

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD

JAN 2022

CYFNOD ARHOLIADAU

ION 2022

MODULE CODE: ACCA6011
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

TIME: 2 HOURS

ANSWER THREE QUESTIONS OUT OF FOUR

Equipment or materials required - Scientific Calculator

Adnoddau neu ddefnyddiau sydd eu hangen – cyfrifiannell wyddonol

**YOU MUST SHOW DETAILED WORKINGS WHEN ANSWERING
NUMERICAL QUESTIONS.**

QUESTION ONE

- 1a) Your team leader has put you in charge of developing a feature for a sleep disorder diagnosis application. This feature will classify someone as either having an elevated likelihood of obstructive sleep apnoea (OSA), or not. You have decided to use a Naïve Bayes classifier for this problem and base the Naïve Bayes classifier decisions on age group, gender and BMI grouping.

In order to demonstrate the method to your supervisor you plan to test the approach by manually classifying the likelihood of OSA for an individual with the following attributes:

- **BMI Group = Medium;**
- **Age Group = Lower;**
- **Gender = Male**

Table 1, below, holds training data that have been gathered previously for a variety of subjects.

Using the Naïve Bayes method, determine which classification, OSA or not OSA, is more likely for the individual given the values above and the training data in table 1.

Age Group	OSA = Yes	OSA = No
Upper	3/9	4/5
Lower	6/9	1/5

BMI	OSA = Yes	OSA = No
High	2/9	3/5
Medium	4/9	1/5
Low	3/9	1/5

Gender	OSA = Yes	OSA = No
Female	3/9	4/5
Male	6/9	1/5

Table 1. OSA Subject Data.

[20 Marks]

- 1b) The Naïve Bayes method typically results in very small probability values which can lead to numerical errors. Suggest a method that can overcome this problem and explain how it achieves this.

[5 Marks]

QUESTION TWO

- 2a) Give a definition of the terms “uninformed search” and “informed search” within the context of A.I. Provide one example algorithm of each.

[2 Marks]

- 2b) Describe the operation of Dijkstra’s algorithm and provide an analysis of this algorithm highlighting its run time and space complexity. Discuss the purpose of any data structures used in its implementation.

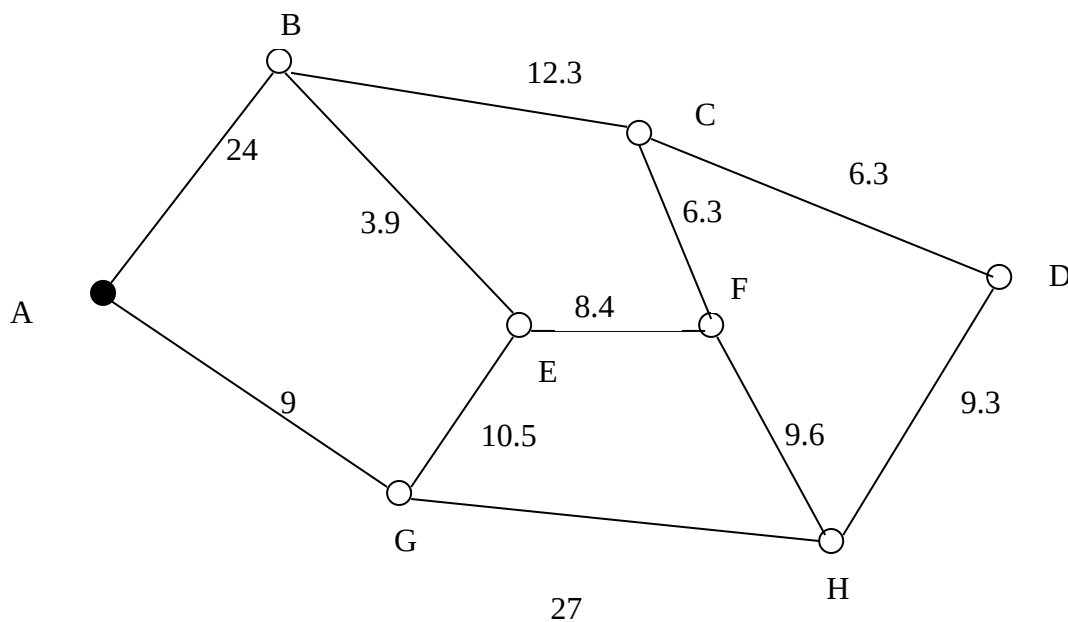
[7 Marks]

- 2c) Explain how Dijkstra’s algorithm can be adapted to become the A* shortest path algorithm and identify any constraints required to ensure optimality of this algorithm.

[4 Marks]

- 2d) Using the labelled graph below, and starting at the node labelled A, illustrate the working of Dijkstra’s algorithm. Hint: show the development of the algorithm by detailing the contents of the open and closed lists at each stage.

[12 Marks]



QUESTION THREE

- 3a) Give a pseudo-code description of a standard Genetic Algorithm that uses the genetic operators of crossover and mutation, and identify key variables in the algorithm, explaining their function and purpose. Assume the genotype is an ordered fixed length string.

[5 Marks]

- 3b) Critically evaluate the effectiveness of common terminating conditions used by genetic algorithms.

[6 Marks]

- 3(c) A fixed length chromosome (labelled, x) is composed of 8 genes each representing an algebraic variable a,b,c,d,e,f,g and h. The chromosome is represented by the string of variables, x=abcdefgh. Each variable can be a digit between 0 and 9. Show the result of performing a crossover operation on Parent 1 and Parent 2 (shown below) using the cut points indicated. Assume two children are produced.

Chosen cut points

Parent 1: **18456732**
Parent 2: **35897162**

[6 Marks]

- 3d) If the fitness function is given by:-
$$f(x) = (a + e) - (b + c - d) - f + g + h,$$
then evaluate the fitness of each of the two offspring in part c) of this question stating any assumptions you make.

[8 Marks]

QUESTION FOUR

- 4a) Within the context of machine learning, explain the terms supervised and unsupervised learning and, in each case, outline the processes involved in creating a predictive model from a given data set.

[7 Marks]

- 4b) Explain, with supporting arguments, whether the Naïve Bayes ML algorithm and the k-means algorithm are examples of supervised or unsupervised machine learning algorithms.

[6 Marks]

- 4c) With reference to the perceptron neuron shown in figure 4a below, explain the purpose of the synaptic weights w_{k1} , w_{k2} and w_{k3} .

[2 Marks]

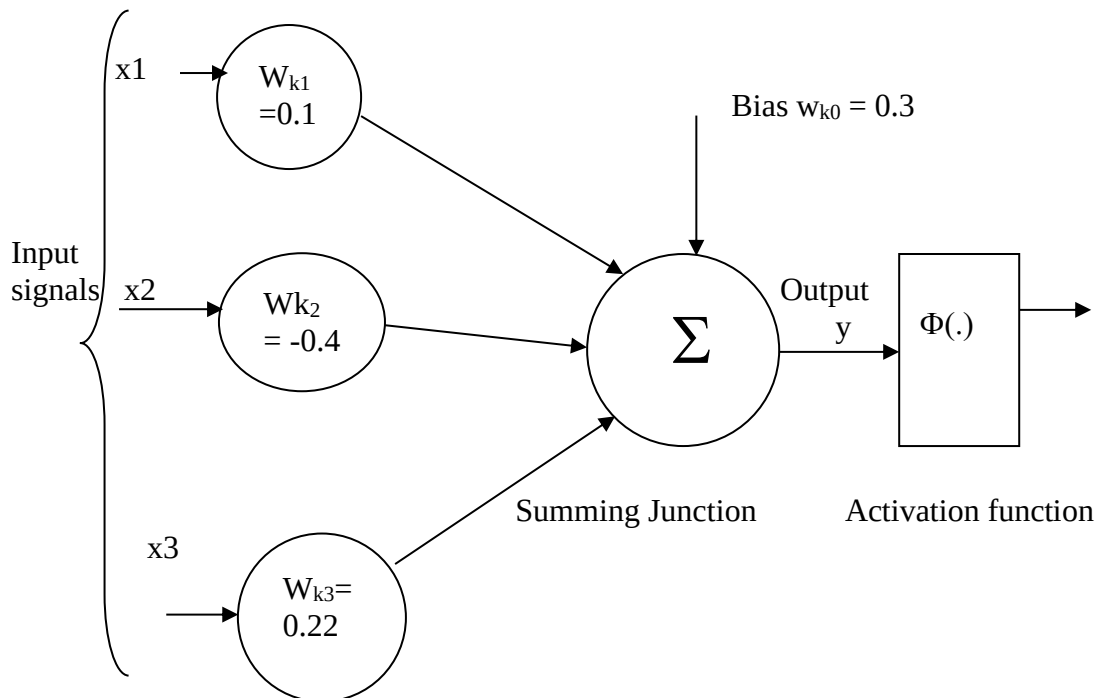


figure 4a: Rosenblatt perceptron neuron.

- 4d) Calculate the output of the activation function of the perceptron in figure 4a when $x_1=0.8$, $x_2=-0.22$, $x_3=0.12$ and the activation function is a Rectified Linear Unit (ReLU) given by $\Phi(\max(0, y))$. Repeat this calculation using the logistic activation function, given by equation Q4. Explain why the use of a ReLU is sometimes preferred to the logistic function.

$$\phi(y) = \frac{1}{1+e^{-y}}$$

Equation Q4

[10 Marks]