THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

This exam paper must not be removed from the venue

Venue _____

Seat Number _____

Student Number |__|__|__|__|__|__|__|__|

Family Name _____

First Name _____

School of Information Technology and Electrical Engineering

EXAMINATION

Semester Two Final Examinations, 2017

COMP3702 Artificial Intelligence

This paper is for St Lucia Campus students.

Examination Duration: 120 minutes

Reading Time: 10 minutes

Exam Conditions:

This is a Central Examination

This is a Closed Book Examination - no materials permitted

During reading time - write only on the rough paper provided

This examination paper will be released to the Library

Materials Permitted In The Exam Venue:

(No electronic aids are permitted e.g. laptops, phones)

Calculators - Casio FX82 series or UQ approved (labelled)

Materials To Be Supplied To Students:

1 x 14 Page Answer Booklet

Instructions To Students:

Additional exam materials (eg. answer booklets, rough paper) will be provided upon request.

For Examiner Use Only

Question	Mark

Total _____

1. **[5 points]** Mr Search says that *informed search is **always** more efficient than blind search*. Is Mr Search correct? Please explain your answer.

2. **[10 points]** Suppose Ms Design came to you and present two different models of the same problem. Let's say the two models are called Model-A and Model-B. In Model-A, when the input size increases, only the size of the action space increases, and it increases linearly in the input size. In Model B, only the number of steps to reach the goal increases. Again, this increase will be linear in the input size. If you know that the input size can be quite large and Ms Design plans to use Breadth First Search to solve the problem, which model would you recommend? Please explain your answer.

3. **[10 points]** In class, we discussed how min-max tree represents a 2-player zero-sum game. Can we use the same representation for an n-player zero-sum game when $n > 2$? If we can, please explain what max level represents and what min level represents. If we cannot, please explain why.

4. **[15 points]** Recall the Value iteration algorithm for MDP. Mr Efficient claimed that his algorithm *Modified Value Iteration* (presented in Algorithm 1) will have the exact same properties as the commonly known Value Iteration algorithm, but is much more efficient. Is Mr Efficient correct if we are interested on whether we can converge to the optimal MDP solution? Please explain your answer. Note: you don't need to provide a formal proof, an explanation using the properties of convergence of value iteration is sufficient.

Algorithm 1 Modified Value Iteration($\langle S, A, T, R \rangle$)

Initialize $V^0(s) = R(s)$ for all state $s \in S$.
Let $t = 0$
repeat
  Let s be a state sampled uniformly at random from S.
  Let $S' = S' \cup s$
until $size(S') \leq 0.25 \times size(S)$
repeat
  for all state $s \in S'$ **do**
    $V^{t+1}(s) = \max_{a \in A} \left(R(s) + \gamma \sum_{s' \in S'} T(s, a, s') V^t(s') \right)$
  Let $t = t + 1$
until $\max_{s \in S} |V^{t+1}(s) - V^t(s)| \leq 1e - 5$

5. **[20 points]** QCarRental is opening its business!!! Their first order of business is to buy cars that customers can rent. To this end, they have a choice between buying 2 Tesla Model X or 5 GenCar. **A GenCar** costs $40,000. Since QCarRental already has a wide customer base for this type of car, they know that all GenCar will be rented out for $175 per day per car for 330 days per year with certainty. When a customer rents the car, the cost for maintenance and gas that QCarRental must pay is $25 per day per car. When the car is not being rented (i.e., 35 days in a year), the GenCar cars would be in a mechanic repair shop for minor repairs, which cost $30 per car per day. **A Tesla Model X** costs $120,000, QCarRental does not have any information about customer's desirability yet. However, based on the market price, they plan to rent out each Tesla for $500 per day. When a customer rents a Tesla, the daily maintenance cost charged to QCarRental is $10 per day per car. When it is not being rented out, the cost is $5 per day per car. QCarRental is expecting each Tesla to be in a mechanic repair shop and undergo minor repairs for 35 days in a year, and costs $30 per car per day. QCarRental hypothesises that each Tesla will be rented out for 330 days per year, and is currently conducting a survey (with the cost of $250) on what is the probability that their hypothesis is correct. For a conservative estimate on expected utility, one can assume that the rest of the probability mass will be the Tesla cars are not rented for the entire of the 330 days.

Suppose QCarRental is deciding which cars to buy based only on the first year profit after buying the cars. Using the concept of Maximum Expected Utility and conservative estimate of the probability that customers will rent Tesla Model X, please answer the following questions:

(a) **[10 points]** Suppose the survey reveals that the probability that each Tesla is rented for 330 days per year is 75% and Tesla offers an upgrade that allows you to rent out the Tesla car for $600 per car per day with no effect on its demand. Should you buy GenCar or Tesla Model X without modification or Tesla Model X with modification?

(b) **[10 points]** What should the results of the survey be for QCarRental to buy 2 Tesla Model X (without modification)? Please explain how you arrive to this conclusion.

6. **[20 points]** Darth Vader has kidnapped Luke Skywalker and placed him in one of the cells in his dungeon. R2D2 is sent to the dungeon to free Luke with as little cost as possible. The dungeon contains three cells, two of the cells contain Vaders monsters and one contains Luke. When R2D2 enters the dungeon, it assumes that Luke can be in any room with equal probability. Breaking into a cell with a monster inside, would cause R2D2 to be attacked by the monster and must pay a cost of $2,000 to repair itself. Breaking into a cell where Luke is, would free Luke and R2D2 will be rewarded $1,000. With a cost of $300, R2D2 can scan the dungeon to observe which cell Luke might be in. However, the result of this scanning is not perfect. A single scan of the dungeon identifies the cell where Luke is with 70% accuracy. All false scanning results are equally probable. The optimal strategy for R2D2 in this task can be framed as a POMDP problem. Please provide the POMDP model for this.

oOo End of Examination! oOo