CS2550

THE UNIVERSITY OF WARWICK

Second Year Examinations: Summer 2017

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.

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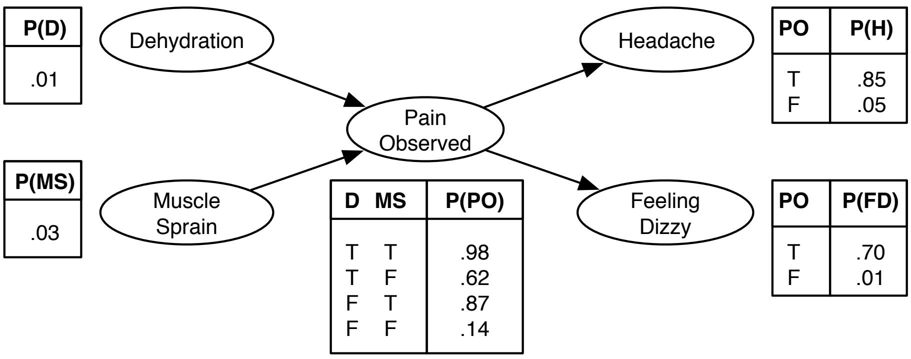
1. (a) Probabilistic inference can be used to support different kinds of reasoning. Explain four common uses. [4]

   (b) Suppose a program you have written crashes. The API you used has a bug which, when it occurs, causes your program to crash 14 times in 10,000. Testing shows that the prior probabilities of your program crashing and the API bug occurring are 1/5000 and 1/100 respectively. What is the probability that the API bug occurred? [3]

   (c) There are two independent tests for identifying a memory fault. Test A is 93% effective at identifying a memory fault when one is present with a 16% false positive rate. Test B is 70% effective with a 1% false positive rate. Suppose the prior probability of a memory fault is 1/500. If only one test can be used, which test returning positive is a better indicator of a memory fault? Justify your answer mathematically and give $P(memoryFault|A)$ and $P(memoryFault|B)$. [6]

   (d) Given the following Bayesian network use inference by enumeration to compute the probability of dehydration given that a headache and feeling dizzy are observed. [12]



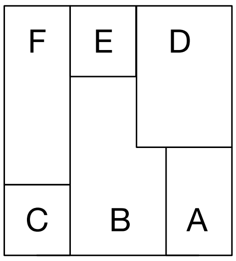
D	MS	P(PO)
T	T	.98
T	F	.62
F	T	.87
F	F	.14

PO	P(H)
T	.85
F	.05

PO	P(FD)
T	.70
F	.01

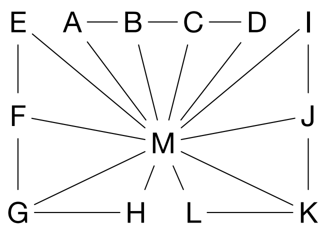
2. (a) Explain the following heuristics, and how and why they are used in a backtracking search:
   - minimum remaining values,
   - degree heuristic, and
   - least constraining value. [6]

   (b) Suppose that you are given the following map, corresponding to the CSP containing variables $\{A, B, C, D, E, F\}$ such that the variables represent regions in the map, and regions should be coloured from the set $\{red, green, blue\}$ with the constraint that adjacent regions must not be the same colour.



   i. Draw a constraint graph for this problem. [3]
   ii. Use the backtracking algorithm with application of appropriate heuristics to find a solution to this problem. Show all the steps carried out by the algorithm. [6]

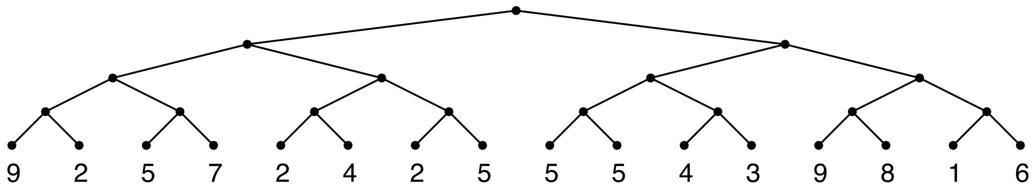
   (c) Explain how cutset conditioning could be used in the following constraint graph to make the search more efficient, and state the upper bound on the number of nodes expanded with and without cutset conditioning. Assume that each variable has the same domain, which is of size 3. [6]



   (d) Describe how you would use a genetic algorithm to find an optimal set of parameters for an automated traffic control system. The system contains 50 traffic lights, each of which have parameters that define each traffic light cycle in terms of how long the lights are green and how long they are red.

   [4]

3. (a) Describe the minimax with alpha-beta pruning algorithm and show how it operates on the following tree, where the first player is the maximising player. State which move the first player should choose, and what utility they should expect. You should show the resulting search tree. [7]



(b) In games where the legal moves by a player are determined by chance, explain how the minimax algorithm can be extended to determine the optimal move for a player. [2]

(c) i. Describe how a cut point can be chosen for a 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]

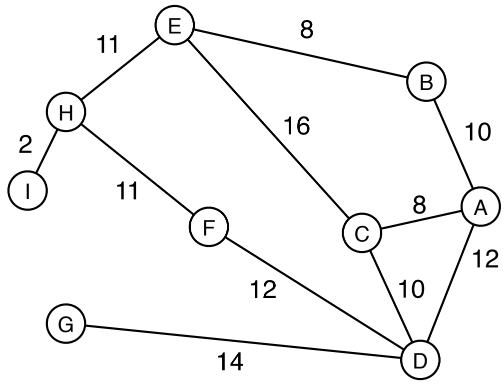
(d) i. Explain the process of selecting and fulfilling open preconditions in a partial-order planner. [2]

ii. Describe how a clobbering conflict might occur during planning, and how to resolve it. [3]

iii. Describe what is meant by conditional planning, and why it is useful. [3]

4. (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 **I**. Suppose that you are given a heuristic, h_1, defined by the following table.

Node	A	B	C	D	E	F	G	H	I
h_1	30	21	29	24	12	12	4	2	0



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 any of its ancestors.

i. Uniform cost search [5]

ii. Greedy best-first search [4]

iii. A* search [5]

(b) Now suppose that you are given an alternative heuristic, h_2, defined as follows.

Node	A	B	C	D	E	F	G	H	I
h_2	35	27	35	29	12	17	28	2	0

Will this heuristic also lead to the optimal path being discovered by the A* algorithm? Explain your reasoning. [2]

(c) Formally prove that A* is an optimal search strategy for locally finite graphs. [4]

(d) Explain how the notion of iterative deepening can be used to reduce the memory overhead of A*. [5]

5. (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 recency, refractoriness and specificity are useful techniques for conflict resolution. [3]

   (c) Alec and Beth are meeting friends in a restaurant, but they did not book a table. Alec offers Beth a bet that they will have to wait for a table, and whoever loses the bet should buy dinner, which has a fixed price of £50. Had there been no bet, they would share the cost of dinner equally. Beth assesses the chances of having to wait for a table, which depends on whether there is a full audience for a performance in the nearby theatre. She estimates the probability of having to wait if there is a full audience to be 7/10, and the probability of having to wait if the audience is not full to be 1/10. The prior probability of a full audience is 5/10.

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

   ii. Solve the decision tree to determine whether Beth 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 newspaper review of the performance. What additional information will be required to solve the new influence diagram? [4]