



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

**UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR
FIRST SEMESTER EXAMINATIONS
FOR THE DEGREE
IN
COMPUTER SCIENCE**

COURSE CODE: BCS 472

COURSE TITLE: MACHINE LEARNING

DATE: 07/12/2022

TIME: 3:00-5:00pm

INSTRUCTIONS TO CANDIDATES

Answer **Question ONE (1)** and any other **TWO**

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 2 Printed Pages. Please Turn Over.

SECTION A: COMPULSORY QUESTION **{30 MARKS}**

QUESTION 1

- a) Explain Machine Learning, and hence Give an example of learning machines. **(3 Marks)**
- b) In the context of application of statistical tools and datasets in machine learning, explain the following. **(6 Marks)**
- i. Generalization
 - ii. Underfitting
 - iii. Overfitting
- c) Make use of a "hypothetical dataset "to explain supervised learning. **(5 Marks)**
- d) Make use of a "hypothetical dataset "to explain unsupervised learning. **(3 Marks)**
- e) In some machine learning problems, we perform regression. Explain the following within the applied context. **(8 Marks)**
- i. Best Fit Line
 - ii. Hypothesis
 - iii. Mean Squared Error
 - iv. Cost function
- f) Explain the Confusion Matrix with Respect to Machine Learning Algorithms. **(3 Marks)**
- g) Discuss any three known Applications of Supervised Machine Learning in Modern Businesses. **(3 Marks)**

SECTION B: ANSWER ANY TWO QUESTIONS {20 MARKS EACH}.

QUESTION 2

- a) Explain regression and hence describe any two types of regression that can be applied in machine learning. (10 Marks)
- b) Describe training and test sets, use a valid example. (6 Marks)
- c) With reference to question (b) above, explain “cross-validation”. (2 Marks)
- d) Describe “model selection” as applied in machine learning problems. (2 Marks)

QUESTION 3

- a) Discuss neuron networks, and hence outline the area of suitability for three common types. (4 Marks)
- b) Explain the K Mean Algorithm. (6 Marks)
- c) Explain the K Nearest Neighbor Algorithm. (4 Marks)
- d) Use any **three** distinct points to distinguish supervised learning from unsupervised learning. (6 Marks)

QUESTION 4

Kisumu county government wants to use the COVID-19 test positivity rate (i.e. the proportion of tests with a positive result) to estimate the number of COVID-19 infections in the community. In the data collected, the positivity rate is labelled with one of three levels of positivity (+, ++ and +++) and the number of people infected are categorised as **high (H)**, **medium (M)** or **low (L)**.

| | | | | | | | |
|------------|---|----|----|----|-----|----|----|
| timestep | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| infections | L | M | H | H | H | M | M |
| positivity | + | ++ | ++ | ++ | +++ | ++ | ++ |

- a) Define and estimate the components of an appropriate HMM for this application, without smoothing. (4 Marks)
- b) What assumptions are implicit with the use of an HMM? Are they appropriate in the context of this application? (4 Marks)

- c) You are in time-step 7 and you now observe the following positivity rates, but you do not know the number of infections:

| | | | |
|------------|-----|----|----|
| timestep | 8 | 9 | 10 |
| positivity | +++ | ++ | ++ |

- i. Predict the number of infections for each time-step using the Viterbi algorithm, showing the equations and calculations you make. **(8 Marks)**
- d) Briefly describe any two shortcomings of the HMM developed for predicting the number of infections. **(4 Marks)**

QUESTION 5

- a) Explain reinforcement learning **(2 Marks)**
- b) Describe four characteristics of reinforcement learning problems. **(8 Marks)**
- c) A Naïve Bayes classifier has to decide whether the document “London Paris” is news about the United Kingdom (class U) or news about Spain (class S).
- i. Estimate the probabilities that are relevant for this decision from the following document collection using maximum Likelihood estimation. (Answer with fractions) **(3 Marks)**

| | document | class |
|---|---------------|-------|
| 1 | London Paris | U |
| 2 | Madrid London | S |
| 3 | London Madrid | U |
| 4 | Madrid Paris | S |

- ii. Based on the probabilities, which class does the classifier predict? Explain your answer. Show your understanding of the Naïve Bayes classification Rule. **(4 Marks)**
- iii. Explain why the implementations of a Naïve Bayes classifier often use log probabilities. **(3 Marks)**

End of Exam