VU Machine Learning

Winter Term 2025

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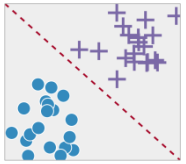
Topics

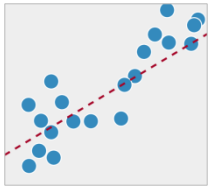
- Lecture deals with *supervised* machine learning & reinforcement learning

- Unsupervised learning: e.g. cluster analysis (is **not** part of this lecture)

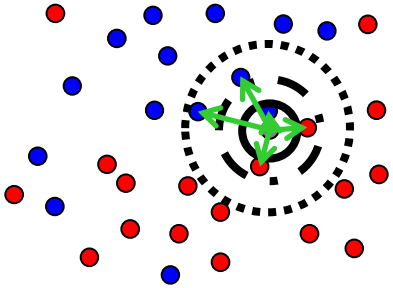
- Supervised prediction of a nominal class label: *classification*



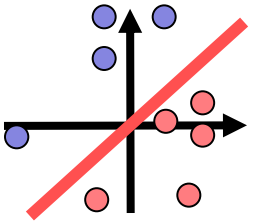
- Supervised learning to predict continuous output variables: *regression*

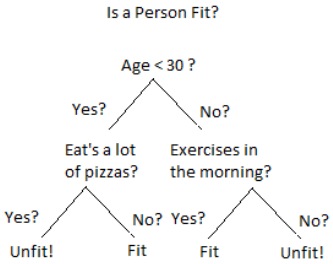


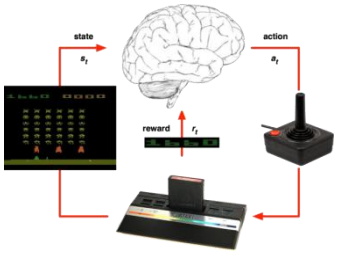
Topics



- Data types & data preparation
- Supervised machine learning algorithms
  - Decision Trees, Random Forests
  - Support Vector Machines
  - Bayesian Networks
  - Regression techniques
  - Logistic Regression
  - Perceptron, Neural Networks, Deep Learning
- Metalearning & Automated ML
- Ensemble learning
- Reinforcement learning
- Model selection
- Evaluation, Significance testing







Target Group & Prerequisites

- Prerequisites:
  - Basic mathematics & statistics knowledge
  - Vector / matrix operations, probability density functions, etc..
  - **Programming! (one of Python, R, Matlab, Java ...)**

- Target group:
  - Limited number of places available
  - Acceptance ranked according to target group
    1. Primarily: master/PhD students in **computer science** studies
       - Also: master students with the lecture in their curriculum
    2. Erasmus students with ML in their learning agreement
    3. Computer sciences students **finishing** their bachelor within this semester
    4. If places available
       1. PhD students from other faculties, if relevant to their studies
       2. All other students
  - If you are in “category” 2-4:
    - Contact us, explain why you want to take the course

Course support

- Register for the course in TUWEL to access material
  - https://tuwel.tuwien.ac.at/course/view.php?id=68219
  - linked from TISS (automatic access when applied to lecture in TISS)

- TUWEL used for
  - Course materials (lecture slides, further readings)
  - Lab assignments
  - Forum

  - TISS forum etc. will **NOT** be used !!

Dates

- Lectures on Tuesdays 08:00-10:00, HS17 & Thursdays 16:00-18:00, EI9
  - **Not every week two lectures! But blocked in the earlier part of the semester**
  - **Tentative! Updated lecture schedule available in TUWEL!**

- Introduction, Perceptron
- Naïve Bayes, Covering Algorithms
- k-NN, Evaluation (intro), Data pre-processing
- Bayesian Networks
- Decision Trees, Evaluation (imbalanced, ...), Random Forests
- Predicting Numeric Values I
- Neural Networks: MLP, Deep Learning intro & CNN
- Predicting numeric values II
- Deep Learning: CNN, Transfer Learning, Robustness
- Automated Machine Learning, Metalearning
- Ensembles (ctd), Privacy, Explainability
- Reinforcement Learning
- Gradient Boosting, Recurrent Neural Networks
- Significance testing, Feature Selection, Q&A
- Reinforcement Learning 2
- Support Vector Machines

Evaluation

- Written exam (in class room): January 2026
  - **1 repetitions in February**
- Exercises/assignments
  - Different tasks (experiments, implementation, ...)
  - Group work of (**exactly**) 3 students
    - You need to form groups yourself. Start early!
    - **You are responsible for managing the work in your group**
      - Grading will be the same, even if group members leave
  - Late hand-in (max one week!): 20%-points penalty deduction
  - (i.e., you can only reach 80% of the points awarded)

- Exam and exercises contribute each 50% to overall grade
  - Each part (exam, each assignment) individually has to be passed with a positive grade !

Assignments

- Preliminary small exercise: dataset selection & description

- 1st assignment: Experimentation
  - With a machine learning **API** (e.g. Python sk-learn, R, Matlab, ..)
  - Experiments with data pre-processing, different data sets & **classifiers**
  - Written report (~10 pages)
  - Discuss pre-processing, findings, differences in results per technique and datasets, patterns found, …
  - Interpret and analyse result
  - In-class presentations
- 2nd assignment: Implementation & evaluation of an algorithm
  - Regression OR classification
  - Individual discussions

Assignments

- 3rd assignment: Detailed Experiments and programming
  - Implementation of machine learning algorithm / techniques
  - E.g., Python, Matlab, R (other languages on request), Java (WEKA),
  - Group work (can be the same as for the first assignments)
  - Discussions: end of January
    - Attendance at presentation compulsory
  - More details after the second assignment

Assignments – presentations

- You will present your findings in hand-in discussions (~30 minutes) or presentations (slots of ~2 hours, with 8-10 groups in each slot)
  - All are in-class (no online / hybrid option)
  - **Each group member has to be present for the whole slot**

  - You can pick your slot in TUWEL, several dates will be available
  - But there is a first-come first-serve policy
    - I.e. if you have time restrictions, book a slot that suits you in time!
    - If you fail to present, it counts as not having submitted

Assignments

- Timing
  - Preliminary exercise 0:
    - Available from next week week, submission 15.10.
  - Exercise 1:
    - Available after lecture 5, submission 10.11.
  - Exercise 2:
    - Available after lecture 10, submission 10.12.
  - Exercise 3:
    - Available after lecture 14, submission before presentations
      - January 20

  - Presentations/Discussions: in the days after each of Exercise 1/2/3

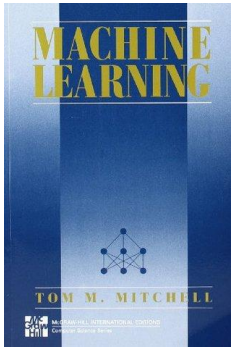
Related lectures

- Self-Organising Systems (188.413)
  - Unsupervised: Self-Organising Maps, Genetic Algorithms, Agents, …
  - Winter semester
- Information Retrieval (188.412)
  - Feature extraction from text & music, (genre) classification
  - Summer semester
- Problem Solving and Search in Artificial Intelligence (181.190)
  - AI search techniques, learning in search
  - Summer semester
- Security, Privacy and Explainability in Machine Learning (194.055)
  - Attacks on ML; explaining ML models; data privacy for machine learning
  - Summer semester
- https://www.ml.tuwien.ac.at/teaching/
  - E.g. theoretical Foundations and Research Topics in Machine Learning (194.100)

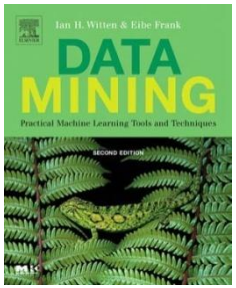
Literature

Books

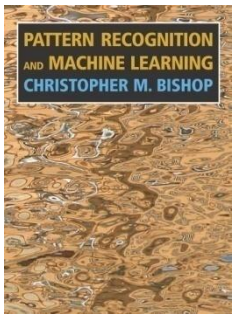
- Tom Mitchell, “Machine Learning”



- Ian Witten, “Data Mining: Practical Machine Learning Tools and Techniques” (WEKA Authors)



- Christopher Bishop, “Pattern Recognition and Machine Learning”



- Ian Goodfellow and Yoshua Bengio and Aaron Courville “Deep Learning”, https://www.deeplearningbook.org/

Questions ?