



**ZCAS University**

**SCHOOL OF COMPUTING, TECHNOLOGY AND APPLIED SCIENCES**

**CAS4192 MACHINE LEARNING TECHNIQUES**

**FINAL SEMESTER EXAMINATION**

**TUESDAY 28 NOVEMBER, 2023**

**08:30 - 11:30 HOURS**

**TIME ALLOWED : WRITING – THREE HOURS : READING – 5 MINUTES**

**INSTRUCTIONS:**

1. Section A: this question is **compulsory** and must be attempted.
2. Sections B: Answer **THREE (3)** questions from this section.
3. This examination paper carries a total of **100 marks**.
4. Candidates must **not turn this page** until the invigilator tells them to do so.

## **SECTION A: Question 1 is compulsory and must be attempted**

**NOTE: Your answers should NOT be brief. Give detailed essay style reasoned answers with structured paragraphs and headings.**

Product recommendations have become an integral part of modern consumer experiences. In an era where options abound, navigating through the multitude of products available can be overwhelming. Hence, the significance of tailored suggestions cannot be overstated. From personalized algorithms on e-commerce platforms to word-of-mouth recommendations, consumers rely on these pointers to make informed choices.

These recommendations are often driven by a blend of data analytics, user preferences, and behavioral patterns. Algorithms crunch vast amounts of data, examining purchase history, browsing habits, and demographic information to generate suggestions. The aim is to anticipate and fulfill consumer needs, presenting them with options that align with their tastes and requirements.

Moreover, the influence of peer recommendations remains potent. Word-of-mouth, whether through social media, reviews, or direct interactions, holds sway over consumer decisions. The human touch in these recommendations adds a layer of trust and relatability, often guiding individuals towards products they might not have considered otherwise.

Ultimately, product recommendations serve not only as a convenience but as a means to streamline choices in an increasingly saturated market. By offering tailored suggestions, they facilitate decision-making, saving time and effort while enhancing the likelihood of a satisfying purchase experience. In this digital age, where information overflow can be daunting, these recommendations act as guiding beacons, aiding consumers in navigating the seas of available products.

- a) Identify the type of machine learning algorithms you would use for the task of Product recommendations. Explain your reasoning at length. **(10 Marks)**
- b) Identify, explain and Justify the features you would extract from the Product recommendations to train the machine learning model. **(10 Marks)**
- c) Discuss how you would evaluate the performance of the machine learning model during the training phase. **(10 Marks)**
- d) Identify and evaluate ethical considerations you would need to address when using a machine learning model to recommend products. **(10 Marks)**

**[Total: 40 Marks]**

## **SECTION B: Attempt any THREE questions in this section**

### **Question 2**

Machine learning's efficacy intertwines with robust algorithms, diverse data, and intricate architectures. Algorithms span supervised and unsupervised learning, harnessing techniques from regression to reinforcement learning. Quality data, pivotal for model efficacy, demands cleanliness and relevance, amplified by quantity yet not solely reliant on volume. Architectures, notably neural networks, boast specialized structures like CNNs and RNNs tailored for specific data types. Performance hinges on metrics like accuracy, precision, and recall, while continuous enhancements via regularization, hyperparameter tuning, and ethical considerations propel the field. Deployment efficiency and scalability culminate the process, ensuring models endure real-world demands while upholding ethical standards.

- a) Explain the concepts of overfitting and underfitting in machine learning. Provide examples of scenarios where each might occur. **(6 Marks)**
- b) Compare and contrast feedforward neural networks with recurrent neural networks, highlighting their respective architectures and typical applications. **(6 Marks)**
- c) Write short notes with examples on the following aspects of machine learning: **(8 Marks)**
  - i) Hyper-parameter Tuning
  - ii) Feature Engineering
  - iii) Accuracy
  - iv) Precision

**[Total: 20 Marks]**

### **Question 3**

- a) The K-Nearest Neighbors (KNN) algorithm is a simple, instance-based learning method used for both classification and regression tasks in machine learning. Explain how the KNN algorithm makes predictions for classification and regression tasks. **(6 Marks)**
- b) The Expectation-Maximization (EM) algorithm is an iterative method used in unsupervised machine learning to estimate parameters in probabilistic models with latent or unobserved variables. Describe how the EM algorithm iteratively maximizes the likelihood function in the context of unsupervised learning and latent variable models. **(6 Marks)**
- c) Hidden Markov Models (HMMs) are statistical models used to model sequential data, particularly when dealing with temporal or sequential patterns. Describe four areas where HMMs can be used. **(8 Marks)**

**[Total: 20 Marks]**

### **Question 4**

Machine learning algorithms epitomize versatility and precision, molding the landscape of AI applications. Supervised algorithms, from linear regression to neural networks, masterfully predict outcomes and classify data. Unsupervised counterparts, like clustering and dimensionality reduction, uncover hidden patterns within vast datasets. Reinforcement learning algorithms navigate

environments, learning through trial and error to optimize decision-making. Each algorithm thrives on distinct data nuances, demanding clean, diverse datasets for optimal performance. The evolution of these algorithms is relentless, perpetually refining through ensemble methods, hyperparameter tuning, and ethical considerations to yield more accurate, fair, and impactful outcomes across industries and domains

- a) Describe the primary objective of Gradient Descent and how it operates to minimize the cost or loss function in model training. **(6 Marks)**
- b) Decision trees are predictive models used in machine learning for both classification and regression tasks. Explain how decision trees partition the feature space and make predictions or classifications. **(8 Marks)**
- c) Clustering or cluster analysis is a machine learning technique, which groups the unlabelled dataset. Describe how clustering is used to partition images into distinct regions or objects based on pixel attributes. **(6 Marks)**

**[Total: 20 Marks]**

#### **Question 5**

- a) Explain the role of Matplotlib python library in visualizing data for machine learning tasks. Provide examples of how this library can be used to create various types of plots for data exploration and model evaluation. **(6 Marks)**
- b) Describe Reinforcement Learning (RL) and outline its key components, including agents, environments, actions, rewards, and the exploration-exploitation tradeoff. **(8 Marks)**
- c) Consider a retail company aiming to forecast sales based on historical data. Describe how linear regression can be applied to predict future sales trends, including the key features (variables) that might influence the sales prediction. **(6 Marks)**

**[Total: 20 Marks]**

**END OF EXAMINATION**