

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 7

LEFEL 7

EXAMINATION PERIOD
MAY 2021

CYFNOD ARHOLIADAU
MAI 2021

MODULE CODE: ACCA7026
ARTIFICIAL INTELLIGENCE

TIME: 2 HOURS

ANSWER THREE QUESTIONS OUT OF FOUR

Equipment or materials required - Scientific Calculator

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**WHEN ANSWERING QUESTIONS, YOU MUST SHOW DETAILED WORKINGS
OF ANY NUMERICAL CALCULATIONS.**

QUESTION ONE

1a) Your team leader has put you in charge of developing a feature for a tennis video game. This feature will calculate the likelihood of winning or losing against another player and tells you which outcome is more likely. You have decided to use a Naïve Bayes classifier to determine the probability of Winning or Losing and base your decision on the following attributes:

- opponent's ranking;
- opponent's fitness;
- opponent's skill and
- the first serve speed of your opponent in mph.

These values are already available and are used elsewhere in the game.

In order to demonstrate the method to your supervisor you plan to test the approach by manually calculating the probability of a win and the probability of a lose using the following test values:

- **Opponent's Fitness=Medium;**
- **Opponent's Skill=Normal;**
- **Ranking=Low**
- **Serve Speed=80.0mph**

Table 1 (overleaf) holds training data that have been gathered previously for a variety of opponents.

Using the Naïve Bayes method, determine which result – a win or a loss, is more likely given the values above and the match training in table 1 overleaf.

Note, you will need to first calculate the probable first serve speed using the Gaussian distribution, $g(x)$ where,

$$g(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad \text{equation 1,}$$

$$\text{The sample standard deviation, } \sigma^2 = \sqrt{\frac{\sum(x-\mu)^2}{n-1}} \quad \text{equation 2,}$$

μ is the mean, and n is the number of samples.

[20 Marks]

(Question one continued overleaf)

Match	1 st Serve Speed (mph)	Opponent's Fitness	Opponent's Skill	Opponent's Ranking	Win?
1	81.1	High	High	Low	No
2	85.2	High	High	High	No
3	76.2	Medium	High	Low	Yes
4	75.3	Low	High	Low	Yes
5	70.5	Low	Normal	Low	Yes
6	79.3	Low	Normal	High	No
7	72.2	Medium	Normal	High	Yes
8	90.6	High	High	Low	No
9	72.9	High	Normal	Low	Yes
10	69.8	Low	Normal	Low	Yes
11	79.4	High	Normal	High	Yes
12	71.2	Medium	High	High	Yes
13	80.3	Medium	Normal	Low	Yes
14	83.0	Medium	High	High	No

Table 1.

- 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.

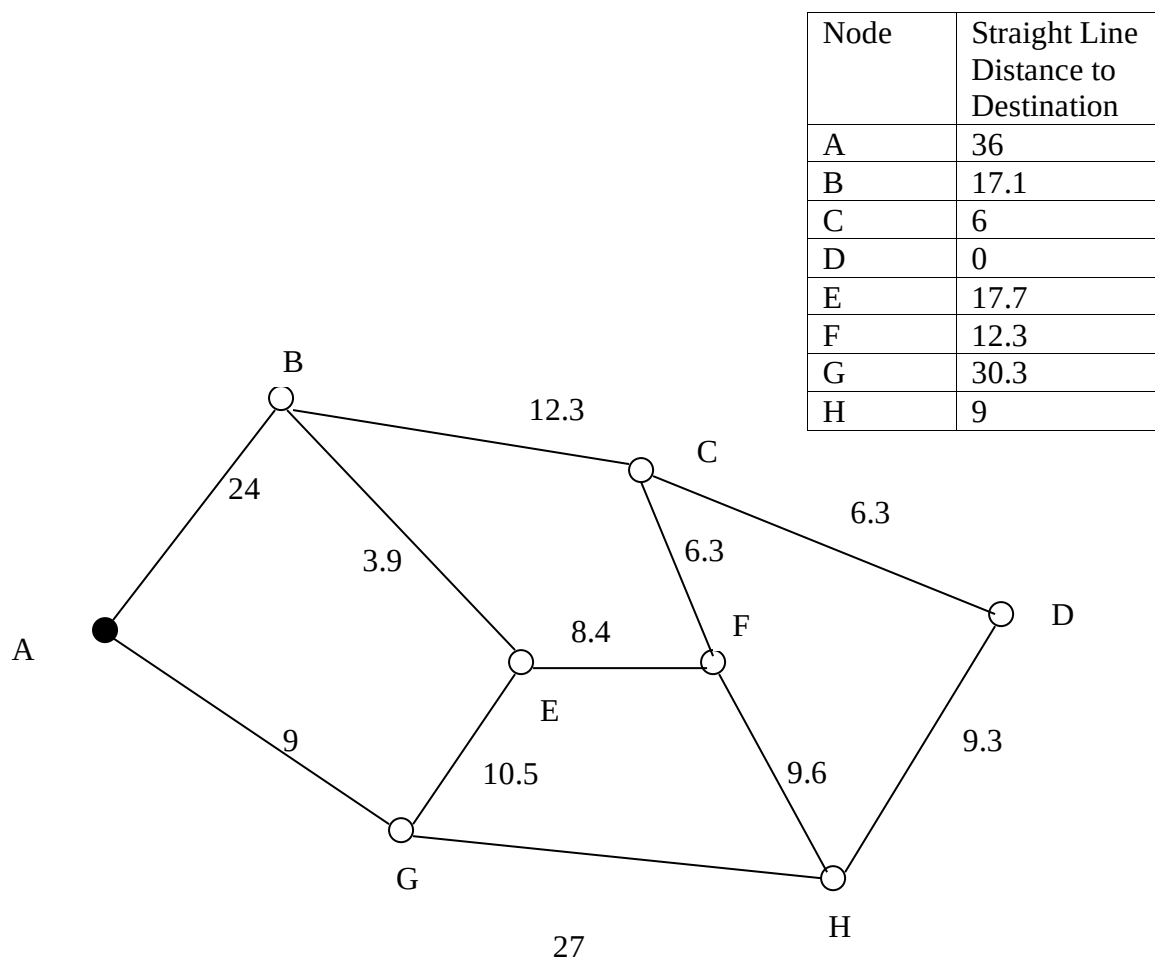
[7 Marks]

- 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) The following graph shows the travelled distance between several nodes and also includes a table showing the straight-line distance from the current node to the destination. Using this graph as an example and starting at the node labelled A with destination node D, illustrate the working of the A* algorithm, show the development of the path at each successive stage of the search.

[12 Marks]



QUESTION THREE

- 3(a) 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.

[4 Marks]

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

[5 Marks]

- 3(c) Describe the standard genetic operators of crossover and mutation as used in your pseudocode in part (a) of this question. What purpose does each of these operations serve?

[4 Marks]

- 3(d) 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**

[4 Marks]

- 3e) 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 d) of this question stating any assumptions you make.

What would be the value of the chromosome's gene alleles if the chromosome had maximum fitness? Explain your reasoning.

[8 Marks]

QUESTION FOUR

- 4a) Explain how convolution methods used in image processing are applied in edge detection. Illustrate your answer by showing how the Sobel convolution masks provided in figure 4i are used to calculate the new gradient magnitude and angle orientation of the pixel at Row2 Col2 of the input image shown in figure 4ii.

-1	0	+1
-2	0	+2
-1	0	+1
	Gx	

+1	+2	+1
0	0	0
-1	-2	-1
	Gy	

	Col1	Col2	Col3	Col4	Col5
Row1	100	150	150	30	30
Row2	150	150	30	30	15
Row3	150	30	30	15	0
Row4	30	30	15	0	0

Figure 4i

figure 4ii

[9 marks]

- 4b) Evaluate the Sobel edge detection method and suggest how this approach might be improved.

[4 marks]

- 4c) Computer Vision systems use the binary morphological operations of dilation and erosion. Describe these operations and explain what is meant by the terms “structuring element”, “fitting” and “hitting.” What effects do dilation and erosion have on an image?

[5 Marks]

- 4d) Figure 4iii shows a structuring element and two binary images. Each image has two 3 by 3 areas outlined. These are labeled A,B and C,D. Analyze the images and, for the given structuring element, indicate which areas could represent a hit, a no hit, a no fit and a fit. Explain your choices.

[7 Marks]

Structuring element : $\begin{matrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{matrix}$

Images:

Image 1

```

0 1 1 0 0 0 0 0
0 0 1 1 0 0 0 0
A → 0 1 1 1 0 0 0 0
0 1 1 1 1 1 1 0
0 0 0 1 1 1 0 0
0 0 0 1 1 1 0 0
0 0 0 1 1 1 1 0
0 0 0 0 0 1 1 1
    
```

Image 1

Image 2

```

0 1 1 0 0 0 0 0
0 0 1 1 0 0 0 0
C → 0 1 1 1 0 0 0 0
0 1 1 1 1 1 1 0
0 0 0 1 1 1 0 0
0 0 0 1 1 1 0 0
0 0 0 1 1 1 1 0
0 0 0 0 0 1 1 1
    
```

Image 2

Figure 4iii

Diwedd/End