Large Scale Data Mining

Introduction, Logistics

credits:www.mmds.org

Who are we ?

- **Dr. Avishek Anand**
  - **post-doc researcher**
  - **Information Retrieval, Text mining, Graph mining**
  - **anand@l3s.de**

- **Jaspreet Singh (TA)**
  - **PhD student**
  - **Information Retrieval**
  - **singh@l3s.de**

What is Data Mining?

- **Given lots of data**
- **Discover patterns and models that are:**
  - **Valid:** hold on new data with some certainty
  - **Useful:** should be possible to act on the item
  - **Unexpected:** non-obvious to the system
  - **Understandable:** humans should be able to interpret the pattern

Data Mining

- **But to extract the knowledge data needs to be**
  - **Stored**
  - **Managed**
  - **And ANALYZED ← this class**

Data Mining ≈ Big Data ≈ Predictive Analytics ≈ Data Science

Data Mining Tasks

- **Descriptive methods**
  - Find human-interpretable patterns that describe the data
    - **Example:** Clustering

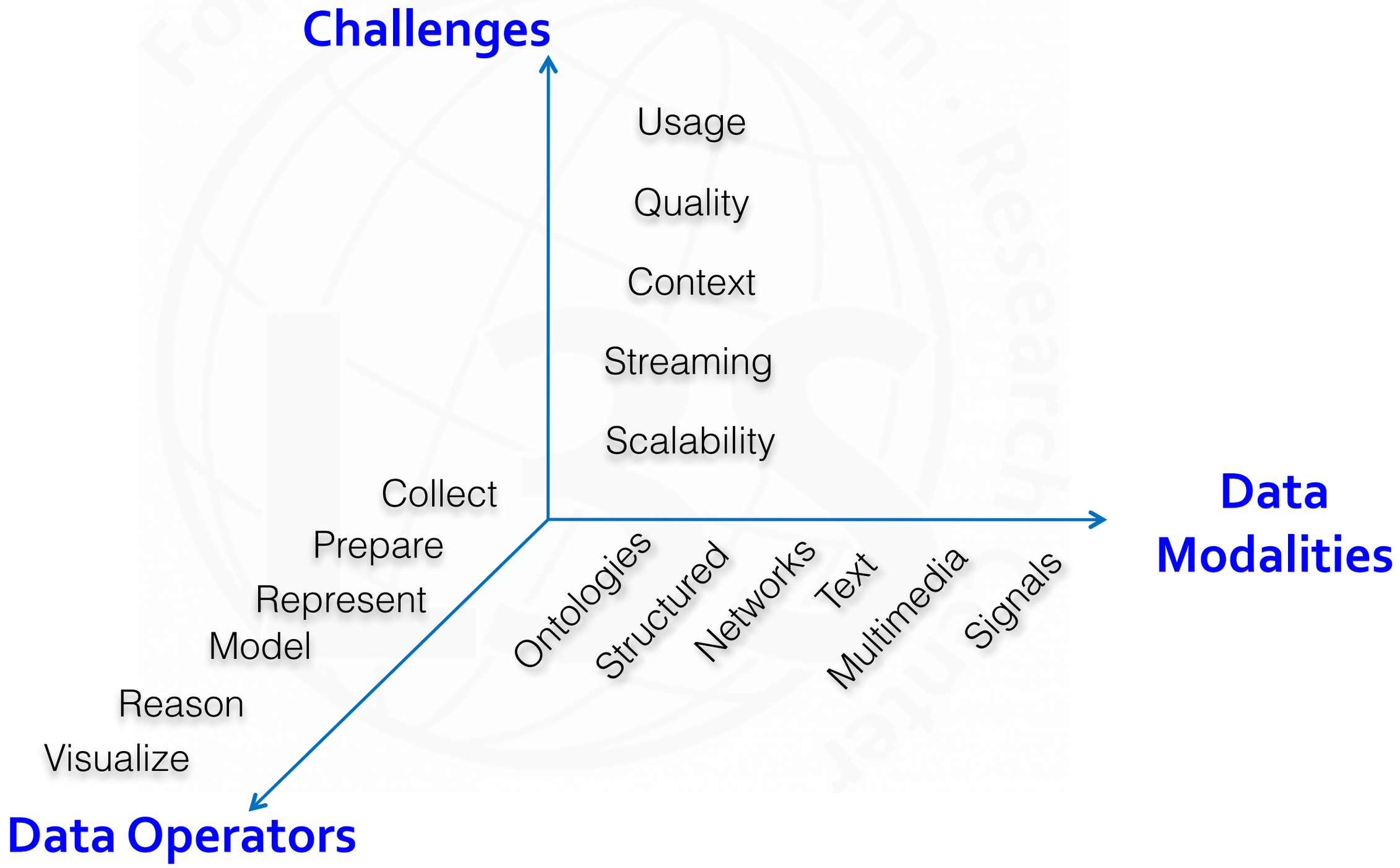
- **Predictive methods**
  - Use some variables to predict unknown or future values of other variables
    - **Example:** Recommender systems

Pitfalls and Risks

- **A risk with "Data mining" is that an analyst can "discover" patterns that are meaningless**

- Statisticians call it **Bonferroni's principle**:
  - Roughly, if you look in more places for interesting patterns than your amount of data will support, you are bound to find crap

What matters when dealing with data?



This Lecture

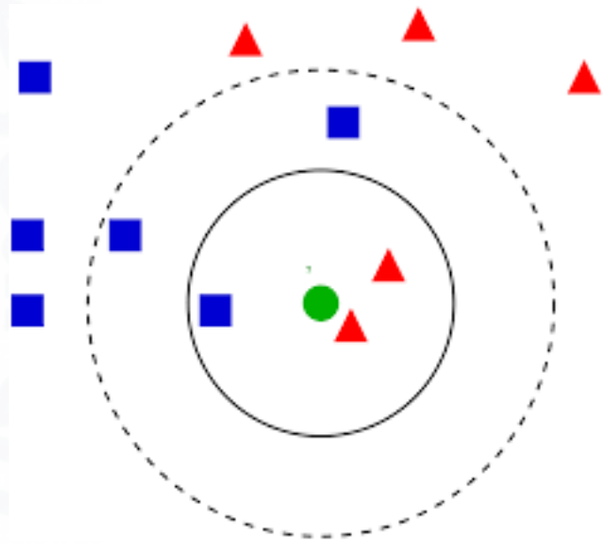
- **This class overlaps with machine learning, statistics, artificial intelligence, databases but more stress on**
  - **Scalability** (big data)
  - **Algorithms**
  - **Computing architectures**
  - Automation for handling **large data**

What will we learn?

- **We will learn to solve real-world problems:**
  - Finding Similar Items
  - Market Basket Analysis
  - Spam detection
  - Duplicate document detection

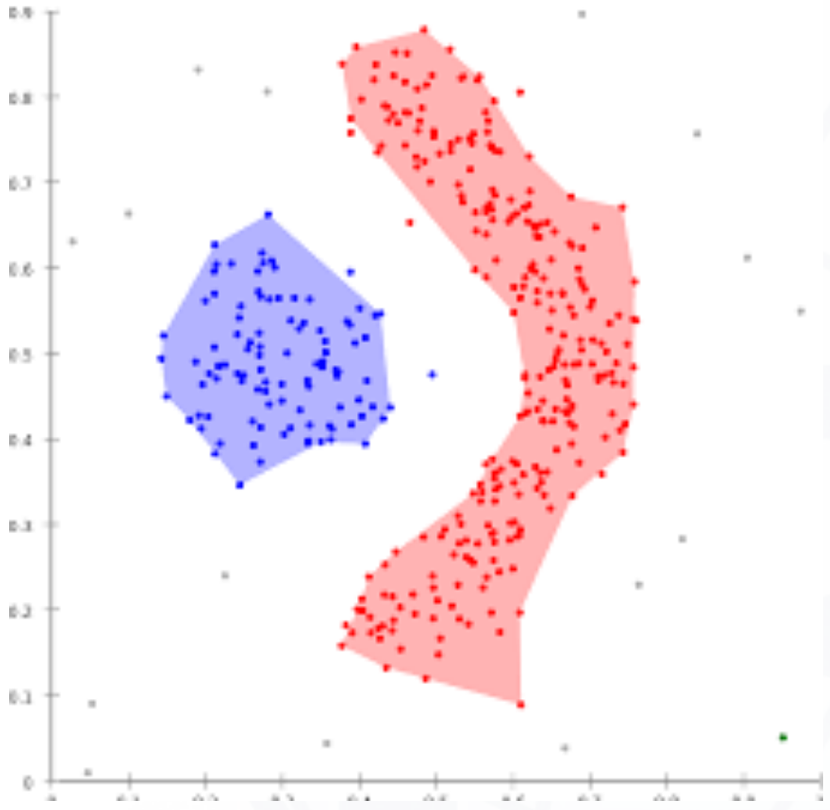
- **We will learn various "tools":**
  - Optimization (stochastic gradient descent)
  - Dynamic programming (frequent itemsets)
  - Hashing (LSH, Bloom filters)
  - Probabilistic analysis

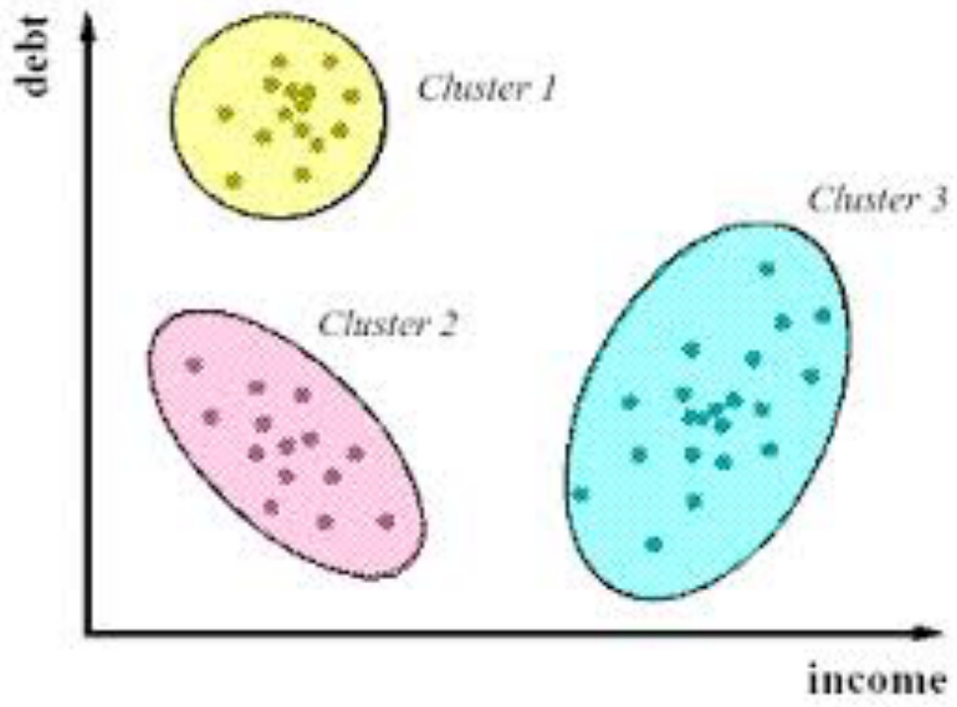
Finding Similar Items



- What are the near duplicates / similar items / nearest neighbours ? How do we find this efficiently for large input ?

Clustering



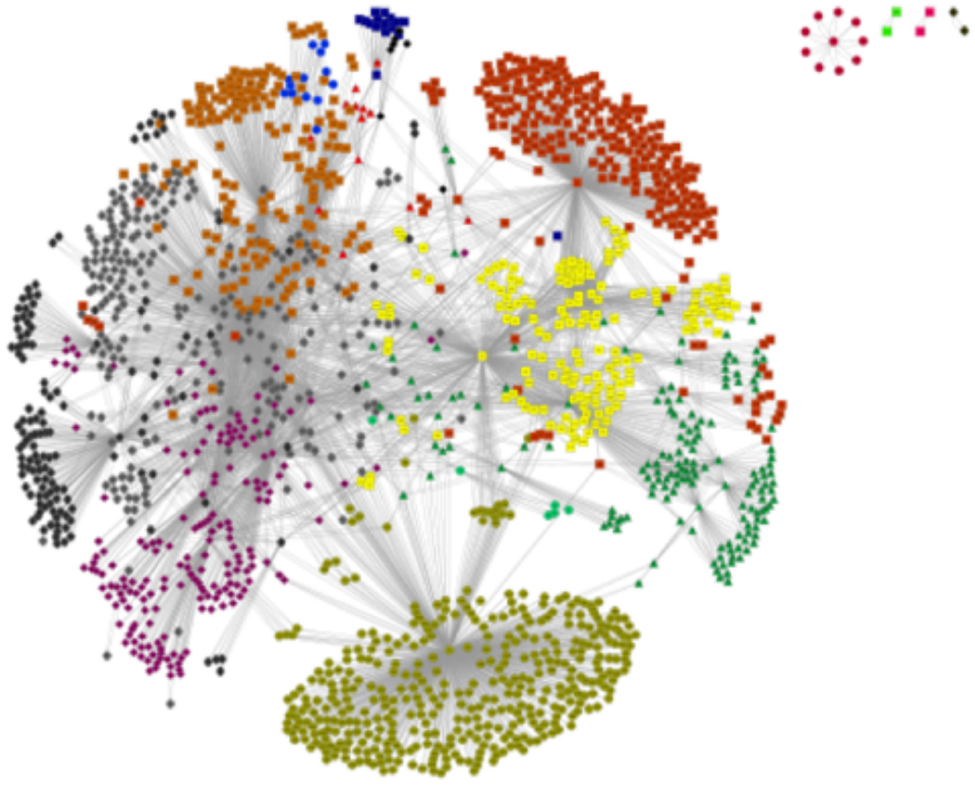


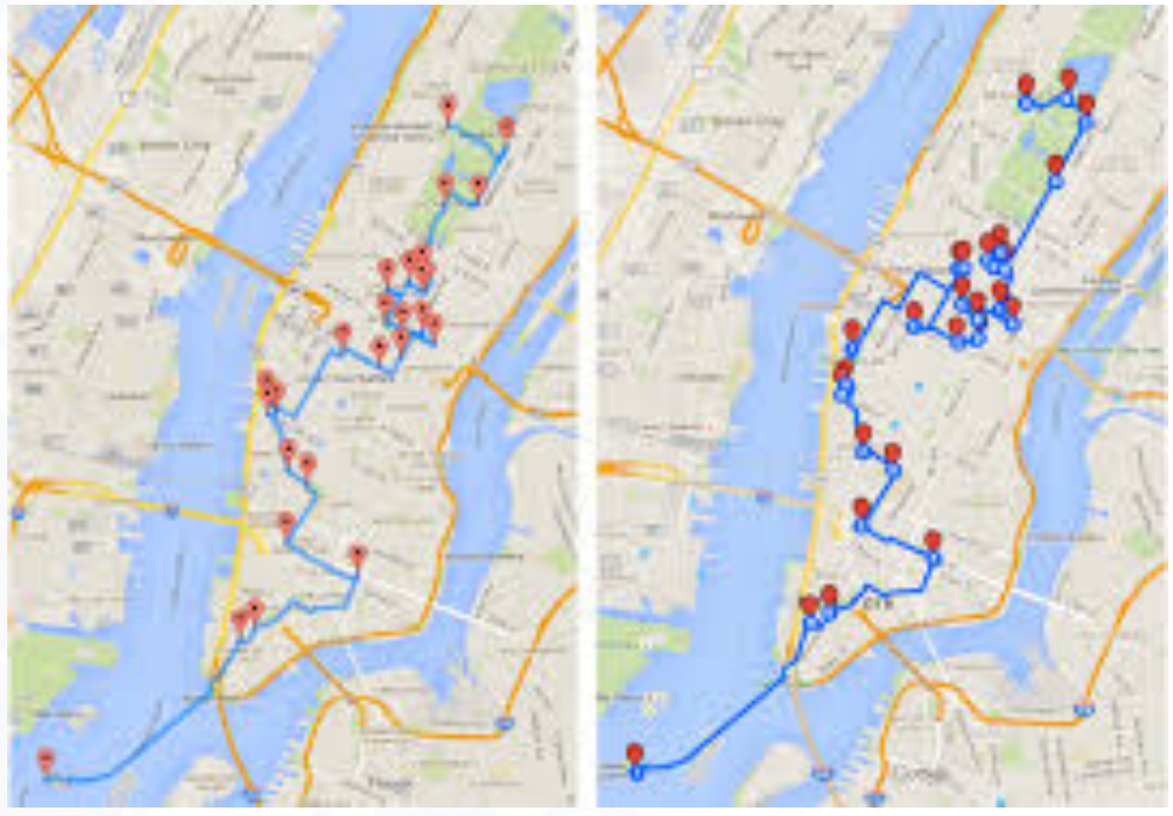
- What are the clusters given large input collections ?

Mining Data Streams

- How do we sample data in a stream ?
- How do we count distinct elements in a stream ?

Mining Graphs





- How do we find communities in large graphs ?
- How do we find shortest paths in massive graphs in reasonable time ?

What will we learn?

- **We will learn to mine different types of data:**
  - Data is high dimensional
  - Data is a graph
  - Data is infinite/never-ending

- **We will learn to use different models of computation:**
  - MapReduce
  - Streams and online algorithms
  - Single machine in-memory

About the Course

Course Logistics

- **Course website:**

http://www.l3s.de/~anand/lsdm16/

- Lecture slides (at least 30min before the lecture)
- Homeworks, solutions

- **Readings:** Book **Mining of Massive Datasets** with A. Rajaraman and J. Ullman

- ITIS Students: part of the theoretical foundations

Free online:
http://www.mmds.org

Logistics: Communication

- **For e-mailing us, always use:**
  - anand@l3s.de,singh@l3s.de
  - Use this prefix in the subject field **[lsdm16]**
  - You can message via Stud.ip as well

- **We will post course announcements to the course webpage - via twitter (make sure you check it regularly)**

Work for the Course

- **7-8 Assignments:**
  - Theoretical and programming questions
  - **Assignments take time. Start early!!**
  - **5-6 questions per assignment, online on the lecture day**
  - **Due date Tuesday after the lecture 11:59 am**

- **How to submit?**
  - **Homework write-up:**
    - **Submit @ Jaspreet's office or (11:59 am),**
    - **Scan and send to singh@l3s.de (11:59 pm)**

Tutorials

- After the lecture (with Jaspreet)
- Successfully evaluated assignments will be offered for solution presentation
- Each presentation (whiteboard) should be ~10 minutes..max 15 minutes
- 3 successful presentations give you 1 bonus point
- 1 bonus point = 0.3 grade improvement in your final exam

Final Exam

- Written Exam
- Duration : 2 hours
- 1 bonus point = 0.3 grade improvement in your final exam
  - 1.3 + 1 bonus point = 1.0
  - 5.0 + 1 bonus point = 5.0
- Modelled on Assignments
- More applied and algorithmic aspects rather than memorising

Prerequisites

- **Algorithms and Data Structures**
  - Dynamic programming, basic data structures
- **Basic probability**
  - Moments, typical distributions, MLE, …
- **KDD1**
  - Foundation lecture running this semester

Quiz

Quiz

- **Anonymous**
- **Tear off your Quiz Number on the top right**
  - Save it with you if you want to know your scores
- **Duration : 20 minutes**
- After the test: Shuffle the deck and redistribute
- Crowdsourcing