RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Science in Applied Science
Third Year - Semester I Examination – July/August 2023

COM3303 – ARTIFICIAL INTELLIGENCE

Time: Three (03) Hours

- This paper has four (04) questions in eighteen (18) pages.
- Answer ALL questions.
- All questions carry equal marks.
- Write your answers in English using the space provided in this question paper.
- Do not tear off any part of this question paper.
- Note that questions appear on both sides of the paper.
- If a page is not printed, please inform the supervisor immediately.
- Calculators are allowed.

Examination Index No:	

To be completed by the examiners:

	Question numbers				Total Marks
Questions	1	2	3	4	
Marks					

1.

a) Based on the capabilities, Artificial Intelligence (AI) can be divided into three categories namely, Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI). State the main capabilities of these three AI categories based on the following aspects. (06 marks)

i. Learning and adaptability

ii. Consciousness and self-awareness

b) Group the following AI applications into ANI, AGI, and ASI categories.

AI Applications: Virtual Assistants, Image and Speech Recognition, Fraud Detection, Chatbots, Creative Arts, AI solutions for climate change, AI solutions for pandemic response, Self-driving hyperloops.

Note that a hyperloop is a high-speed transportation system that use near-vacuum tubes to propel passenger pods at incredible speeds. (04 marks)

ANI	AGI	ASI

c) Self-driving cars are a perfect example of **Limited Memory Systems**. Justify this statement using the two characteristics of self-driving cars. (03 marks)

d) Mention 2 advantages and 2 disadvantages of using **AI-based News Anchors** for media. (04 marks)

Advantages	Disadvantages

Question 1. parts (e) to (g) are based on the following case study.

Case Study: AI-Based Personalized Shopping Assistant

An online fashjon retailer wants to enhance its customer experience by providing a personalized shopping assistant powered by AI. The goal is to increase customer engagement, improve satisfaction, and boost sales by offering tailored product recommendations and assistance throughout the shopping journey.

e) Specify the data to be collected as knowledge about each customer to develop this proposed AI-based personalized shopping assistant (02 marks)

f) How does this suggested shopping assistant determine the customer's interaction with the platform in operation? (02 marks)

g) For what purpose this AI-shopping assistant can use **Machine Learning** models. Write two facts. (04 marks)

2.

a) How does the learning objective differ between supervised learning and reinforcement learning? (02 marks)

b) After reading the case study below, find the agent, environment, state(s), action, and reward.

Reinforcement Learning (RL) Case: Teaching a Dog to Fetch a Ball

In this simple reinforcement learning case, it is required to train a virtual dog agent to fetch a ball in a 2D environment. The agent interacts with the environment, and through trial and error, it learns to take actions that maximize the cumulative reward it receives from the environment. The goal is to teach the dog to fetch the ball consistently using reinforcement learning techniques. (05 marks)

agent:

environment:

state (s):

action:

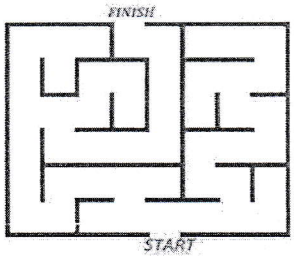
reward:

c) What is meant by **Brute Force** and **Cleverness** in AI- Applications? (02 marks)

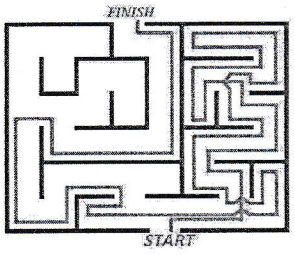
Question 2, part (d) is based on the following scenario.

"Solving a maze" refers to finding a shortest path from a given starting point to a designated destination (exit or finish) in a puzzle-like structure known as a maze. Mazes consist of passages, walls, and dead ends as shown in Figure 1. The objective is to navigate from the starting point to the exit while following a specific set of rules. Brute force and cleverness are two different approaches in AI applications when it comes to problem-solving or optimization.

Figure 1: Solving a maze.



Before finding the path from start to end.



After finding the path from start to end.

d) Briefly explain how brute force and cleverness are used in solving the maze problem to find the shortest path from start to finishing position. (04 marks)

e) A single node perceptron with sigmoid activation function classifies the data into two classes. Justify this statement using AND logic gate realization. Note that the answer should contain the truth table with inputs, output, and polarity. Take e as 2.718.

(07 marks)

f) Sketch the perceptron that realizes the AND gate of Question 2 (e). Clearly indicate the derived values for the weights and bias on the diagram. (05 marks)

3.

a) What is the goal of the **Backpropagation Algorithm** in Neural Network Training? (02 marks)

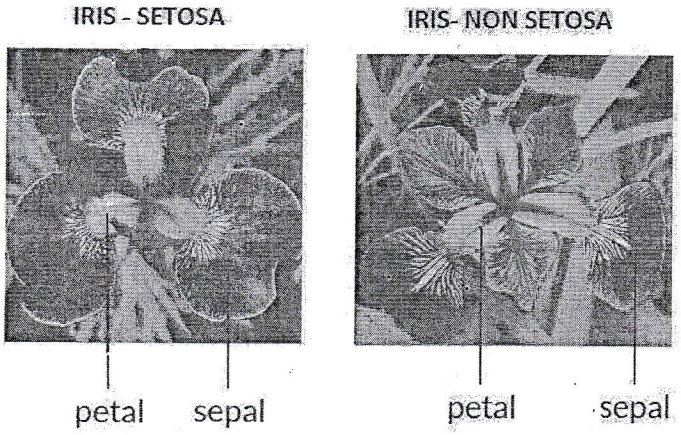
b) Explain using a diagram the effect of setting an unreasonable (too small or too high) value for the Learning Rate parameter in the backpropagation algorithm. (03 marks)

Answer the Question 3, parts (c) to (h) based on iris flower classification case study.

Case Study: Iris Flower Classification

The goal is to design a neural network that can classify iris flowers into two categories: "Setosa" and "Non-Setosa" based on their petal and sepal lengths and widths as shown in Figure 2.

Figure 2: Iris Flower types



The data set consists of 4 samples as shown in Table 1. It presents average values for floral traits (X1, X2, X3, and X4) along with the target variable (Setosa or Non-setosa) (Y) of each flower sample.

Table 1: Flower traits and target variable.

Sample Number	X1= Sepal Length (cm)	X2 = Sepal Width (cm)	X3= Petal Length (cm)	X4= Petal Width (cm)	Y= SETOSA (Target)
1	0.236	0.277	0.104	0.043	1
2	0.218	0.230	0.104	0.043	1
3	0.281	0.260	0.403	0.521	0
4	0.265	0.233	0.389	0.393	0

The proposed feed-forward neural network for iris classification consists of two layers. The fist layer consists of three nodes. The weights of the first layer of the neural network are shown in Table 2 and the bias is 0.1 for each node and each sample. Note that the ReLU is used as the first layer activation function.

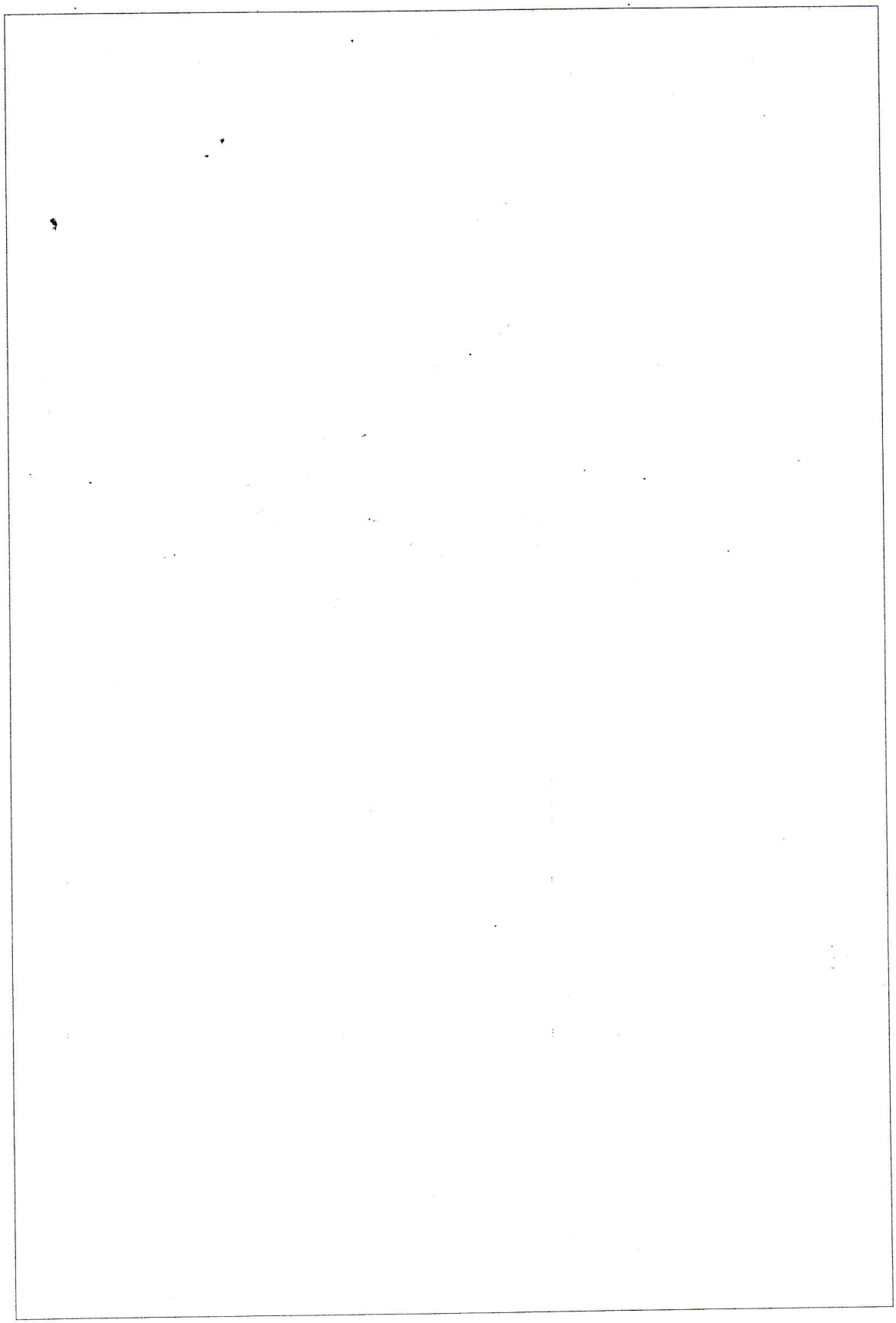
Table 2: Weights of the first layer.

Floral trait	Node 1	Node 2	Node 3
X1	0.5	1	0.5
X2	1	2	1
X3	1	2	1
X4	0.5	1	0.5

c) Write the feature matrix for the four flower samples. (02 marks)

d) Write the weight matrix for the first layer. (02 marks)

e) Compute the weighted sum using the feature matrix, weight matrix, and bias. (12 marks)



f) Compute the net output of the fist layer of the Neural Network. (02 marks)

g) What will be the net output of the first layer if the following activation function is used instead of ReLU?

$$\theta(Z) = \begin{cases} 1 \; if \; Z > 0.9 \\ 0 \; if \; Z \leq 0.9 \end{cases}$$

(01 mark)

h) Mention why it is not recommended to use sigmoid as an activation function of hidden layers in a deep learning model (01 mark)

4.

a) In a Deep Learning model, what is the purpose of the **Loss Function** and **Optimizer**? (02 marks)

Write the answers to Question 4, parts (b) and (d) based on the following case study.

Case Study: Movie Review Classifier

A movie review classifier is a neural network that is designed to analyze and categorize movie reviews based on their sentiment or polarity, determining whether a review is favorable or unfavorable. The main goal of a movie review classifier is to automatically classify and distinguish between positive and negative opinions expressed in movie reviews.

The list below (I to V) represents the first five samples of movie reviews extracted from the standard data set that used to train the classifier.

I. One of the most intense opening ever 😊
II. This is the most epic opening of a movie.
III. Best intro to any movie ever <3 <3.
IV. This opening sets the tone for the movie.
V. What a movie ….

b) When training the model, **One-hot Encoding** is used as the data preprocessing technique. Write the data dictionary for one hot coding based on the five sample movie reviews. (05 marks)

c) Write One-hot Encoded reviews for each of the sample movie reviews listed I through V. Clearly state the review sample number and the data dictionary in the answer.
(05 marks)

d) Assume that the following python script is extracted from the program designed to implement the movie review classifier. It defines the structure of the proposed model.

```
from keras import models
from keras import layers
model = models.Sequential()
model.add(layers.Dense(16, activation='relu', input_shape=(10000,)))
model.add(layers.Dense(16, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))
```

After analyzing the code snippet, sketch the proposed deep learning model to develop the movie review classifier. Clearly label the layers, activation functions, layer parameters, input, and output. Assume that the training dataset consists of 25000 reviews and is one-hot encoded with a dictionary of 10000 words. (02 marks)

Analyze the Keras training output of movie review classifier and answer the Question 4, parts (e) to (k).

In preparing the dataset, the training dataset is further divided into training and validation sets with 15000 and 10000 samples. Also, Adam and binary cross-entropy were used as optimization and objective functions, respectively. Moreover, the model was trained for 7 epochs using 512 mini-batches on the Keras platform. The training output generated by Keras is listed below.

```
Epoch 1/7
30/30 [==============================] - 6s 85ms/step - loss: 0.5220 - accur
acy: 0.7756 - val_loss: 0.3841 - val_accuracy: 0.8726
Epoch 2/7
30/30 [==============================] - 1s 35ms/step - loss: 0.3031 - accur
acy: 0.9032 - val_loss: 0.3163 - val_accuracy: 0.8771
Epoch 3/7
30/30 [==============================] - 1s 34ms/step - loss: 0.2234 - accur
acy: 0.9291 - val_loss: 0.2792 - val_accuracy: 0.8893
Epoch 4/7
30/30 [==============================] - 1s 35ms/step - loss: 0.1729 - accur
acy: 0.9459 - val_loss: 0.2767 - val_accuracy: 0.8885
Epoch 5/7
30/30 [==============================] - 1s 34ms/step - loss: 0.1412 - accur
acy: 0.9556 - val_loss: 0.3044 - val_accuracy: 0.8812
Epoch 6/7
30/30 [==============================] - 1s 34ms/step - loss: 0.1151 - accur
acy: 0.9655 - val_loss: 0.3033 - val_accuracy: 0.8850
Epoch 7/7
30/30 [==============================] - 1s 33ms/step - loss: 0.0955 - accur
acy: 0.9728 - val_loss: 0.3166 - val_accuracy: 0.8816
```

e) What does 30/30 mean in output? (02 marks)

f) How long did the system take to complete the training? (01 mark)

g) What is the purpose of using validation and training datasets when training the model? (02 marks)

h) Plot the training and validation loss curves with respect to epochs. (02 marks)

i) After analyzing the Keras output, explain the problem identified in this model.
(01 mark)

j) How can the accuracy of the test data set be determined using this model? (01 mark)

k) Briefly explain the advantage of using mini batches for training in this deep learning model.
(02 marks)

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