for an email application. You are trying to build a spam detector using the Naïve Bayes algorithm. You collect different example emails of SPAM and HAM. Imagine each email has words in this case denoted as the alphabetic letters. Examples of the emails are:

SPAM: [(a,b,a,a,b,b,c,c),(d,e,e,f,d,a,t),(a,f),(e,d),(f,f,e,b,g), (e,r,a,f)]

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HAM: [(b,b,a),(c,c,t,t,d),(e,f,a,b,e,e,f,g,s), (e,a,r,w,a)]

(i) Calculate the prior probability of receiving a SPAM email. What is the corresponding prior probability of receiving a HAM email. [2 marks]

(ii) Based on your example emails, calculate the parameters: P(a|SPAM), P(f|HAM), P(e|SPAM), P(e|HAM) [4 marks]

(iii) You receive an email with the following content (b,s,a,d). Will your spam detector flag it off as spam or ham. Provide the corresponding probabilities to support your answer. [6 marks]

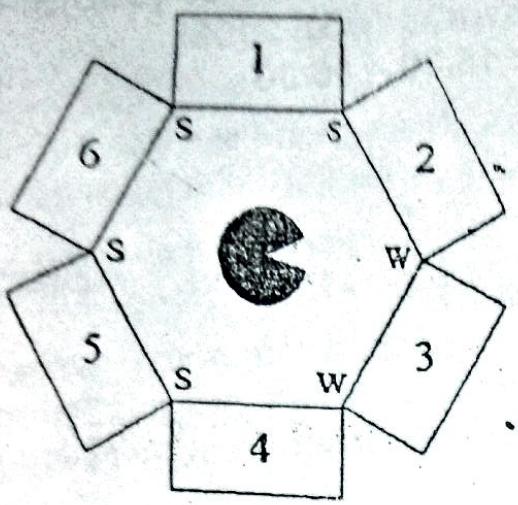

Figure:2

You have modeled this problem using variables Xi for each corridor i and domains P, G, and E.

i. State the binary and/or unary constraints for this CSP. [4marks]

ii. Cross out the values from the domains of the variables that will be deleted in enforcing arc consistency. [2 mark]

iii. According to MRV, which variable or variables could the solver assign first? [2 marks]

iv. Assume that you know that X6 = G. List all the solutions of this CSP or write none if no solutions exist. [2 marks]

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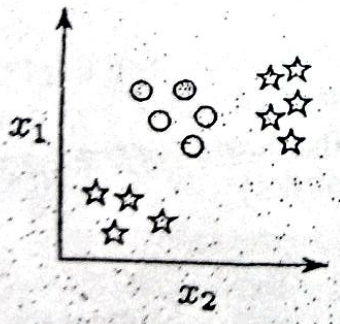
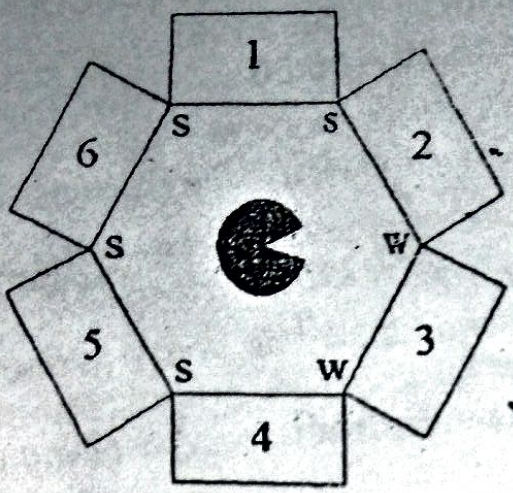
a) Give the formula for the Euclidean distance between two 3-dimensional arrays: [x1,x2,x3] and [y1,y2,y3] [5 marks]

b) Imagine you have the following 2-dimensional data in two classes (star and circle), and wish to build a classifier to predict the class of new points. Would a nearest neighbour classifier or a classifier which finds a linear decision boundary work best here? Briefly explain your choice. [5 marks]



c) If you wanted to build some classification software to run on a mobile device, it may have to operate with very little memory and storage space. Would a nearest neighbour classifier or a method which finds a linear decision boundary be best in this case? Briefly explain your choice. [5 marks]

d) Explain the difference between *classification* and *regression*. [6 marks]



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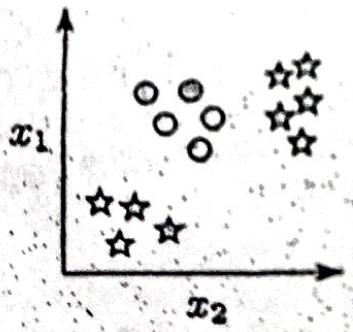

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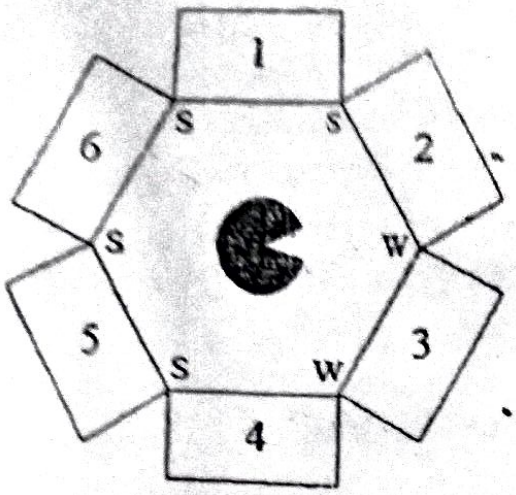

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You have modeled this problem using variables Xi for each corridor i and domains P, G, and E.

i. State the binary and/or unary constraints for this CSP. [4marks]

ii. Cross out the values from the domains of the variables that will be deleted in enforcing arc consistency. [2 mark]

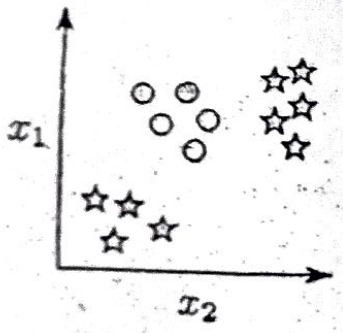
iii. According to MRV, which variable or variables could the solver assign first? [2 marks]

iv. Assume that you know that X6 = G. List all the solutions of this CSP or write none if no solutions exist. [2 marks]

Question four

a) Give the formula for the Euclidean distance between two 3-dimensional arrays: [x1,x2,x3] and [y1,y2,y3] [5 marks]

b) Imagine you have the following 2-dimensional data in two classes (star and circle), and wish to build a classifier to predict the class of new points. Would a nearest neighbour classifier or a classifier which finds a linear decision boundary work best here? Briefly explain your choice. [5 marks]

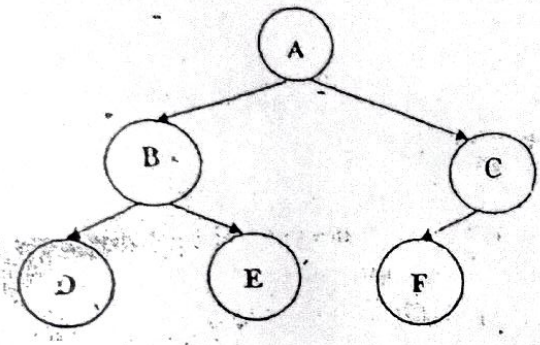


c) If you wanted to build some classification software to run on a mobile device, it may have to operate with very little memory and storage space. Would a nearest neighbour classifier or a method which finds a linear decision boundary be best in this case? Briefly explain your choice. [5 marks]

d) Explain the difference between *classification* and *regression*. [5 marks]

Question five

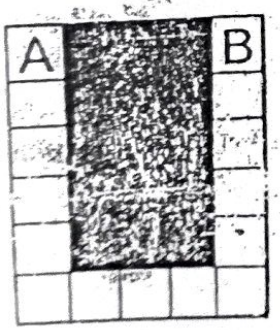
a) For the following search tree, show in which order the nodes are searched for breadth first search. [5 marks]

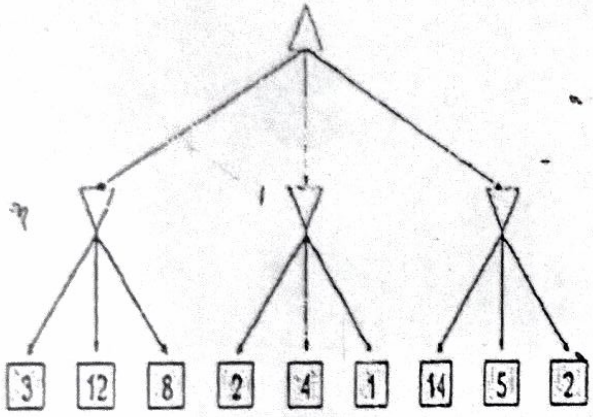


b) Show the order the nodes are searched in the above tree for depth first search. [5 marks]

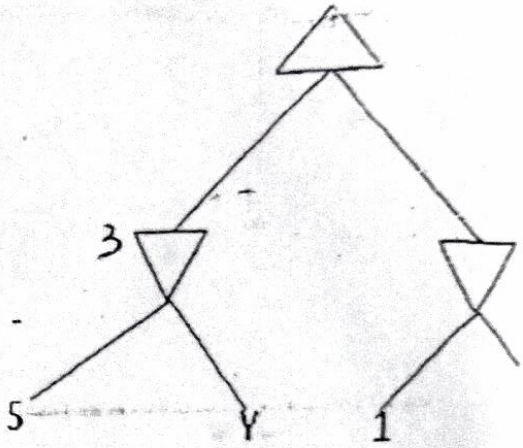
c) For what types of search problems can A* search be used instead of depth first search or breadth first search? [5 marks]

d) Consider the following simple maze, where the task is to find a path from A to B. If the straight-line distance from any point to B is used as a heuristic, explain why the greedy best first search will never find the solution. [5 marks]





(a)

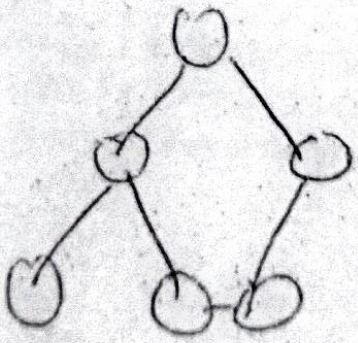


(b)

Figure 2:

b) Indicate with an X the branches/ nodes that will be prunned by the α - β prunning technique [3 marks]

c) Consider the game tree in Figure:2(b). For what values of Y will the indicated prunning take place based on the α - β prunning technique [2 marks]



NB: Read more abt prunning

CSC 2114 Artificial Intelligence - CAT1
(BSc CS & BSc SE).

A: Answer questions 1 and 2 and any one of section B.

Time: 1.0 hours

Question 1

1. What components need to be specified inorder to formally define a search problem ? [3 marks]
2. What is the solution to a (i) Search problem, (ii) CSP problem [2 marks]
3. Explain what the terms complete and optimal mean with regard to search algorithms [4 marks]
4. AI is about building agents that act rationally. Explain your understanding of *agents* and or *rationality*. [4 marks]
5. Differentiate a reflex agent from a planning agent. Are these agents always rational ? [5 marks]
6. Differentiate a state space graph from a search tree. [4 marks]
7. What is a fringe ? Explain the data structures used to implement the fringe in DFS, BFS, and UCS search algorithms. [5 marks]
8. What three things need to be formally specified in order to get a valid CSP problem ? [3 marks]

Question 2

1. Consider the graph shown in Figure 1 (A is the initial state and G is the goal state, numbers on the links are path/link costs and the numbers next to the states are heuristic estimates). Search can proceed with a variety of algorithms, resulting in different search trees. Assume that children of a node are visited in alphabetical order. Draw a search tree and provide the resulting solution that would be generated when a graph search with a *closed/visited list* is performed on the graph using each of the following search strategies.

   (a) Depth first search [4 marks]
   (b) Breadth first search [4 marks]
   (c) Uniform cost search [6 marks]
   (d) A^* search [7 marks]
   (e) Best-first (greedy) search [4 marks]

School of Computing & IT

CSC 2114 Artificial Intelligence - CAT1
(BSc CS & BSc SE).

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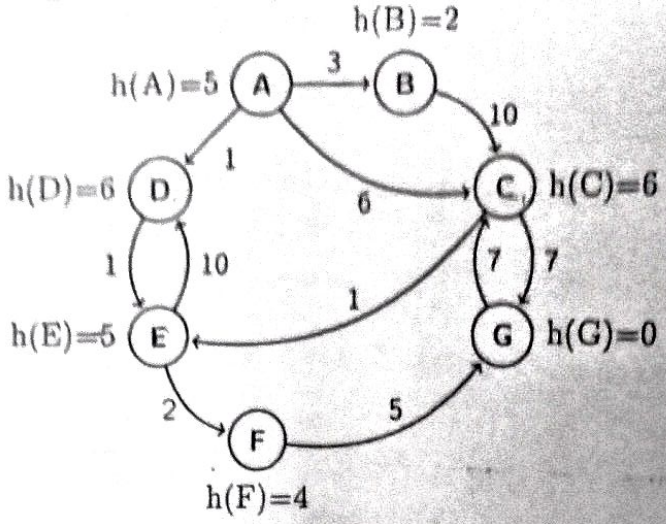


Figure 1: Graph Search

B: Select any One question

Question 3

1. You are in charge of allocating rooms to tests scheduled for 9^{th} October 2016. You have just received the test schedule from the exam coordinator which provides information about the papers,time and number of students expected to sit a particular paper. This scheduled is listed in table 1 . A list of rooms available that day with their corresponding capacity is also provided to you by the custodian as shown in table 2. Your allocations must meet the following constraints for proper management of the tests.

   - Students sitting the same paper must fit in one room.
   - Each paper must be allocated its own room.

Table 1: Test Schedule

Paper	Time	Number of Students
CS2114	8:00-9:30	350
CS2100	10:00-11:00	300
BS2102	10:00-11:00	100
CS1101	8:30-9:30	120
BIT1100	9:00-10:00	200
BIS1101	11:30-11:30	300
BIT1102	12:00-1:00	100
BSE1209	11:30-12:30	100

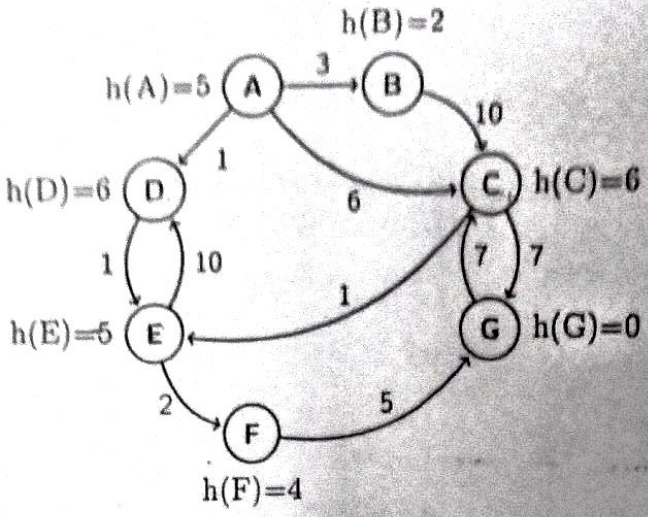
Table 2: Rooms Available

Room	Time Available	Sitting Capacity
R1	7:00-12:00	400
R2	8:30:00-2:00	400
R3	7:00-1:30	250
R4	7:00-11:30	200
R5	7:00-2:00	200

(a) Using papers as variable and rooms as domains, list the valid domains for each of the papers. [5 marks]

(b) By using the minimum remaining value (MRV) heuristics, which variable(s) should be assigned first. [5 marks]

(c) List one solution to this CSP or state that none exist. [5 marks]



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School of Computing and Informatics Technology
Semester 1 Test2 2015/2016
CS 2114: Artificial Intelligence

Date: 21/11/2015

INSTRUCTIONS

- The test consists of 4 questions
- **The student must attempt question 1 and any other two from the remaining three questions**

Compulsory question

1. Consider the tree shown in figure 1. The numbers on the arcs are the arc lengths. Assume that the nodes are expanded in alphabetical order when no other order is

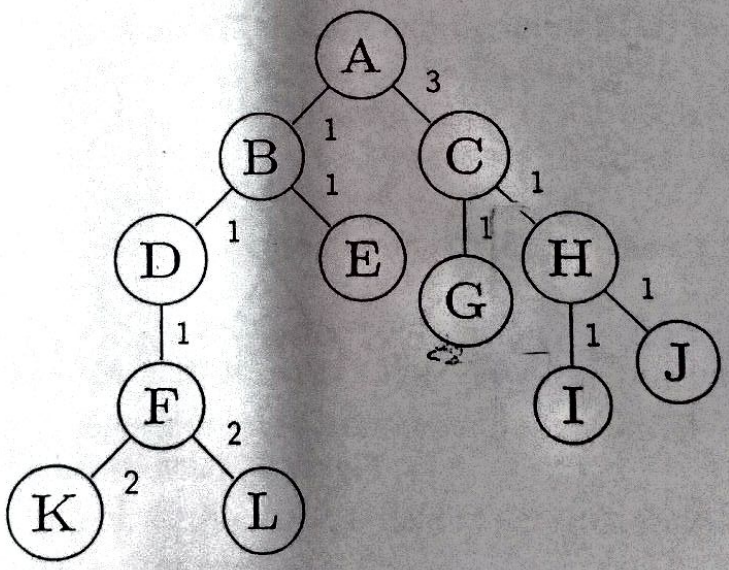

Figure 1: Tree search

specified by the search, and that the goal is state G. What order would the states be expanded by each type of search? Stop when you expand G. Draw the resulting tree after each search.

(a) Breadth First [6 marks] (b) Depth First [6 marks]

(c) Uniform Cost Search [8 marks]

Attempt any two from questions 2 to 4

2. (a) Briefly discuss your understanding of machine learning. (4 marks)

   (b) Machine learning tends to be broken down into three broad classes of *learning*. Identify these classes and using examples expound on what they mean. (6 marks)

3. A doctor is called to see a sick child. The doctor has prior information that 90% of sick children in that neighborhood have the flu (F), while the other 10% are sick with measles (M). Assuming that there no other sickness in that neighborhood. A well-known symptom of measles is a rash (R). The probability of having a rash if a child has measles is 0.95. However, occasionally children with flu also develop rash, and the probability of having a rash if a child has flu is 0.08.

   (a) Calculate [6 marks]

   i. $P(\neg R|M)$ ii. $P(\neg R|F)$ iii. P(R)

   (b) Upon examining the child, the doctor finds a rash. What is the probability that the child has measles? show your working[4 marks]

   i. what is the probability of Flue,

   ii. What is the probability of measles

4. Consider the game tree given in figure 2

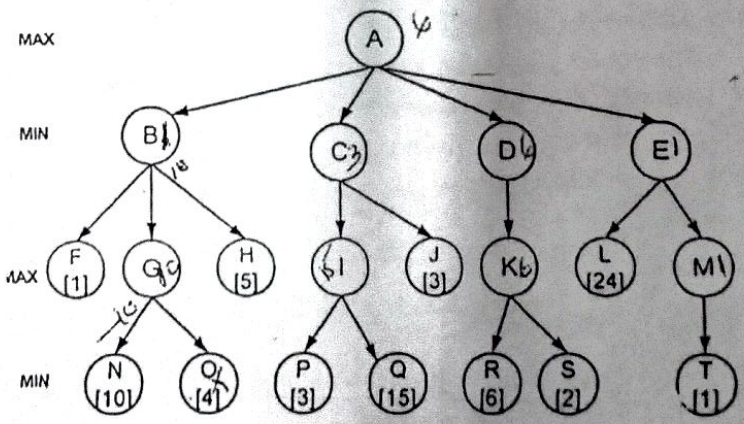

Figure 2: game tree

   (a) Using minimax only, indicate the values of the following nodes [4 marks]

   i. B iii. D v. G vii. K

   ii. C iv. E vi. I viii. M

   (b) What will be the final minimax value of node A? [2 marks]

   (c) Perform a minimax search from left to right with alpha-beta pruning, and list all the nodes that are note evaluated by alpha-beta [4 marks]

Good Luck!