Machine Learning Algorithms
LVA 389.204

Markus Rupp

23.9. 2020

Literature

- Watt, Borhani, Katsegallos, „Machine Learning Refined“ (1.st and 2nd edition)
- M.Rupp, „Script to Adaptive filtering course“

- Sergios Theodoridis, **Machine Learning: A Bayesian and Optimization Perspective, 2nd edition**
- Ali Sayed, „Fundamentals of adaptive Filtering“

MIT Course 6034

- 1: https://www.youtube.com/watch?v=TjZBTDzGeGg&list=PLUl4u3cNGP63gFHB6xb-kVBiQHYe_4hSi
- 2: https://www.youtube.com/watch?v=PNKj529yY5c&list=PLUl4u3cNGP63gFHB6xb-kVBiQHYe_4hSi&index=2
- 9:
- 10:https://www.youtube.com/watch?v=09mb78oiPkA
- 11: https://www.youtube.com/watch?v=SXBG3RGr_Rc
- 12a:
- 12b:
- 13: https://www.youtube.com/watch?v=kHyNqSnzP8Y
- 14: https://www.youtube.com/watch?v=L73hY1pBcQI
- 15: https://www.youtube.com/watch?v=sh3EPjhhd40
- 16: https://youtu.be/_PwhiWxHK8o

Basics (37)

- Classification problems
- Regression vs classifcation
- Architectures of neural networks
- Binary classification
- LS solution
- Iterative Algorithms

Gradient Algorithms (39)

- Wiener Solution
- Gradient Descent
- Analysis
- Advanced Gradient Search: Newton update, convex cost function

LMS Analysis (31)

- Classic Analysis of LMS algorithm
- Based on second order statistics

Classification Algorithms (24)

- Separability
- Perceptron Learning Algorithm
- Margin Perceptron Learning
- Hard Margin VSM

Perceptron Learning Algorithm (64)

- LMS Analysis by energy arguments
- PLA Analysis
- RNN Analysis

Optimization Problems (25)

- Reformulations of the optimization problem for classification
- Lagrangian Formulations
- Solving SVMs
- Increasing Dimensions: Kernels

Neural Networks and the Backpropagation Algorithm (29)

- Multi layer perceptrons
- Learning for multiple layers: backpropagation

Boosting (45)

- The equalizer problem
- RLS
- Newton LMS
- Kalman

Finding Multiple Categories (15)

- Lloyd‘s Algorithm
- K Means Algorithm
- Derivatives

Organisation

- Due to Corona we will not have a lecture with my presence
- Instead all lecture material is augmented by audio for self study
- The effort for the LVA is roughly as follows
- 2SWS Lectures (50/100)
- 1SWS Home Exercises (30/100)
- 1SWS Small project (20/100)

Organisation

- We end by an oral exam which will focus on your project
  - While going with you step by step through your project , related questions will be posed.
- Homeworks as well as the project require written reports.
  - Homeworks are optional but you gain credit (4 homeworks in total)
  - Handing in a project is required to be admitted to the oral exam
- Final grading is to 30% of homework, 20% of project report and 50% on your oral exam.

Homeworks

- Consisting of calculus & Python coding exercises → Focus on coding
- 4 exercise dates → discussion of results via Zoom
  - 7.5 points per exercise → 30 points in total
  - 1 additional point if you get asked to present your results (4 points max)
  - No teamwork → no points if you cannot explain your result
- Handled via TUWEL
  - Homework sheets available 2 weeks prior to exercise
  - Upload via TUWEL → hard deadlines
  - Upload should include short report + code → more details on TUWEL

Project

- The project is mandatory to be admitted to the oral exam
  - Hand in code + report prior to exam date
  - Projects will be handed out by the end of December
- Each student receives a distinct dataset → no teamwork
  - Solve a practical classification/regression problem
  - Compare different algorithms & discuss results
- More information on TUWEL

Organisation

- For homework and projects, you will be educated by
- Lukas Eller, email: lukas.eller@tuwien.ac.at

- In case you have questions to the lecture, don‘t hesitate to contact me: markus.rupp@tuwien.ac.at