TECHNISCHE UNIVERSITÄT
KAISERSLAUTERN

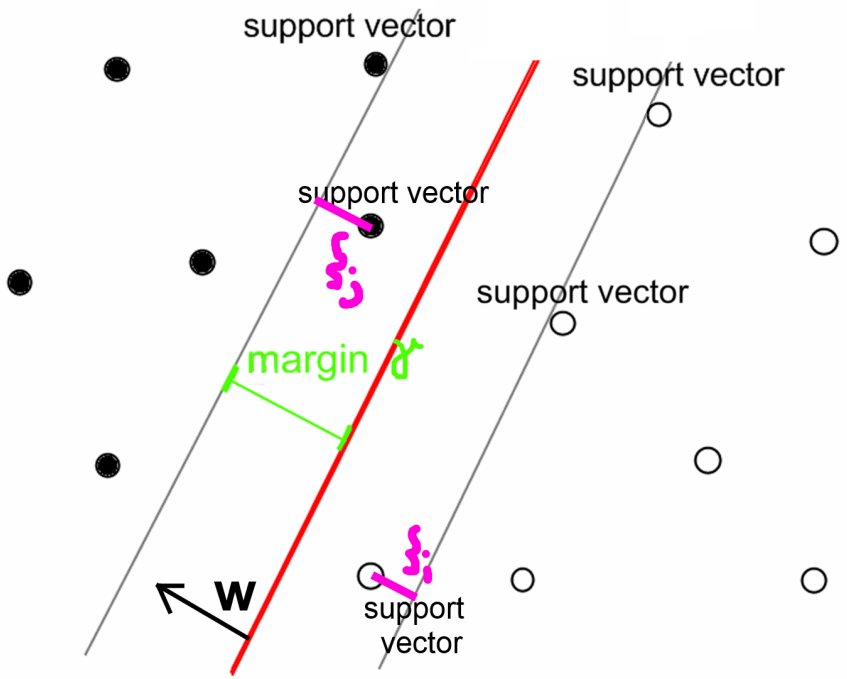
1.3 Organization

Machine Learning 1: Foundations

Marius Kloft *(TUK)*

Contents

Lecture 2: Linear Classifiers & Support Vector Machines (SVMs)



Soft-Margin SVM

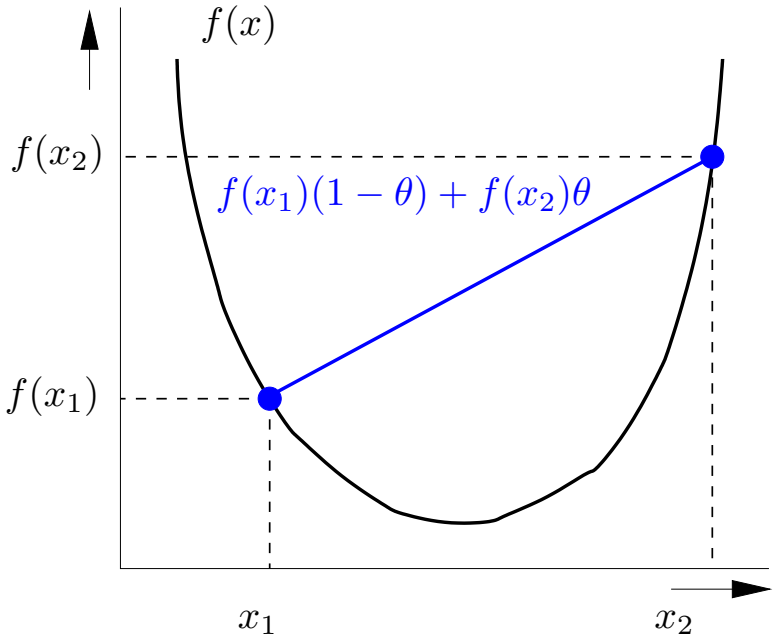
$$\max_{\mathbf{w}\in\mathbb{R}^d, b\in\mathbb{R}, \boldsymbol{\xi}\in\mathbb{R}^n} \frac{1}{2}\|\mathbf{w}\|^2 + \sum_{i=1}^{n} \xi_i \quad \text{s.t.} \quad 1-\xi_i \leq y_i\left(\mathbf{w}^\top \mathbf{x}_i + b\right) \quad \forall i$$

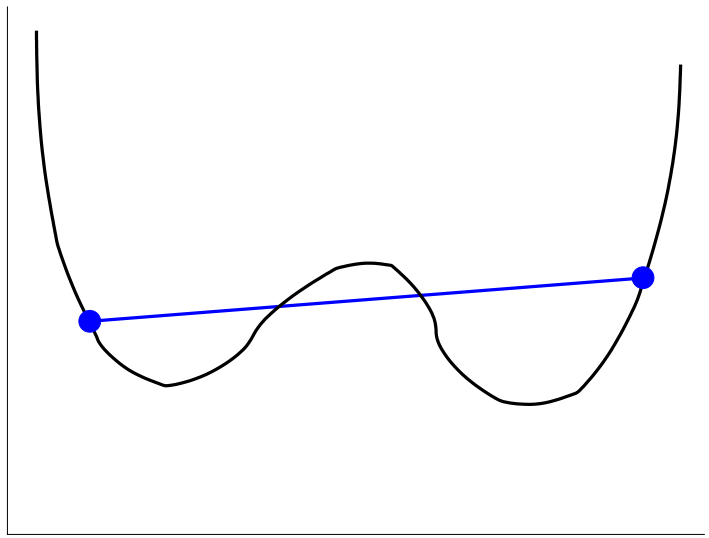
Lecture 3: Convex Optimization

Definition

A function $f : \mathbb{R}^d \to \mathbb{R}$ is **convex** if and only if for all $\mathbf{x}_1, \mathbf{x}_2 \in \mathcal{X}$ and all $\theta \in \mathbb{R}$ with $0 \leq \theta \leq 1$ it holds:

$$f((1-\theta)\mathbf{x}_1 + \theta\mathbf{x}_2) \leq (1-\theta)f(\mathbf{x}_1) + \theta f(\mathbf{x}_2)$$

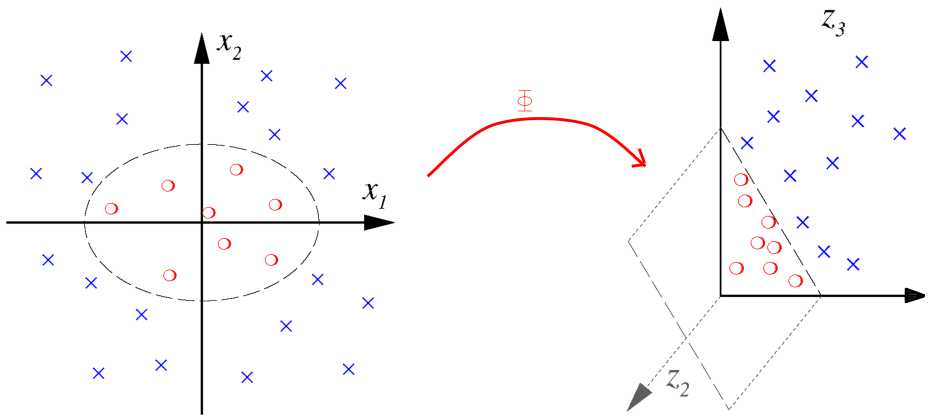




Lecture 4: Kernels Methods

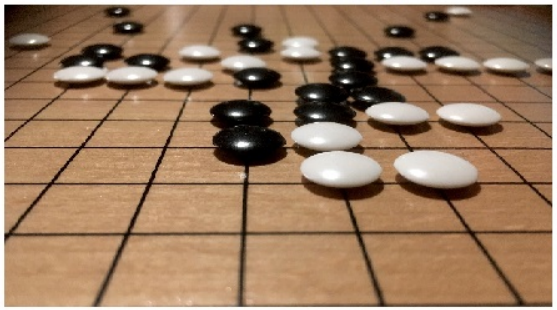
Kernel Trick

- Substitute all occurrences of scalar products $\langle \mathbf{x}_i, \mathbf{x}_j \rangle$ in SVM by kernel $k(\mathbf{x}_i, \mathbf{x}_j)$
- E.g., polynomial kernel $k(\mathbf{x}_i, \mathbf{x}_j) := (\langle \mathbf{x}_i, \mathbf{x}_j \rangle + b)^m$
- Corresponds to mapping inputs into high-dimensional vector space spanned by all monomials of degree $\leq m$
- Makes linear learning algorithm non-linear



Lecture 5.+6.: Deep Learning – The Hype

AlphaGo beats Go human champ



Deep Net outperforms humans in image classification

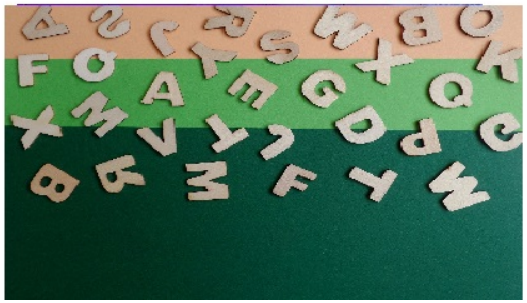
IMAGENET

Autonomous search-and-rescue drones outperform humans

DeepStack beats professional poker players

Computer out-plays humans in "doom"

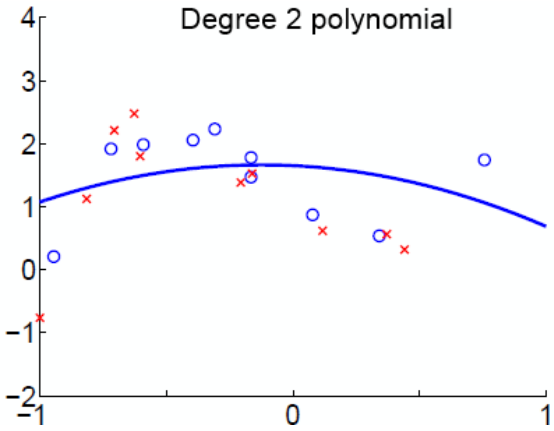
IBM's Watson destroys humans in jeopardy



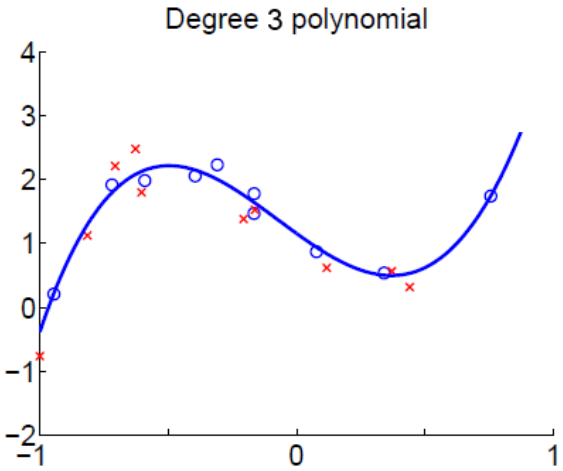
Deep Net beats human at recognizing traffic signs

Lecture 7: Overfitting

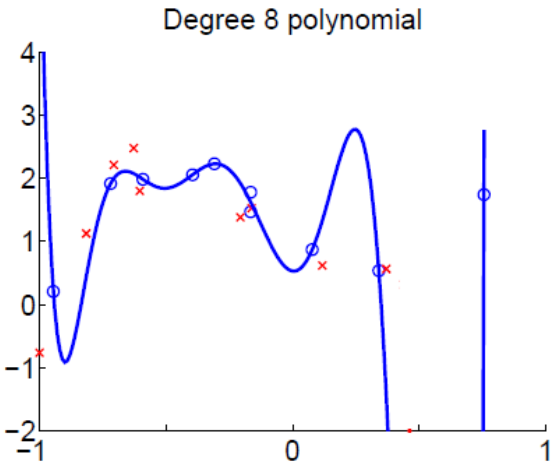
underfitting



just right

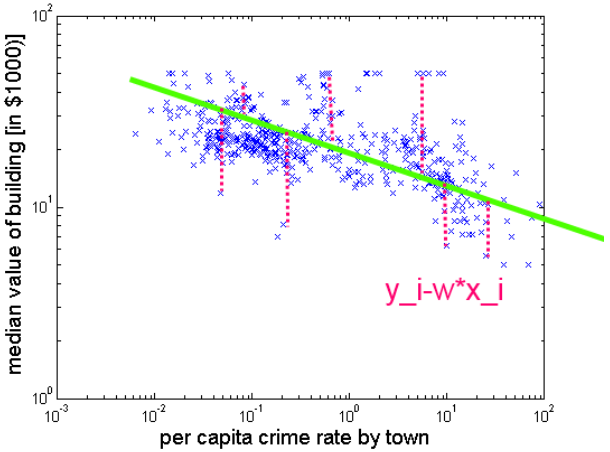


overfitting

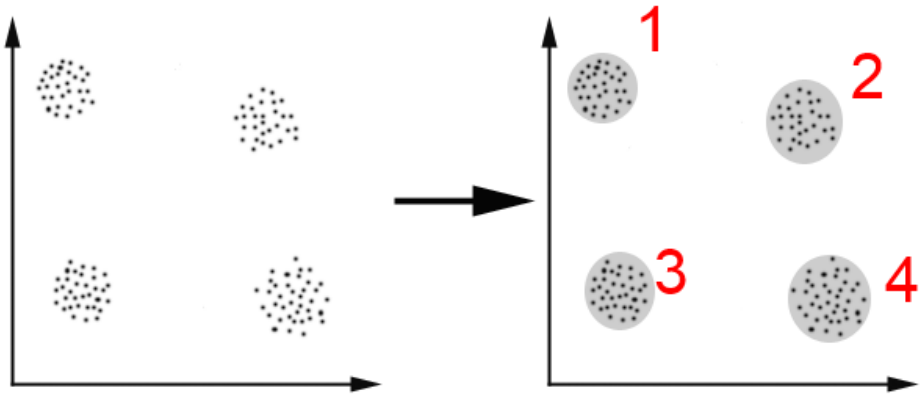


complexity

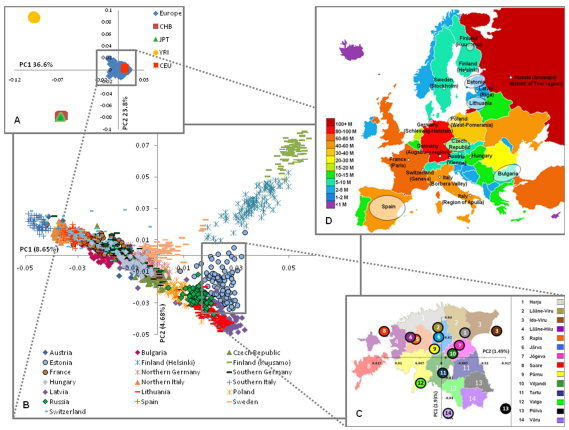
Lectures 8–10: Beyond classification



8: Regression



9: Clustering



10: Dimensionality Reduction

Lecture 11: Random Forests – Kaggler's Favorite

Schedule

20.04.2021: 0. Testing and Setup
27.04.2021: 1. Intro, About::Us, Organization
04.05.2021: X. Math Crash Course
11.05.2021: 2. Linear SVMs
18.05.2021: 3. Convex Optimization
25.05.2021: 4. Kernel Methods
01.06.2021: 5. Deep Learning 1/2
08.06.2021: 6. Deep Learning 2/2
15.06.2021: 7. Regularization
22.06.2021: 8. Regression
29.06.2021: 9. Clustering
06.07.2021: 10. Dimensionality reduction
13.07.2021: 11. Random Forests
20.07.2021: 12. Semester Recap

Good book accompanying the lecture

- Duda *et al.* (2001): Pattern Classification, Chapter 1.
  - Available for free online: `https://kplus.ub.uni-kl.de/Record/KLU01-000924363`
- Deep learning 'bible':
  - Goodfellow *et al.* (2016): Deep Learning

Overview

- ML 1 consists of two parts:
  - Lecture (4h)
  - Exercise course (2h)
- 8 ETCS
- Transition area of (advanced) BSc and (entry) MSc
- If MSc: credited for CS theory or specialization in Intelligent Systems

About the Class

Typical class structure

Tuesday	11:45 – 15:15	Lecture Slot
Friday	<no-slot>	Exercise Slot

However, due to Covid-19 these slots will only be used in case of interactive sessions.

Course Website and Course Material

We use OLAT:
`https://https://olat.vcrp.de/auth/RepositoryEntry/3168305234`

Contains:

- Enrollment (Password: **integer**)
- Slide uploads
- Lecture uploads
- Script upload
- Homework assignments & submission of homework

Course Website and Course Material

We use Mattermost:
`https://ml-chat.cs.uni-kl.de/signup_user_complete/?id=uh4xb7z3nbdx9gec4ojarjj85h`

Contains:

- Communication capabilities
- Discussions
- Messaging

Here, pose your questions on the **organization** of the course exercises. You can use mattermost also for chat with students. Use mattermost first to get into contact with us.

Course Website and Course Material

We will use Q2A

`https://q2a.cs.uni-kl.de/`

Contains:

- Question answering system
- Ask sophisticated/professional questions here
- Ask questions in the category **TF "Intelligent Systems"**
- Always use the tag **ML1**

Here, pose your questions on the content of classes and exercises. I.e., pose ML questions here. This way you will know if your question has already been asked.

Lecture

Goals:

- Impart basic knowledge about ML
- Get to know some basic ideas
- See connections

Exercise Course

Goals:

- Apply theoretical ideas from the lecture to practical problems
- Sometimes little theory tasks
- Implement algorithms and play around with standard libraries

Exercise Course

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- Apply theoretical ideas from the lecture to practical problems
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Orga:

- Create exercise groups of 1-3 students
- We upload model solutions to the homework assignments of the last exercise class
- In the exercise course there is also space for a Q&A session about the lecture
- TA is Billy Joe Franks

Problem sheet

- Responsible: Billy Joe Franks (in charge of exercises)
  HiWi: Till Werner, Geri Gokaj
- Three or four problems per exercise class (mix of theory and practice, 1-2 will be mandatory)
- Group size: 1–3
- Sheets are not fully corrected, graded and **mandatory**
- Handwriting solutions are not allowed (LaTeX is mandatory)
- Submission via OLAT system
- Use mattermost to get into contact with us. Use Q2A to ask questions about content.
  - Contact: Billy

Exam

Due to Covid-19 this is not set in stone.

Written exam

- Theory (as learned in the lecture)
- Practical stuff (from the problem sheets and **code**!)

Exam admission

- Each sheet contains 1 or more mandatory exercises.
- You need **80%** of the mandatory exercises to be admitted to the exam (Individual)

Contact

Marius Kloft and Billy Joe Franks

Due to Covid-19 office hours are temporarily not relevant.

- Building 36, Room 312 and Room 316
- Billy's office hours: to be determined (after Covid-19 situation resolved)
- Marius' office hours: to be determined (after Covid-19 situation resolved)
- Always approach Billy first (via Mattermost) and try solving the issue with him
- Only then contact Marius via mattermost (with Billy cced in the chat)
  - do not write email to marius

Math Requirements

Warning

Machine learning uses heavy machinery from **linear algebra** and **multivariate calculus**

Prerequisites for this course can be studied as follows:

- Our **recommendations**:
  - `https://ml.informatik.uni-kl.de/teaching/`
- Coursera specialization: **Mathematics for Machine Learning**
  - `https://www.coursera.org/specializations/mathematics-machine-learning`
  - Course 1: Linear Algebra
  - Course 2: Multivariate Calculus

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Do not forget about the math placement test

Questions?

Refs I

R. O. Duda, P. E. Hart, and D. G. Stork, Pattern classification, 2nd Edition. Wiley, 2001, ISBN: 9780471056690.

I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning. The MIT Press, 2016, ISBN: 0262035618.