LIT
DEPARTMENT OF
INFORMATION TECHNOLOGY

Semester: Semester 2 (Summer 2014-2015)

Date/Time: Wednesday 6th May 2015, 9:30 AM – 11:30 AM

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

Stage: Year 3

Module: ARTIFICIAL INTELLIGENCE

COMP 7003

Time Allowed: 2 hours

Instructions: Attempt any three (3) questions

Additional Attachments: None

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

Question No. 1 **(33 Marks)**

For the 8-puzzle problem, given this initial starting state:

2	8	7
3	1	4
5	6	

(a) Using breadth first search, show the search tree that would be built down to level 2 (assume level zero is the root of the tree). *(8 marks)*

(b) Using depth first search, show the state of the search tree down to level 3 (stop once you have fully expanded one node that goes to level 3) *(8 marks)*

(c) What is the worst-case time and space complexity of the above two algorithms. *(6 marks)*

(d) Describe the terms complete and optimal with regards to evaluating search strategies? *(5 marks)*

(e) Are either depth-first-search or breadth-first-search complete or optimal? Justify your answer. *(6 marks)*

Question No. 2 **(33 Marks)**

Consider the following scenario:

d has been murdered. *a*, *b*, and *c* are suspects (i.e., at most one of *a*, *b*, and *c* are guilty). *b* claims that he did not know the victim *d* (i.e., if *b* did know *d*, then *b* is lying). *a* and *c* claim that *b* did know *d* (i.e., if *b* did not know *d*, then *a* and *c* are lying). Anyone who lies is guilty.

(a) Express the key facts and relationships using *first order predicate calculus*. *(9 marks)*

(b) Convert the expressions above into clauses in conjunctive normal form (CNF). *(9 marks)*

(c) Prove using the resolution refutation process that *b* committed the murder (is guilty). *(15 marks)*

Question No. 3 **(33 Marks)**

(a) What are the main problems in reasoning about actions and change? *(6 marks)*

(b) What is meant by an operator in the context of STRIPS? *(8 marks)*

(c) What is meant by regression planning? *(8 marks)*

(d) For the operators and initial state description given below, explain how a regression planner searches for a plan to satisfy a goal, and give an example of a plan that achieves the goal $On(b, a) \wedge On(c, b) \wedge OnTable(a)$ *(11 marks)*

- 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: $On(c, a) \wedge OnTable(a) \wedge OnTable(b) \wedge ArmEmpty$
- goal state: $On(b, a) \wedge On(c, b) \wedge OnTable(a)$
- 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 **(33 Marks)**

(a) A certain disease occurs in 1 percent of the population. A blood test for this disease has a 2 percent false positive rate, and a 5 percent false negative rate (i.e., 2 percent of those not having the disease test positive, and 5 percent of those having the disease test negative). Use two Boolean random variables: D = "has disease" and P = "tests positive." *(18 marks)*

i) What is the **prior** probability of getting a positive test?
ii) If you test positive, what is the probability that you actually **have** the disease?
iii) If you test negative, what is the probability that you do **not** have the disease?

(b) Consider the Bayesian network A → B ← C with three Boolean random variables and their conditional probability tables defined by: *(15 marks)*

$P(A) = 0.2$
$P(B \mid A, C) = 0.25$
$P(B \mid A, \neg C) = 0.5$
$P(B \mid \neg A, C) = 0.3$
$P(B \mid \neg A, \neg C) = 0.8$
$P(C) = 0.55$

i) Compute $P(\neg A, B, C)$
ii) Compute $P(\neg A \mid \neg C)$
iii) Compute $P(A \mid B, \neg C)$

Question No. 5 **(33 Marks)**

Write an overview of each of the following topics:

(a) Local search algorithms *(11 marks)*

(b) Expert systems *(11 marks)*

(c) Neural networks *(11 marks)*