VICTORIAN CERTIFICATE OF EDUCATION

2016

ALGORITHMICS (HESS)

Practice Exam 1

2016

SOLUTIONS

SECTION A – Multiple-choice Questions

1	2	3	4	5	6	7	8	9	10
C	A	C	D	B	B	C	D	A	B

11	12	13	14	15	16	17	18	19	20
B	C	D	A	D	C	C	B	D	A

SECTION B

Question 1 (4 marks)

	0 marks	1 mark	2 marks	3 marks
Correct solution		Algorithm provided will lead to a valid solution		
Complexity of algorithm design		Approach used is simplistic and is basically brute force	The approach to solving the problem utilises some advanced algorithm design patterns to lead to a more efficient or optimised solution	A valid attempt to use a dynamic programming approach to solve the problem has been used

Question 2 (11 marks)

Nisura dislikes mornings immensely, and will often skip breakfast because he sleeps in. On his way to school he passes by a local milk-bar where he usually likes to buy a Big-M.

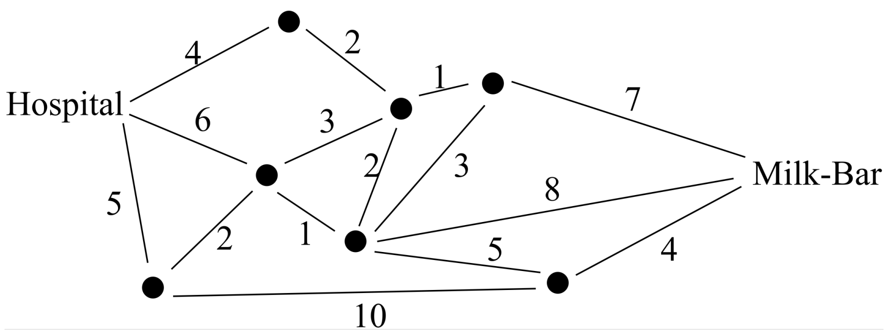
One day, whilst he is waiting in line to buy his Big-M, Nisura contemplates how he could use ADTs to model the customers waiting to be served in the milk-bar. There are two people serving customers in the milk-bar and every customer can have a variety of items that they are wishing to purchase.

a. Which ADT could be used for modelling this scenario and why? 2 marks

Choice of ADT such as Queue or Priority Queue (or otherwise with appropriate justification)	A1
Appropriate justification for using the proposed ADT	A2

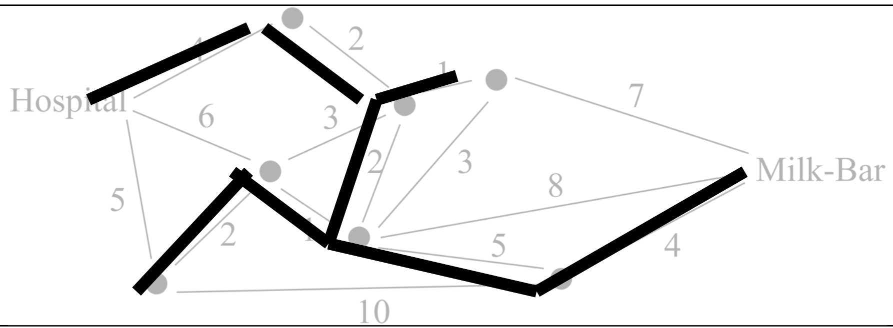
Whilst day-dreaming about ADTs, Nisura slips and knocks his head. An ambulance is called to collect Nisura and take him to hospital. For some reason, Aaron and Jack are in charge of giving directions to the ambulance.

They have the following map in front of them showing the roads from the hospital to the milk-bar. The weightings on the roads indicate the time it will take the ambulance to travel along that road.



Aaron suggests that they use a minimal spanning tree to find the shortest path to the milk-bar.

b. On the diagram below, draw the minimal spanning tree for this graph. 1 mark

	**A1**

SECTION B - continued

c. Explain why the minimal spanning tree does not provide a good solution to the problem Aaron and Jack are trying to solve. 2 marks

The minimal spanning tree does not provide the shortest path from one node to another but rather the collection of edges that result in all vertices being connected to the graph with the minimal total weight of edges	**A1**
As they are looking for a path for the ambulance to follow to get to Nisura in the shortest time, the minimal spanning tree is not suitable.	**A2**

Jack proposes that they use either Dijkstra's Algorithm, The Bellman-Ford Algorithm or Floyd-Warshall's Algorithm to solve their problem

d. In the space below, compare the suitability of each of these algorithms to the problem that is being solved and justify which algorithm Aaron and Jack should use. 6 marks

	0 marks	**1 mark**	**2 marks**
Dijkstra's		Identification that Dijkstra's is the answer	Clear description of how Dijkstra's algorithm is used to find the shortest path between a specific node and another
Bellman Ford		Identification that Bellman Ford is not the answer	Clear description of how the Bellman Ford algorithm is used to find the shortest path between a specific node and all other nodes
Floyd Warshall		Identification that Floyd Warshall is not the answer	Clear description of how the Floyd Warshall algorithm is used to find the shortest path between all pairs of nodes in the graph

Question 3 (3 marks)

Joel and Michael want to test an algorithm that they have written which takes the following inputs:

{Fast, Medium, Slow}
{1, 2, 3, 4, 5}
{Water, Not Water}

What are the minimum number of pair-wise tests that they would need to do to test these inputs? List a possible combination of pair-wise tests that would satisfy testing all pairs.

15	**A1**
Any correct variation of:	**A2 + A3**

1	Fast	Water
2	Medium	Not Water
3	Slow	Water
4	Fast	Not Water
5	Medium	Water
1	Slow	Not Water
2	Fast	Water
3	Medium	Not Water
4	Slow	Water
5	Fast	Not Water
1	Medium	Water
2	Slow	Not Water
3	Fast	Water
4	Medium	Not Water
5	Slow	Water

Question 4 (4 marks)

Turing Machines are an abstract model of computation.

Outline 4 key characteristics of a Turing Machine.

Turing Machines consist of a reader which can read the value on a given piece of tape,	**A1**
A writer which can write a new value on the tape in place of what was already there	**A2**
An infinitely long piece of tape with values printed on it	**A3**
A set of predetermined states that the Turing Machine can exist and transition between based on the values that it reads on the tape	**A4**

Question 5 (9 marks)

a. In the space below describe the context of John Searle's Chinese Room Argument, including a description of the Chinese Room thought experiment and John Searle's interpretation of it's meaning. 6 marks

Non-Chinese speaking Man locked inside a room with no access to what is going on outside	**A1**
Native Chinese speaker outside of the room can pass messages in chinese to the man inside the room	**A2**
Man locked in the room follows comprehensive set of instructions that dictate how to respond to provided message	**A3**
Response is outputted and convinces the person on the outside that the person in the room understood what the message said	**A4**
John Searle argued that this was an example of how modern machines worked and that the man in the room didn't actually understand what it was doing	**A5**
And that even if a machine could pass the Turing Test, it wouldn't necessarily understand what it was doing and so strong Artificial intelligence is not possible.	**A6**

b. Provide and explain in detail a commonly used counter argument to John Searle's Chinese Room. 3 marks

Correct identification and description of a counter argument to the Chinese Room Argument	**A1 + A2**
Explanation of how this argues against the Chinese Room Argument	**A3**

Question 6 (8 marks)

Eugenia and Mathen are having an argument about the meaning of the Church-Turing Thesis.

Mathen states
"The Church-Turing Thesis says that a Turing Machine can compute anything but it might take infinite time and resources to do it."

Eugenia retorts with
"You're confused Mathen! The Church-Turing Thesis is simply a definition for what computability means. It says that anything that is computable must be capable of being done on a Turing Machine with finite time and resources"

In the space below, discuss the accuracies and inaccuracies of each student's statements and provide a statement of your own regarding the meaning of the Church-Turing Thesis.

Mathen is completely incorrect	**A1**
Eugenia's statement about the CT thesis being a definition for what computability means is correct.	**A2**
Eugenia's statement regarding the fact that being computable means being done by a Turing Machine is correct	**A3**
But Eugenia is incorrect in that a Turing Machine can take infinite time and resources to compute something as demonstration that it is computable.	**A4**

	0 marks	**1 mark**	**2 marks**	**3 marks**	**4 marks**
Own statement	No statement made	An attempt to describe the meaning of the Church Turing Thesis has been made but it contains large errors or misconceptions	Statement provided contains one error or major omission from describing the meaning of the Church Turing Thesis	Statement provided is clear and accurately describes the meaning of the Church Turing Thesis with a minor omission	Statement provided is clear, concise and accurately describes the meaning of the Church Turing Thesis

Question 7 (9 marks)

Ben and Kavindu are getting sick and tired of Deep eavesdropping on their conversations. In order to stop him, they decide to start sending coded messages to one another.

In a simplified version of their code, a message consisting of a string of As, Bs, Cs and Ds undergoes a final transformation before being transmitted.

- each A is replaced by 1 0 1
- each B is replaced by 1 1 0 0
- each C is replaced by 0 1 1 0
- each D is replaced by 1 1 0

The transmitted message was:

{1 1 0 0 1 1 0 0 1 1 0 1 1 0 1 0 1 1 1 0 0 1 0 1 1 0 1 1 1 0 0 0 1 1 0 1 1 0 1 1 0 1 1 0 1 1 0}

Not wanting to be left out, Deep decides to try and write an algorithm that can decipher the code. In the space provided, write an algorithm, in pseudocode, which can determine all the possible messages that could result in a transmitted message like the one above.

	0 marks	1 mark	2 marks	3 marks
Clarity of pseudocode	Not shown	Pseudocode has large sections that are not clear or are incomplete	Pseudocode is mostly clear and easy to follow but contains some parts that are not clear or not detailed enough	Pseudocode is clear and easy to follow and
Solution	Algorithm will not result in a solution	Algorithm will lead to a solution in some cases	Algorithm will lead to a solution/s but not necessarily the solution	Algorithm will lead to valid solution/s
Algorithm Design		Design approach is brute force	Design approach uses some tricks to reduce time complexity	Design approach is an elegant way of finding a solution

Question 8 (8 marks)

Ever since learning about DNA computing in class, Sebastian has become quite paranoid that Finn is going to be able to use DNA computing to hack into his computer.

Explain whether DNA computing is actually a threat to computer security. In your answer, include a discussion of NP completeness.

Computer security is based on the premise that there are some problems that are incredibly difficult to find solutions to but that are easy to verify once an answer is obtained (NP – complete problems)	**A1** + **A2**
An example of this is finding the prime factors of a very large number	**A3**
If it becomes possible to solve any NP complete problem in P time then this would pose a threat to computer security	**A4**
DNA computing is basically mass parallel processing	**A5**
It will not change the order of complexity meaning that these problems are still NP – complete	**A6**
It will not change the order of complexity meaning that these problems are still NP – complete	**A7**
As such DNA computing is not a threat to computer security	**A8**

Question 9 (6 marks)

Gabe is keen to solve the Travelling Salesman Problem so that he can become the world's greatest door-to-door Encyclopedia Salesman. He decides to use Randomised Heuristics to help him solve the problem.

Explain how Randomised Heuristics might help Gabe find a solution to the Travelling Salesman Problem. Include in your answer a discussion on the quality of the solution that he will get from using this approach.

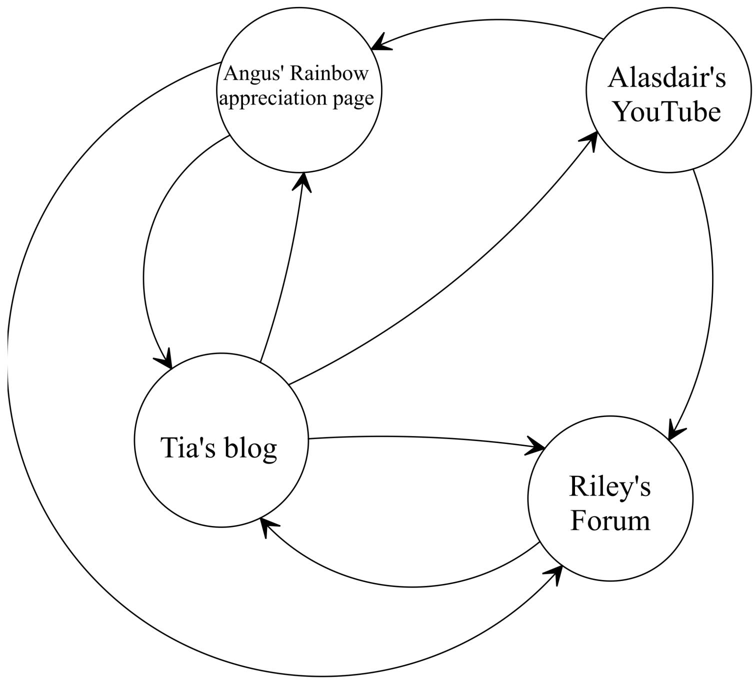
	0 marks	**1 mark**	**2 marks**	**3 marks**
Description of Randomised Heuristics	Not shown	Some discussion, with errors or omissions, of a possible approach to using of randomised heuristics to solve the TSP	Comprehensive discussion of one valid approach to using randomised heuristics to solve the TSP	Comprehensive discussion of more than one valid approach to using randomised heuristics to solve the TSP
Discussion of Quality of solution from this approach	Not shown	Recognition that solutions obtained from this approach are likely to be sub-optimal	Discussion of how solutions generated using this approach are not guaranteed to be optimal but will be 'better' solutions	Comprehensive discussion of how this approach will give better quality solutions in more reasonable time frames than brute force approaches but these solutions cannot be guaranteed to be optimal.

Question 10 (5 marks)

Riley wants to start up a rival search engine to Google which he will call Booschle. He doesn't want to come up with his own algorithm, though, so he decides to use PageRank to rank pages on Booschle. Consider the 4 webpages depicted below. Each directed edge indicates which webpage is referenced by another (depicted by an arrow going from the webpage that is referencing the other webpage, to the webpage that is being referenced).

Use PageRank to determine the ranking that would be assigned to each webpage after the second iteration of PageRank.

For the purposes of this question, you can use a dampening factor of 0.5.

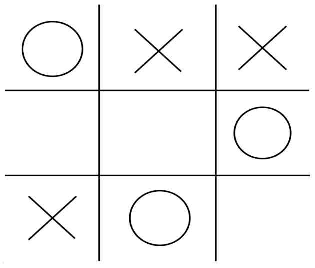


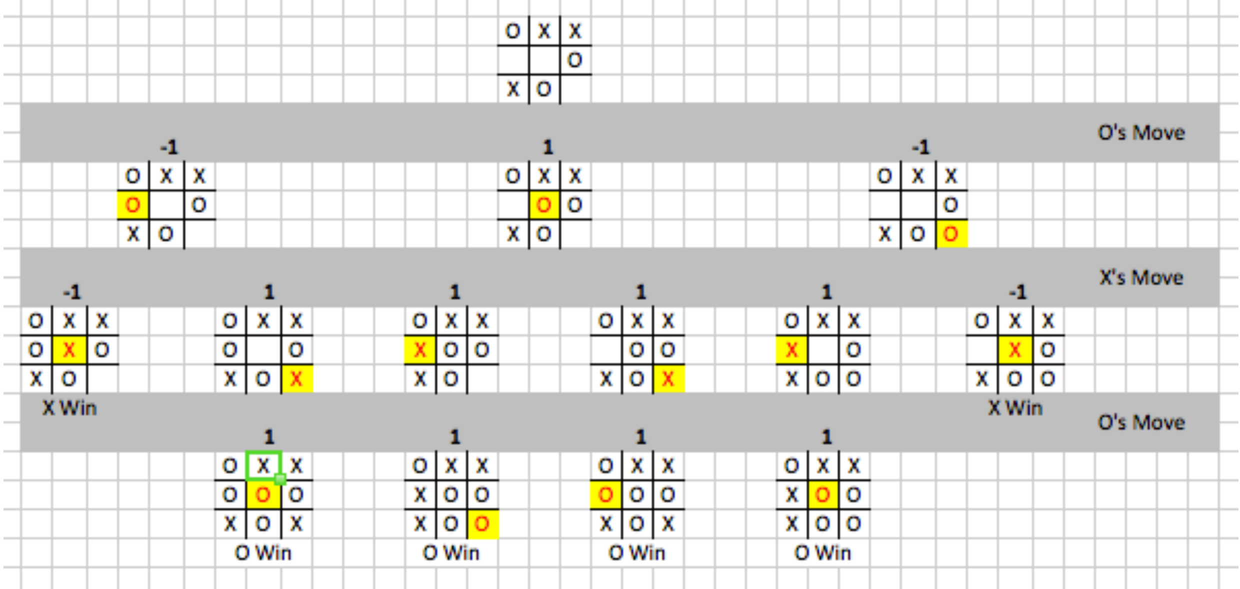
Initial allocation of ¼ value to each website	**M1**
After 1st iteration: Angus = 5/12 Alasdair = 2/12 Tia = 1/2 Riley = 8/12	**M2 + M3**
After 2nd iteration: Angus = 2/12 = 1/6 Alasdair = 8/12 = 2/3 Tia = 33/48 Riley = 27/48	**A1 + A2**

Question 11 (8 marks)

Annoyed by Riley's ranking system, Tia decides to challenge Riley to a game of Tic-Tac-Toe. Riley, being a confident Tic-Tac-Toe'r accepts and they start playing. After 3 turns the board is in the state as shown in the diagram below and it is now Tia's (O's) turn.

Show, in the space provided, how the minimax algorithm could be used to determine the next move that Tia should make.





Deduct ½ a mark for each error to a maximum of 8 marks	**A1 -> A8**

SECTION B - continued

Question 12 (5 marks)

Angus, whilst appreciating the natural beauty of a rainbow, is inspired to start converting an iterative algorithm that he knows into a recursive one.

The iterative algorithm, 'sum_iter' that Angus knows is defined in pseudocode below:

```
Function sum_iter(x)
    running_total = 0
    while x is not equal to 0
        running_total = running_total + x
        x = x – 1
    return running_total
```

In the space provided, convert the iterative pseudocode for 'sum_iter' into a tail recursive algorithm.

Function Sum_TR(*x*, *value*)
If $x \leq 1$
    Return *value*
Else
    Sum_TR(*x*-1, *value* + *x*)	

Deduct a mark for every omission or mistake to a maximum of 5 marks.	**A1 >A5**

END OF QUESTION AND ANSWER BOOK