



Optimization for Machine Learning

Offered in 114-2

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Serial Number

35160



Course Number

IE5061



Course Identifier

546 U0690



No Class



3 Credits



Elective

GRADUATE INSTITUTE OF INDUSTRIAL ENGINEERING



Kevin Dowhon HUANG



Fri 2, 3, 4



國青101



Type 2



30 Student Quota

NTU 30



No Specialization Program

🇬🇧 English

↔ NTU COOL

↔ Core Capabilities and Curriculum Planning

📖 Notes

The course is conducted in English ◦

↗ NTU Enrollment Status

Enrolled	Remaining	Registered
16 / 30	14	0

📄 Course Description

Machine learning is a fast-growing field and plays a central role in the era of AI and big data with many applications in prediction and data analysis. In particular, optimization formulations and algorithms are key to analysis and design of efficient methods in machine learning problems. This course will focus on the optimization models arising from various machine learning problems and introduce efficient algorithms for solving these models. The course will cover basic convex analysis, model formulation, and fundamental (stochastic) first-order methods, supplemented with recent developments in the related literature.

🕒 Course Objective

The students are expected to achieve the following after taking this course:

1. Students will be able to identify the underlying optimization model in different machine learning problems.
2. Students will be able to identify different structures and properties of optimization models in machine learning problems, and how to choose appropriate algorithms based on the problem structure.
3. Students will be able to construct analysis for basic optimization algorithms such as gradient descent, stochastic gradient descent. In addition, students will be able to understand and follow the logic in the analysis for more complicated algorithms.
4. Students will be able to read scientific paper in the related field on their own and summarize the findings and their own understanding, and verify the results in the paper if necessary.

Course Requirement

Linear Algebra

Multivariate Calculus

Probability and basic statistics knowledge.

Basic knowledge for optimization

Basic knowledge for machine learning (not required but recommended)

 Expected weekly study hours before and/or after class

 Office Hour

 Designated Reading

References

1. "Optimization for Machine Learning" (Neural Information Processing series) edited by Suvrit Sra, Sebastian Nowozin, Stephen Wright et al., MIT Press 2012
2. "First-order and Stochastic Optimization Methods for Machine Learning" by Guanghui Lan, Springer 2019
3. "Lectures on Convex Optimization" by Yurii Nesterov, 2018.
4. "Convex Optimization: Algorithms and Complexity" by Sebastien Bubeck. 2015.

Grading

1. NTU has not set an upper limit on the percentage of A+ grades.
2. NTU uses a letter grade system for assessment. The grade percentage ranges and the single-subject grade conversion table in the NATIONAL TAIWAN UNIVERSITY Regulations Governing Academic Grading are for reference only. Instructors may adjust the percentage ranges according to the grade definitions. For more information, see [the Assessment for Learning Section](#) °

Adjustment methods for students

Make-up Class Information

Course Schedule

2/27 Week 1	No Class (National Holiday)
3/6 Week 2	Introduction to this course, Concepts Review, Preparations
3/13 Week 3	Optimization models for machine learning (regression, classification, dimension reduction)
3/20 Week 4	Optimization models for machine learning (recommender system, neural network)
3/27 Week 5	Basic theory for optimization (convex optimization and analysis, optimality conditions)
4/3 Week 6	No Class (National Holiday)
4/10 Week 7	Basic theory for optimization (conjugate, subdifferentials, duality)
4/17 Week 8	Midterm Exam
4/24 Week 9	Optimization methods (Gradient method, proximal gradient methods, conditional gradient methods)
5/1 Week 10	No Class (National Holiday)
5/8 Week 11	Optimization methods (Accelerated gradient methods)

5/15 Optimization methods (Subgradient methods)

Week 12

5/22 Optimization methods (Stochastic gradient method, stochastic
Week 13 subgradient method)

5/29 Optimization methods (Stochastic gradient method, stochastic
Week 14 subgradient method)

6/5 Optimization methods (ADMM methods, primal-dual methods)
Week 15

6/12 Final Exam
Week 16

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NTU Course

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