CS6487: TOPICS IN MACHINE LEARNING

Effective Term
Semester B 2025/26

Part I Course Overview

Course Title
Topics in Machine Learning

Subject Code
CS - Computer Science
Course Number
6487

Academic Unit
Computer Science (CS)

College/School
College of Computing (CC)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
CS5487 Machine Learning: Principles and Practice or
CS5489 Machine Learning: Algorithms and Applications or
CS5491 Artificial Intelligence

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course examines advanced concepts and recent developments in machine learning. The course will consist of a mix of lectures, to introduce advanced concepts, and student-led seminars, for discussing recent developments. At the end of the course, students will have working knowledge of as well as practical experience in advanced machine learning. This is a topics course and the course syllabus will be adjusted to fit the interests of the students.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe advanced machine learning algorithms and how they are derived.			x	
2	Apply advanced machine learning algorithms to solve real-world problems.				x
3	Analyze and evaluate the effectiveness of advanced machine learning algorithms, and assess their relative merits.			x	
4	Design new advanced machine learning algorithms to address algorithmic shortcomings and solve particular problems.				x
5	Document and report the derivation and evaluation of advanced machine learning through a written report and oral presentation.				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	In the first 10 weeks of the course, students will engage in lectures about selected advanced machine learning algorithms, and the intuition and theory behind them.	1	2 hours
2	Seminar	In the last 3 weeks students will present their topics of interest in the form of a seminar.	1, 5	2 hours

3	Tutorial	Each week, students will work on problems during the tutorial sessions to gain better understanding of the lecture material.	1	1 hour
4	Midterm		2, 3	
5	Course Project	Students will review/ survey literature on advanced machine learning. Students will report their results in a course report.	2, 3, 4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Midterm	2, 3	20	-	Yes
2	Student-led seminar	1, 5	20	-	Yes
3	Course Project	2, 3, 4, 5	30	For a student to pass the course, at least 30% of the maximum mark for the examination AND course project must be obtained.	Yes

Continuous Assessment (%)

70

Examination (%)

30

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination AND course project must be obtained.

Assessment Rubrics (AR)

Assessment Task

Student-led Seminar (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1.1 ABILITY to APPLY machine learning to small problems and INTERPRET the results.
1.2 ABILITY to COMPARE the accuracy and efficiency of machine learning algorithms.

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
Midterm (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
2.1 ABILITY to EXPLAIN machine learning algorithms, and INTERPRET results from machine learning algorithms.
2.2 ABILITY to EVALUATE, COMPARE, and CONTRAST different machine learning approaches.

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
Course Project and Presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
3.1 ABILITY to APPLY machine learning to real-world problems and INTERPRET the results.
3.2 ABILITY to EVALUATE, COMPARE, and CONTRAST different machine learning algorithms.
3.3 ABILITY to REPORT about machine learning experiments.

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
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
4.1 ABILITY to EXPLAIN machine learning algorithms, and INTERPRET results from machine learning algorithms.
4.2 ABILITY to EVALUATE, COMPARE, and CONTRAST different machine learning approaches.
4.3 ABILITY to DESIGN and DERIVE new machine learning algorithms.

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
Student-led Seminar (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
1.1 ABILITY to APPLY machine learning to small problems and INTERPRET the results.
1.2 ABILITY to COMPARE the accuracy and efficiency of machine learning algorithms.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate to Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Midterm (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

2.1 ABILITY to EXPLAIN machine learning algorithms, and INTERPRET results from machine learning algorithms.
2.2 ABILITY to EVALUATE, COMPARE, and CONTRAST different machine learning approaches.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate to Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Course Project and Presentation (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

3.1 ABILITY to APPLY machine learning to real-world problems and INTERPRET the results.
3.2 ABILITY to EVALUATE, COMPARE, and CONTRAST different machine learning algorithms.
3.3 ABILITY to REPORT about machine learning experiments.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate to Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

4.1 ABILITY to EXPLAIN machine learning algorithms, and INTERPRET results from machine learning algorithms.
4.2 ABILITY to EVALUATE, COMPARE, and CONTRAST different machine learning approaches.
4.3 ABILITY to DESIGN and DERIVE new machine learning algorithms.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate to Basic

Failure

(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Topics will be adjusted according to student interests. Possible topics will include:

- Deep Neural Network
  - Backpropagation, stochastic gradient descent
  - Architecture design
  - Backpropagation, stochastic gradient descent
  - Problems with deep learning
  - Tensor optimization
- Theoretical Deep Learning
  - Empirical risk minimization
  - Generalization bound
  - Matrix sensing
- Synergies between Optimization and Deep Learning
  - Multi-objective deep learning
  - Neural Combinatorial Optimization
  - Automated algorithm design

Reading List

Additional Readings

	Title
1	C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2	T. Hastie, R. Tibshirani, and J. Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd Ed.)", Springer-Verlag, 2009.
3	J. Pearl, "Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference (Representation and Reasoning)", Morgan Kaufmann Pub, 1998.
4	I. Goodfellow, Y. Bengio and A. Courville "Deep Learning", MIT Press 2016.
5	Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012
6	Koller and Friedman, "Probabilistic Graphical Models: Principles and Techniques", The MIT Press, 2009