CS2550

THE UNIVERSITY OF WARWICK

Second Year Examinations: Summer 2015

Artificial Intelligence

Time allowed: 2 hours.

Answer **FOUR** questions.

Read carefully the instructions on the answer book and ensure that the particulars required are entered on the front cover of EACH answer book you use.

Approved calculators may be used.

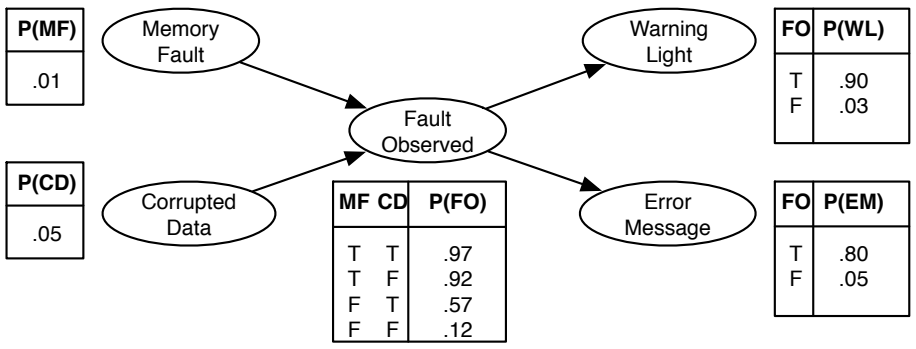
---

1. (a) Explain the four types of reasoning that can be done using probabilistic inference. [4]

   (b) Your friend complains that their computer is slow. When a computer has a virus, this causes it to be slow in 85% of cases. The prior probability of a computer being virus infected is 1/10,000 and the prior probability of a slow computer is 1/500. What is the probability that your friend's computer has a virus? [3]

   (c) There are two independent tests for a disease. Test A is 97% effective at identifying the disease when it is present, but has a 15% false positive rate and Test B is 80% effective with a 2% false positive rate. Suppose that 1 in 250 people have the disease. Only one test can be used. Which test returning positive is a better indicator of the disease? Justify your answer mathematically and give $P(disease|A)$ and $P(disease|B)$. [6]

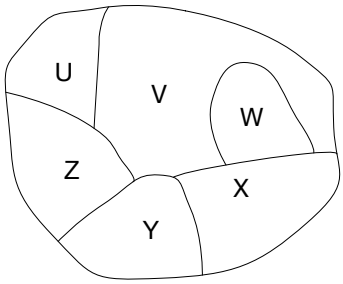
   (d) Given the Bayesian network given below use inference by enumeration to compute the probability of a memory fault given that a warning light and error message are observed. [12]



---

2. (a) Explain the following heuristics, and how they are used in a backtracking search.
   - minimum remaining values,
   - degree heuristic, and
   - least constraining value. [6]

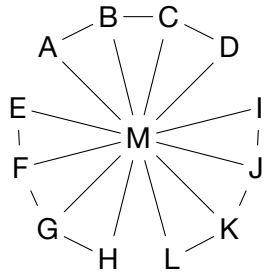
   (b) Consider the CSP below in which $\{U, V, W, X, Y, Z\}$ are variables that should be assigned a frequency f such that $f \in \{low, medium, high\}$, with the constraint that adjacent regions must not be assigned the same frequency.



   i. Draw a constraint graph for this problem. [3]

   ii. Use the backtracking algorithm with appropriate heuristics to find a solution to this problem. Show all the steps carried out by the algorithm. [6]

   (c) Explain how cutset conditioning could be used in the following constraint graph to make the search more efficient, and state the upper bound on the number of nodes expanded with and without cutset conditioning. Assume that each variable has the same domain, which is of size 5. [6]

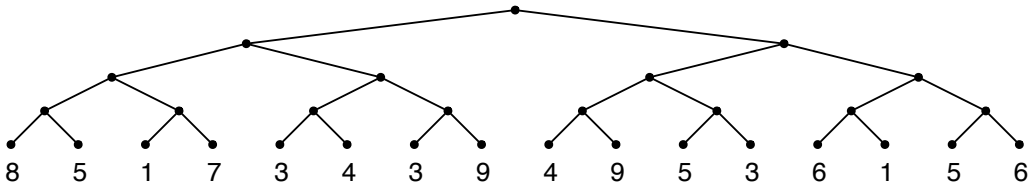


   (d) Describe the operation of a simulated annealing search. [4]

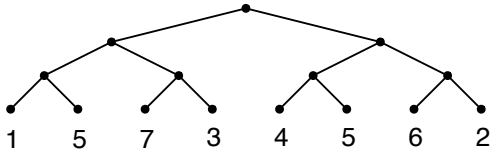
Continued...

3. (a) Describe the minimax algorithm and list the assumptions that are made. [3]

   (b) Consider the following adversarial search tree, where the first player is the maximising player. Use the minimax algorithm to determine which move the first player should choose, and what utility they should expect. You should show the resulting search tree. [4]



   (c) Describe the alpha-beta pruning algorithm and show how it operates on the following tree, again assuming that the first player is the maximising player. State which move the first player should choose. [4]



   (d) i. Describe how a cut point can be chosen for the depth-first search of the game tree, as carried out by the minimax algorithm. [4]

   ii. Explain the horizon problem that is potentially faced when using such a cut point. How can this be avoided? [4]

   (e) Local search algorithms are a special type of search. How does a local search differ from more general search techniques? [1]

   (f) Suppose that you been asked to fine tune the control system of an autonomous drone. Describe a genetic algorithm could be used to find the best values for the set of parameters that control the drone. You should include in your answer an explanation of crossover and mutation. [5]

4. (a) Explain, using examples, how forward and backward chaining control reasoning in rule-based systems. [3]

   (b) i. What is meant by conflict resolution in the context of rule-based systems? [2]

   ii. Describe how and why refractoriness and specificity are useful techniques for conflict resolution. [3]

   (c) Ian and Jen enter a weekly cross-country running race. Ian offers Jen a bet that whoever loses the race between them will buy the post-race drinks. They usually spend £30 on drinks, which they split equally (if there is no bet). Jen assesses her chances of winning, which depends on whether the course is muddy. If the course is muddy Jen estimates she has a 6/10 chance of winning and if it is not muddy she has a 3/10 chance. The probability of a muddy course is 7/10.

   i. Show a decision tree for the problem. [4]

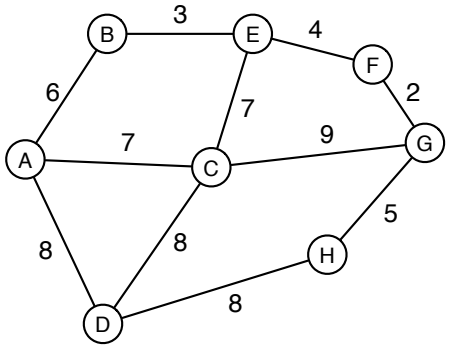
   ii. Solve the decision tree to determine whether Jen should accept the bet. [6]

   iii. Represent the problem using an influence diagram. [3]

   iv. Extend the influence diagram to show how you would incorporate the availability of a pre-race course inspection. What additional information will be required to solve the new influence diagram? [4]

5. (a) Consider the state space shown below, in which the arcs represent the legal successors of a node. Arcs are bi-directional and are labelled with the cost of performing the corresponding action. The start state is **A** and the goal is **F**. Suppose that you are given a heuristic, h_1, defined by the following table.

Node	A	B	C	D	E	F	G	H
h_1	12	7	4	12	4	0	1	6



For each of the following search methods, show the resulting search tree, list the sequence in which nodes are removed from the queue, and state how many nodes are expanded. You should also state the route found and its associated cost. Assume that nodes are inserted into the queue in alphabetical order. When expanding a node, do not generate its parent.

i. Uniform cost search [5]

ii. Greedy best-first search [4]

iii. A* search [5]

(b) Now suppose you are given another heuristic, h_2, defined by the following table.

Node	A	B	C	D	E	F	G	H
h_2	12	7	4	12	7	0	5	8

i. Use A* to determine a route from **A** to **F** using h_2 as the heuristic, showing your search tree and giving the sequence of nodes expanded. State the route found and its associated cost. [3]

ii. For the above problem, which is the better heuristic, h_1 or h_2, and why? [2]

(c) Briefly outline alternative procedures for how you might determine heuristics for a problem, and how you might combine multiple heuristics into a single useful heuristic. [6]

6. (a) Describe the operation of the PRS architecture. [10]

   (b) Using the PRS architecture, sketch a design for a robot vacuum cleaner in terms of the goals, intentions, plans or other architectural components that would be required. [15]