PROGRAMMING IN PYTHON II

Project Design and Outline

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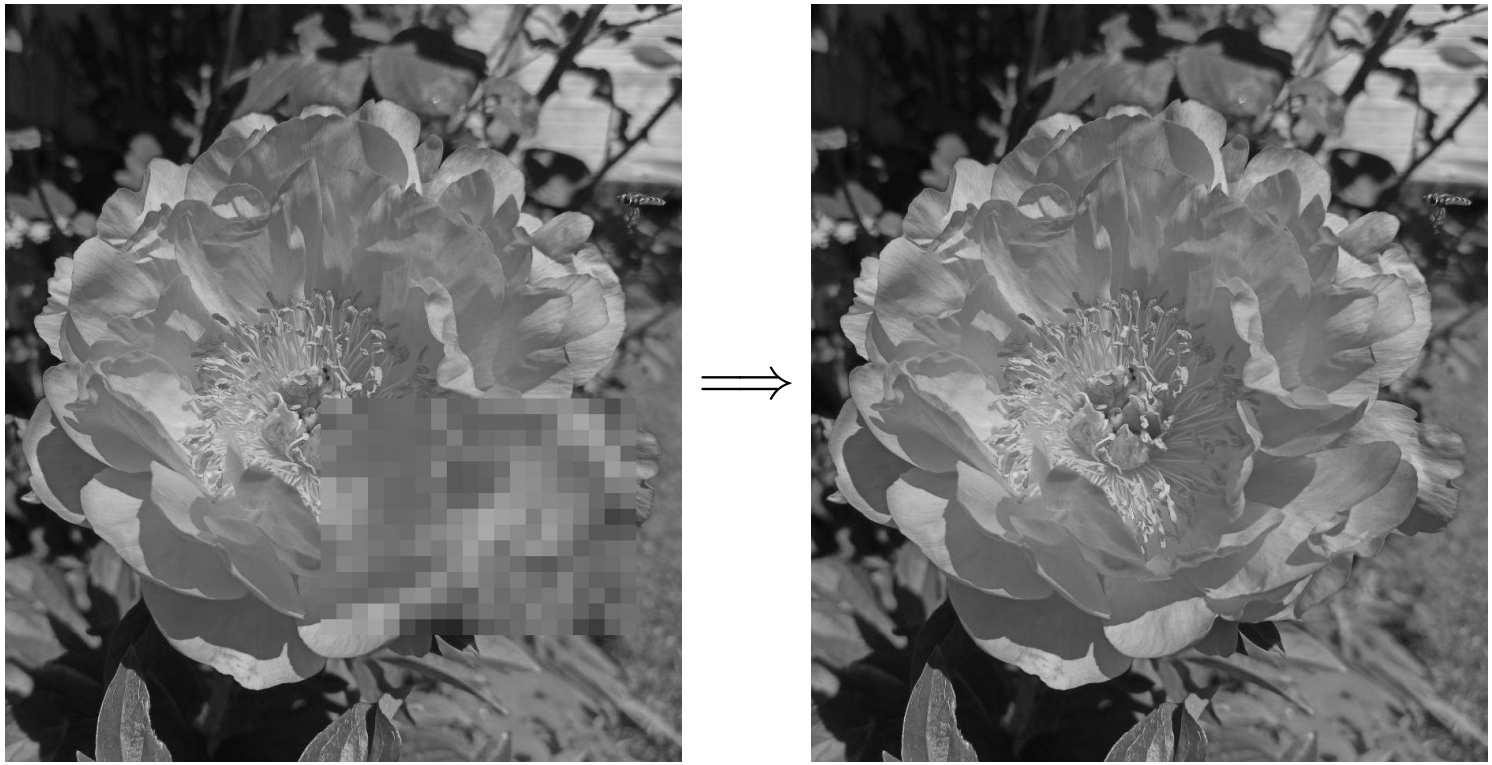
Motivation (2)

- When designing or implementing an ML project, you have to consider and constantly reevaluate multiple aspects
- Spoiler alert: The choice of the ML method itself is only one aspect of many

Motivation (2)

- We will go through the outline of the project design
- We will cover the details during the semester
- We will use our ML project as example



Project Design

- Common important aspects:
  1. What is the **project goal**?
  2. What **data** do you have? What data do you need? What does the data look like?
  3. What **hardware/software** do you have? What hardware/software could you have?
  4. What **ML method(s)** should you use?
  5. How to **evaluate** the methods/models?
- **There is no one-fits-all solution!** Specific tasks require specific considerations!

Project Goal

What is the project Goal?

- Very important aspect and often overlooked
- Requires communication with people from different fields, including management
- **Do not** make simplifications here! Make sure you are aware of the real (end) goal and communicate this!
- Rinse and repeat to overcome language barriers

Data (1)

What data do you have? What data do you need? What does the data look like?

- Data is money. Big data is big money.
- Sometimes the goals will follow from sufficiently large existing data
  - Best case but rather rare (our hunger for data is only limited by computational restrictions!)
- Sometimes the goals will follow from existing but insufficiently large data
  - Common case
  - Has influence on choice of ML method
  - Allows for educated guesses at sufficiently large data size
  - Can be a starting point for collecting more data

Data (2)

- Sometimes the goals are not backed up by any data
  - Very tricky and potentially dangerous!
  - You would have to make guesses about how much and which data would be needed
  - You would have to make guesses about the ML method performance in advance
  - You will need to interface with the data collection process (first get small dataset, then collect more)
  - You might waste a lot of time and money
- A dataset might be unsuitable for your purposes
  - Biases, artifacts, labeling errors, ...

Data (3)

- Make the most of your data
  - Talk to experts in the field of application/read up on the topic
  - Perform analysis of the data (e.g., clustering) and look for possible issues (e.g., biases, batch-effects)
  - Check if there is auxiliary data available
    - Pre-training on similar data, unused sorted-out data, data that is not suitable for training but for evaluation, . . .
  - Perform data preprocessing and augmentation
    - Normalization, oversampling, cross-validation splits, data augmentation, . . .

Hardware/Software

What hardware/software do you have? What hardware/software could you have?

- CPU, GPU or TPU based?
- Size of RAM and disk storage?
- Hardware compatible with ML software? Software restrictions from company/collaborations?
- Short-term or long-term project?
  - Rent or own? Little compute over long time or lots of compute over short term?
  - Possible start: First design/implement/experiment on owned hardware, then perform final tuning on rented hardware if needed

Methods

What ML method(s) should you use?

- Depends on goal, data and hardware
- You will need a theoretical understanding of the methods to judge which ones to consider
  - Literature research
  - Later semesters of AI study
- Start with baselines/less complex methods and models
  - Statistics, logistic regression, SVM, Random Forest, . . .
  - Check Supervised Learning before Reinforcement Learning and Unsupervised Learning

Evaluation

How to evaluate the methods/models?

- Which score/performance measure?
- Do you need to correct for biases?
- Which aspects of the goal are more important?
- What do you want to generalize to?

Python II Project: Goal (1)

Python II Project: Goal (2)

- Image Depixelation (recreation of pixelated area within an image)
- End goal: Best score on challenge server leaderboard
  - Pixelated image is fed into model, and model predicts plausible values for the pixelated area
  - Size of the pixelated area and pixelation block size should be freely selectable
  - Images should be grayscale images
- What is “plausible”?
  - Luckily, the challenge server decides for us: “Plausibility” is measured by the root-mean-squared error (RMSE) of the predicted pixels

Python II Project: Data (1)

- We will create our own dataset
- We will have the following data:
  - JPEG images up to 250kB
  - 100 images per student
  - Assumption: We collect roughly 30k valid images

Python II Project: Data (2)

- We will crop out parts of the original images, so we know the ground truth (no need to collect labels)
- This is probably a case with sufficient data for training our methods, but
  - We can use data augmentation to increase the dataset size
  - We could use additional data from the Internet (but it will not be necessary)
- We will have to
  - Clean up the raw data (exclude invalid files)
  - Perform analysis and preprocessing
  - (Possibly) perform data augmentation

Python II Project: Hardware, Software and Methods

- Hardware:
  - Notebook with CPU and 4GB of RAM should suffice
  - No need to rent/buy expensive hardware to speed up computations (you can, if you want)
- Main software:
  - Python $\geq$ 3.9
  - PyTorch
- Methods:
  - Simple **Convolutional Neural Network (CNN)**
  - You may also use other NN types/more complex settings
  - Design and fine-tuning is up to you

Python II Project: Evaluation

- Challenge server score determines the evaluation method
- Will use the root-mean-squared error (RMSE) of the predicted pixels