



LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD

JANUARY 2021

CYFNOD ARHOLIADAU

IONAWR 2021

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

TIME: 2 HOURS

ANSWER THREE OUT OF FOUR QUESTIONS

Equipment or materials required – Approved Scientific Calculator; Course Notes

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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 soldier that patrols and defends a camp.

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

When first instantiated, the soldier AI will enter patrol mode, moving around the base looking out for enemy activity. If its energy level goes below 30% of its maximum, then it will attempt to return to base. After restoring energy levels, the soldier AI will return to patrolling again.

If an enemy is spotted when patrolling, then the soldier will attack the enemy. When the soldier'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 soldier will return to patrolling the base perimeter. If the soldier's damage levels fall to zero at any time, then it will die.

- i) Develop and draw the state transition diagram for this Soldier 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]

QUESTION TWO

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

[4 marks]

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

[3 Marks]

- 2c) An A.I. game bot assesses her confidence in winning a magic contest with a Wizard by using the following fuzzy rules:

Rule 1

IF relative power is high
OR damage value is low
THEN confidence is low

Rule 2

IF relative power is medium
AND damage is high
THEN confidence is medium

Rule 3

IF relative power is low
THEN confidence is high

Here relative power is the power of the opponent based upon a comparison of her power and her opponent's power. She assesses the relative power of her opponent to be 11 units. The damage value is the damage level of her opponent. This value is 6 units.

Using these rules and the membership functions defined below, find the level confidence the AI bot has in beating her opponent. Use the Centroid Defuzzification method in your answer.

(Q2 continued overleaf).

Please Turn Over.

QUESTION TWO (continued)

The membership functions for the linguistic variables are as follows:

For Relative Power:

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

and for Damage Value:

$$\mu_{Damage}^{High}(x) = \begin{cases} = 1 & x \geq 10 \\ = \frac{x-5}{5} & 5 \leq x < 10 \\ = 0 & x < 5 \end{cases} \quad \mu_{Damage}^{Low}(x) = \begin{cases} = 1 & x < 5 \\ = \frac{7.5-x}{2.5} & 5 \leq x < 7.5 \\ = 0 & x \geq 7.5 \end{cases}$$

(Q2 continued overleaf).

Please Turn Over.

Question TWO (continued)

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

$$\mu_{Confidence}^{Medium}(x) \begin{cases} = 0 & x < 0.2, x \geq 0.8 \\ = \frac{x-0.2}{0.2} & 0.2 \leq x < 0.4 \\ = 1 & 0.4 \leq x < 0.6 \\ = \frac{0.8-x}{0.2} & 0.6 \leq x < 0.8 \end{cases}$$

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

$$\mu_{Confidence}^{Low}(x) \begin{cases} = 1 & x < 0.2 \\ = \frac{0.4-x}{0.2} & 0.2 \leq x < 0.4 \\ = 0 & x \geq 0.4 \end{cases}$$

[18 Marks]

QUESTION THREE

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

[5 Marks]

- 3b) A linear regression algorithm has been trained using a training data set and has produced the following linear model:

$$h_{\theta}(x) = \theta_0 + \theta_1 x \quad (\text{equation Q3b})$$

where $\theta_0 = 0.418$ and $\theta_1 = 0.163$.

What is the predicted output of this model if $x = 0.6$?

[6 Marks]

If the expected true value of this model is 0.38 when $x = 0.6$, calculate the residual error.

[4 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 their cut points, illustrate the cross over genetic operator used to generate two children from the parents.

Chosen cut points

↓ ↓
Parent 1 10111 0101110 101011
Parent 2 01101 0111000 011110

[5 Marks]

QUESTION FOUR

- 4a) 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]

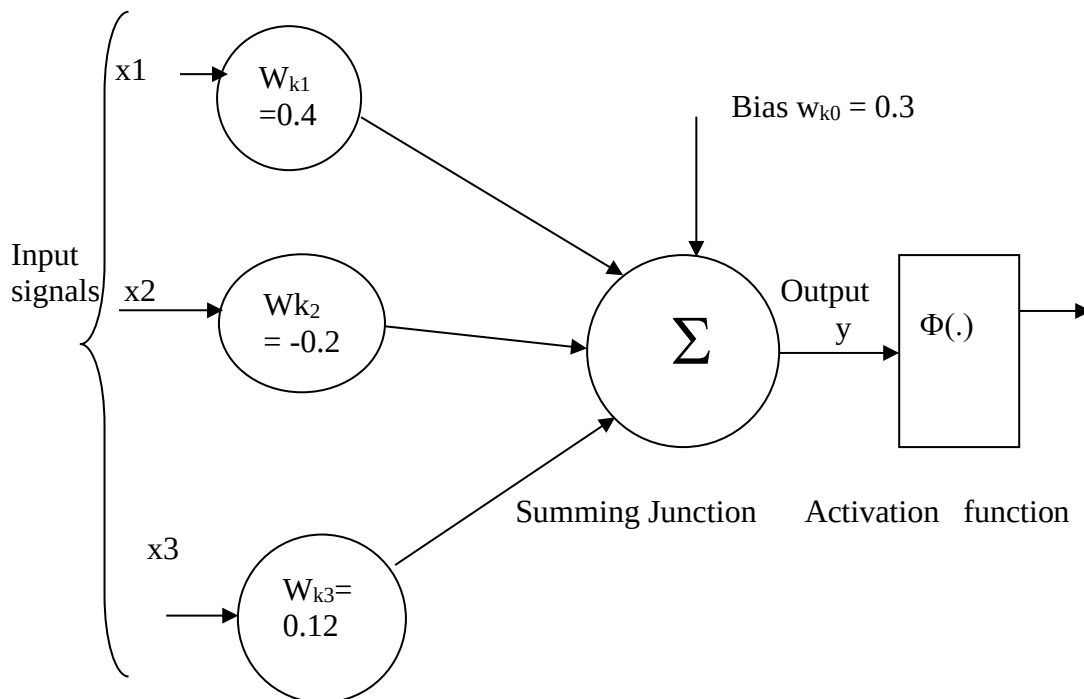


figure 4a: Rosenblatt perceptron neuron.

- 4b)
- Calculate the output of the activation function of the perceptron in figure 4a when $x_1=0.9$, $x_2=0.8$, $x_3=-0.12$ and the activation function is a Rectified Linear Unit (ReLU) given by $\Phi(\max(0, y))$.
- [10 Marks]
- If the ReLU activation function of this neuron is replaced with a sigmoid function, calculate the output of this neuron. Assume the input values and bias used are those of Q4b,i) above.
- [6 Marks]
- 4c) The ReLU activation function suffers from a problem known as the “*dying ReLUs*.” Explain what this is and how it occurs. Describe a modification to the ReLU function that will help alleviate this problem.

[5 Marks]