THE UNIVERSITY OF WESTERN AUSTRALIA

Computer Science and Software Engineering

SEMESTER 2, 2016 EXAMINATIONS

CITS3001
Algorithms, Agents and Artificial Intelligence

FAMILY NAME: _____ GIVEN NAMES: _____

STUDENT ID: | | | | | | | | | SIGNATURE: _____

This Paper Contains: **5** pages **(including title page)**
Time allowed: **2:00 hours (including reading time)**

INSTRUCTIONS:

Answer all questions. Each question is worth 10 marks. The total for the paper is 100.

Most questions require only brief answers: point form answers are fine where appropriate.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found.

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Supervisors Only - Student left at:

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Q1. Algorithms

(a) Describe the relationship between *dynamic programming* (DP) and recursion. **3 marks**

(b) Describe the heuristics used in the Boyer-Moore pattern matching algorithm. **3 marks**

(c) Explain how *radix sort* works. **4 marks**

Q2. Optimisation

(a) Describe the insertion methods for solving geometric instances of the travelling salesman problem. **3 marks**

(b) What is meant by the term *NP-hard*?
Give an example of an NP-hard problem. **3 marks**

(c) Define the *local optima* of a state-space. Describe how *Tabu Search* tries to avoid local optima. **4 marks**

Q3. Uninformed search

(a) Give pseudo-code for a *breadth-first search.* **2 marks**

(b) Is a *depth-first search* optimal and/or complete?
Explain your answer. **3 marks**

(c) Given a search tree with branching factor b, depth d, and nearest goal at depth g, what is the time complexity of an iterative deepening search? **2 marks**

(d) Explain *bidirectional search* in the context of word chess. **3 marks**

Q4. Game-playing

(a) In game playing, what is the relationship between incompleteness, non-determinism and uncertainty? **3 marks**

(b) What role does an *evaluation function* play in the minimax algorithm? **3 marks**

(c) Explain, with an example, how the ordering of nodes affects an **αβ** search. **4 marks**

Q5. Informed search

(a) Show that an admissible heuristic ensures that the *A** algorithm returns an optimal solution. **4 marks**

(b) Suppose we are using the *A** algorithm to solve word chess. Which of the following heuristics is better, and why?

a. The remaining distance is the length of the word, minus the length of the longest prefix that matches the target word.
b. The remaining distance is the number of characters in the word that do not appear in the target word.
c. The remaining distance is the number of characters in the word that do not match the character in the same position in the target word. **3 marks**

(c) Is a *Simplified Memory-bounded A** complete? Explain your answer. **3 marks**

Q6. Sequential decision problems

(a) How is uncertainty incorporated into the *transition model* of a sequential decision problem (SDP)? **2 marks**

(b) Describe the key elements of a policy in the context of a voting round in the game *The Resistance.* **4 marks**

(c) What is the Bellman equation and how is it used to determine the utility of a state? **4 marks**

Q7. Learning agents

(a) Describe a decision tree for the process of selecting an elective unit in your course, given the features: *class size*, *whether it is interesting, whether group work is involved,* and *how difficult is the material.* **3 marks**

(b) Given your answer for (a), describe the process of inducing such a decision tree from historical data. **4 marks**

(c) Define and contrast *Supervised Learning, Reinforcement Learning,* and *Unsupervised Learning.* **3 marks**

Q8. Reinforcement learning

(a) Define the terms *passive learning, active learning, utility learning* and *Q-learning*. **3 marks**

(b) Describe the role of α (the learning rate) in *temporal-difference learning*. **2 marks**

(c) Demonstrate the process of *Adaptive Dynamic Programming* in the following space:

0.1	0.2	0.3	0.4	0.5

An agent may choose to move left or right, with the values in the squares being the probability that the opposite move is performed. The utility for exiting to the right is 1, and the utility for exiting to the left is -1. **5 marks**

Q9. Logical agents

(a) Use first order logic and the predicates *Student(x), Fails(x), Question(y)* and *Wrong(x, y)* to express the sentence:
If any student fails, then they must have got all questions wrong. **3 marks**

(b) Given your answer for (a), and the constant *C* (for Callum), apply resolution to formalise the argument:
If any student fails, then they must have got all questions wrong.
Callum got at least one question right.
Therefore, Callum passed. **5 marks**

(c) How does situation calculus manage predicates that change over time? **2 marks**

Q10. Planning and acting

(a) What is the role of topological sorting in a *partial-order planner*? **3 marks**

(b) How is planning different to informed search?
When would we use a partial order planner rather than A*? **4 marks**

(c) Describe the main components of a *Goal-Based Agent*. **3 marks**

END OF PAPER
