



LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD

MAI 2022

CYFNOD ARHOLIADAU

MAI 2022

**MODULE CODE: ACCA6011
AI AND MACHINE LEARNING**

TIME: 2 HOURS

ANSWER THREE OUT OF FOUR QUESTIONS

Equipment or materials required – Approved Scientific Calculator

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QUESTION ONE

- 1a) A computer game is under development and you are part of the team responsible for the game's AI state machine implementation. You are responsible for designing the high-level game state machine that controls the actions of an AI shark that patrols and defends an underwater enemy base.

The Game Design team has developed the following set of draft requirements that describe the desired actions of the shark AI.

When first instantiated, the Shark will enter patrol mode, swimming around the base looking out for enemy activity. If the shark's energy level goes below 30% of its maximum, then the shark will begin foraging/hunting for food. After feeding the shark's energy levels will have been replenished and the it will return to patrolling the base.

If an enemy is spotted, either when foraging for food or when patrolling, then the shark will attack the enemy. When the shark's damage value falls below 20% of its maximum it will retreat and will only begin patrolling again when all is quiet. If the enemy retreats then the shark will return to patrolling the base perimeter.

If the shark's damage levels fall to zero at any time then it will die.

- i) Develop and draw the state transition diagram for this Shark AI Control state machine. Include appropriate states and transition events.

[12 Marks]

- ii) Given an "Attack" state exists, describe using pseudo code the actions taken when executing this state. Assume the standard Enter/Execute/Exit state machine design approach.

[7 Marks]

- 1b) Compare and contrast different methods for implementing state machines in games software.

[6 Marks]

PTO

QUESTION TWO

- 2a) Identify and briefly describe the procedures involved in the operation of a fuzzy logic expert system.

[6 marks]

- 2b) State two defuzzification techniques and indicate which method you would choose for a real time application giving arguments for your choice.

[4 Marks]

- 2c) An A.I. game bot assesses his chances of gaining entry into a guarded dungeon unseen using the following fuzzy rules:

Rule 1

IF overall attention of guards is high
OR strength of lock is high
THEN chance of success is low

Rule 2

IF overall attention of guards is medium
AND strength of lock is low
THEN chance of success is medium

Rule 3

IF overall attention of guards is low
THEN chance of success is high

His assessment of the overall attention of the guards is 12.5 units and lock strength value is 6 units.

With the above rules and the membership functions defined below, deduce the chance of success the AI bot has in successfully entering the dungeon. Use the Centroid Defuzzification method in your answer.

The membership functions for the linguistic variables are shown overleaf:

QUESTION TWO (continued)

For overall attention of guards:

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

$$\mu_{Attention}^{Low}(x) \begin{cases} = 1 & x \leq 10 \\ = \frac{15-x}{5} & 10 \leq x \leq 15 \\ = 0 & x \geq 15 \end{cases}$$

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

And for Lock Strength:

$$\mu_{Strength}^{High}(x) \begin{cases} = 1 & x \geq 10 \\ = \frac{x-5}{5} & 5 \leq x \leq 10 \\ = 0 & x \leq 5 \end{cases}$$

$$\mu_{Strength}^{Low}(x) \begin{cases} = 1 & x \leq 5 \\ = \frac{7.0-x}{2.5} & 5 \leq x \leq 7.0 \\ = 0 & x \geq 7.0 \end{cases}$$

QUESTION TWO (continued)

The Degree of Membership (DOM) of the output “Chance of Success” fuzzy sub-sets is given by the following membership functions:

$$\mu_{Chance}^{Medium}(x) \left\{ \begin{array}{ll} = 0 & x \leq 0.2, x \geq 0.8 \\ = \frac{x-0.2}{0.2} & 0.2 \leq x \leq 0.4 \\ = 1 & 0.4 \leq x \leq 0.6 \\ = \frac{0.8-x}{0.2} & 0.6 \leq x \leq 0.8 \end{array} \right.$$
$$\mu_{Chance}^{High}(x) \left\{ \begin{array}{ll} = 0 & x \leq 0.6 \\ = \frac{x-0.6}{0.2} & 0.6 \leq x \leq 0.8 \\ = 1 & x \geq 0.8 \end{array} \right.$$
$$\mu_{Chance}^{Low}(x) \left\{ \begin{array}{ll} = 1 & x \leq 0.2 \\ = \frac{0.4-x}{0.2} & 0.2 \leq x \leq 0.4 \\ = 0 & x \geq 0.4 \end{array} \right.$$

[15 Marks]

PTO

QUESTION THREE

- 3a) The following equation is used in a Naïve Bayes classifier. Explain why the denominator of this equation is usually ignored when implementing a classifier. Why is normal to work with the logarithms of the probabilities when using equation Q3?

$$P(y|x) = \frac{P(x|y)P(y)}{\sum_{y'} P(x|y')P(y')} \quad \text{(equation Q3)}$$

[7 Marks]

- 3b) 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 fencing 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=High, Opponent's Skill=Medium, Opponent's Ranking=High, Your Ranking=Normal}

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 Q3, the test values above and the probabilities from the five training tables overleaf, determine which result, a win or a loss, is more likely.

[18 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
Low	3/9	1/6

Your Ranking	Win = Yes	Win = No
High	3/9	4/6
Normal	6/9	2/6

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

Q3 Probability Tables

QUESTION FOUR

- 4a) A genetic algorithm has a fixed length chromosome (labelled, x). It is composed of 7 genes, each representing an algebraic variable a, b, c, d, e, f and g . The chromosome is represented by the string of variables, $x=abcdefg$. 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

$\downarrow \quad \downarrow$
 Parent 1: **2135723**
 Parent 2: **3558132**

[5 Marks]

- 4b) If the fitness function is given by:-
 $f(x) = (a + e) - (b + c - d) - f + g$,
 then evaluate the fitness of each of the two offspring in part a) of this question stating any assumptions you make.

[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} .

[4 Marks]

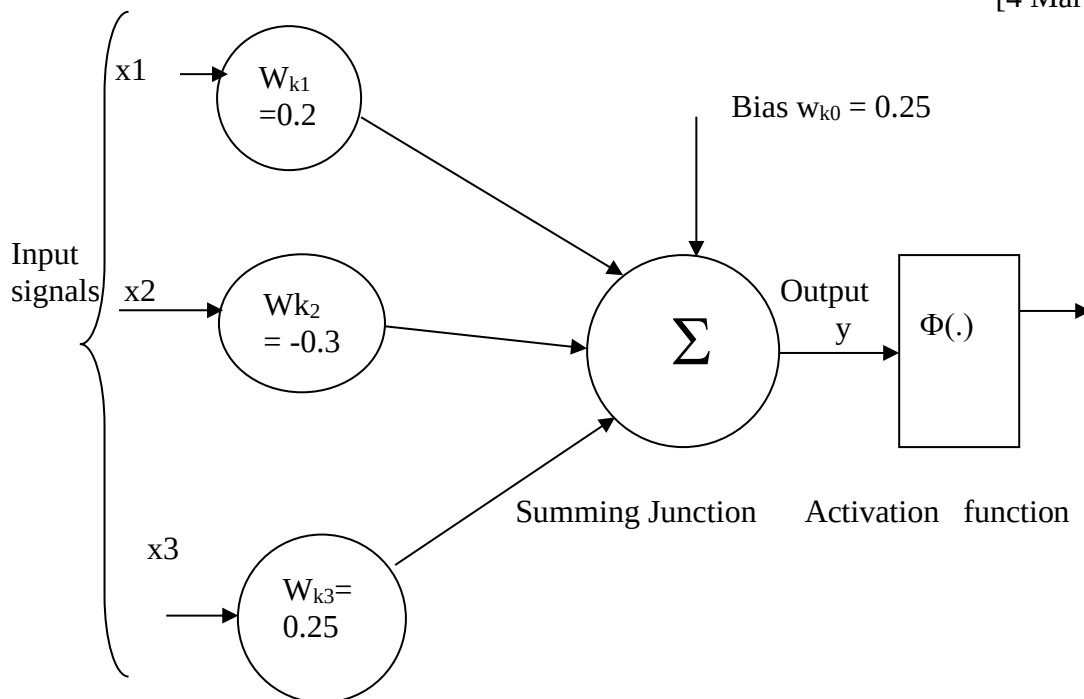


figure 4a: Rosenblatt perceptron neuron.

- 4d) Calculate the output of the activation function of the perceptron in figure 4a when $x_1 = 0.7$, $x_2 = 0.6$, $x_3 = -0.23$ and the activation function is a Rectified Linear Unit (ReLU) given by $\Phi(\max(0, y))$.

[10 Marks]

END