DUBLIN INSTITUTE OF TECHNOLOGY

DT228 BSc. (Honours) Degree in Computer Science

Year 3

Supplemental Examinations
2017/2018

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

INTERNAL EXAMINERS
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EXTERNAL EXAMINER
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XXTH AUGUST
XX.00 – YY.00

2 HOURS

INSTRUCTIONS TO CANDIDATES
ANSWER **FOUR** QUESTIONS OUT OF **FIVE**.
ALL QUESTIONS CARRY EQUAL MARKS.

1 Financial Advisor Knowledge

The function of the advisor is to help a user decide whether to invest in a savings account or the stock market. Some investors may want to split their money between the two. The investment that will be recommended for individual investors depends on their income and the current amount they have saved according to the following criteria:

1. Individuals with an inadequate savings account should always make increasing the amount saved their first priority, regardless of their income.
2. Individuals with an adequate savings account and an adequate income should consider a riskier but potentially more profitable investment in the stock market.
3. Individuals with a lower income who already have an adequate savings account may want to consider splitting their surplus income between savings and stocks, to increase the cushion in savings while attempting to increase their income through stocks.

The adequacy of both savings and income is determined by the number of dependents an individual must support. The rule is to have at least €5,000 in the bank for each dependent. An adequate income must be a steady income and supply at least €15,000 per year plus an additional €4,000 for each dependent.

Note that if the amount saved is greater than the minimum savings, then the savings account is deemed adequate, otherwise inadequate. Similarly with the adequacy/inadequacy of the income.

(a) Express the above knowledge in the Predicate Calculus in terms of the following predicates and functions:

amount_saved/1, dependents/1, earnings/2
savings_account/1, income/1, investment/1
minsavings(Y) and minincome(Y) (functions).

(10 marks)

(b) Translate your knowledge described in part (a) into Prolog.

(10 marks)

(c) Show how you might tie together all the Prolog rules from part (b) into an executable program.

(5 marks)

2 (a) Using a diagram and some comments, describe how an artificial neuron operates as a simple computing element. Mention two different activation functions in your answer.

(8 marks)

(b) In a multilayer perceptron, describe what is meant by feedforward and backpropagation. Outline how feedforward might be implemented in a language like Java (no code required).

(5 marks)

(c) Describe how a multilayer perceptron could be trained and afterwards used when presented with a large training data set.

(6 marks)

(d) Illustrate how a perceptron that acts as an AND gate is trained by computing the weight adjustments for the first two epochs in the table below.

(6 marks)

Threshold $\theta = 0.2$, learning rate $\alpha = 0.1$.

Epoch	Inputs		Desired output	Weights		Weighted Sum	Actual Output	Error	Weight adjustments	
	x_1	x_2	Y_d	w_1	w_2	X	Y	e	Δw_1	Δw_2
1	0	0		0.4	-0.2					
	0	1								
	1	0								
	1	1								
2	0	0								

3 (a) Using a Prolog functor as the appropriate data structure for recording information on a car such as value, registration number, year of purchase, mileage and make; declare three example cars.

(5 marks)

(b) Write a rule to display value and mileage information on all ***ford*** cars in the database using the type of data in part(a).

(5 marks)

(c) Given facts like:

```
parent(tom, mary).
parent(tom, jim).
parent(jim, sue).
```

Write a predicate which could infer that tom is an ancestor of sue.

(5 marks)

(d) What happens when the following query is presented to a Prolog interpreter?

```
a(X,b(2,abc),[1,2,3,4]) = a(person(tom,24),b(_,Y),[_,Z|T]).
```

What happens if `=` is replaced with `==` ?

(5 marks)

(e) Given the Fibonacci sequence: 0,1,1,2,3,5,8,13,21,34,…
Write a Prolog predicate fib(N, Y) to calculate any term of the sequence.

(5 marks)

4 (a) What is uncertainty? When can knowledge be inexact and data incomplete or inconsistent? Give an example of inexact knowledge.

(8 marks)

(b) Given the forecasting rules below, show how they would fire to forecast tomorrow's weather when provided with the following information: there is rain today and the rainfall is low with a certainty factor of 0.8, and also it is cold with a certainty factor of 0.9. This formula may be useful:

$$cf(cf_1, cf_2) = cf_1 + cf_2 \times (1 - cf_1)$$

Rule: 1
if today is rain
then tomorrow is rain {cf 0.5}

Rule: 2
if today is dry
then tomorrow is dry {cf 0.5}

Rule: 3
if today is rain
and rainfall is low
then tomorrow is dry {cf 0.6}

Rule: 4
if today is rain
and rainfall is low
and temperature is cold
then tomorrow is dry {cf 0.7}

Rule: 5
if today is dry
and temperature is warm
then tomorrow is rain {cf 0.65}

Rule: 6
if today is dry
and temperature is warm
and sky is overcast
then tomorrow is rain {cf 0.55}

(9 marks)

(c) Compare Bayesian reasoning and certainty factors. Which applications are most suitable for Bayesian reasoning and which for certainty factors?

(8 marks)

5 (a) Explain briefly each of the following in the context of machine learning:

- supervised learning
- classification
- regression
- clustering

(6 marks)

(b) Mention four approaches to machine learning and briefly describe two of them.

(6 marks)

(c) In the context of supervised learning, suppose a 200 record data set was presented to a learning algorithm, suggest how the set might be divided into 3 groups for training, validation and testing and what is meant by these terms.

(5 marks)

(d) In diagram 1 below there are 20 squares and 40 triangles. Diagram 2 shows the same distribution plus an extra input whose shape is unknown and a neighbourhood of the input which has 3 squares and 1 triangle. Using the data from the diagrams, illustrate how Naïve Bayes Classification works in deciding whether the input can be classified as a square or triangle.

The Bayes formula is

$$P(H|E) = P(H)P(E|H)/P(E)$$

(8 marks)

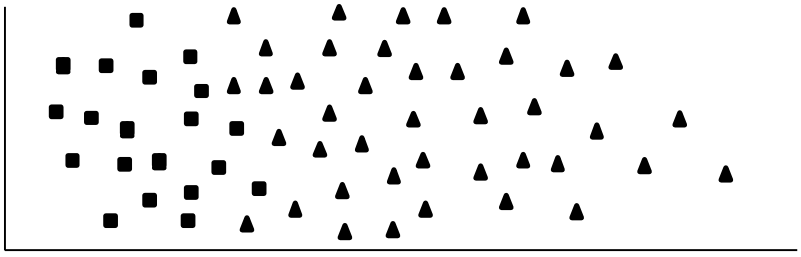

Diagram 1

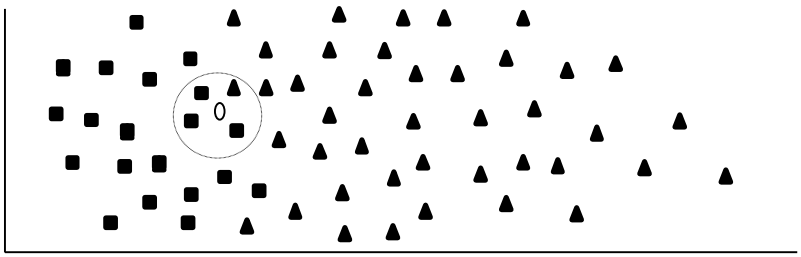

Diagram 2