

# Exercise 1: Classification

VU Machine Learning  
Winter Semester 2021

## Goals

In this exercise, you will perform classification using multiple algorithms on a number of different datasets. The goal is to experiment with these different combinations and settings, and go through the whole machine learning process from getting your data, preparing it, making your predictions, to evaluating and comparing the results, discussing them and drawing final conclusions. You will experience how the size of your dataset affects the runtime and how different preprocessing strategies and parameters impact the performance of classifiers. You will learn how to measure and compare these changes, and thus improve the overall performance. You should investigate such changes, provide comparisons of your results and analyze them, to be able to discuss your findings.

You will also participate in our own Kaggle Competition within this course, in which you might earn bonus points for the exercise.

## Groups

Groups of exactly 3 students

- It is beneficial to remain in the groups from Exercise 0, but you may switch
- **Work as a team**

## Deliverables

Submission package, Name: Group00\_NameNameName

- 10-15 page report (including tables & diagrams)
- Code & scripts

Presentation

- Presentation dates will be published in the upcoming weeks  
In total, you will present 2 exercises out of 3; either Exercise 1 OR 2, AND exercise 3.

## Tools

Generally, you shall use APIs to enable repeatable, scalable experiments. Tools you can use include:

- Python / scikit
- WEKA (<http://www.cs.waikato.ac.nz/ml/weka/>) - use the API, not GUI
- R (<http://www.r-project.org/>) – advanced & powerful software – if you know R already, or you want to learn it
- Rapid Miner
- MATLAB

## Exercise

### **Datasets:**

You will use 4 datasets:

- 2 from our own Kaggle competition
- 1 from Exercise 0 (unless you encounter issues)
- 1 that you still need to find

IMPORTANT: You must choose diverse datasets, with different properties

- number of samples – small vs. large
- number of dimensions – low vs. high dimensional
- number of classes – few vs. many classes
- pre-processing needed...

### **Classifiers:**

You will choose 3 different classifiers from different types of learning algorithms

- So in the end you will have  $4 \times 3$  combinations of datasets  $\times$  classifiers
- You can use any classifier - ones already covered in the lecture, ones that will be covered in the lecture, and also those that won't be covered in the lecture
- But make sure that you choose from at least two different "types" / "paradigms" - i.e. do not choose 3 tree-based classifiers, or 3 NN based classifiers, or 3 ensembles, ....

### **Task:**

Perform necessary steps as presented in the lecture:

#### **Importing the data**

**Data Exploration and Preprocessing** (missing values, outliers, scaling, encoding, etc.)

Carry out the **classification**:

- Run classifiers, and **Experiment** with:
  - Different classifiers and your datasets
  - Different parameter settings (= several results per classifier per dataset, not only random/best)

Evaluate and analyse the **performance** (primarily effectiveness, but also provide basic details on efficiency):

- Choose **suitable, multiple performance measures**
- Make **valid** comparisons (among the classifiers, across your datasets, parameters, preprocessing effects...)
- (How) can you improve the results?
- Can you identify any patterns/trends?
  - Which methods work well and which did not, is there e.g. one method outperforming the others on all datasets?
  - How do the results change when preprocessing strategies change? How sensitive is an algorithm to parameter settings?
  - Are there differences across the datasets? Design your experiments so that you can investigate the influence of single parameters.

Perform **significance testing** against at least one **baseline**

- Make sure you are comparing results that **can** be compared to each other!

Compare **holdout** to **cross-validation**

- Pay attention to your splits and settings

- Are there differences? Why? In which metrics? What could have caused it?
- Compare/document changes in **runtime** behavior with the changing e.g. dataset size

Summarize your results in **tables, figures!**

Document your **findings, issues:**

Write a report

Make a presentation

Upload your best results to **Kaggle competition** (more information below)

You do not need to implement the algorithms, rely on libraries/modules

- Code just for loading data, pre-processing, running configurations, processing/aggregating results, ...

#### Grading scheme: **with** presentation

20% datasets & classifiers description/choice reasoning, preprocessing  
 30% classification  
 30% analysis of results, summary, interesting findings  
 10% presentation  
 10% submission package & report(formal requirements, clarity, structure)

#### Grading scheme: **without** presentation

20% datasets & classifiers description/choice reasoning, preprocessing  
 35% classification  
 35% analysis of results, summary, interesting findings  
 10% submission package & report(formal requirements, clarity, structure)

Keep in mind that the grading categories are dependent on each other (e.g. if you do not use preprocessing when needed, your classification and overall analysis will suffer)

Your methodology and reasoning are more important for grading than just achieving the highest e.g. accuracy when performing classification

## **Pointers for your project**

Apply the knowledge from the lectures

Document the whole process

Carefully design your experiments

- work out your **experiment design together as a group**

Important points:

- Explain your choice of **datasets**, introduce them, their characteristics
- Briefly describe the **preprocessing** steps and argue why you chose them
  - Evaluate their **impact** on the results (mainly scaling)
- Explain your choice of **classifiers**, describe their characteristics
  - there is no need to give lengthy explanation about how a classifier works (do not repeat what you heard in the lecture)
- Argue on your choice of **performance measures**
  - Think and find multiple, suitable measures, argue why you chose them (why are they necessary, what do they measure/tell us about the performance), and if they are sufficient
- In the report, include a paragraph briefly describing the steps you took to **ensure** that the **performance of the classifiers can be compared** (think if the comparison makes sense & research what needs to be fulfilled in order to e.g. compare

the performance of multiple classifiers on one dataset, how to compare the impact of parameter changes etc.)

- **Discuss** your experimental results, compare them using **tables** and **figures**
- Provide an **aggregated** comparison of your results as well - i.e. a big table of the best settings and results for all combinations (and a summary/findings/conclusions!)
  - The idea is to extract knowledge from your results, not just list everything without explanations

## Presentation

Presentation dates will be published in the upcoming weeks

- ~10 minutes
- Present findings specific to your project
  - Interesting findings, issues, conclusions
  - Usefulness of the algorithms for your datasets
  - Comparison of classifiers
  - Keep the overview of datasets, algorithms brief, Do not repeat materials from the lectures, No code in your presentation slides

## Report

10-15 pages long, Name of the report file: Group00\_NameNameName

Full report of your work, document the whole process

- Datasets, preprocessing, algorithms, experiments, explanation of your choices, arguments, comparisons, analysis, discussion, tables, figures, conclusion.....
- Structure & Readability
  - Important: structure, organization, clarity and readability of the report
  - Pay attention to clarity and readability of the report, and your tables and visualizations (scale, legend, axis labels, etc.)
  - You are free to choose your own structure/outline, but make sure basic formal requirements are fulfilled (length, title, sections, page numbering, your names, etc.)
- Do not include code in the report (only in the your submission package)

## Competition

We will use Kaggle In-class (<https://inclass.kaggle.com>) for a competition

Submission requires a simple CSV file

- for each sample in the test set: <id>,<predicted class>

Pick two of the datasets provided in TUWEL

Number of uploads to Kaggle per day is limited - start early!

- That way you also have early feedback on your results compared to other groups  
First try locally what works, only then upload to Kaggle
- 15% Bonus points for the top 3 teams!  
+5% Bonus if you also have your notebooks running in Kaggle  
(% of your grade, hence you can get 20 bonus points only if your project grade is 100%)
- Group name: Group00 NameNameName
- Your notebook's name: Group00 NameNameName (no points otherwise!)  
See <https://www.kaggle.com/notebooks>

**Keep it private, and share it with the kaggle users "rmayer" &  
"AndreaSiposova"**