

SPRING EXAMINATIONS 2018

Year 3 Wednesday 21st February 2018, 9.30 AM – 12.30 PM

> LC_KGDVM_KTH LC_KCMPM_JTH

Course:	Bachelor of Science (Honours) in Computing (Games Design and Development) Bachelor of Science in Computing
Year:	Year 3
Subject:	STATISTICS, ALGORITHMS & ARTIFICIAL INTELLIGENCE COMP 07028
Time Allowed:	3 Hours
Instructions:	 Attempt any TWO (2) questions from Section A and any TWO (2) questions from Section B All question carry equal marks. Start each question on a new page. Write the question number at the top of each page.

5. Circle the numbers of the questions you answer at the front of your answer book.

Additional Attachments or Exam Material to accompany this paper: None

Internal Examiners: Eugene Kenny External Examiners: Derek O Reilly

SECTION A

Question 1

(Total 25 Marks)

a) Draw the graph represented by the following adjacency matrix.

	А	В	С	D	E	F	G	Н
А	0	0	2	3	4	0	0	0
В	0	0	3	0	0	6	2	0
С	2	3	0	5	0	4	0	1
D	3	0	5	0	0	0	0	0
E	4	0	0	0	0	0	4	2
F	0	6	4	0	0	0	2	0
G	0	2	0	0	4	2	0	0
Н	0	0	1	0	2	0	0	0

b) Outline *Kruskal's* algorithm and show how it can be used to construct a minimum (10 marks) spanning tree using the graph from part (a) above.

c) Outline *Dijkstra's* algorithm and show how it can be used to calculate the shortest (10 marks) path from a given source vertex to all other reachable nodes in a graph using the graph from part (a) above and vertex *A* as the source vertex.

Question 2

a) Create the Knuth-Morris-Pratt DFA for the string aacaaab over the alphabet {a, b, (10 marks) c} by completing the following table. Where state 0 is the start state and state 7 is the accept state.

0	1	2	3	4	5	6
а	1	2		4	5	6
b	0	0				7
с	0	0	3			

You may use the following partially-completed graphical representation of the DFA to help you but you are only required to complete the table above.



- **b)** Draw the NFA corresponding to the regular expression ((MOBY)|DI*K). Clearly (10 marks) distinguish between your epsilon and match transitions.
- **c)** If *M* is the length of the pattern string to be matched and *N* is the length of the text (5 marks) string, what is the running time for the Brute-force substring matching algorithm for typical inputs (in English texts say) and in the worst case. Justify your answer in each case.

(Total 25 Marks)

(5 marks)

Question 3

(Total 25 Marks)

- a) What is a Reduction? What does it mean to say that one problem reduces to (10 marks) another?
- **b)** What does it mean to say that a problem is in *P* or in *NP*? What does it mean to (10 marks) say that a problem is *NP*-complete?
- c) What does in mean for a problem to be *intractable*? What approaches can taken (5 marks) when faced with an intractable problem.

SECTION B

Question 4

a) Consider the following map:

(Total 25 Marks)

(20 marks)



- *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 route you would take and the cost of that route.

Straight Line Distance to M

А	223	Е	165	Н	111	K	32
В	222	F	136	I	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?

Question 5

(Total 25 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 form (15 marks) (CNF).
- **b)** Prove using the resolution refutation process that the Reverend could not have (10 marks) committed the murder.

Question 6

(Total 25 Marks)

a) For each of the truth tables below say whether it is possible for a perceptron to (10 marks) learn the required output.

In each case, explain the reason behind your decision.

i)	Input	0	0	1	1
	Input	0	1	0	1
	Required Output	1	0	0	1
ii)	Input	0	0	1	1
	Input	0	1	0	1
	Required Output	1	1	0	0
iii)	Input	0	0	1	1
	Input	0	1	0	1
	Required Output	1	1	1	1

b) You are a robot in a lumber yard, and must learn to discriminate Oak wood from (15 marks) 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