UNIVERSITY OF WESTMINSTER
SCHOOL OF COMPUTER SCIENCE & ENGINEERING

Student Id: _____

Student Forename(s): _____

Student Surname: _____

In Class Test

Code: 6COSC020W **Level:** 6

Title: Applied AI

Date: 17 Dec 2021

Duration: 90 minutes – online

Examiner(s): Artie Basukoski

INSTRUCTIONS TO CANDIDATES

- You must answer **ALL** questions.
- You have 90 mins to complete the test.
- There are 100 points in total in this test
- The points you will score will be converted to a percentage, which will then be reported to registry.
- Use a tick, a circle or the choice letter to answer the Multiple-Choice Questions.
- If you want to delete/correct and of your Multiple-Choice answers, please write **ERR** next to the answer(s) you have given.
- Do NOT detach any of this booklet pages.
- ALL answers must be answered in the space provided in the booklet.
- If you need scrap paper or extra space for your answer(s) then use the back side of one of the pages in this booklet (do not forget to state clearly, in the space provided under the question, where your answer can be found/continues).

DO NOT TURN OVER THIS PAGE
UNTIL THE INVIGILATOR INSTRUCTS YOU TO DO SO

MARK

%

Part A 10 points	Part B 20 points	Part C 20 points	Part C 10 points	Total 60 points

PART A: [30 POINTS]

*Indicate whether each of the following statements is **T**rue or **F**alse (to answer put a 'T' or an 'F' in the space to the left of each question number):*

____ 1. A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date.

[1 Point] T

____ 2. If we interpret the predicate **Spouse(x,z)** as "x is the Spouse of z", the following FOL formula means "Everyone can be the spouse of any given person."

$$\exists x \forall x,y,z \; Spouse(x,z) \wedge Spouse(y,z) \Rightarrow x=y$$

[2 Points] F

____ 3. Move ordering has no effect on Alpha-Beta pruning.

[1 Point] F

____ 4. The following table is a valid discrete probability distribution.

x	-5	6	9
$P(x)$	0.5	0.25	0.25

[1 Points] T

____ 5. A and B are independent when P(A|B) = P(A).

[1 Point] T

____ 6. A perceptron can model any logical function.

[1 Point] F

____ 7. Learning in Neural Networks happens through the adjustment of the weights.

[1 Point] T

____ 8. Voice assistants such as Siri, Corona, are now good at coping with embedded sentences.

[1 Point] F

____ 9. In computer vision applications, classification is more difficult than object segmentation.

[1 Point] F

____ 10. A typical Automatic Feature extraction and Classification system consists of Input Layer, Convolution and Pooling layers, and a finally fully connected output layer.

[1 Point] T

TEST CONTINUES OVERLEAF

PART B: [70 POINTS]
Multiple choice. Circle the correct answer.

1. Given **b** stands for branching factor, and **d** stands for depth. What is the time and space complexity of DFS.

   A. Time: $O(b^d)$, Space: $O(b^d)$
   B. Time: O(bd), Space: $O(b^d)$
   C. Time: $O(b^d)$, Space: O(bd)
   D. Time: O(bd), Space: O(bd)

[3 Point] C

[1 Points]

2. Which Agent task environment description best characterises playing a game of tennis.

   A. Partially observable, stochastic, sequential, dynamic, continuous, multi-agent.
   B. Partially observable, stochastic, sequential, dynamic, continuous, single agent (unless there are alien life forms that are usefully modeled as agents).
   C. Partially observable, deterministic, sequential, static, discrete, single agent. This can be multi-agent and dynamic if we buy books via auction, or dynamic if we purchase on a long enough scale that book offers change.
   D. Fully observable, stochastic, episodic (every point is separate), dynamic, continuous, multi-agent.

[3 Points] D

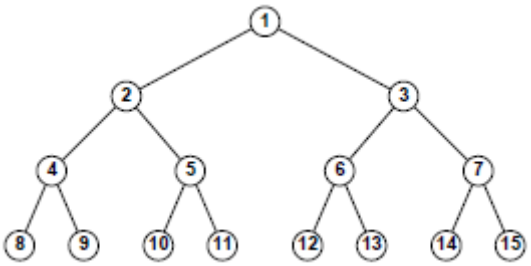
3. A robot is trying to navigate out of a maze. You can turn the robot to face north, east, south, or west. The robot will stop before hitting a wall, turn around and continue. If **b** stands for branching factor, and **d** stands for depth. How large is the state space generated by the robot ?

   A. Infinite
   B. $O(b^d)$
   C. O(bd)
   D. $O(d^{b\}}$

[3 Points] A

4. What is the sequence of nodes visited during Breadth First Search?

TEST CONTINUES OVERLEAF



A. `1,2,4,8,9,3,6,12,5,10,7,14,11,15`
B. `1,4,8,9,5,10,11,3,6,12,13,7,14,15`
C. `1,2,4,5,8,9,10,11,6,7,12,13,14,15`
D. `1,2,3,4,5,6,7,8,9,10,11,12,13,14,15`

[3 Points] B

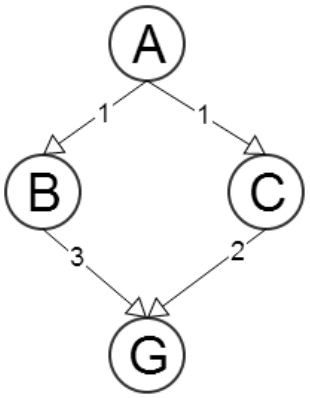
TEST CONTINUES OVERLEAF

5. Consider a state space where the start state is number 1 and each state k has three successors: numbers 3k, 3k + 1 and 3k + 2. So, the successors to state 1 are 3, 4 and 5, the successors to state 3 are 9, 10 and 11, so on. Which of the following is the order of the nodes visited using depth first search to a depth of 2? (Hint: draw a graph)

   A. `1,3,4,5,9,10,11,12,13,14,15,16,17`
   B. `1,3,9,10,11,4,12,13,14,5,15,16,17`
   C. `1,3,9,10,11,4,12,13,14,5,15,16,17`
   D. `1,3,9,5,8,10,11,12,13,14,15,16,17`

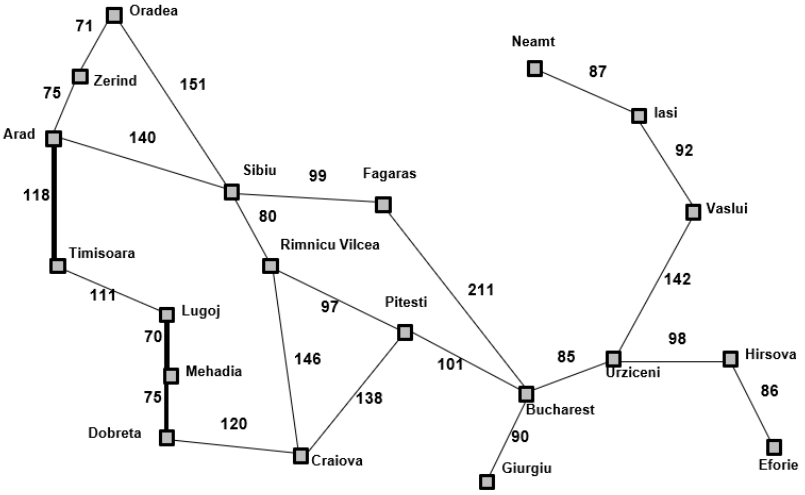
[7 Points] B

6. In the following diagram A is the start node and G is the goal node.
   Evaluation function is given by f (n) = g(n) + h(n), where
   g(n) = cost so far to reach n
   h(n) = estimated cost to goal from n
   f (n) = estimated total cost of path through n to goal
   Which heuristic function is not admissible?



   A. `h(B) = 3, h(C) = 4`
   B. `h(B) = 3, h(C) = 2`
   C. `h(B) = 2, h(C) = 1`
   D. `h(B) = 2, h(C) = 0`

[5 Points]



Straight−line distance to Bucharest

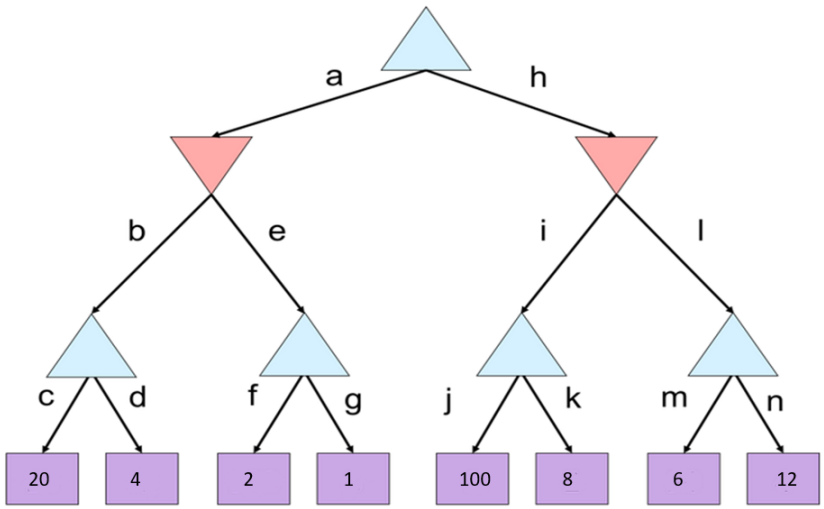
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	178
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	98
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

7. A∗ is applied to the problem of getting from Sibiu to Bucharest using the **straight-line distance heuristic**. Which of the following is the correct application of the evaluation function f(x) = g(x) + h(x) for the given nodes?

   A. Rimnicu Vilcea[193+97], Pitesti[98+101]
   B. Faragas[0+178], Bucharest[211+0]
   C. Rimnicu Vilcea[80+193], Pitesti[177+98]
   D. Faragas[253+99], Bucharest[178+0]

[5 Points] C

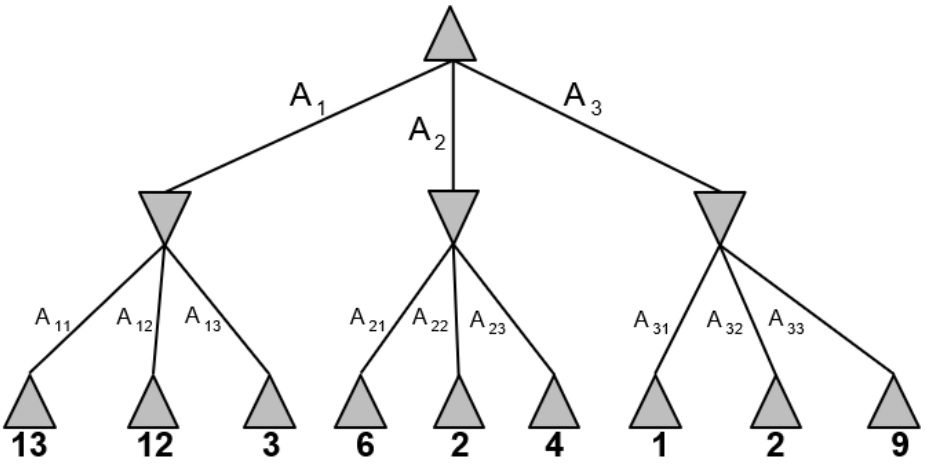
8. In the following game tree generated using the MiniMax algorithm, what will be the value in the root node?



   A. 100
   B. 20
   C. 12
   D. 8

[4 Points] C

9. Which branches in this game tree will be pruned by the Alpha-Beta algorithm.



A. A2 A3

B. A12 A13 A22 A23 A32 A33

C. A22 A23 A32 A33

D. A23 A32 A33

[5 Points] C

10. What is the CNF form for the following sentence?

$$(P \Rightarrow P) \Leftrightarrow Q$$

You may use the following logical equivalences for your conversion:

$(\alpha \wedge \beta)$	$\equiv (\beta \wedge \alpha)$	commutativity of $\wedge$
$(\alpha \vee \beta)$	$\equiv (\beta \vee \alpha)$	commutativity of $\vee$
$((\alpha \wedge \beta) \wedge \gamma)$	$\equiv (\alpha \wedge (\beta \wedge \gamma))$	associativity of $\wedge$
$((\alpha \vee \beta) \vee \gamma)$	$\equiv (\alpha \vee (\beta \vee \gamma))$	associativity of $\vee$
$\neg(\neg\alpha)$	$\equiv \alpha$	double-negation elimination
$(\alpha \Rightarrow \beta)$	$\equiv (\neg\beta \Rightarrow \neg\alpha)$	contraposition
$(\alpha \Rightarrow \beta)$	$\equiv (\neg\alpha \vee \beta)$	implication elimination
$(\alpha \Leftrightarrow \beta)$	$\equiv ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha))$	biconditional elimination
$\neg(\alpha \wedge \beta)$	$\equiv (\neg\alpha \vee \neg\beta)$	De Morgan
$\neg(\alpha \vee \beta)$	$\equiv (\neg\alpha \wedge \neg\beta)$	De Morgan
$(\alpha \wedge (\beta \vee \gamma))$	$\equiv ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma))$	distributivity of $\wedge$ over $\vee$
$(\alpha \vee (\beta \wedge \gamma))$	$\equiv ((\alpha \vee \beta) \wedge (\alpha \vee \gamma))$	distributivity of $\vee$ over $\wedge$

A. (P v ¬P v ¬Q) ^ (¬P v Q) ^ (P v Q)
B. (¬P v ¬Q) ^ (¬P v Q) ^ (P v Q)
C. (P ^ ¬Q) v (¬P ^ Q) v (P ^ Q)
D. (P ^ ¬P) v (¬Q ^ ¬P) v (Q ^ P)

[5 Points] A

11. Using the premises 1,2, and 3, provided, which of the options can be proven using Propositional Resolution?

Premises

1. **A => C**
2. **A => B**
3. **C => D**

A. A v B

B. `B v C`

C. `¬C v B`

D. `D v ¬C`

[6 Points] D

12. Given the Joint Probability distribution below, what is *P* (X < 6, Y < 9) ?

		y		
		1	3	9
x	2	0.13	0.04	0.08
	4	0.25	0.25	0.00
	6	0.13	0.04	0.08

A. `0.625`

B. `0.67`

C. `0.8`

D. `0.75`

[5 Points] A

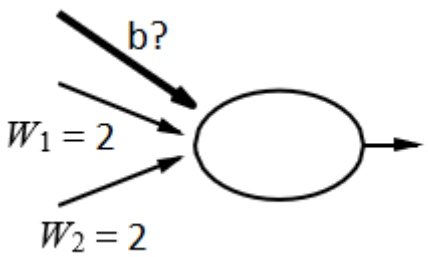
13. The pior probability that the day starts cloudy is 0.4.
The prior probability of rain is 0.1.
The probability of a cloudy start given that rain happens is 0.5.
What is the probability that it rains given that I know the day starts cloudy.

$$P(x|y) = \frac{P(y|x)}{P(y)}P(x)$$

A. 0.125
B. 0.6
C. 0.5
D. 0.15

[4 Points] A

14. What value for the bias (**b**) will cause the following perception to behave like an OR gate when the inputs are binary?



$$output = \begin{matrix} 1 \; if \; w1 * x1 + w2 * x2 + b >= 0 \\ 0 \; if \; w1 * x1 + w2 * x2 + b < 0 \end{matrix}$$

A. b = - 2.1

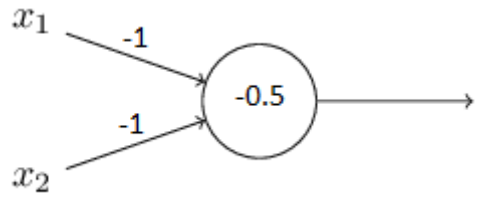
B. b = - 1.1

C. b = 0

D. b = 0.5

[5 Points] B

15. Which logical function does the following perceptron model when the inputs are binary?
Here threshold = -0.5



$$\text{output} = \begin{cases} 0 & \text{if } \sum_j w_j x_j \leq \text{ threshold} \\ 1 & \text{if } \sum_j w_j x_j > \text{ threshold} \end{cases}$$

A. AND

B. OR

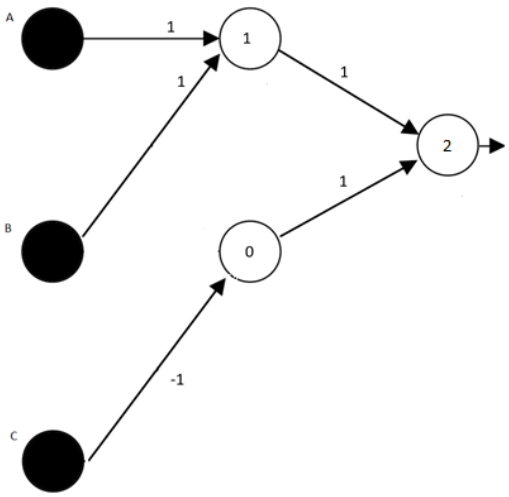
C. XOR

D. NAND

[5 Points] D

16. Which logical function does the following MLP model when the inputs are binary?

$$\text{output} = \begin{cases} 0 & \text{if } \sum_j w_j x_j \leq \text{ threshold} \\ 1 & \text{if } \sum_j w_j x_j > \text{ threshold} \end{cases}$$

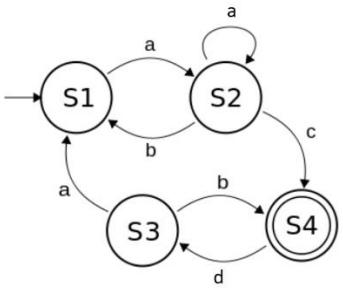


A. A ^ B ^ C

B. A ^ B v ¬C
C. A v ¬B ^ ¬C
D. A v B ^ ¬C

[6 Points] D

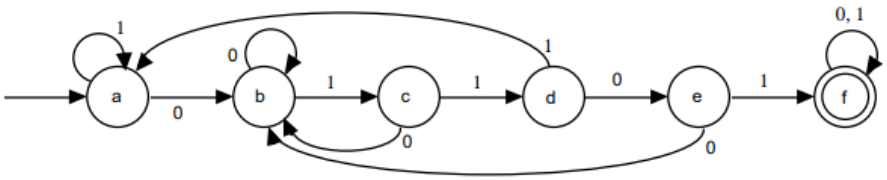
17. Which of the strings is not **accepted** by the FSM?



A. aacdbdb
B. ababacdaac
C. aaaacdaab
D. ababacdbdb

[4 Points] C

18. Which binary numbers can be **generated** by the following FSM?



A. 1110010110110011O1
B. 0001110001100011O0
C. 1111000111100111O1
D. 1010101010101010

[4 Points] A

19. The convolution operation of which filter with the image below results in the given feature map ?

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Image

3	5	3
2	4	5
2	4	3

Feature map

A.

1	0	0
1	1	1
0	1	0

B.

0	1	0
1	1	1
0	1	0

C.

1	0	1
1	1	1
0	1	0

D.

1	0	1
1	0	1
0	1	0

[4 Points] B

20. Which option below is the result of 2x2 Max-Pooling on the following feature map ?

9	3	22	66
0	34	70	38
12	12	9	2
12	12	45	6

Feature map

A.

34	70
12	45

B.

12	49
12	12

C.

9	66
12	6

D.

34	38
12	6

[3 Points] A