

OPTIMIZATION AND MACHINE LEARNING

Instructor: Assistant Professor Aristotelis E. Charalampakis, achar@uniwa.gr

Class: Wednesdays 2:10-4:40 p.m. at

Office Hours:-

Textbook: NO Textbook

Recommended Reading:

- 1) Wheeler J. P. An Introduction to Optimization, with Applications in Machine Learning and Data Analytics. CRC Press, 2024.
- 2) Chong, Edwin KP, Wu-Sheng Lu, and Stanislaw H. Zak. An Introduction to Optimization: With Applications to Machine Learning. John Wiley & Sons, 2023.
- 3) Antoniou A., Lu W.-S. Practical Optimization: Algorithms and Engineering Applications. Springer, 2nd edition, 2021.
- 4) Géron A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media, 3rd edition, 2022.

CONTENTS

- Introduction to Optimization
- Linear Programming: The Simplex Method, the Dual Problem, the Big M Method.
- Nonlinear Programming: Lagrange Multipliers and the KKT Conditions, Iterative Methods (Newton's Method, Steepest Descent, Secant Methods)
- Heuristic Methods (Genetic Algorithms, Particle Swarm Optimization, Differential Evolution).
- Introduction to Machine Learning.
- Supervised and Unsupervised Learning.
- Univariate and Multivariate Linear Regression.
- Feature mapping, Normal Equations.
- Logistic regression / Classification, Cost function.
- Multiclass classification.
- Underfitting/Overfitting, Regularization.
- Artificial Neural Networks (Multi-class prediction, Cost function, Backpropagation, High bias / high variance, Learning curves, Error analysis, Precision/Recall).
- Support Vector Machines (SVM).
- Clustering. The K-means Algorithm.
- Dimensionality reduction. Principal Component Analysis.
- Anomaly detection.
- Recommender systems.
- Gradient Descent with Large Datasets.
- Pipelines.