IMAG/e

TU/e Technische Universiteit Eindhoven University of Technology

8DC00 Medical Image Analysis

Maureen van Eijnatten
Cian Scannell
Seb Harrevelt

Where innovation starts

Outline for today:

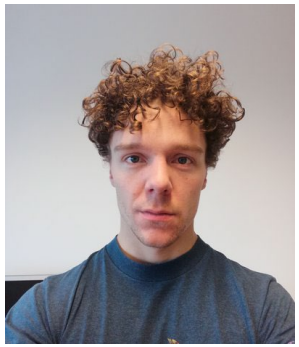
- Course introduction
- Introduction to image registration
  - Causes of misalignment
  - Applications of medical image registration
  - Classification of image registration methods
- Geometrical transforms
  - Recap linear algebra
  - Rigid and affine transformations
  - Non-linear transformations

Dr. Maureen van Eijnatten

Background: BSc and MSc in Medical Technology & Physics (VU University Amsterdam), PhD in Medical Image Processing for 3D Printing (Amsterdam UMC)
Research: Image-guided treatments, deep learning, cone-beam computed tomography

Dr. Cian Scannell

Background:
Research:



Seb Harrevelt, MSc

Background:
Research:

Guest lecturers

t.b.d.

Teaching assistants:

Roderick Westerman (MSc student)

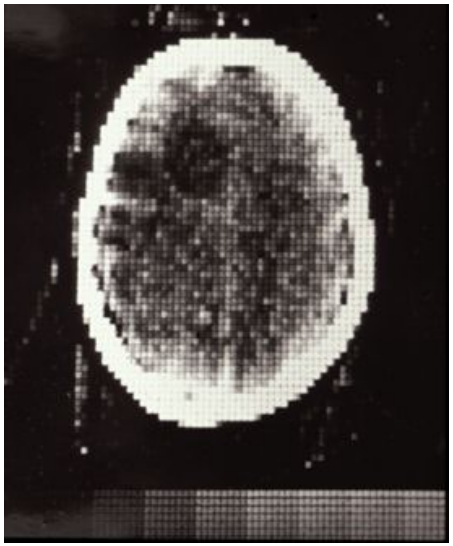
Kirsten Lukassen

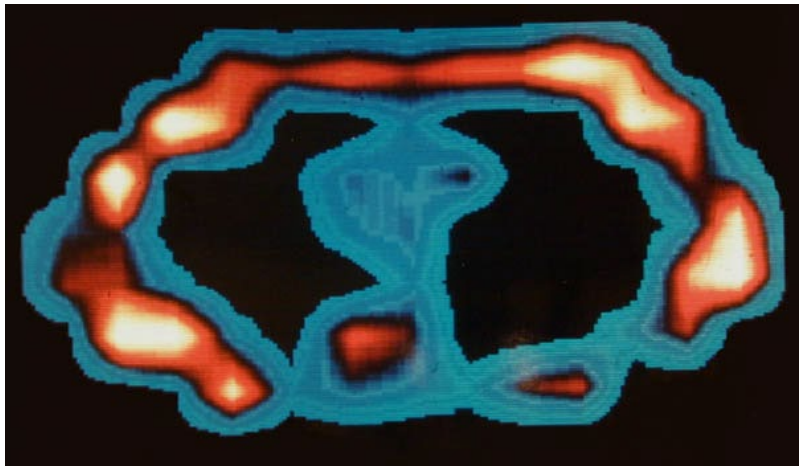
Lieke Bergmans

Rebecca Pelsser

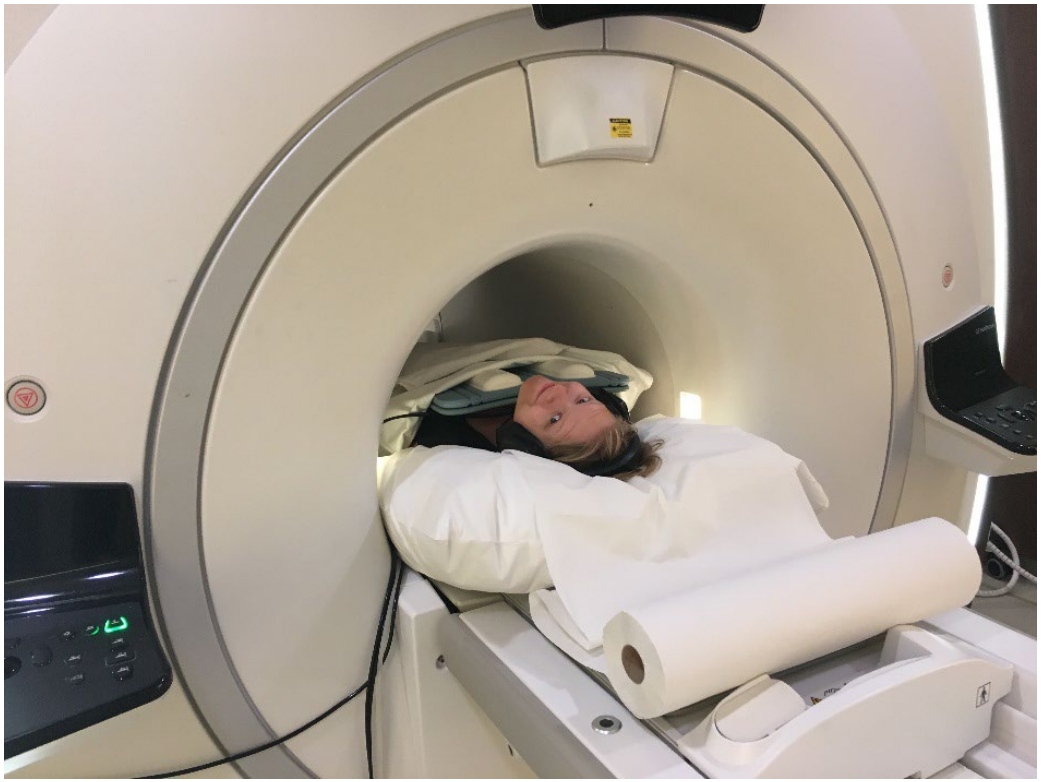
Linh Nguyen

You



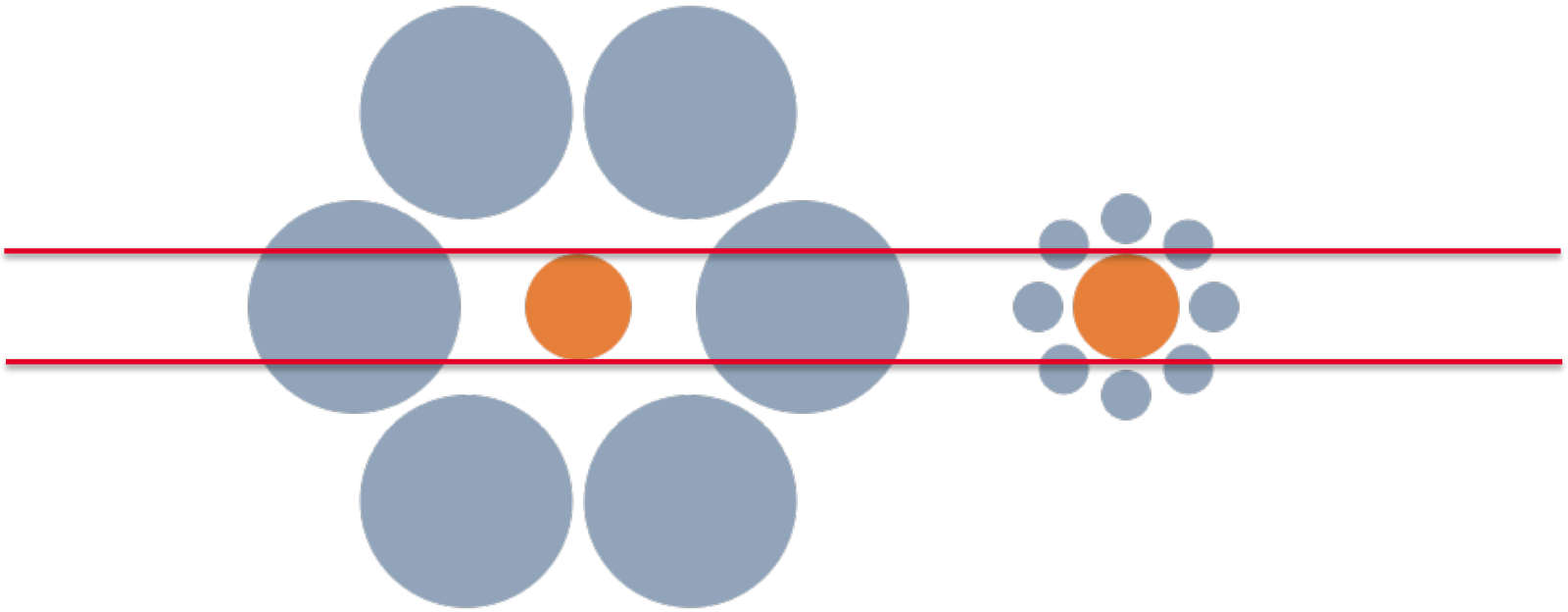


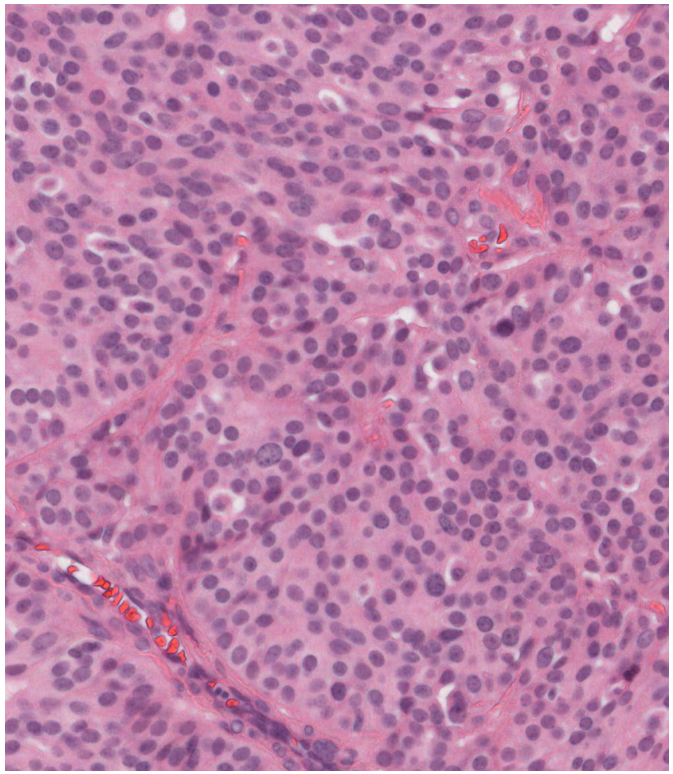
Present day in the Netherlands: 9K CT scans, 5K MR scans per 100K people

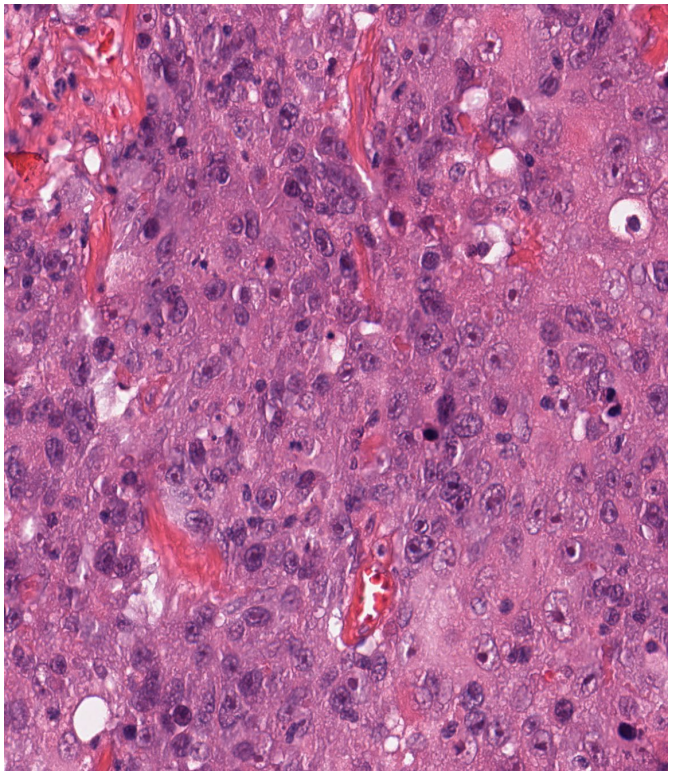


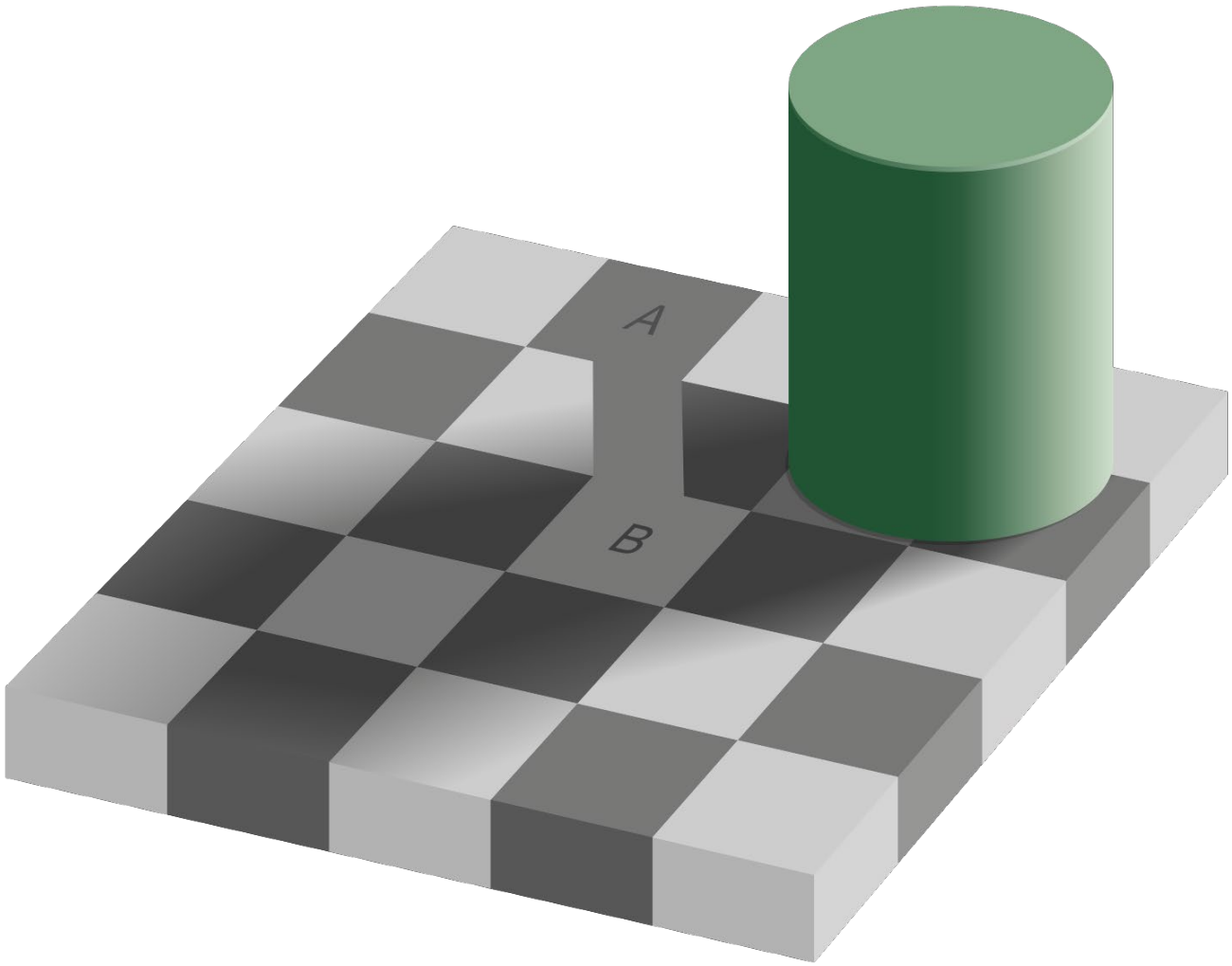
Source: Eurostat (2014)

Why automatic image analysis?








A
B

The goal of medical image analysis is to develop automatic methods that enable **faster, more reliable and quantitative** analysis of medical images.

Learning goals

After completing the course, the student…

..has insight of the role of medical image analysis tasks in addressing clinical questions.

… has knowledge of how basic engineering and mathematical techniques can be used to design medical image analysis methods.

… can implement and apply medical image analysis methods.

… can analyze the results of medical image analysis methods.

Place of the course in the curriculum:

8QA01 Image Analysis Project (1st year BSc)

8DB00 Image Acquisition and Processing (2nd year BSc)

8DC00 Medical Image Analysis (3rd year BSc or MSc)

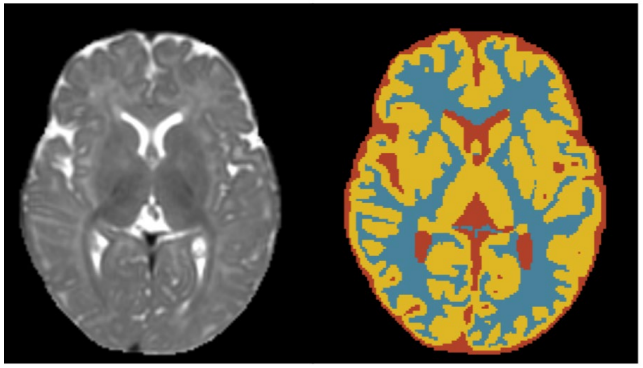
8P361 Project Imaging (3rd year BSc)

8DM20 Capita Selecta in Medical Image Analysis (MSc)

8DM40 Machine Learning in Medical Imaging and Computational Biology (MSc)

Overview of different medical image analysis tasks (2D, 3D, 3D+, …)

Image segmentation

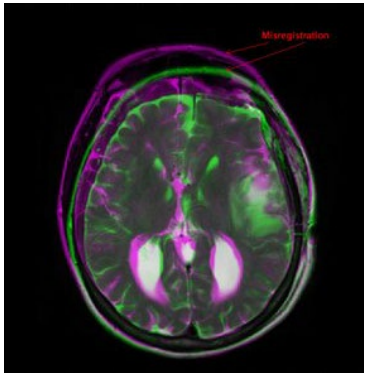


Dividing an image into multiple regions with similar properties (e.g., intensity values).

NB: these regions typically correspond to different anatomical structures.

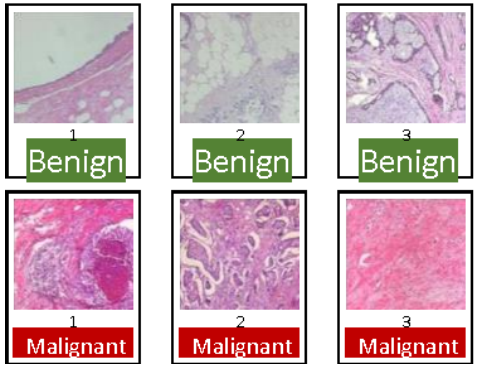
+ validation & active shape models (lecture no. 4!)

Image registration



Finding an optimal transformation that aligns two images.

Computer-aided detection (CAD)



Categorizing/labeling images based on specific rules.

Official definition: “systems that assist doctors in the interpretation of medical images, often based on machine learning”

This course

Course organization

Two main topics:

1. Medical image registration (Maureen)
2. Computer-aided diagnosis (Mitko)

Lectures, exercises & project work

8DC00

Medical Image Analysis (MIA)

8DB00 *Beeldvorming en -verwerking (year 2)*

8DM20 *Capita Selecta in Medical Image Analysis (Master)*

8DM50 *Machine Learning in Medical Imaging and Biology (Master)*

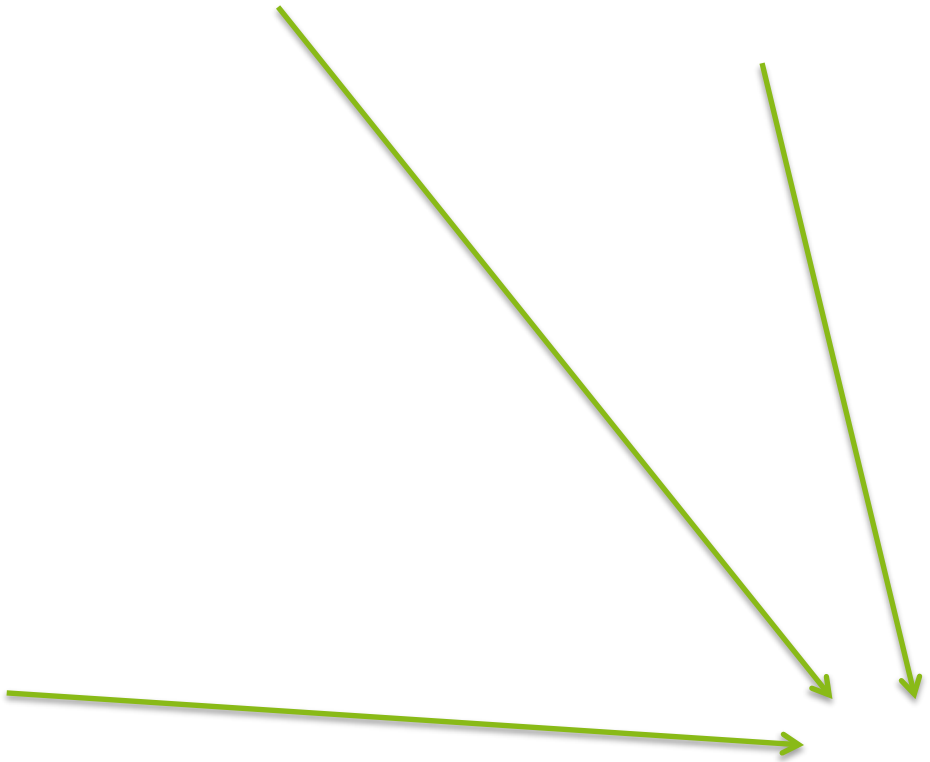
Pre-assessment:

Python quiz (week 1)

Covered during the whole course (Jupyter notebooks & 2 MIA-projects):

Python programming skills → Programming skills, implementation of basic engineering and mathematical techniques (e.g., optimization) in Python

Notebook 0.1



Legend: = MIA module = assessment = Jupyter notebook

Course schedule

Tuesdays and Thursdays: lectures and practicals (guided self-study)

Practicals:

You can work in **groups of up to 4 students** on:

- Exercises
- Project work

You can sign yourself up into a group on Canvas.

Focus is on exercises; project work should be independent.

Exercises

Goals:

- Help you study the material
- Develop code that can be used for the project work
- Not graded

Projects

- 2 projects (registration, CAD)
- Short report & code
- Graded

Detailed description of the project deliverables and assessment rubric can be found in the project handouts.

Guided project work: questions and extension of the code developed in the exercises that will guide you to a **minimal project solution**.

Assessment

- Projects
  - Medical image registration (15%)
  - Computer-aided diagnosis (15%)
- Written exam (70%), out of which 10% are questions related to the project, i.e. project accounts for 40% of the grade

Reading assignment:

- Study the following paper:

  Graham, Simon, et al. "*Hover-net: Simultaneous segmentation and classification of nuclei in multi-tissue histology images*." *Medical Image Analysis* 58 (2019): 101563.

  https://doi.org/10.1016/j.media.2019.101563

- Give a brief summary of the proposed method and discuss its advantages and weak points in your second **project report**. Assessment will be included in the grade of the report.

Important deadlines:

1. 10/09 Complete Python quiz in Canvas (**mandatory**)
2. 30/09 Submit report & code project 1 (image registration)
3. 25/10 Submit report & code project 2 (CAD)
4. 01/11 9:00-12:00 Written exam

Communication – digital platforms we will use during this course

- Communication
- Python quiz
- Hand in assignments (project reports & code)

- Course overview
- Python code for exercises and projects
- Handouts lectures

Communication

Main communication channel is Canvas: post your questions in the Discussion section.

The single best answer by a student* will get plus half a grade for the project work.

* Assessed by teachers and student assistants, assessment criteria: clearly written and helpful, demonstrates good understanding of the material.

Emailing is **discouraged** (e.g. only for individual circumstances and not related to content). If you do email, use the tag [8DC00] in the subject line.

How to effectively ask questions?

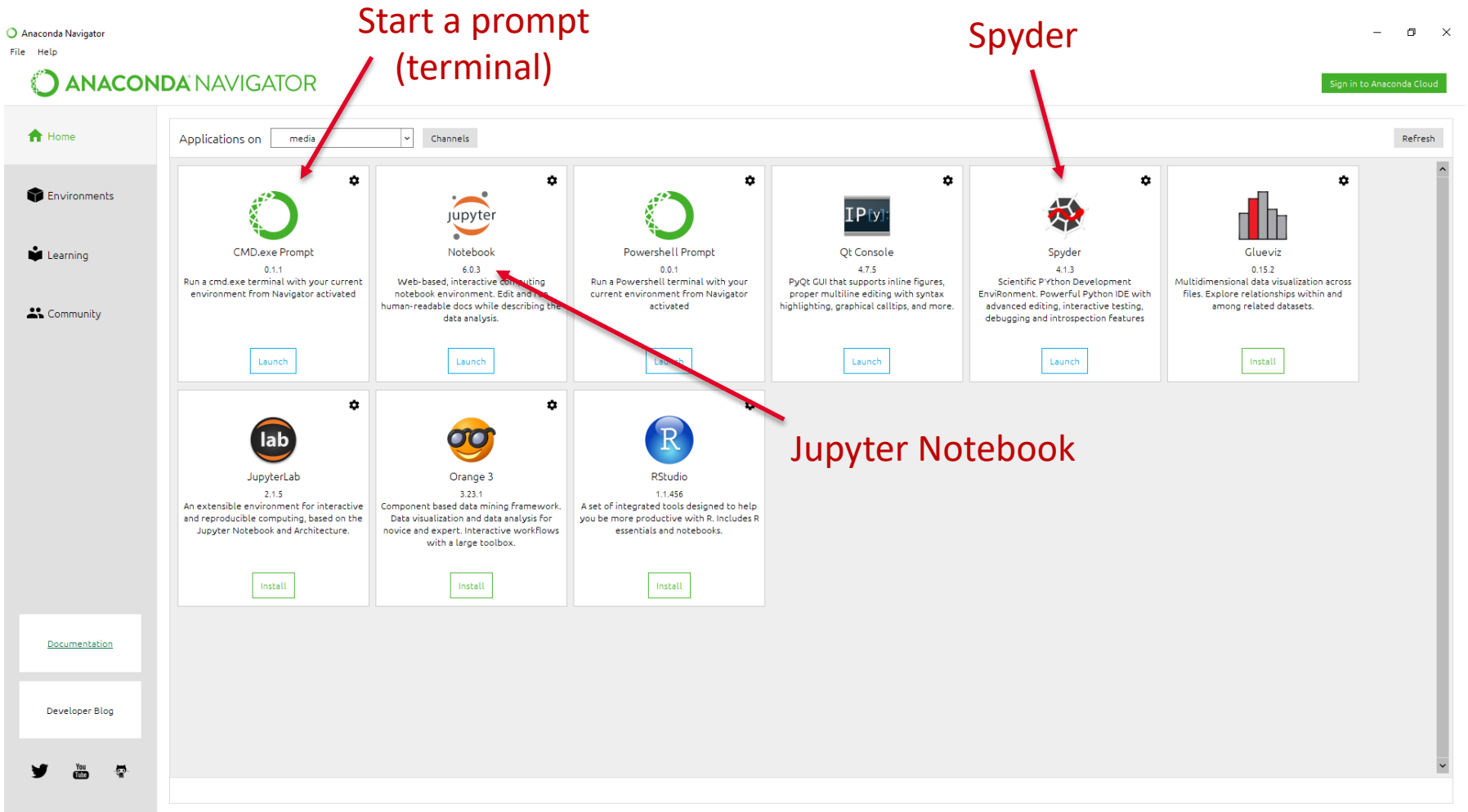
- **Start the question by explaining the context**
  - State the goal of the task you are working
- **Formulate a specific question**
  - “I don’t know how to solve Exercise 2” is not a specific question.
  - Be clear and honest about what you want to get out.
  - “Is this enough for the project work?” is not allowed.

- **Demonstrate that you have attempted to answer the questions or solve the problem**
  - Formulate a provisional answer (does not matter if it is correct or not)

- **Python:**
  - Read the documentation
  - Error messages are informative!
  - Before asking for help, make sure that your problem is reproducible

- **How to get started with the exercises and project work?**
  - Github page: https://github.com/tueimage/8dc00-mia
  - Follow software installation instructions:
    - Anaconda / packages
    - Python
    - Jupyter

If you prefer a GUI: Anaconda Navigator



Example of setting up a Python environment:

https://www.youtube.com/watch?v=AxSwTvnwCUU&t=45s