Introduction to machine learning

Federica Eduati, Mitko Veta, Cian Scannell

Eindhoven University of Technology
Department of Biomedical Engineering

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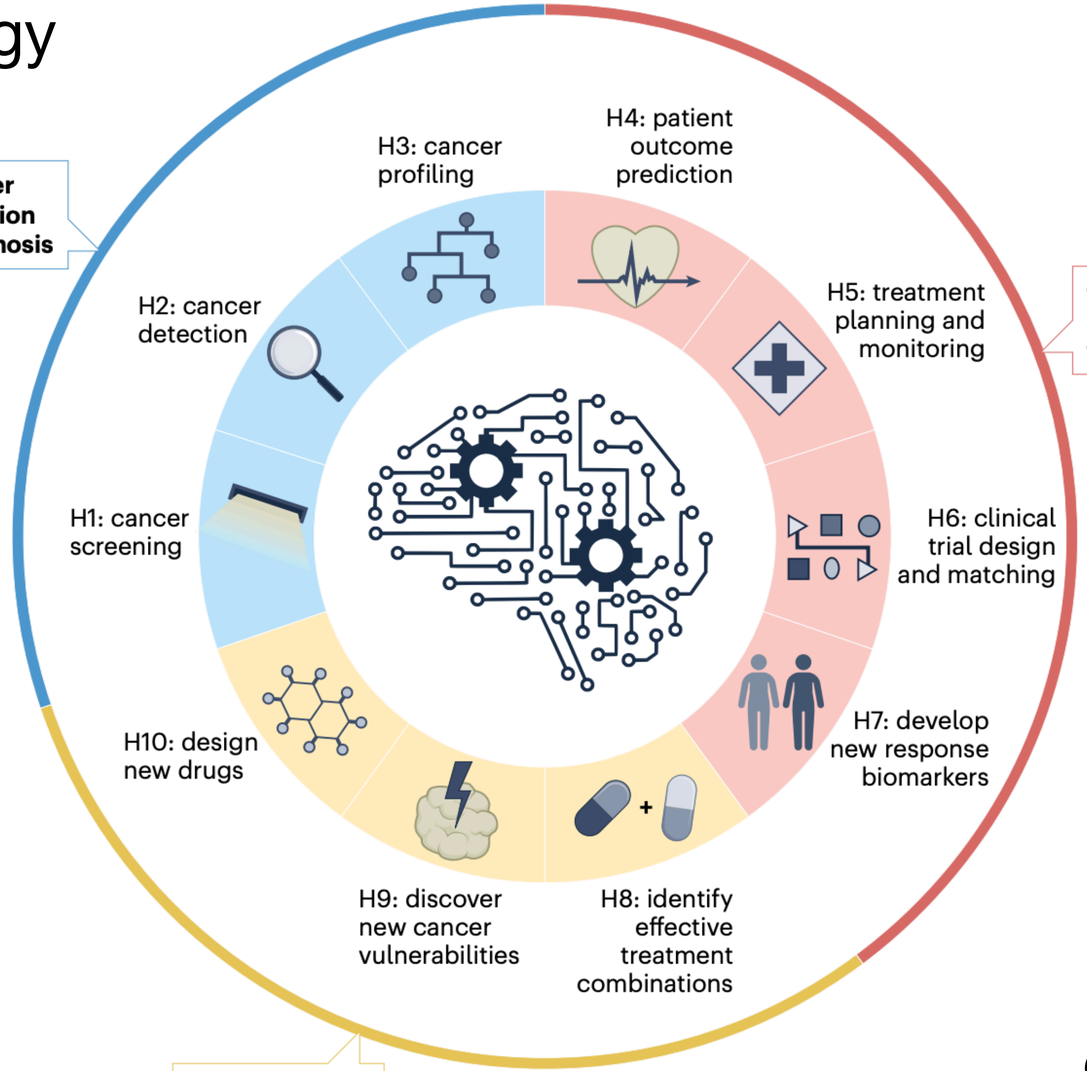
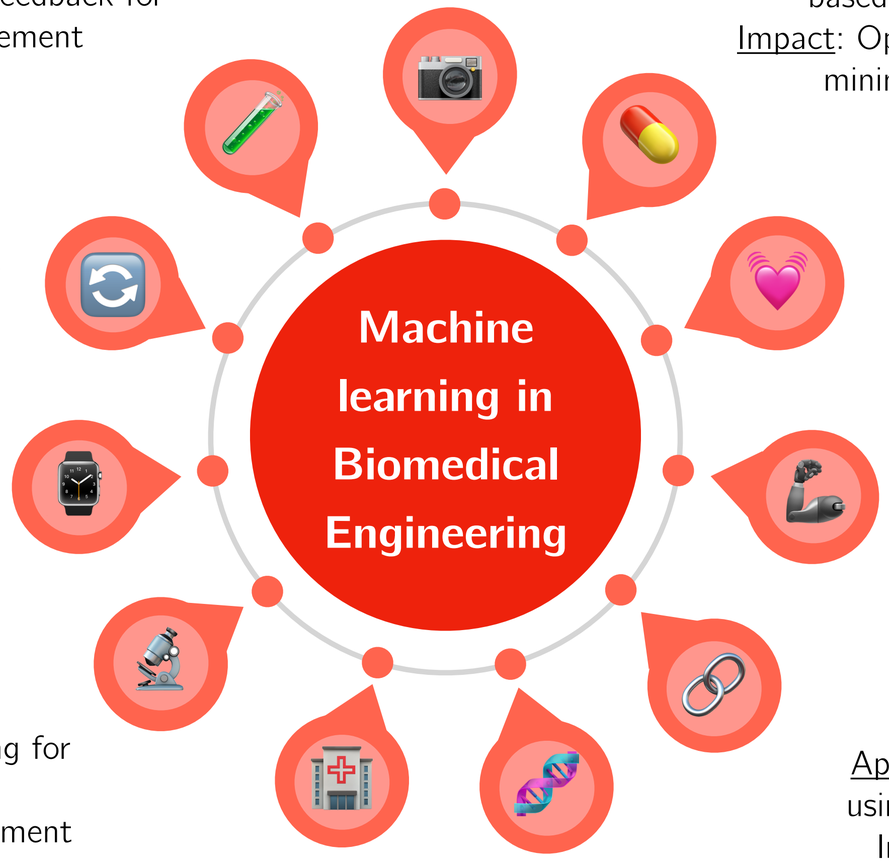
AI: from basic research to clinical application

AI in precision oncology



Chang et al., Hallmarks of artificial intelligence contributions to precision oncology, *Nature Cancer*, 2025



Medical Imaging
Application: Cancer detection from CT, MRIs
Impact: Early diagnosis with high accuracy

Molecular Biosensing
Application: ML-enhanced sensors for real-time disease monitoring
Impact: Immediate feedback for patient management

Personalised Medicine
Application: Tailoring treatments based on patient data
Impact: Optimised therapy with minimal side effects

Systems Biology
Application: Modelling biological systems and pathways
Impact: Deeper understanding of life processes

Signal Processing
Application: Real-time heart disease monitoring (ECG)
Impact: Early warning of cardiac events

Wearable Tech
Application: Monitoring chronic diseases (e.g., diabetes)
Impact: Real-time health insights for patient management

Soft Tissue Engineering
Application: ML-driven design of biomaterials for tissue repair
Impact: Improved outcomes in tissue regeneration

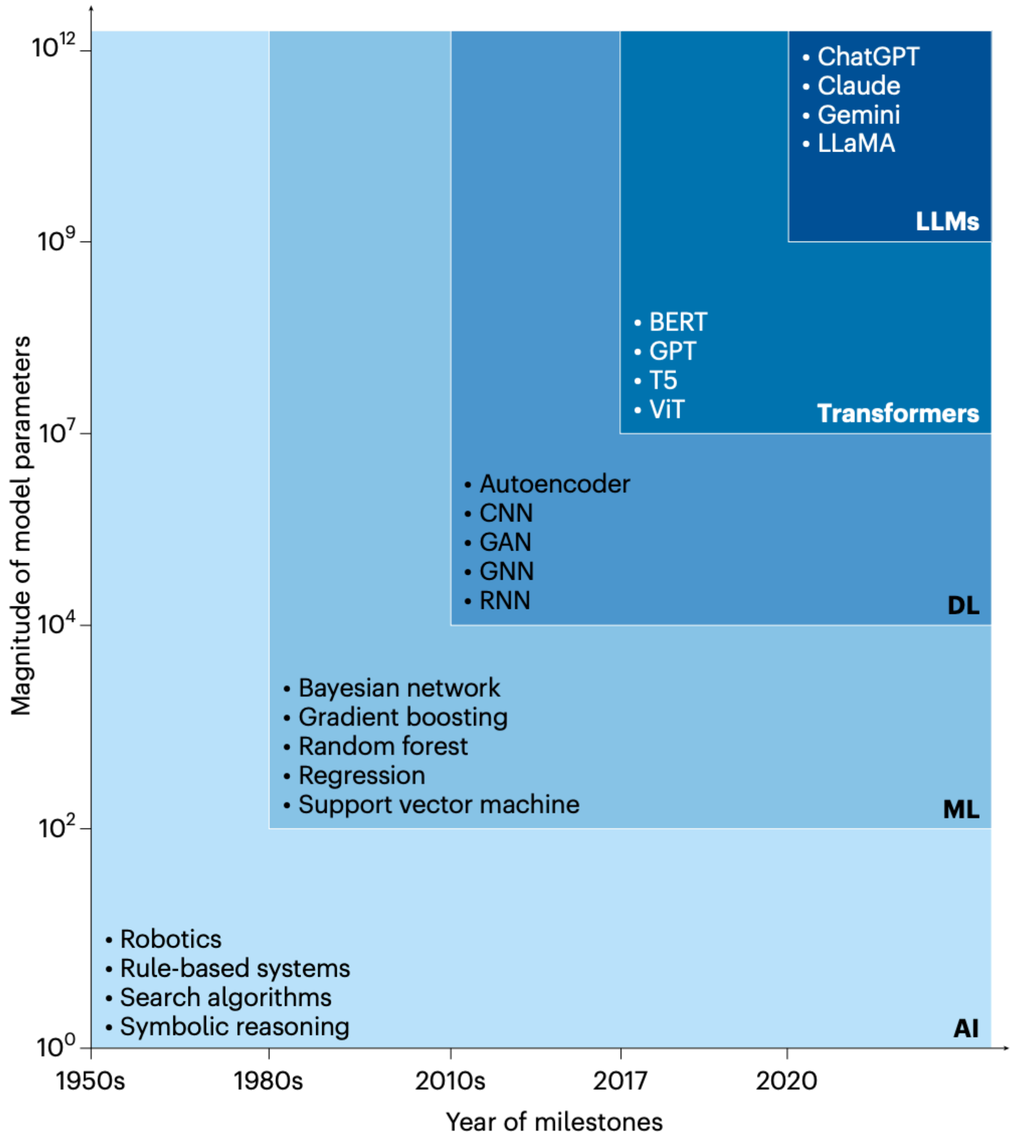
Drug discovery
Application: Virtual screening for drug candidates
Impact: Faster drug development

Protein engineering
Application: Designing proteins using ML for targeted therapies
Impact: Innovations in drug development

Healthcare operations
Application: Predicting hospital admissions
Impact: Efficient resource management

Nanomedicine
Application: ML for designing and optimising nanoparticle drug delivery systems
Impact: Targeted treatment with reduced side effects

How AI models have grown over time



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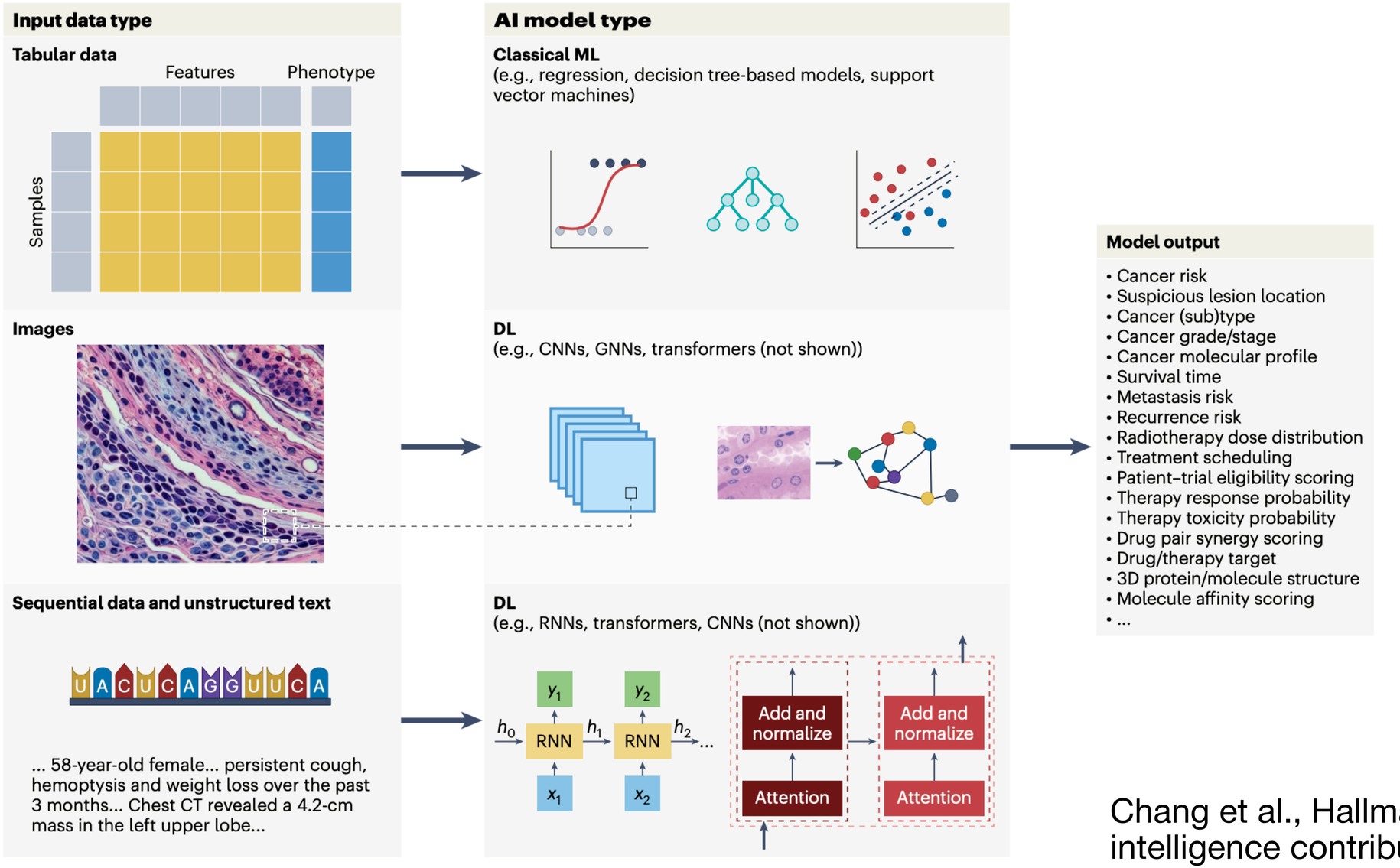
Choosing the right model for the problem



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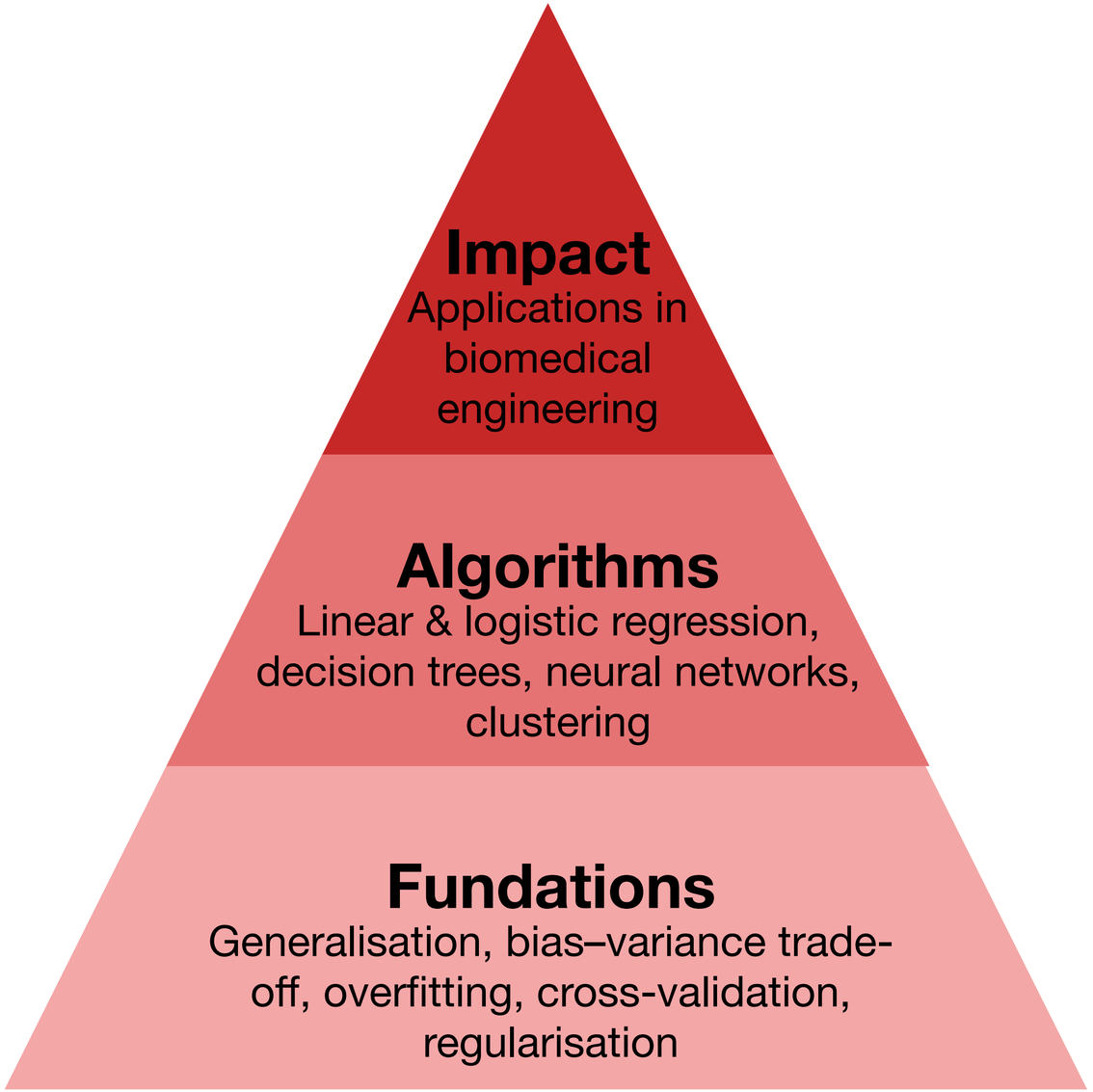
How we approach machine learning



Course structure

Week	Lecture	Practical
1	Machine learning fundamentals	Project 0: Introduction
2	Linear and logistic regression	Project 1.1:Linear and logistic regression
3	Regularization for linear models	Project 1.2: Regularization for linear models
4	Methods for classification	Project 1.3: Application of linear models to a case study
5	Neural networks, part 1	Project 2.1:Neural networks, part 1
6	Neural networks, part 2	Project 2.2: Neural networks, part 2
7	Unsupervised learning	Project 2.3: Application of neural networks to a case study

Week 1-7 lectures and practicals (all on Wednesday). Week 8 (the week before the exam) has no lecture nor practical.

Assessment

- 70% written exam
- 30% practicals

Practicals: connecting theory and practice

- Work in groups of up to 5
- Mix of programming tasks and open questions
- Purpose:
  - Strengthen theory from lectures
  - See hands-on what ML concepts mean in practice
  - Intermediate feedback on your understanding
- Two projects are graded (1.3 and 2.3) $\rightarrow$ 30% of final grade (group grade*)

* Individual grades may deviate if needed

Practicals: structure

- Divided in 3 projects
  - Project 0: Introduction (week 1)
  - Project 1: Linear models (weeks 2-4)
    - Project 1.1: Linear and logistic regression
    - Project 1.2: Regularisation for linear models
    - **Project 1.3: Application of linear models to a case study**
  - Project 2: Neural networks (weeks 5-7)
    - Project 2.1:Neural networks, part 1
    - Project 2.2: Neural networks, part 2
    - **Project 2.3: Application of neural networks to a case study**

Project 1.3 and Project 2.3 will be graded

Practicals: deliverables

- Submit a single zip file per group via Canvas (see submission deadlines in Canvas)
- Must include:
  - One Jupyter notebook
    - with experiments, results, visualisations, and answers to questions
  - Python functions and/or classes (.py files)
    - only if you used them in your notebook
- Clear documentation of your code and reasoning
- Follow the rubric on GitHub for grading criteria

Exam: concepts and reasoning

- Written exam (Week 9) $\rightarrow$ 70% of final grade
- Covers all lecture topics (not just those in practicals)
- Mix of:
  - Multiple choice (concept checks)
  - Open questions (reasoning, interpretation)
- Purpose:
  - Assess your grasp of the fundamentals
  - Test your ability to reason with ML concepts

Study material & tools

- Main guidance: lecture, lecture slides and practicals
- Book: “An introduction to statistical learning with applications in python:, G. James, D. Witten, T. Hastie, R. Tibshirani, J. Taylor

- GitHub repository is used for material dissemination
- Canvas is used for communication and submission/grading
- Lecture schedule is in My Timetable and on GitHub

Your feedback matters

- We are continuously improving this course
- Share your thoughts on:
  - Lecture clarity
  - Practical workload & learning value
  - Exam preparation
  - ...
- Using suggestion box or talk to us directly
- Formal evaluations at the end of the course