SDSC4016: FUNDAMENTALS OF MACHINE LEARNING II

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Fundamentals of Machine Learning II

Subject Code
SDSC - School of Data Science
Course Number
4016

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
SDSC3006 Fundamentals of Machine Learning I

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This elective course provides students who have the basic foundations of machine learning with an intensive studies of advanced machine learning and deep learning techniques for data science. Topics include traditional machine learning models, deep learning techniques and other related methods.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Articulate Fundamental Concepts: Clearly articulate fundamental principles, ideas, theories, and methods utilized in machine learning and deep learning, illustrating understanding through specific examples.	20	x		
2	Analyze Models: Critically analyze and compare various machine learning and deep learning models, highlighting their strengths and limitations in different scenarios.	20	x		
3	Implement Methods: Implement common machine learning and deep learning algorithms to analyze and interpret datasets effectively.	40	x	x	x
4	Design Solutions: Develop and evaluate novel algorithms to address practical problems, demonstrating creativity and advanced problem-solving skills in machine learning and deep learning.	20	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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Engage in lectures that combine direct teaching with interactive demonstrations, where students are encouraged to participate actively and reflect on the content in real-time.	1, 2, 3, 4	39 hours in total

2	Mini-project	Address a real-world machine learning problem by developing a solution, documenting the process in a detailed report, and synthesizing findings in a structured presentation. This project is student-led under the structural guidance of the instructor to foster independence and applied learning.	1, 2, 3, 4	After class
3	Take-home assignments	Complete take-home assignments that consist of interactive problem-solving and hands-on computer exercises. These assignments provide instant feedback to enhance learning and application of theoretical knowledge.	2, 3, 4	after class

Assessment Tasks / Activities (ATs)

	ATs	**CILO No.**	**Weighting (%)**	**Remarks (e.g. Parameter for GenAI use)**
1	Test Design tests to assess comprehension and application of fundamental theories in machine learning and deep learning, as well as the practical implementation of these theories in dataset analysis.	1, 2, 3, 4	30	
2	Mini-Project Facilitate mini-projects that encourage students to apply learned concepts to solve complex problems, demonstrating their ability to achieve the intended learning outcomes practically and creatively.	1, 2, 3, 4	25	

3	Mini-Project Presentation Conduct presentations where students showcase their project work, emphasizing their mastery of the subject matter and their ability to communicate complex ideas effectively.	1, 2, 3, 4	25	

Continuous Assessment (%)

80

Examination (%)

20

Additional Information for ATs

(open-book taken-home programming exam)

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

Test

Criterion

Ability to understand and apply the fundamental theory of machine learning and deep 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

Mini-Project Report

Criterion

Ability to demonstrate the understanding of the basic concepts, fundamental theory, deep learning methods, and their applications to some datasets.

Excellent (A+, A, A-)

High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal level

Assessment Task
Mini-Project Presentation

Criterion
Ability to demonstrate how well the intended learning outcomes are achieved.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal level

Assessment Task
Examination

Criterion
Ability to use Python to implement appropriate machine learning methods on given datasets and make accurate predictions.

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

Part III Other Information

Keyword Syllabus

Traditional machine learning, including Supervised Learning like SVM, regularizations, matrix factorization, tree; Unsupervised Learning like clustering, PCA, factor analysis; Semi-supervised Learning; Reinforcement learning.

Deep Learning, including feed-forward neural networks, convolutional neural networks, recurrent neural networks, autoencoders, generative adversarial networks, self-attention, transformer, deep RL, graph neural networks.

Reading List

Compulsory Readings

	Title
1	Lecture slides and other related material

Additional Readings

	Title
1	An Introduction to Statistical Learning, by James, Witten, Hastie, Tibshirani, Springer 2013
2	The Elements of Statistical Learning, by Hastie, Tibshirani, Friedman, Springer 2001
3	Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2012). Foundations of machine learning (Adaptive computation and machine learning). Cambridge, MA: MIT Press.
4	Tom Mitchell. “Machine Learning”. McGraw-Hill, 1997.and http://www.cs.cmu.edu/~tom/NewChapters.html
5	Learning Theory: An Approximation Theory Viewpoint, by Cucker and Zhou, Cambridge University Press, 2007.