

# SDSC3006: FUNDAMENTALS OF MACHINE LEARNING I

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## Effective Term

Semester A 2023/24

## Part I Course Overview

### Course Title

Fundamentals of Machine Learning I

### Subject Code

SDSC - School of Data Science

### Course Number

3006

### Academic Unit

School of Data Science (DS)

### College/School

School of Data Science (DS)

### Course Duration

One Semester

### Credit Units

3

### Level

B1, B2, B3, B4 - Bachelor's Degree

### Medium of Instruction

English

### Medium of Assessment

English

### Prerequisites

MA1503 Linear Algebra with Applications or MA2503 Linear Algebra and MA2506 Probability and Statistics or MA2510 Probability and Statistics

### Precursors

Nil

### Equivalent Courses

Nil

### Exclusive Courses

Nil

## Part II Course Details

### Abstract

This introduction course provides students with an extensive exposure to the fundamental elements of machine learning. This course will cover the classic statistical learning and the modern machine learning methods, with the focus on supervised learning. Topics cover the elementary concepts and general principles, classification, regularization, linear model, model selection, neural network models.

### Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain clearly fundamental principles and methods of machine learning	20	x		
2	Classify various learning tasks and select appropriate machine learning methods	20	x	x	
3	Apply machine learning techniques and algorithms to datasets and assess the performance by error analysis	30	x	x	x
4	Solve practical problems using machine learning methods	30	x	x	x

#### A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

#### A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

#### A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

### Teaching and Learning Activities (TLAs)

TLAs		Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Formal lectures	1, 2, 3, 4	2 hours/week
2	Laboratory work	Applying machine learning algorithms to datasets and understanding results	2, 3	1 hour/week

**Assessment Tasks / Activities (ATs)**

ATs		CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Homework assignments	3, 4	30	These are skills based assessment to enable students to demonstrate the basic concepts, methods and algorithms of machine learning, and applications of learning algorithms in some applications.
2	Project	1, 2, 3, 4	20	The assignment provides students chances to demonstrate their achievements on machine learning methods learned in this course.

**Continuous Assessment (%)**

50

**Examination (%)**

50

**Examination Duration (Hours)**

2

**Additional Information for ATs**

Note: To pass the course, apart from obtaining a minimum of 40% in the overall mark, a student must also obtain a minimum mark of 30% in both continuous assessment and examination components.

**Assessment Rubrics (AR)****Assessment Task**

Homework assignments

**Criterion**

Ability to learn the basic concepts and apply methods and algorithms of machine learning.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

### Assessment Task

Project

### Criterion

Ability to apply methods and algorithms of machine learning to solve practical problems and present results.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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### Assessment Task

Examination

### Criterion

Ability to solve learning tasks using machine learning methods.

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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## Part III Other Information

### Keyword Syllabus

Review of linear regression

Fundamental concepts of machine learning: supervised/unsupervised learning; function approximation; bias-variance trade-off; training/testing errors; cross validation

Classical classification: k-NN; LDA and QDA; Logistic regression; Naive Bayesian classifier

Parametric and nonparametric regression: local polynomial regression, cubic spline, regression spline

Regularization forms: ridge regression; Lasso regression

Support vector machine: maximal margin; separating hyperplane; soft margin

Trees and ensemble methods: CART; random forest; Bagging; Boosting

Unsupervised learning: K-means; hierarchical clustering

## Reading List

### Compulsory Readings

Title	
1	Lecture slides and other related material
2	An Introduction to Statistical Learning, by James, Witten, Hastie, Tibshirani, Springer 2013

### Additional Readings

Title	
1	Pattern Recognition and Machine Learning, by Christopher M. Bishop. Springer, 2006
2	The “Machine Learning” course of Andrew Ng at the website: <a href="https://www.coursera.org/learn/machine-learning">https://www.coursera.org/learn/machine-learning</a>
3	Tom Mitchell. “Machine Learning” . McGraw-Hill, 1997
4	Learning Theory: An Approximation Theory Viewpoint, by Cucker and Zhou, Cambridge University Press, 2007.