THE UNIVERSITY OF HONG KONG

FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE

CSIS0270/COMP3270 ARTIFICIAL INTELLIGENCE

Date: 9 Dec 2014 Time: 2:30pm – 5:30pm

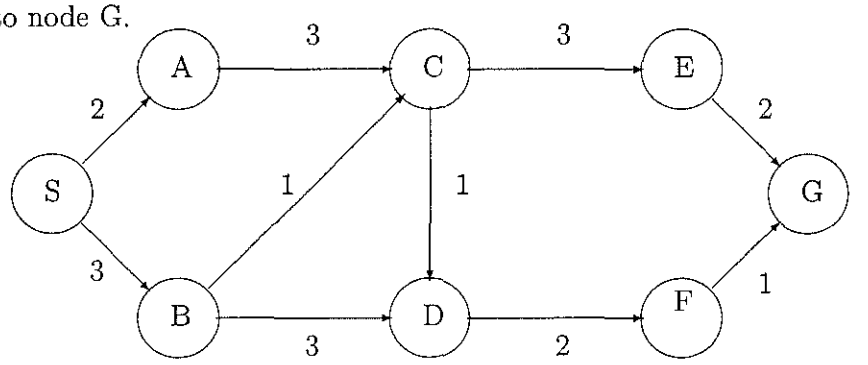
Only approved calculators as announced by the Examinations Secretary can be used in this examination. It is the candidate's responsibility to ensure that their calculator operates satisfactorily, and candidates must record the name and type of the calculator used on the front page of the examination script.

Instructions:

- This paper contains 6 questions on 4 pages.
- The mark for each question is enclosed in a pair of square brackets after the questions.
- Answer ALL questions.
- Total Mark is 100.

1. (a) What is Turing test? [2]
   (b) What is iterative deepening search? Why is it preferred to depth-first search? [3]
   (c) Write down a drawback on Hill-climbing algorithm. Explain how this occurs. [2]
   (d) Do you think game playing is an exhibition of intelligence? Write one paragraph on this topic. [5]
   (e) Will the minimax procedure apply to multiplayer game? How can you formulate a multiplayer game as a tree search problem? [4]

2. The graph below shows the search space of a problem. Nodes are labeled with a letter and edges are labeled with the cost of traversing the edge. The heuristic function h is given in the table. A* algorithm is used to find the shortest path from node S to node G.



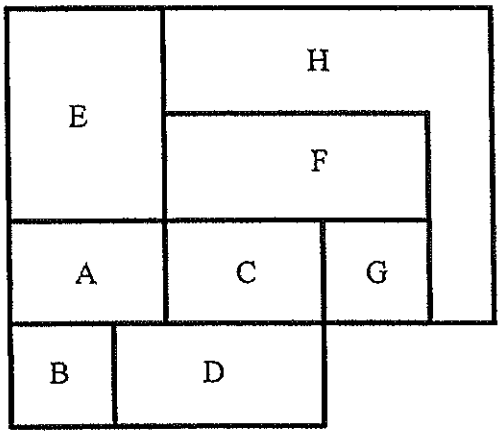
node	S	A	B	C	D	E	F	G
h	6	4	4	4	3.5	1	1	0

   (a) Apply the A* algorithm on the above graph, filling in the table with (f, g, h) after the node name. The first two lines are filled as example. If you find a new path to a node already on the queue, update its cost (using the lower f value) instead of adding another copy of that node to the queue. Keep the queue sorted. [8]

Iteration	Node Expanded	Sorted Queue, $Node(f, g, h)$
0	–	S(6,0,6)
1	S	A(6,2,4), B(7,3,4)
2	?	...

   (b) For the solution found by A*, give the cost and sequence of nodes comprising the path. [3]
   (c) If $h_1(n)$ and $h_2(n)$ are admissible and consistent heuristics, is the following heuristic admissible and consistent? Explain. [4]
      (i) $(h_1(n) + h_2(n))/2$
      (ii) $\min(h_1(n), h_2(n))$

3. Color the following map using only red, green and blue so that any two adjacent regions (that share an edge) have different colors. During the coloring process, variables are chosen by *minimum remaining values* (*MRV*), and degree heuristics, and their values by *least constraining value* (*LCV*) heuristics. If there is a tie in choosing a region to color, choose in alphabetical order. If there is a tie in choosing a color, then choose in the order red, green and then blue.



(a) Draw the constraint graph for the above map-coloring problem. [5]

(b) Explain what are *minimum remaining values* heuristics, degree heuristics and *least constraining value* heuristics. [6]

(c) In solving CSP, we use *forward checking* to reduce the domain size. Explain what is *forward checking*. [2]

(d) Color the above map by filling the following table. Each stage contains the steps assigning a color to a variable, then followed by forward checking. Circle the color of the already assigned variable, and show the current domains of the unassigned variables (i.e. their legal colors) after each steps. The first assignment has been done for you. (Bold face is used in the table for chosen color, instead of circle for easy formatting) [8]

	A	B	C	D	E	F	G	H
Initial Domain	R G B	R G B	R G B	R G B	R G B	R G B	R G B	R G B
1st assign+*FC*	**R**	G B	G B	G B	G B	R G B	R G B	R G B
2nd assign+*FC*								
...								

(e) What is *arc consistency*? Which is a stronger heuristics in reducing the domain size, *arc consistency* or *forward checking*? [3]

4. (a) What is the meaning of an inference algorithm being *sound*? *complete*? [4]

   (b) Consider the following knowledge base (KB). Rewrite the KB in conjunctive normal form. [5]

$$V \vee T$$
$$P \wedge \neg U$$
$$R \vee \neg Q$$
$$V \Rightarrow W$$
$$P \Rightarrow Q$$
$$S \Rightarrow (U \vee T)$$
$$(P \wedge R) \Rightarrow S$$

   (c) Apply resolution and show that the proposition T is entailed. [4]

5. Consider the following text:

> Anyone who does not sink and weights the same as a duck is a witch. Everyone who is made of wood weights the same as a duck. Everyone who is a witch is burned. Bob is made of wood, and does not sink.

   (a) Represent the text in First-Order Logic. [4]

   (b) Convert the FOL sentences to Conjunctive Normal Form. Show all steps. [8]

   (c) Are these Horn clauses? Explain. [2]

   (d) Answer the query "Will we burn Bob?" using Resolution. [4]

6. (a) Write down the Bayes Theorem. [2]

   (b) Consider that the data has n attributes, $x_1, \cdots, x_n$, and C to be the class label. Write down the basic assumption in Naive Bayes model for $x_1, \cdots, x_n$. [2]

   (c) Based on Bayes Theorem and your assumption, show that [4]

$$P(C|x_1, \cdots, x_n) = \alpha P(C) \prod_i P(x_i|C)$$

   What is α?

   (d) Assuming a Normal distribution for each attribute, how many parameters are needed for each class? What are they? [2]

   (e) Explain how you can use the Naive Bayes model to perform classification. [4]

END OF PAPER