MONASH University

Examination Period

EXAM CODES:	FIT5047
TITLE OF PAPER:	Mock eExam (**2021-S1**)
EXAM DURATION:	**2 hours (10 minutes reading time)**

Rules

During an exam, you must not have in your possession any item/material that has not been authorised for your exam. This includes books, notes, paper, electronic device/s, mobile phone, smart watch/device, calculator, pencil case, or writing on any part of your body. Any authorised items are listed below. Items/materials on your desk, chair, in your clothing or otherwise on your person will be deemed to be in your possession.

You must not retain, copy, memorise or note down any exam content for personal use or to share with any other person by any means following your exam.

You must comply with any instructions given to you by an exam supervisor.

As a student, and under Monash University's Student Academic Integrity procedure, you must undertake your in-semester tasks, and end-of-semester tasks, including exams, with honesty and integrity. In exams, you must not allow anyone else to do work for you and you must not do any work for others. You must not contact, or attempt to contact, another person in an attempt to gain unfair advantage during your exam session. Assessors may take reasonable steps to check that your work displays the expected standards of academic integrity.

Failure to comply with the above instructions, or attempting to cheat or cheating in an exam may constitute a breach of instructions under regulation 23 of the Monash University (Academic Board) Regulations or may constitute an act of academic misconduct under Part 7 of the Monash University (Council) Regulations.

Authorised Materials

OPEN BOOK	☐ YES	☑ NO	
CALCULATORS	☑ YES	☐ NO	Calculator
DICTIONARIES	☐ YES	☑ NO	
NOTES	☐ YES	☑ NO	
SPECIFICALLY PERMITTED ITEMS	☐ YES	☑ NO	

if yes, items permitted are:

Instructions

Question 1

[**Agents**] Consider the vacuum agent presented in class, but assume that the room has 8 squares and a square can get dirty after it has been cleaned.

10 Marks

(a) Use PEAS to specify the task environment.

(b) Specify the attributes of the environment.

Please answer question on your blank piece of paper.

- After your exam finishes, you'll have **extra time** to access your phone to scan a **QR code** and **upload** your answer.
- Clearly label each page with **Student ID** and **this question number** (and **sub part** if applicable) (for example, 'Question 7a')
- **Do not** write your Name on it

No. of answer sheets: 1

Question 2

[**Algorithm A***] The evaluation function $f(n) = d(n) + W(n)$, where $d(n)$ is the cost of arriving at node n and $W(n)$ is the sum of Manhattan Distance for each tile, is used in conjunction with the algorithm $A*$ to search from the start node:

15 Marks

2	8	3
1	6	4
7		5

To the goal node:

1	2	3
8		4
7	6	5

Use this evaluation function to search forward (from start node to goal node) and backward (from the goal node to the start node). Where would the backward search meet the forward search?

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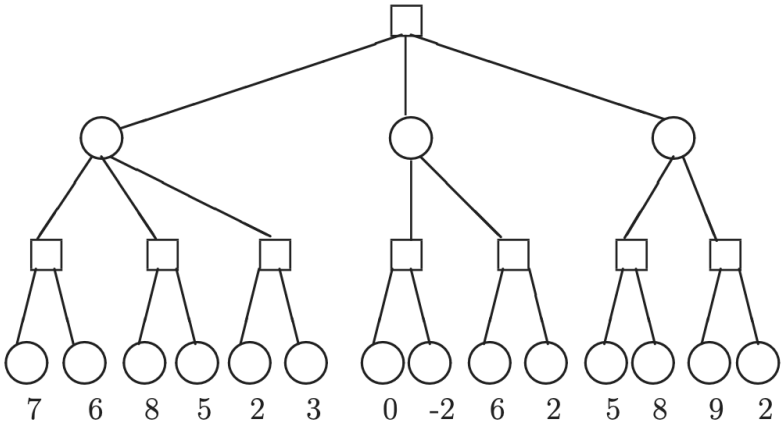
No. of answer sheets: 2

Question 3

[**Game playing**] Consider the following game tree, where MAX plays in the square positions and MIN plays in the circles.

10 Marks



(a) Conduct an α-β search of this game starting at the leftmost node to determine which move should MAX make. Draw the resulting game tree so that only the visited nodes appear in your diagram, i.e., **without** the nodes that are cut off. Indicate clearly the backed up value of each node, the updates performed on the backed up values, the α cut-offs and the β cut-offs you have performed.

(b) What is the best move for MAX and what is its backed up value?

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Question 4

[**Forward/backward chaining**] Apply forward and backward reasoning to the following Horn clauses to prove PassExam.

10 Marks

R1: $Enroll \wedge StudyHard \wedge Understand \Rightarrow PassExam$
R2: $AskGoodQuestions \Rightarrow Understand$
R3: $PayTuitionFee \Rightarrow Enroll$
R4: $NeverPlayGame \wedge SitAllDay \Rightarrow ReadAndWork$
R5: $ReadAndWork \Rightarrow StudyHard$
R6: $StudyHard \Rightarrow AskGoodQuestions$
$PayTuitionFee$
$NeverPlayGame$
$SitAllDay$

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Question 5

[**Resolution**] From "Horses are animals", it follows that "The head of a horse is the head of an animal." Demonstrate that this inference is valid by carrying out the following steps:

15 Marks

(a) Translate the premise and the conclusion into a well formed formula (wff) in First order logic. Use three predicates: $HEADOF(h, x)$ (meaning "h is the head of x"), $HORSE(x)$, and $ANIMAL(x)$.

(b) Negate the conclusion, and convert the premise and the negated conclusion into CNF.

(c) Use resolution to show that the conclusion follows from the premise.

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Question 6

[**Bayesian Network**] Consider a student who has the choice to buy or not buy a textbook for a course. We'll model this as a decision problem with one Boolean decision Node, B, indicating whether the student chooses to buy the book, and two Boolean chance nodes, M, indicating whether the student has mastered the material in the book, and P, indicating whether the student passes the course. Of course, there is also an *additive* utility node, U. A certain student, Sam, has a utility function: 0 for not buying the book and -$100 for buying it; and $2000 for passing the course and 0 for not passing. In this case, the additive utility for passing and buying the book is $2000 - 100$.

15 Marks

Sam's conditional probability estimates are as follows:
$Pr(p|b, m) = 0.9 \quad Pr(m|b) = 0.9$
$Pr(p|b, \neg m) = 0.5 \quad Pr(m|\neg b) = 0.7$
$Pr(p|\neg b, m) = 0.8$
$Pr(p|\neg b, \neg m) = 0.3$
You might think that P would be independent of B given M, but this course has an open-book final – so having the book helps.

(a) Draw the decision network for this problem.

(b) Compute the expected utility of buying the book and of not buying it.

(c) What should Sam do?

The Naïve Bayes formula is: $\Pr(C|v_{i1}, \ldots, v_{in}) = \alpha \prod_{k=1}^{n} \Pr(v_{ik}|C_i = c) \Pr(C_i = c)$,

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Question 7

[**Supervised Machine Learning**] Consider the following dataset consisting of 3 binary features and a binary class variable.

15 Marks

Feature 1	Feature 2	Feature 3	Class
1	0	0	0
1	0	1	1
1	1	1	1
1	1	1	1
0	1	1	0
0	0	1	0

(a) Based on the dataset above, estimate the prior probability of Class 1.

(b) What is the initial entropy of the class labels over all the data? Show the formula before plugging-in numbers.

(c) If we were to split the data into 2 groups based on the value of Feature 1, what would be the entropy for each group?

(d) What is the Information Gain of Feature 1?

(e) You are told the Information Gain for Feature 2 and Feature 3 **after splitting on Feature1** is 0.08 and 0.19 respectively. Draw a decision tree for this problem.

(f) We will now build a Naïve Bayes model for predicting the class from these data. Draw the Bayesian Network that corresponds to the Naive Bayes model.

(g) From the data table, write down the conditional probability estimates required for the Naïve Bayes model.

(h) What class does the Naïve Bayes model predict for a new data item with values (1, 1, 1) for Features 1, 2 and 3 respectively? What is the probability of each class? How does the Naïve Bayes classification compare to the decision tree classification?

The formula for Entropy is: $H(X) = -\sum_{i=1}^{n} \Pr(x_i) \log_2 \Pr(x_i)$

Please answer question on your blank piece of paper.

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No. of answer sheets: 2

Question 8

[**K-means clustering**] Assume we have following data with two attributes, apply the K-means clustering algorithm where K=2 and initialized cluster centroid C1=(1.25, 1.25) and C2=(1.75,4.75). You should use Euclidean distance to perform your calculations. **Be sure to show all your work**.

10 Marks

Instance	D1	D2
X1	1.0	1.5
X2	1.0	4.5
X3	2.0	1.5
X4	2.0	3.5
X5	3.0	2.5
X6	5.0	6.0
X7	4.0	5.5
X8	6.0	1.5

Please answer question on your blank piece of paper.

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