

 Semester:
 Semester 2 (Summer 2015-2016)

 Date/Time:
 Monday 16th May 2016, 9:30 AM - 11:30 AM

 Programme:
 Bachelor of Science in Computing Bachelor of Science (Honours) in Computing (Software Development) Bachelor of Science (Honours) in Computing (Games Design and Development)

 Stage:
 Year 3

 Module:
 ARTIFICIAL INTELLIGENCE

COMP 7003

Time Allowed: 2 hours

Instructions: Attempt any four (4) questions

Additional Attachments: None

External Examiners: Derek O'Reilly Internal Examiners: Janice O'Connell, Eugene Kenny

Question No. 1

(a) Consider the following map:



Using the A* algorithm work out a route from town A to town M. Use the following cost functions:

- g(n) = The cost of each move as the distance between each town (shown on map)
- h(n) = The Straight Line Distance between any town and town M. These distances are given in the table below.
- i) Provide the search tree for your solution.
- ii) Indicate the order in which you expanded the nodes and state the (10 marks) route you would take and the cost of that route.

Straight Line Distance to M

A	223	E	165	Н	111	K	32
В	222	F	136	Ι	100	L	102
С	166	G	122	J	60	М	0
D	192						

(b) The straight line distance heuristic used above is known to be an *admissible* (5 *marks*) heuristic. What does this mean and why is it important?

(10 marks)

Consider the following scenario:

There has been a murder! The police are not releasing many details. Suspects are Prof. Purple, General Horseradish, or Reverend Fields. The murder either took place in the study or the hall. The murder weapon was either a heavy candlestick or a revolver. The Reverend is too old and frail to wield the candlestick. We know that the revolver was not taken out of the study. Only the General and the Professor had access to the study.

- (a) Translate the facts in the above scenario into clauses in conjunctive normal (15 marks) form (CNF).
- (b) Prove using the resolution refutation process that the Reverend could not (10 marks) have committed the murder.

Question No. 3(25 Marks)(a) What are the main problems in reasoning about actions and change?(5 marks)(b) What is meant by regression planning?(5 marks)

- (c) For the operators and initial state description given below, explain how a (15 marks) regression planner searches for a plan to satisfy a goal, and give an example of a plan that achieves the goal $On(b, a) \wedge On(c, b) \wedge OnTable(a)$
 - blocks are represented by constants: a, b, c, ... etc.
 - states are described using the following predicates:

On(x, y)	block x is on block y
OnTable(x)	block x is on the table
Clear(x)	there is no block on top of block x
Holding(x)	the arm is holding block x
ArmEmpty	the arm is not holding any block

- initial state: $On(c, a) \land OnTable(a) \land OnTable(b) \land ArmEmpty$
- goal state: $On(b, a) \land On(c, b) \land OnTable(a)$
- operators:

[Holding(x), Clear(y)] **STACK**(x, y) [On(x, y), ArmEmpty, $\neg Holding(x)$, $\neg Clear(y)$]

[On(x, y), Clear(x), ArmEmpty] UNSTACK(x, y) [Clear(y), Holding(x), $\neg On(x, y)$, $\neg ArmEmpty$]

[OnTable(x), Clear(x), ArmEmpty] **PICKUP**(x) [Holding(x), $\neg OnTable(x)$, $\neg ArmEmpty$,]

[Holding(x)] **PUTDOWN**(x) [OnTable(x), ArmEmpty, $\neg Holding(x)$,]

Question No. 4

(a) Consider the following Bayesian Network containing four Boolean random *(10 marks)* variables:



Compute:

i) $P(\neg C | A, B)$

ii) $P(A, B, C, \neg D)$

(b) You are a robot in a lumber yard, and must learn to discriminate Oak wood *(15 marks)* from Pine wood. You choose to learn a *Decision Tree* classifier. You are given the following examples:

Example	Density	Grain	Hardness	Class
1	Heavy	Small	Hard	Oak
2	Heavy	Large	Hard	Oak
3	Heavy	Small	Hard	Oak
4	Light	Large	Soft	Oak
5	Light	Large	Hard	Pine
6	Heavy	Small	Soft	Pine
7	Heavy	Large	Soft	Pine
8	Heavy	Small	Soft	Pine

- i) Draw the decision tree that would be constructed by recursively applying information gain to determine the most informative attribute.
- ii) Classify these new examples as Oak or Pine using your decision tree above.

Density = Light, Grain = Small, Hardness = Hard Density = Light, Grain = Small, Hardness = Soft

Question No. 5

Write an overview on any *two* of the following topics:

- i) Local search algorithmsii) Expert systemsiii) Neural networks