

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD
MAI 2021

CYFNOD ARHOLIADAU
MAI 2021

MODULE CODE: ACCA6011

ADVANCED AI AND MACHINE LEARNING

TIME: 2 HOURS

ANSWER THREE OUT OF FOUR QUESTIONS

Equipment or materials required – Approved Scientific Calculator

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

QUESTION ONE

- 1a) Briefly describe the processes of fuzzification, inference, composition, and defuzzification within the context of fuzzy logic systems and explain how these tasks relate to each other.

[8 marks]

- 1b) An A.I. game bot assesses his chances of successfully traversing a danger zone occupied by zombies using the following fuzzy rules:

Rule 1

IF risk of zombie attack is high
OR damage value is high
THEN chance of success is low

Rule 2

IF risk of zombie attack is medium
AND damage value is low
THEN chance of success is medium

Rule 3

IF risk of zombie attack is low
THEN chance of success is high

His estimate of the risk of being attacked by zombies is 12 units.

The damage value refers to his own damage level value. This value is 5.5 units.

Using the above rules and the membership functions defined below, deduce the AI bot's chance of successfully cross the danger zone. Use the centroid defuzzification method in your answer.

The membership functions for the linguistic variables are as follows:

For risk of zombie attack:

$$\mu_{risk}^{Medium}(x) = \begin{cases} 0 & x \leq 10 \\ \frac{x-10}{5} & 10 < x \leq 15 \\ 1 & 15 < x \leq 25 \\ \frac{30-x}{5} & 25 < x \leq 30 \end{cases} \quad \mu_{risk}^{Low}(x) = \begin{cases} 1 & x \leq 10 \\ \frac{15-x}{5} & 10 < x \leq 15 \\ 0 & x > 15 \end{cases}$$

$$\mu_{risk}^{High}(x) = \begin{cases} 0 & x \leq 25 \\ \frac{x-25}{25} & 25 < x \leq 50 \\ 1 & x > 50 \end{cases}$$

And for Damage Value:

$$\mu_{Damage}^{Low}(x) = \begin{cases} 1 & x \leq 5 \\ \frac{7-x}{2} & 5 < x \leq 7 \\ 0 & x > 7 \end{cases} \quad \mu_{Damage}^{High}(x) = \begin{cases} 1 & x > 10 \\ \frac{x-5}{5} & 5 < x \leq 10 \\ 0 & x \leq 5 \end{cases}$$

The DOM of the output chance of success fuzzy sub-sets is given by the following membership functions:

$$\mu_{success}^{Low}(x) = \begin{cases} 1 & x \leq 0.2 \\ \frac{0.4-x}{0.2} & 0.2 < x \leq 0.4 \\ 0 & x > 0.4 \end{cases} \quad \mu_{success}^{Medium}(x) = \begin{cases} 0 & x \leq 0.2; x > 0.8 \\ \frac{x-0.2}{0.2} & 0.2 < x \leq 0.4 \\ 1 & 0.4 < x \leq 0.6 \\ \frac{0.8-x}{0.2} & 0.6 < x \leq 0.8 \end{cases}$$

$$\mu_{success}^{High}(x) = \begin{cases} 0 & x \leq 0.6 \\ \frac{x-0.6}{0.2} & 0.6 < x \leq 0.8 \\ 1 & x > 0.8 \end{cases}$$

[17 Marks]

QUESTION TWO

- 2a) The following equation is used in a Naïve Bayes classifier. Identify the various terms of the equation and explain why the denominator of this equation is usually ignored when implementing a classifier.

$$P(y|x) = \frac{P(x|y)P(y)}{\sum_{y'} P(x|y')P(y')} \quad (\text{equation Q2})$$

[5 Marks]

- 2b) Your team leader is investigating the use of AI in games development and has become interested in Bayesian methods, in particular the use of Naïve Bayes classifiers to predict wins and losses. He has put you in charge of developing a feature for a martial arts combat video game based on a Naïve Bayes classifier. This classifier will determine the probability of winning or losing given a particular opponent. Your algorithm bases its decision on the following attributes: opponent's ranking; your skill; your opponent's skill and the relative speed of the opponent. 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:

{Your Skill=Medium, Opponent's Skill=Medium, Ranking=Normal, Speed=Slow}

The following **five** tables hold training data that have been gathered previously and each table details the recorded conditional probabilities of Winning or Losing for any given attribute.

Using equation Q2, the test values above and the probabilities from the five training tables overleaf, determine which result, a win or a loss, is more likely.

[20 Marks]

Opponent's Ranking	Win = Yes	Win = No
High	3/9	4/6
Normal	6/9	2/6

Your Skill	Win = Yes	Win = No
High	2/9	3/6
Medium	4/9	1/6
Low	3/9	2/6

Opponent's Skill	Win = Yes	Win = No
Fast	2/9	2/6
Medium	4/9	3/6
Slow	3/9	1/6

Opponent's Speed	Win = Yes	Win = No
Fast	3/9	4/6
Slow	6/9	2/6

Overall Probability of Win=Yes	9/15
Overall Probability of Win=No	6/15

Q2 Probability Tables

QUESTION THREE

3a) The lookup table of Table 3a details the state transitions of a state machine.

Using the information in the table draw a labelled state diagram of this state machine. Assume state A is the initial, start-up, state.

		Event				
		1	2	3	4	5
State	A	D	B	C		
	B	C		D	A	
	C	D				C
	D		B	C	A	

Table 3a

[10 Marks]

3b) Explain the distinction between classification and regression. State, with supporting arguments, whether these tasks are supervised or unsupervised examples of machine learning.

[5 Marks]

3c) Give a pseudo-code description of a standard Genetic Algorithm and discuss the purpose of the fitness function in your algorithm.

[5 Marks]

3d) Given the following two genotypes and a cut point, illustrate the cross over genetic operator used to generate two children from the parents.

Chosen cut point

↓

Parent 1 11000 0101110 101011
 Parent 2 11001 1010011 100110

[5 Marks]

QUESTION FOUR

- 4a) With reference to the perceptron neuron shown in figure 4a below, explain how the synaptic weights w_{k1} , w_{k2} and w_{k3} enable the neuron to learn from training examples.

[6 Marks]

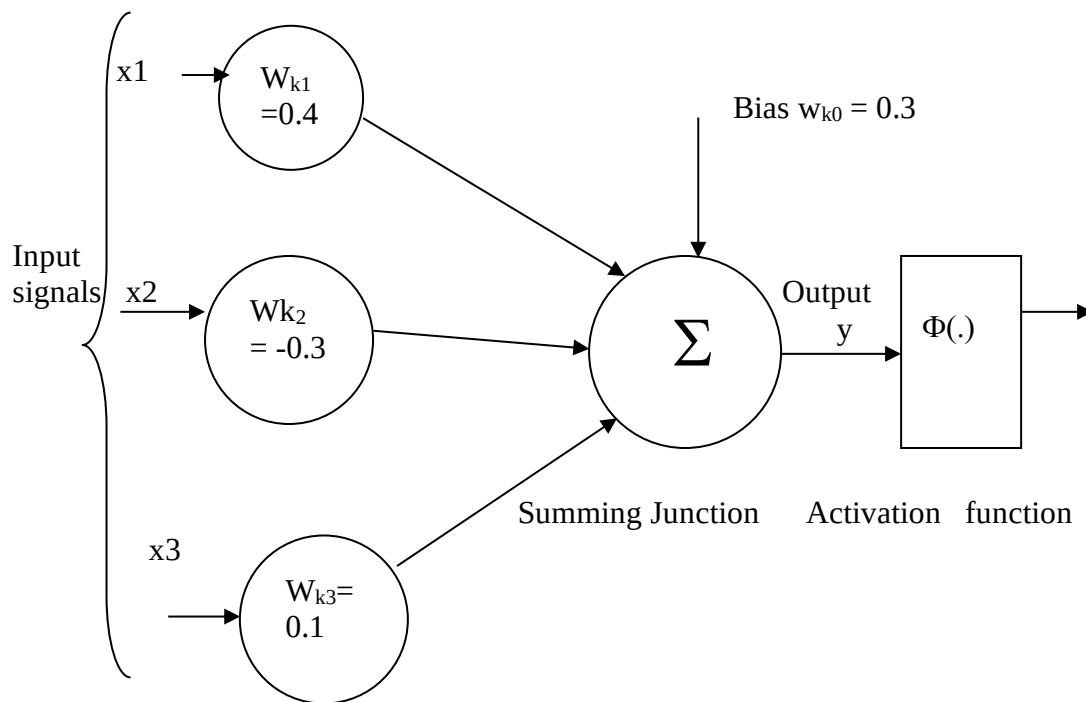


figure 4a: Rosenblatt perceptron neuron.

- 4b) Calculate the output of the activation function of the perceptron in figure 4a when $x_1=2.8$, $x_2=0.5$, $x_3=-1.2$ and the activation function is the sigmoid function of equation 4b.

$$f(x) = \frac{1}{(1 + e^{-x})} \quad \text{equation 4b)}$$

[10 Marks]

- 4c) If the sigmoid function is replaced with a ReLU activation function, calculate the output of this neuron. Assume the input values and bias used are those of Q4b) above.

[9 Marks]