

# DS801: Advanced Optimization for Data Science, Spring 2024

MW(월수) 9:00-10:15 pm, E2-2 (산업경영학동) #1122

**Instructor:** Dabeen Lee, [dabeenl@kaist.ac.kr](mailto:dabeenl@kaist.ac.kr), E2-2 #2109.

**Lectures:** Mondays and Wednesdays 9:00-10:15 am.

**Office hours:** Tuesdays 2:00-3:00 pm.

**Teaching assistant:** To be announced.

**Course webpage:** <https://dabeenl.github.io/DS801>

*Assignments and lecture notes will be uploaded to the webpage as well as KLMS.*

**Course description** This course provides a thorough overview of modern optimization methods used in machine learning, data science, and artificial intelligence. We cover not only mathematical foundations but also practical implementations throughout the course. This course builds upon basic optimization theory topics that are taught in courses such as IE539: Convex Optimization and AI505: Optimization for AI, and it is designed to discuss more advanced yet practical concepts and techniques for data science.

**Key topics** Optimization methods and algorithms for machine learning, data science, and artificial intelligence.

- Review of first-order methods, SGD, and their applications in machine learning.
- Black-box optimization: Bayesian optimization, Zeroth-order optimization
- Optimization for RL: Value iteration, Policy iteration, Policy gradient, RL with Human Feedback (RLHF), Multi-agent RL.
- Optimization for deep learning: Acceleration, Variance reduction, Adaptive methods, Adversarial learning.

**Texts** There is no required textbook for this course, but students may find the following list of materials useful to follow the topics covered in this course:

- Convex Optimization: Algorithms and Complexity, *Bubeck*, <https://arxiv.org/abs/1405.4980>
- Lecture Notes: Optimization for Machine Learning, *Elad Hazan*, <https://arxiv.org/abs/1909.03550>
- Optimization for Deep Learning: Theory and Algorithms, *Ruoyu Sun*, <https://arxiv.org/abs/1912.08957>

**Prerequisites** There are no formal prerequisites but you should be comfortable with the basic optimization knowledge from previous courses such as

- IE539: Convex Optimization,
- AI505: Optimization for Artificial Intelligence.

**Assessment structure**

- Grading: ABC
- Assignments (50%), a course project (20%), and a take-home final exam (30%).