R228/406

DUBLIN INSTITUTE OF TECHNOLOGY
KEVIN STREET, DUBLIN 8

BSc (Hons) in Computer Science

Stage 4

SUPPLEMENTAL EXAMINATIONS 2008

ARTIFICIAL INTELLIGENCE 2

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Duration: 2 Hours

Answer Question 1 (40 marks) **and**

any 2 Other Questions (30 marks each).

1. (a) The logical operator $\iff$ is read *if and only if*. $P \iff Q$ is defined as being equivalent to $(P \Rightarrow Q) \wedge (Q \Rightarrow P)$. Based on this definition, show using truth tables the logical equivalence of $P \iff Q$ and $P \vee Q \Rightarrow P \wedge Q$.

(5 marks)

(b) Distinguish between **false negatives** and **false positives**.

(5 marks)

(c) In the context of machine learning, explain what is meant by **overfitting** the training data.

(5 marks)

(d) In the context of inductive learning explain what is meant by a **consistent hypothesis**.

(5 marks)

(e) Let us say we have three classification algorithms. How can we order these three from best to worst?

(20 marks)

2. (a) Consider the domain of dealing 5-card poker hands from a standard deck of 52 cards, under the assumption that the dealer is fair.

(i) Given that the number of combinations of r objects that can be selected, without regard to order and without repetition, from n distinct objects is given by the equation $\binom{n}{r} = \frac{n!}{(n-r)!r!}$. How many atomic events are there in the joint probability distribution (i.e., how many 5-card hands are there)?

(5 marks)

(ii) What is the probability of each atomic event?

(5 marks)

(iii) What is the probability of being dealt a royal straight flush (i.e. being dealt a hand containing Ace, King, Queen, Jack and 10 all from the one suit)?

(5 marks)

(iv) What is the probability of being dealt a four of a kind (i.e. four kings, or four nines etc.?

(5 marks)

(b) Consider the network for car diagnosis shown in Figure 1.

(i) Extend the network with the Boolean variables *IcyWeather* and *StarterMotor*.

(5 marks)

(ii) How many independent values are contained in the joint probability.

(5 marks)

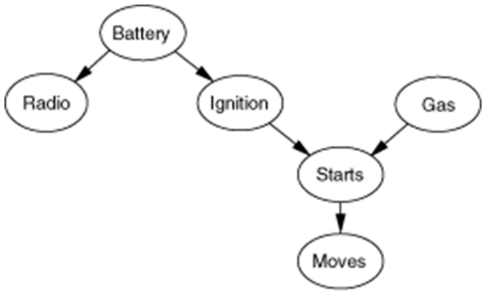

Figure 1: A Bayesian network of a car's electrical system and engine. Each variable is boolean and the true value indicates that the corresponding aspect of the vehicle is in working order.

3. (a) Suppose we generate a training set from a decision tree and then apply decision-tree learning to the training-set. Is it the case that the learning algorithm will eventually return the correct tree as the training set size goes to infinity? Why or why not?

(5 marks)

(b) In the context of inductive logic learning, what is meant by the **extension** of a hypothesis?

(5 marks)

(c) Distinguish between the **generalisation** and **specialization** of a logical predicate.

(10 marks)

(d) For some data sets it is possible to devise multiple hypotheses that are consistent with the data. Describe a heuristic for choosing among multiple consistent hypotheses and explain why your heuristic is reasonable.

(10 marks)

4. (a) What does it mean if two classes C_1 and C_2 are described as **linearly separable**.

(5 marks)

(b) Describe the processing stages of a McCulloch-Pits "unit".

(10 marks)

(c) Construct by hand a neural network that computes the XOR function of two inputs. Make sure to specify what sort of units you are using.

(15 marks)