

**Optimization for Machine Learning 50.579**  
**TTh 2:00-4:00 PM Think Tank 12**  
**Website: <https://edimension.sutd.edu.sg/>**

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**Instructor:** Ioannis Panageas, Office: 1.602.19, Email: [ioannis@sutd.edu.sg](mailto:ioannis@sutd.edu.sg)

**Office Hours:** By appointment.

**Textbook:** Convex Optimization: Algorithms and Complexity by S. Bubeck (online).

**Recommended:** Understanding Machine Learning: From Theory to Algorithms by Shai Shalev Shwartz and Shai Ben-David (online).

**Remark:** Some lectures (e.g., non-convex optimization) are not part of these books.

**Prerequisites:** Introductory undergrad courses\* in Optimization, Linear Algebra and Probability & Statistics.

**Course Description:** This course will provide a theoretical overview of modern optimization methods, for application in machine learning and data science. In particular we will deal with the following: Convexity, Gradient Methods, Stochastic variants, Accelerated Methods, Online Learning and Applications to Game Theory, Maximum Likelihood Estimation, Non-convex Optimization, Critical and Saddle Points, Non-negative matrix factorization, PCA, min-max optimization (GANs), Adam.

**Course Objectives:** Learn some of the important, known theoretical guarantees about particular optimization techniques commonly used in machine learning; Read and understand applied and theoretical papers about Optimization for Machine Learning; Evaluate most important Algorithms, and algorithm convergence guarantees; Characterize trade-offs between time, size of data and accuracy.

**Grading Policy:**

- **Scribing lecture notes (20%):** In a group of 1-2. Deadline is 3 weeks after the lectures. **Latex** template.
- **Homework (30%):** One homework will be given during the 4th week of lectures. You must use **Latex** for your answers (provide a pdf file). Each student has to work individually.
- **Research Project or presenting a paper (50%):** Write a report (group 1-2) in **Latex**. Research projects will be available during the third week of the lectures.

**Important Dates:**

Scribing Lectures Deadline ..... Three weeks after the lecture.  
Homework Deadline ..... Week after recess week.  
Project Deadline ..... 13th week of lectures.  
Project Presentations ..... Last week of lectures.

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\*Basic knowledge.