2023
TP-153

# Course Specification
## (Bachelor)

| | |
|---|---|
| **Course Title:** | **Machine Learning** |
| **Course Code:** | **CSC1403** |
| **Program:** | Bachelor in Computer Science |
| **Department:** | **Computer Science** |
| **College:** | **Computers and Information Technology** |
| **Institution:** | **University of Tabuk** |
| **Version:** | **1.0** |
| **Last Revision Date:** | **27 July 2022** |

## Table of Contents

## A. General information about the course:

### 1. Course Identification

| 1. Credit hours: ( 2 ) | | | | | |
|---|---|---|---|---|---|
| 2. Course type | | | | | |
| A. | ☐ University | ☐ College | ☒ Department | ☐ Track | ☐ Others |
| B. | ☒ Required | | ☐ Elective | | |
| 3. Level/year at which this course is offered: ( Level 8/Year 4) | | | | | |
| 4. Course general Description: | | | | | |
| This course provides fundamental concepts and an understanding of machine learning, covering theoretical foundations and essential algorithms for both supervised and unsupervised learning. The practical component focuses on applying machine learning to real-world examples. The main topics covered include linear and non-linear regression, logistic regression, k-NN, dimensionality reduction, PCA, support vector machines, decision trees, clustering, and neural networks. | | | | | |
| 5. Pre-requirements for this course (if any): | | | | | |
| Math1205: Linear Algebra<br>CSC1401: Artificial Intelligence. | | | | | |
| 6. Co-requisites for this course (if any): | | | | | |
| None | | | | | |
| 7. Course Main Objective(s): | | | | | |
| Upon completion of this course, students will be able to:<br>● Define the fundamental problems of machine learning.<br>● Provide an understanding of techniques, mathematical concepts, and algorithms used in machine learning to facilitate further study in this area.<br>● Provide an understanding of the limitations of various machine learning algorithms and the way | | | | | |

to evaluate performance of machine learning algorithms.

- Read the state-of-art literature in this domain, and build a project based on the state-of-art literature.
- Apply machine learning algorithm to real-world problem, optimize the models and report the expected accuracy of different models using state-of-art tools such as sikit-learn, PyTorch and etc.

## 2. Teaching mode (mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | 30 | 100% |
| 2 | E-learning | | |
| 3 | Hybrid<br>● Traditional classroom<br>● E-learning | | |
| 4 | Distance learning | | |

## 3. Contact Hours (based on the academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1. | **Lectures** | 30 |
| 2. | **Laboratory/Studio** | |
| 3. | **Field** | |
| 4. | **Tutorial** | |
| 5. | **Others (specify)** | |
| **Total** | | 30 |

## B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| **1.0** | **Knowledge and understanding** | | | |
| 1.1 | Define terminologies, concepts, techniques, functions, and algorithms used in machine learning. | K1, and K4 | Lectures | Midterm exams<br>Final exam<br>Assignments |
| 1.2 | Recognize the principles, advantages, limitations, and possible applications of machine learning Algorithms. | K2 | Lectures | Midterm exams<br>Final exam<br>Assignments<br>Projects |
| 1.3 | Demonstrate familiarity with a set of well-known supervised, unsupervised and semi-supervised learning algorithms. | K3 | Lectures | Midterm exams<br>Final exam<br>Assignments |
| **2.0** | **Skills** | | | |
| 2.1 | Apply machine learning concepts in real-life problems. | S1 | Lectures<br>Case study | Assignments<br>Project |
| 2.2 | Build ML algorithms for solving real problems, code them with popular programming languages, and test them with benchmark datasets. | S3 and S4 | Lectures<br>Case study | Assignments<br>Project |
| 2.3 | Analyze and evaluate a learned model in practice. | S4 | Lectures<br>Case study | Assignments<br>Project |
| **3.0** | **Values, autonomy, and responsibility** | | | |
| 3.1 | Demonstrate to communicate and work (effectively and professionally) individually and in groups/teamwork to | V2 | Lectures<br>Group Discussion<br>Case study | Project |

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | accomplish the assigned tasks. | | | |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1. | **Introduction to Machine Learning:** Overview of machine learning: Definition, key concepts, and applications. Types of machine learning problems: Classification, regression, and clustering. | 2 |
| 2. | **Introduction to Python:** Syntax, data types, control flow, and functions. Working with libraries for machine learning: NumPy, Pandas, and Matplotlib. | 2 |
| 3. | **Learning Concepts:** Training, Validation, Test Sets, Overfitting, Underfitting, | 2 |
| 4. | **Linear Regression:** Basics of linear regression-Hypothesis function Cost function- Gradient descent. | 2 |
| 5. | **Logistic Regression:** Logistic regression for binary classification. Logistic function- Maximum likelihood estimation- Handling categorical variables- model evaluation techniques. | 2 |
| 6. | Midterm 1. Introduction to Bayesian Classifiers & Naïve Bayes: Assumptions and applications. | 2 |
| 7. | **Naïve Bayes:** Probability concepts, Bayes theorem, priors, posteriors, Naive Bayes classifier, Applications in text classification | 2 |
| 8. | **Support Vector Machines** Maximal margin classifier intuition, Mathematical optimization with SVMs, Kernels - polynomial, RBF, SVM implementation in Python | 2 |
| 9. | **Perceptron and Neural Networks:** perceptron model, Neural networks components, backpropagation, Activation functions, and loss metrics. | 2 |
| 10. | **Decision Trees:** Decision tree intuition, Entropy, information gain, pruning, Random forests, bagging, boosting, Implementation in sklearn | 2 |
| 11. | **Ensemble Methods:** Ensemble learning approaches, boosting algorithms like AdaBoost, Model stacking, and Voting classifiers | 2 |
| 12. | Clustering: K-means clustering, Agglomerative hierarchical clustering DBSCAN. | 2 |
| 13. | **Midterm 2.** Introduction to Dimensionality Reduction: Benefits of dimensionality reduction, feature selection, and feature extraction | 2 |
| 14. | **Principle component analysis (PCA):** Applications of PCA, PCA for dimensionality reduction, Mathematics of PCA, Implementing PCA in Python with scikit-learn. | 2 |
| 15. | **Introduction to deep learning:** Understanding the fundamental concepts and principles behind deep learning algorithms, and convolutional neural networks | 2 |
| **Total** | | **30** |

## D. Students Assessment Activities

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| **1.** | Assignments | 3, 7, 12 | 15% |
| **2.** | Individual/ group Project | 8 | 15% |
| **3.** | Midterm exam 1 | 6 | 15% |
| **4.** | Midterm exam 2 | 12 | 15% |
| **5.** | Final exam | 16 | 40% |

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

## E. Learning Resources and Facilities

### 1. References and Learning Resources

| | |
|---|---|
| **Essential References** | 1- C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006,<br>ISBN:978-0387310732<br>2- Tom Mitchell, Machine Learning, McGraw-Hill Science/Engineering/Math,1st Ed, 1997, ISBN:978-0070428072 |
| **Supportive References** | Sebastian Raschka, Machine Learning with PyTorch and Scikit-Learn : Develop machine learning and deep learning models with Python,2022 |
| **Electronic Materials** | |
| **Other Learning Materials** | |

### 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| **facilities**<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | Classroom |
| **Technology equipment**<br>(projector, smart board, software) | Whiteboard, data show projector, computer, and internet connection. |

| Items | Resources |
|---|---|
| **Other equipment**<br>(depending on the nature of the specialty) | |

## F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of Teaching | Faculty, Program Leaders, and Advisory Board | Both Direct and Indirect |
| | Students | Indirect |
| Effectiveness of Students Assessment | Faculty, Program Leaders, Advisory Board, and Independent Opinion | Both Direct and Indirect |
| Quality of Learning Resources | Faculty, Students, and Advisory Board | Indirect |
| The Extent to which CLOs have been Achieved | Faculty, Program Leaders, Advisory Board, and Independent Opinion | Direct (as in section B) and Indirect/Surveys |
| | Students | Indirect |
| Other | - | - |

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

## G. Specification Approval

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|---|---|
| **COUNCIL /COMMITTEE** | |
| **REFERENCE NO.** | |
| **DATE** | **26/10/2023** |