Introduction to Student Projects

IE500 Data Mining

UNIVERSITY OF MANNHEIM
Data and Web Science Group

Outline

1. Requirements for the Student Projects

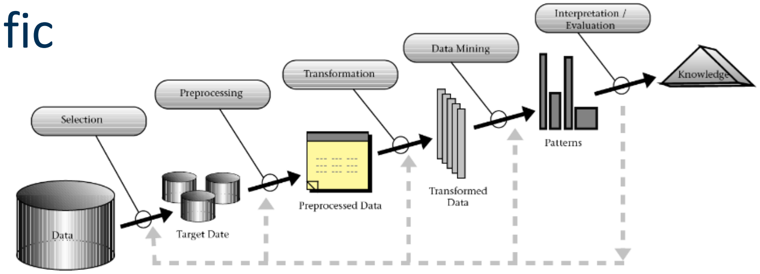
2. Requirements for the Project Reports

3. Final Exam

4. Team Formation

Student Projects

- **Goals**
  - Gain practical experience with the complete data mining process
  - Get to know additional problem-specific
    - preprocessing methods
    - data mining methods



- **Expectation**
  - You select an interesting data mining problem of your choice
  - You solve the problem using
    - the data mining methods that we have learned so far, including
      - proper hyperparameter optimization
      - problem-specific pre-processing and smart feature engineering
    - additional data mining methods which might be helpful for solving the problem and build on what we learned in class

Procedure

- Teams of **six** students
  - realize a data mining project
  - write a 12-page summary of the project and the methods employed in the project
  - present the project results to the other students
    - 10 minutes presentation + 5 minutes discussion

- Final mark for the course
  - 20 % written final report about the project
  - 5 % project presentation
  - 75 % written exam

Where to find interesting Data Sets?

- Data registries
  - Datasets hosted on Amazon AWS https://registry.opendata.aws
  - Google's Dataset Search: https://datasetsearch.research.google.com/
  - Microsoft Datasets: https://msropendata.com/
  - Yahoo Webscope Datasets: http://webscope.sandbox.yahoo.com/
  - Dataset collection on Github: https://github.com/awesomedata/awesome-public-datasets
  - Data Hub: http://datahub.io
  - Linked Open Data Cloud: http://lod-cloud.net/
  - Stanford Large Network Dataset Collection: http://snap.stanford.edu/data/index.html
  - Huggingface: https://huggingface.co/datasets

Where to find interesting Data Sets?

- Public sector data
  - US government: https://www.data.gov
  - UK government: https://data.gov.uk
  - EU: https://www.europeandataportal.eu
  - CIA World Fact Book: https://www.cia.gov/library/publications/the-world-factbook/
  - Health data (over 125 years): https://www.healthdata.gov/

Where to find interesting Data Sets?

- Competitions
  - Kaggle: https://www.kaggle.com/
  - Data Mining Cup: http://www.data-mining-cup.de
  - KDD Cup: https://www.kdd.org/kdd-cup
  - DrivenData: https://www.drivendata.org
  - CrowdAnalytix: https://www.crowdanalytix.com

- If you use a competitions task:
  You **have to** compare your results to results from the competition's forum!

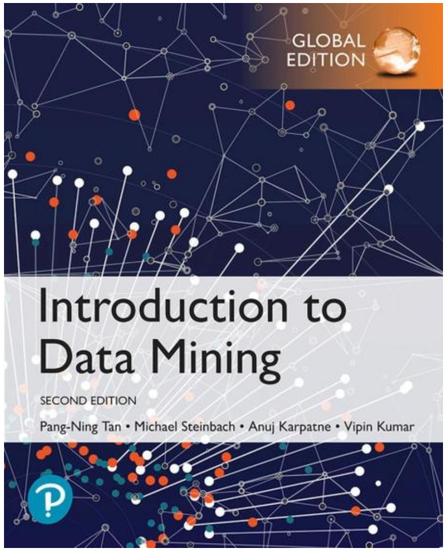
Where to find interesting Data Sets?

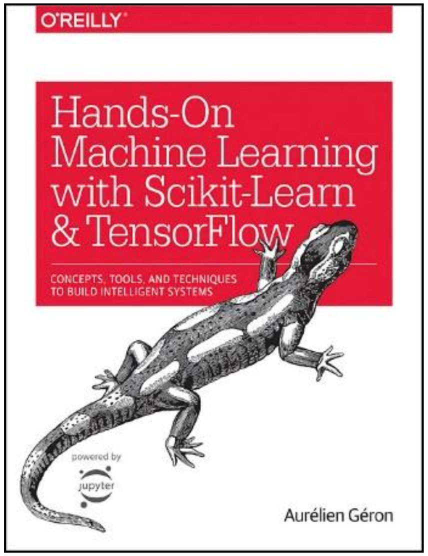
- Language resources
  - WordNet: https://wordnet.princeton.edu
  - EuroWordNet: http://projects.illc.uva.nl/EuroWordNet/
  - Project Gutenberg (36.000 ebooks): http://www.gutenberg.org/
  - New York Times (starts 1851): http://developer.nytimes.com/docs
  - Wikitionary: https://www.wiktionary.org
    as KG: http://kaiko.getalp.org/about-dbnary/

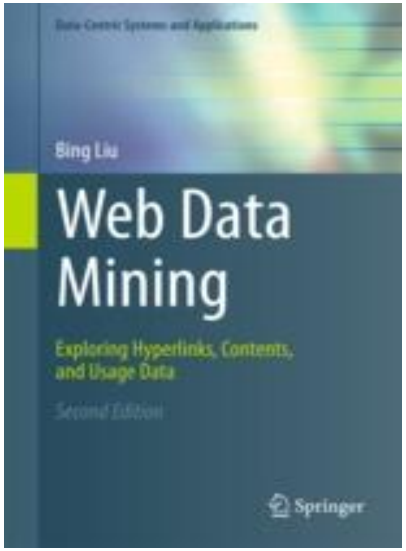
- Knowledge graphs
  - Wikidata: https://www.wikidata.org
  - BabelNet: https://babelnet.org
  - DBpedia: http://wiki.dbpedia.org

Where to Find Additional Information

- Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Pearson / Addison Wesley.
- Aurélien Géron: Hands-on Machine Learning with Scikit-Learn. O’Reilly.
- Bing Liu: Web Data Mining, 2nd Edition, Springer.


GLOBAL EDITION
Introduction to Data Mining
SECOND EDITION
Pang-Ning Tan • Michael Steinbach • Anuj Karpatne • Vipin Kumar


O'REILLY
Hands-On Machine Learning with Scikit-Learn & TensorFlow
CONCEPTS, TOOLS, AND TECHNIQUES TO BUILD INTELLIGENT SYSTEMS
powered by jupyter
Aurélien Géron


Data-Centric Systems and Applications
Bing Liu
Web Data Mining
Exploring Hyperlinks, Contents, and Usage Data
Second Edition
Springer

Where to Find Additional Information

- Check out the solutions to your problem that other people have tried.
  - by looking into the Kaggle discussion groups and code
  - by investigating the state-of-the-art for your your task on Papers with Code
  - by looking at submissions of the KDD Cup or Data Mining Cup
  - or search for relevant scientific papers using Google Scholar, search term:
    “task name + survey”

Papers With Code

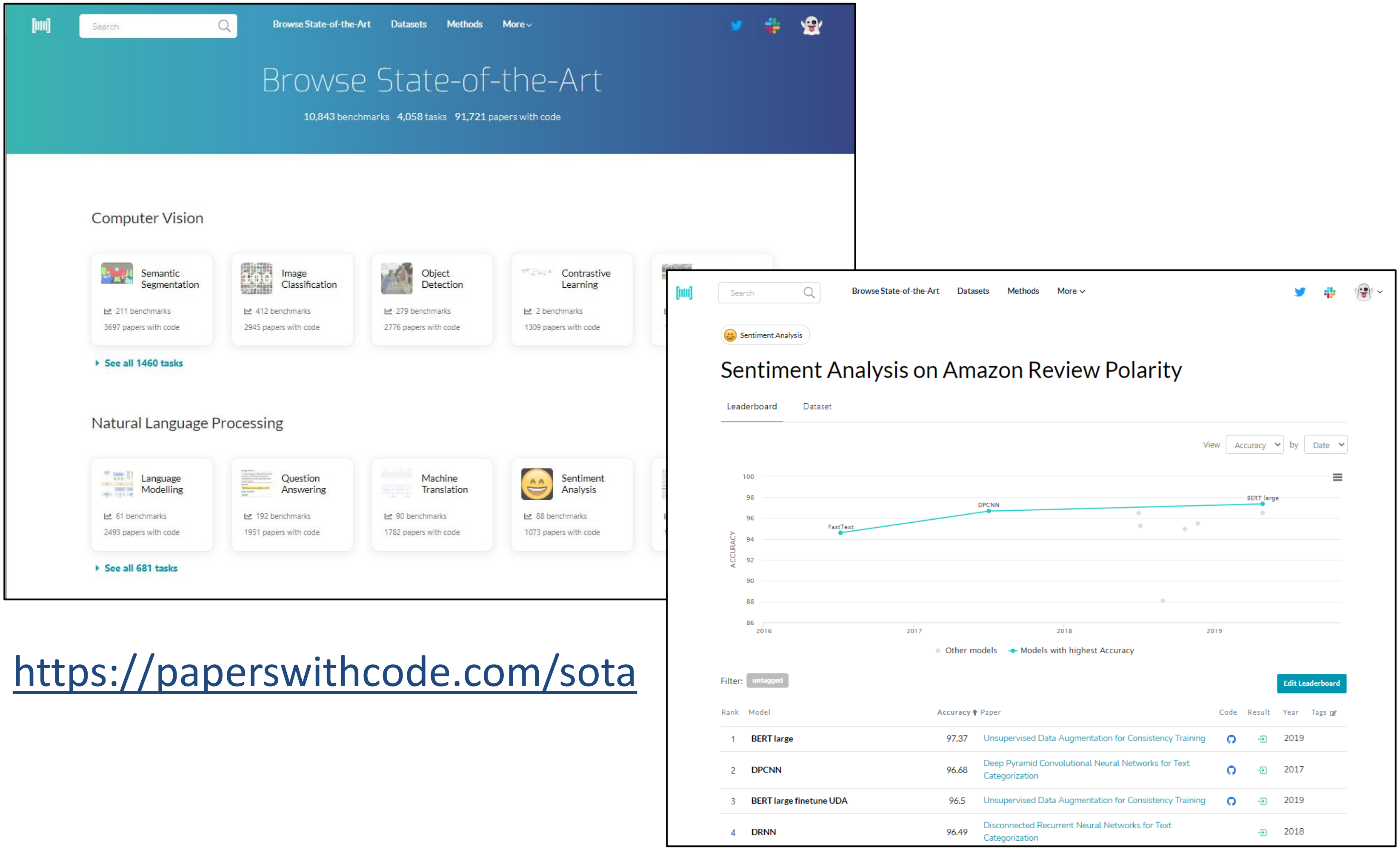
kaggle

Google™

CHAT GPT

DATA MINING CUP
International Student Competition

State of the Art for Specific Tasks



Browse State-of-the-Art

10,843 benchmarks 4,058 tasks 91,721 papers with code

Computer Vision

Task	Benchmarks	Papers
Semantic Segmentation	211 benchmarks	3697 papers with code
Image Classification	412 benchmarks	2945 papers with code
Object Detection	279 benchmarks	2776 papers with code
Contrastive Learning	2 benchmarks	1309 papers with code

See all 1460 tasks

Natural Language Processing

Task	Benchmarks	Papers
Language Modelling	61 benchmarks	2493 papers with code
Question Answering	192 benchmarks	1951 papers with code
Machine Translation	90 benchmarks	1782 papers with code
Sentiment Analysis	88 benchmarks	1073 papers with code

See all 681 tasks

Sentiment Analysis on Amazon Review Polarity

Filter: untagged

Rank	Model	Accuracy	Paper	Code	Result	Year	Tags
1	BERT large	97.37	Unsupervised Data Augmentation for Consistency Training			2019	
2	DPCNN	96.68	Deep Pyramid Convolutional Neural Networks for Text Categorization			2017	
3	BERT large finetune UDA	96.5	Unsupervised Data Augmentation for Consistency Training			2019	
4	DRNN	96.49	Disconnected Recurrent Neural Networks for Text Categorization			2018	

https://paperswithcode.com/sota

Some Projects realized in previous Semesters

- Twitter data
  - humor / hate speech detection
  - Sentiment Analysis of Tweets about Movies
    - Learned classifier from IMDB movie reviews
    - Applied and tested with tweets afterwards
- Airbnb (done very often)
  - predict the prices of new apartments
- Bundesliga Betting Rules
  - Find rules that help you to predict the outcome of a Bundesliga game
- last.fm Playlist Analysis
  - Cluster last.fm users according to the style of the songs they are listening to
  - Find commons sets of songs for the different clusters
- Analysis of Training Data of a Fitness Center
  - Find different customer groups by clustering exercise data
  - Find frequent combinations of exercises
- Sentiment Analysis of Tweets about Movies

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Choose a task/dataset where you have a ground truth
(or can easily generate one)

Dataset Selection: Key Considerations - Pros

- **Rich Feature Space:** Datasets should have multiple, diverse features that allow for creative feature engineering.

- **Adequate Sample Size:** Aim for datasets with at least 10,000 examples to ensure robust modeling.

- **Balanced Complexity:** A dataset should be complex enough to challenge students without being computationally prohibitive.

- **High Data Quality:** Ensure key columns are well-populated (e.g., <5% missing values) so that the data can be effectively used.

- **Novelty:** Prefer datasets that haven't been overused in existing challenges, offering room for innovative approaches.

Dataset Selection: Key Considerations - Cons

- **Overly Simple:** Avoid datasets with too few features (< 5) or a too-basic topic, as this limits feature engineering.

- **Excessively Large:** Datasets with over 1 million records (e.g., huge product datasets) can be too compute-intensive.

- **Over-Saturated:** Datasets with clear guidelines and abundant available code (e.g., well-established challenges).

- **Poor Data Usability:** Be wary of datasets where important columns are empty more than 5% of the time, or where the ground truth is ambiguous.

- *Additional Tip:* Check prior usage—if you're the first to work on a dataset, verify that the dataset is practically usable and that data quality issues won't undermine your project.

Team Formation

- You are allowed to form teams of 6 students as you like!
  - You enter your team consisting of 6 students into the "Team Setup" section (lower part) of the Google spreadsheet (see last slide) until **Sunday, March 16th 23:59**
  - If you are still looking for a team, enter yourself to the "Search for a team" section of the spreadsheet also until **Sunday, March 16th 23:59**
    - Ilias message board can also be used to find teams (see corresponding channel)
  - We will form teams out of the remaining students who did not find a team by themselves on **Monday, March 17th**
    - We will create an Ilias group for teach team and assign you to that group

Team Formation

- If you formed a team,
  you can already start writing the project outline
- Meet with your team to organize your work!
  - Decide project topic
  - Organize writing of project outline

Project Outlines

- Maximum 4 pages (sharp!) including title page
  - Using DWS master thesis layout (PDF!)
  - Include a project name, your team number and name on the first page!
- Due **Sunday, March, 23rd, 23:59**
- Submission via Ilias

- Feedback about your project outlines if required: Wednesday, 02.04.2025, lecture time (10:15-11:45)
  - We will inform you Monday, 31.03.2025 with some feedback and let you know if you need to show up on Wednesday, 02.04.2025

Project Outlines

- Answer the following questions:
  1. What is the problem you are solving?
  2. What data will you use?
     - Where will you get it?
     - How will you gather it?
  3. How will you solve the problem?
     - What preprocessing steps will be required?
     - Which algorithms do you plan to use? Be as specific as you can!
  4. How will you measure success? (Evaluation method)
  5. What do you expect your results to look like? (Model/Clusters/Patterns)

Coaching Sessions

- We will give you tips and answer questions concerning your project
- At the time of the lecture (Wednesdays)
- **Every team has to attend at least one coaching session!**

Coaching Sessions

- We use the calendar feature in Ilias to schedule the coaching sessions
  - **Only one person per group** should book a slot on behalf of the group
  - You choose the week (a whole time slot of 90 minute)
    and we will assign you a 10-15 minute slot within the 90 min slot specific to your group and inform you about the exact time
  - When booking, you must include your **group number/name** and **questions or topics** you want to discuss.
    Blank requests will be ignored!
  - The registration opens exactly one week before it (10:15)
    - First come, first serve

Some Project Management Hints

- Organize your project in **multiple iterations**
  - Every artefact will be improved over time!

- Get a **simple process running early** on to have a baseline

- **Parallelize tasks** while keeping centrally track of results
  - e.g. one central document with results plus reference to exact version of the notebooks/datasets that produced these results
  - sub-groups should explore specific ideas for a specified amount of time

Some Project Management Hints

- **Define concrete milestones**: When should what be finished?
  - e.g. 07.04.25 Data exploration results collected in single document
  - e.g. 14.04.25 Subgroup on sentiment lexica adds results to central document

- **Infrastructure**
  - use shared folder for result document, versions of data, processes, slideset (e.g. MS Teams, Google Drive, github)
  - use ChatGPT for inspiration about additional methods as well as coding

Tasks within the Iterations of the Project

1. Data Exploration and Visualization
2. Data Preprocessing: value normalization, deal with outliers, deal with missing values, feature generation, balance training data if necessary
3. Establish/update baseline (majority class, predict mean value)
4. Try different learning methods using different feature creation methods and feature combinations
5. Perform error analysis in order to understand what is going on!
6. Later iteration:
   - run automatic hyperparameter optimization and attribute selection
   - employ more sophisticated evaluation setup: x-val + holdout vs. nested x-val

Project Presentation

- Present the project results to the other students
  - 10 minutes presentation + 5 minutes discussion
  - During lecture/exercise slot
- Presentations need to be uploaded in Ilias within the respective Ilias groups
  - **Deadline: Wednesday, May 21st, 23:59**
- Presentations are in the lecture slot and two exercise slots
  - For **presentations, attendance is mandatory per session** for all group members, so the exact timing within the session does not matter
  - It is highly recommended to join the other sessions and ask questions
  - We will announce the exact time for each group
    at least one week in advance

Project Report

- Max. 12 pages including title/toc page and reference page
  - max. 10 pages content, no appendix
  - Each extra page downgrades your mark by 0.3!
- Reports and additonal material need to be uploaded in Ilias within the respective Ilias groups
  - **Deadline: Sunday, May 18th, 23:59**

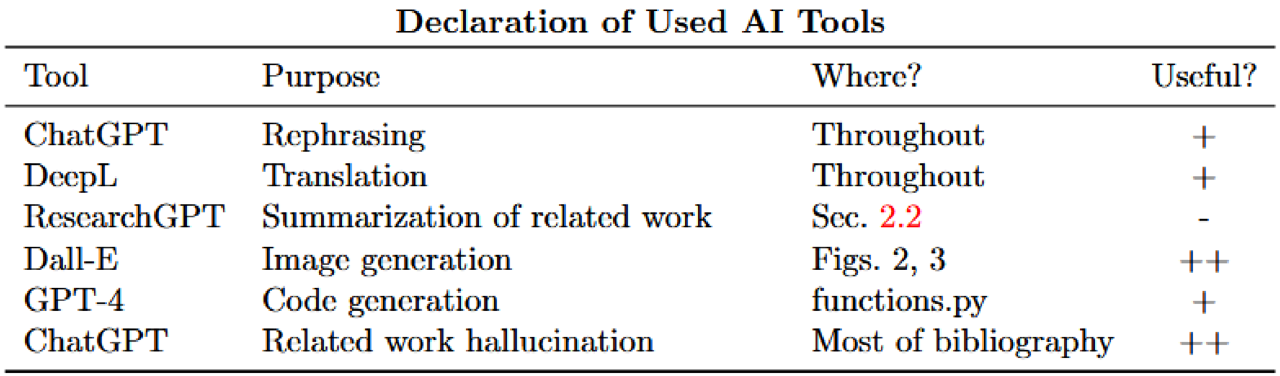
Project Report

- Outline for project report:
  - Application area and goals (0.5 pages)
  - Profile (structure and size) of your data set (minimum 1 page)
  - Preprocessing
  - Data Mining
    - Describe different approaches and parameter settings/optimizations that you tried
  - Evaluation
    - Including description of evaluation setup (split, x-val, nested-x-val?)
    - Including an analysis of the errors still made by the best method, a discussion of the results, and a comparison to state-of-the-art results (together: minimum 2 pages)
  - Results

Project Report

- Requirements
  - You have to use the latex template of the DWS Thesis
  - Please cite sources properly and use your references page
  - Also submit your Python code and (a subset) of your data
  - Include **your names and your team number** on the first page!

- Usage of AI Tools needs to be declared



Declaration of Used AI Tools

Tool	Purpose	Where?	Useful?
ChatGPT	Rephrasing	Throughout	+
DeepL	Translation	Throughout	+
ResearchGPT	Summarization of related work	Sec. 2.2	-
Dall-E	Image generation	Figs. 2, 3	++
GPT-4	Code generation	functions.py	+
ChatGPT	Related work hallucination	Most of bibliography	++

Checklist for Project Reports

- Business Understanding
  - What is the actual problem (in the domain)?
  - What is the target variable?
    - Classification/Regression/Cluster Analysis?

- Data Understanding
  - What is the distribution of labels / target variable?
  - Are all attributes and their types listed and important attributes explained?
  - What is the quality of the data? Wrong values? Outdated?
  - What does correlation analysis reveal about attribute importance?

Checklist for Project Reports

- Preprocessing
  - Are missing values replaced (in case needed)?
  - Checked for outliers (and handled them)?
  - Validity tests of attributes (Height above sea level < 9000)?
  - Check for inconsistencies (age=42, birthday=03/07/1997)
  - Check for duplicates
  - Performed data normalization (e.g. US vs United States)
  - Additional features generated?
  - Has binning been tried out?
  - Feature subset selection necessary?

- External Knowledge:
  - Are additional datasets used?

Checklist for Project Reports

- ML approaches
  - How many different ML approaches were tried out?
  - Do you have at least one symbolic and one non symbolic approach?
  - Do you have at least one baseline (majority class / mean value / domain specific …)?

- Evaluation
  - Is there a train test split or 10-fold cross validation implemented
  - Is the evaluation stratified?
  - Cost matrix or not?
  - Are the hyper parameters tuned (in which range / which attributes) ?
  - Are the tests systematic?
  - Analyse a symbolic model (how does the decision tree / rules /… looks like)
  - What features do have a high impact on the result?

Checklist for Project Reports

- Result
  - Is the result critically evaluated
  - Is the result analyzed against the baseline
  - What does the result mean given the problem (could you use it)

Get Additional Advice from a Stanford Professor

- How to evaluate your model?
  - https://www.youtube.com/watch?v=TxTblROT9lY
- How to structure your project report?
  - https://www.youtube.com/watch?v=DZNwO-p5PGY
- How to present the results of your project?
  - https://www.youtube.com/watch?v=GGx7klcahzY

Christopher Potts

Final Exam

- Date: **Thursday, 12th June 2025**, time tba.
  - Duration: 60 minutes
  - Location: tba
- Structure: open questions that
  - Check whether you have understood the content of the lecture
    - We try to cover all major chapters of the lecture: cluster analysis, classification, evaluation, regression, association analysis, and text mining
  - Require you to describe the ideas behind algorithms or apply the methods
    - What is the advantage or problem of X compared to Y?
    - How do methods react to this special pattern in the data?
    - Given the following data. What happens?
- Might require you to do some simple calculations
  - You need to be able to use the most relevant formulas
  - You are not allowed to use a calculator (calculations are simple)

Deadlines - Overview

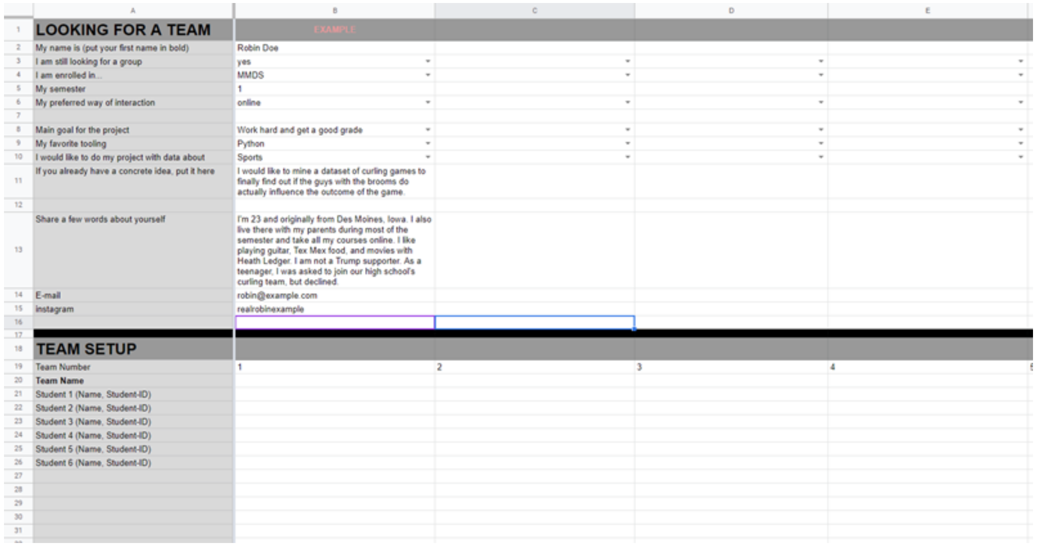
- Team formation until **Sunday, March, 16th, 23:56**
  - Either enter your whole team or
  - Enter your name if you are looking for a team (team assignment on Monday, October 7th)
- Project outline until **Sunday, March, 23rd, 23:59** via Ilias
- Coaching Sessions
  - Every team has to attend at least one coaching session
- Project report until **Sunday, May 18th, 23:59** via Ilias
- Project presentation in PDF until **Wednesday, May 21st, 23:59** via Ilias

Questions?

Team Assignment

- Find your team now!
- Enter your group in “Team Setup” in Google Sheet
  - In case you do not have a team, fill in your details in “Looking for a team”

  => then you will be assigned to a team after the registration period
- Do so until **Sunday October 6th 23:59**
- **Find the URL in the Ilias course**



	A	B	C	D	E
1	LOOKING FOR A TEAM	EXAMPLE			
2	My name is (put your first name in bold)	Robin Doe			
3	I am still looking for a group	yes			
4	I am enrolled in...	MMDS			
5	My semester	1			
6	My preferred way of interaction	online			
7					
8	Main goal for the project	Work hard and get a good grade			
9	My favorite tooling	Python			
10	I would like to do my project with data about	Sports			
11	If you already have a concrete idea, put it here	I would like to mine a dataset of curling games to finally find out if the guys with the brooms do actually influence the outcome of the game.			
12					
13	Share a few words about yourself	I'm 23 and originally from Des Moines, Iowa. I also live there with my parents during most of the semester and take all my courses online. I like playing guitar, Tex Mex food, and movies with Heath Ledger. I am not a Trump supporter. As a teenager, I was asked to join our high school's curling team, but declined.			
14	E-mail	robin@example.com			
15	instagram	realrobinexample			
16					
17					
18	TEAM SETUP				
19	Team Number	1	2	3	4
20	**Team Name**				
21	Student 1 (Name, Student-ID)				
22	Student 2 (Name, Student-ID)				
23	Student 3 (Name, Student-ID)				
24	Student 4 (Name, Student-ID)				
25	Student 5 (Name, Student-ID)				
26	Student 6 (Name, Student-ID)				
27					
28					
29					
30					
31					

Thank you