Module Code and Title: CTE309 Machine Learning
Programme: BE in Information Technology
Credit: 12
Module Tutor: Yeshi Jamtsho
Module Coordinator:

General objectives:
This module aims to familiarize students with a range of Machine Learning (ML) algorithms for constructing intelligent models. It will also provide practical experience, enabling students to apply Machine Learning effectively in addressing real-world problems. The module specifically concentrates on diverse ML techniques and their applications.

Learning Outcomes:
On completion of the module, students will be able to:

1. Differentiate the types of machine learning.
2. Apply appropriate types of machine learning.
3. Perform feature management.
4. Build and tune the machine learning models.
5. Compare the performance of Machine Learning algorithms.
6. Demonstrate a critical understanding of generative AI and machine learning applications.
7. Analyse the potential pitfalls of machine learning algorithms.

Learning and Teaching Approach:

Type	Approach	Hours per week	Total credit hours
Contact	Lecture	3	90
	Practical	3	
Independent study	Term Paper	1	30
	Mini-Project	1	
	Total		**120**

Assessment Approach:

Assessment components consist of **Continuous Assessment (CA) Theory - 35%, Continuous Assessment (CA) Practical - 35%** and **Semester-End Examination - 30%**. The CA Theory will consist of Mid-Term test (15%), Term Paper (15%) and Quiz (5%), and CA Practical will consist of Lab Work (10%), Practical Test (10%) and Mini-Project (15%). Assessments will be carried out continuously through the following assessment components:

A. Mid-term Test: (15%)

Students will take a closed book written exam of 1-hour duration covering Unit I to Unit III. The exam will be marked out of 15 marks. This will be converted to 15% while computing the total marks for the module.

B. Term Paper: (15%)

This task will enable students to do an in-depth study of machine learning techniques and approaches. The tutor will provide a list of application areas of Machine Learning in the 2nd week. Students will work in groups of three. The assessment shall be done as follows:

Conceptual Presentation (5 marks):
Students will be expected to present their ideas and plan to complete the given task in the 4th week. The group shall be assessed as follows:

1	Clarity of problems
1	Confidence
2	Methodology
1	Schedule

Progress Presentation (5 marks):
Students will present their progress in the 8th week to track their progress and provide necessary feedback and recommendations. The group shall be assessed as follows:

2	Timeliness
2	Progress
1	Presentation techniques

Term Paper Report (5 marks):
Students shall submit their full report in the 11th week, in about 1500-2000 words in the format provided by the tutor. The report shall be assessed as follows:

1	Introduction
2	Content
1	Finding and Discussion
1	Organization and references

C. Quiz: (5%)

The students will sit for one monitored closed-book quiz on VLE in a semester. The quiz will enable students to revise the contents of Units I - III. The quiz will carry 5 marks for 30 minutes. The questions will be fill-in-the-blanks, MCQ, writing output of a program, or finding errors in a given program.

D. Lab Work: (10%)

At least 5 of the laboratory classes will be considered for laboratory work assessment where student's work will be assessed by the end of each laboratory class. The criteria for assessment are as follows (10 marks):

2	Punctuality
2	Problem-solving skills
3	Debugging
3	Correctness

E. Practical Test: (10%)

The student will take 2 hours of closed book practical examination which shall be conducted in the 14th week to assess practical knowledge and skills of the individual students.

F. Mini-Project : (15%)

The student group for the Term Paper will be made to implement their findings of a term paper as their mini-project and do the demonstration in the 14th week of the semester. The student's demonstration shall be evaluated as follows (15 marks):

1	Confidence
2	Clarity
4	Implementation
4	Result analysis
4	Question and Answer

G. Semester-end Examination: (30%)

Students will take a closed book written exam of 2 hours duration covering the subject matters of the whole module. The exam will be marked out of 30 marks.

Overview of the assessment approaches and weighting

Areas of Assessment	Quantity	Weighting (%)
A. Mid-term Test	1	15
B. Term Paper	1	15
C. Quiz	1	5
D. Laboratory Work	5-10	10
E. Practical Test	1	10
F. Mini-Project	1	15
G. Semester-end examination	1	30
Total		**100**

Pre-requisites: None

Subject Matter

Unit I: Machine Learning Fundamentals

1.1 Introduction to Machine Learning (ML) including Deep Learning
1.2 Types of learning: unsupervised, supervised and reinforcement learning
1.3 ML pipeline, Importance and application of ML
1.4 Pre-processing: define, and deal with missing and categorical data
1.5 Variable: dependent and independent variable intuition

Unit II: Feature Management

2.1 Feature selection, supervised and unsupervised
2.2 Feature scaling and normalization- min-max scaling and standardization
2.3 Dimensionality reduction- PCA and LDA
2.4 Feature engineering- encoding categorical variables

Unit III: Regression

3.1 Introduction to regression and type of regression: linear and nonlinear
3.2 Regression models: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Support Vector for Regression (SVR), Decision Tree Regression, and Random Forest Regression
3.3 Evaluating regression model performance: RMSE, R-squared and Adjusted R-squared

Unit IV: Classification

4.1 Overview of classification and type of classification models: Linear and nonlinear
4.2 Classification models: Logistic Regression, K-Nearest Neighbours (K-NN), Support Vector Machine (SVM), Kernel SVM, Naive Bayes, Decision Tree Classification, Random Forest Classification
4.3 Evaluating performance, parameters setting, fine tuning: Cross Validation - Training and Test, True positive and False-negative, confusion matrix, CAP analysis

Unit V: Deep Neural Networks

5.1 Intuition: Neural Network and Deep learning.
5.2 Layers: input, hidden, and output layers.
5.3 Activation functions, loss functions, and optimizers.
5.4 Artificial neural network, Convolutional Neural Network, and Recurrent Neural Network.
5.5 Generative AI – fundamentals, prompt engineering, and Generative Adversarial Network (GAN).

Practical List

1. Install and configure an Integrated Development Environment (IDE).
2. Explore and implement library functions.
3. Perform feature selection
4. Perform feature engineering
5. Perform prediction using regression model(s).
6. Solve Classification problems using classification model(s).
7. Implement a simple neural network without using library functions for classification problems
8. Implement neural network(s) using library functions for classification problems.
9. Implement basic applications using Generative AI.

Reading Lists:

Essential Reading:

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2017). *An Introduction to Statistical Learning*. Springer.

Chollet, F. (2018). *Deep Learning with Python*. New York: Manning Publications Co.

Han, J., Kamber, M., & Pei, J. (2012). *Data Mining*. Morgan Kaufmann Publishers.

Additional Reading:

Sen, S., Datta, L., & Mitra, S. (2019). *Machine Learning and IoT*. Taylor & Francis Group, LLC.

Date: February 2024.