16/5/2019

14.00 - 16.00pm

CMPU 4010 Artificial Intelligence

Basement 1, Kevin Street

Programme Code: DT211C, DT228, DT282, DT8900
Module Code: CMPU 4010
CRN: 25771, 22416, 31082, 27131

# TECHNOLOGICAL UNIVERSITY DUBLIN

**KEVIN STREET CAMPUS**

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## BSc. (Honours) Degree in Computer Science (Infrastructure)

## BSc. (Honours) Degree in Computer Science

## BSc. (Honours) Degree in Computer Science (International)

**Year 4**

## International Pre Masters for MSc in Computing

**Year 1**

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SEMESTER 2 EXAMINATIONS 2018/19

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**Artificial Intelligence**


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Mr. Martin Crane – DT228/282


ANSWER **QUESTION 1 (40 MARKS) AND**
ANY **TWO OTHER** QUESTIONS (30 MARKS EACH)

1. **(a)** Explain what is the **Turing test**. Discuss what are the **advantages** of the Turing test as a measure of intelligence?

(10 marks)

**(b)** For each of the following two pairs of first-order predicate logic sentences, define **the most general unifier**, if one exists:

- Pair 1: $\forall x$ Plays(Mary, x) and $\forall y$ Plays(y, Piano)
- Pair 2: $\forall x$ Parent(John, Father(x)) and $\forall x$ Parent(x, Father(Bill))

(5 marks)

**(c)** Outline the criteria used for evaluating and comparing different search algorithms.

(5 marks)

**(d)** Explain the role of **mutation** in **genetic algorithms**.

(5 marks)

**(e)** Convert the following sentence to **conjunctive normal form**:

$(p \Rightarrow (q \Rightarrow r))$

(5 marks)

**(f)** Explain the difference between **general** and **domain-specific** knowledge and provide an example of each.

(5 marks)

**(g)** Write a First-Order Predicate Logic formula of the following statement:

*If a person owns a license they are allowed to drive.*

(5 marks)

2. **(a)** Prove using **Proof by Contradiction** that the knowledge base

$$KB = \{P \vee Q \, , P \Rightarrow Q \}$$

does **not entail** the statement

$$\alpha = P \wedge Q$$

(Note: You will need to convert the knowledge base into conjunctive normal form. Table 1 at the end of the exam paper lists logical equivalence rules that you might find useful.)

(15 marks)

*(Question 2 cont. on next page)*

**(b)** Using truth tables show that $(p \Rightarrow q) \vee (q \Rightarrow p)$ is a tautology.

(5 marks)

**(c)** Using **model enumeration** check whether the knowledge base

$$KB = \{P \wedge Q, P \Leftrightarrow Q\}$$

**does or does not entail** the statement

$$\alpha = P \vee Q$$

(10 marks)

3. **(a)** Briefly compare and contrast the **depth-first** and the **iterative deepening search** algorithms.

(10 marks)

**(b)** A hill-climbing algorithm that never makes downhill moves towards states with lower value (or higher cost) is guaranteed to be incomplete, because it can get stuck on a local maximum.

Describe, in your own words, how **simulated annealing** algorithm addresses this issue.

(5 marks)

**(c)** Discuss the **role of heuristics** in search algorithms. Can we guarantee that a heuristic will always improve the search? Provide examples of two heuristics.

(10 marks)

**(d)** Briefly discuss how **inference** works in **semantic networks**.

(5 marks)

**4. (a)** Discuss the advantages and disadvantages of **rule-based systems.**

(10 marks)

**(b)** Explain why choosing the variable that is most constrained, but the value that is least constrained is a good heuristic for a **constraint satisfaction problem**?

(10 marks)

**(c)** Illustrate how **left-to-right alpha-beta pruning** works for the tree in Figure 1 on next page.

(10 marks)

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

Table 1: List of logical equivalences

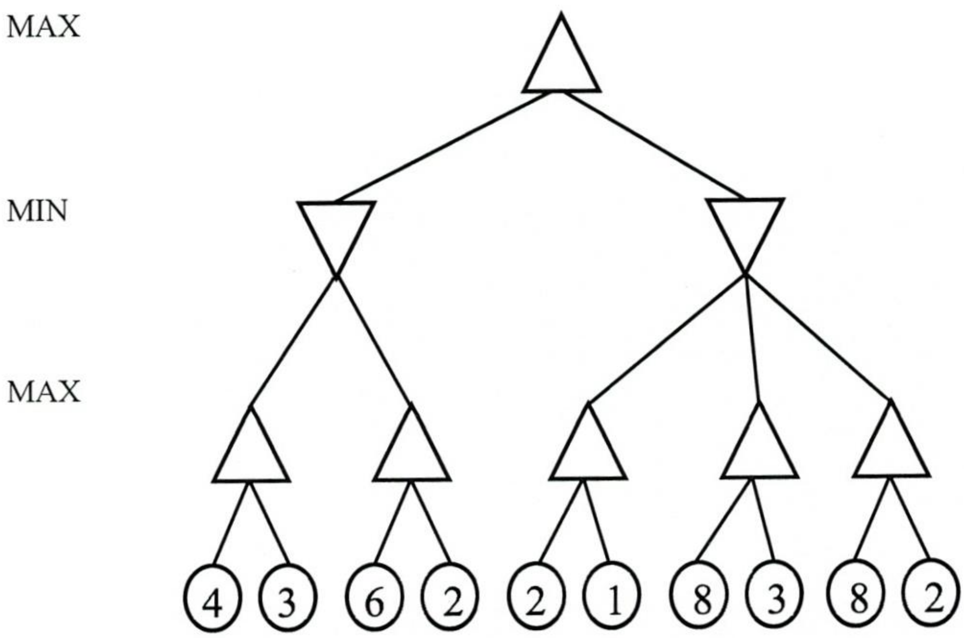


Figure 1: Example game tree for Question 4(c)