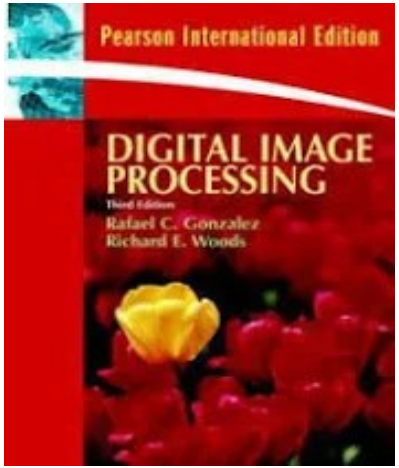
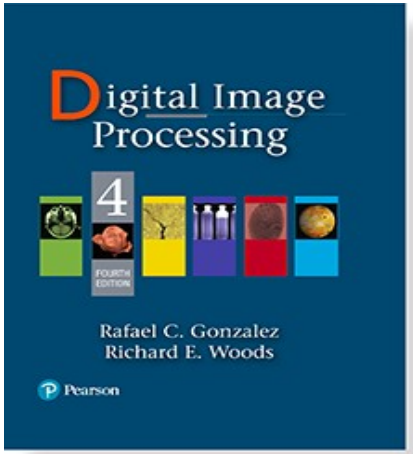
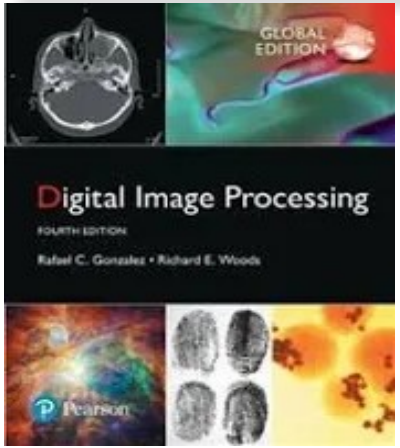
Digital Image processing
Image analysis
FYS-2010

Introduction

The course







Book
Editions:
3rd, 4th
or global 4th

ImageProcessingPlace.com

Course responsible:
Benjamin Ricaud
benjamin.ricaud@uit.no

Teachers:
Benjamin
Elisabeth Wetzer
Tetiana Lutchyn
Samuel kuttner (medical)

Exercise groups:
Magnus Størdal
magnus.stordal@uit.no
Sebastian

Course organization

- Sometimes we follow the book closely, sometimes we deviate
- Take notes, the slides are only a part of the information
- Don't be passive, take notes, ask questions...
- Practice, experiment with Python, explore the web, read blogs

- We use Python, most popular language for machine learning, data science

Week	Topic	Comments	Month
3	Introduction + spatial filtering	no exercise	January
4	Spatial filtering + Fourier	Teacher: Elisabeth Wetzer	
5	Fourier	Teacher: Tetiana Lutchyn + Benjamin	February
6	Fourier	Teacher: Tetiana Lutchyn + Benjamin	
7	Tomography + Img restoration		
8	Img restoration + Color images	Teacher: Elisabeth	
9	Color images + Multiresolution	Teacher: Elisabeth + Tetiana	March
10	mid term exam	Only exercise sessions	
11	mid term exam	no teaching	
12	mid term exam	no teaching	
13	Image compression + segmentation 1	Segmentation: Tetiana	
14	Medical images + segmentation 2	Teacher for medical img Samuel Kuttner	April
15	Superpixels, graphs + Neural networks	Superpixels: Tetiana	
16	Easter holidays		
17	Easter holidays		
18	Neural networks	No lecture on Tuesday	May
19		Last exercise session on Tuesday	
20			
21			
22			June
23			
24	Exam 11th of June		

Course organization

Per week:

- 2x 2 hours lecture
- 2x 2 hours exercises

- One mid term exam: practice
- One final exam, written

Course organization

Communication:

- Canvas https://uit.instructure.com/ (be sure to be registered)
- Discord https://discord.com/ (server link on Canvas)

Exercises and practice:

- Python programming language
- Jupyter notebooks (recommended)

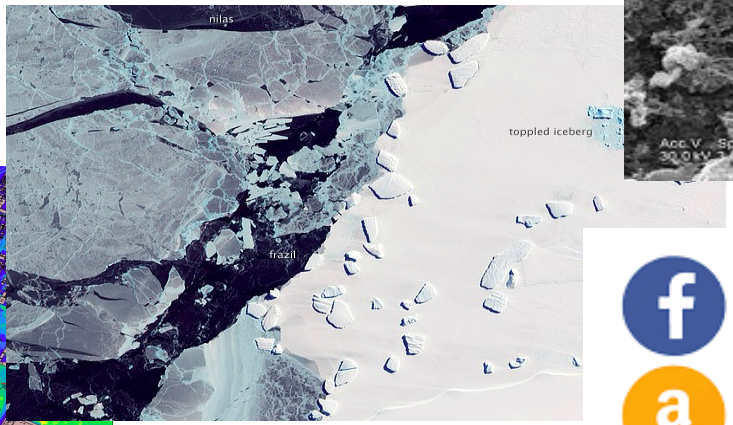
Anaconda for an easy installation on Windows/Mac/Linux
https://www.anaconda.com/
You will need to use Python for the mid-term exam.

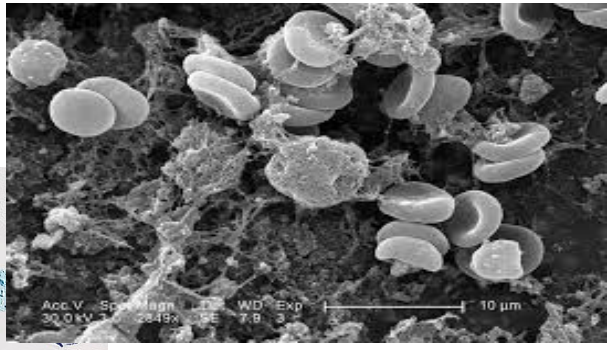
Motivation

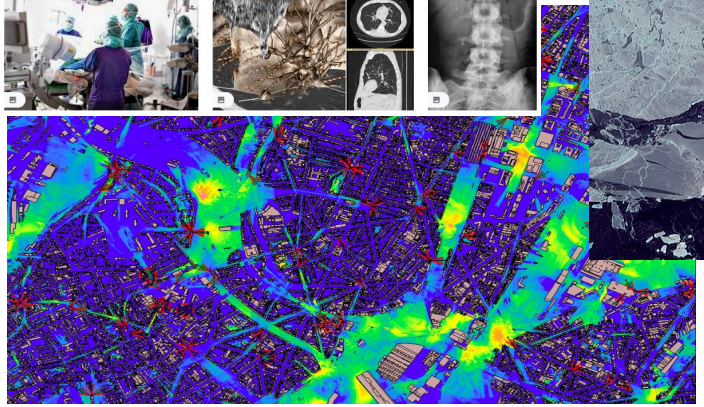
Images everywhere

Healthcare, biology, earth science, physics, technology...

+ everyday life







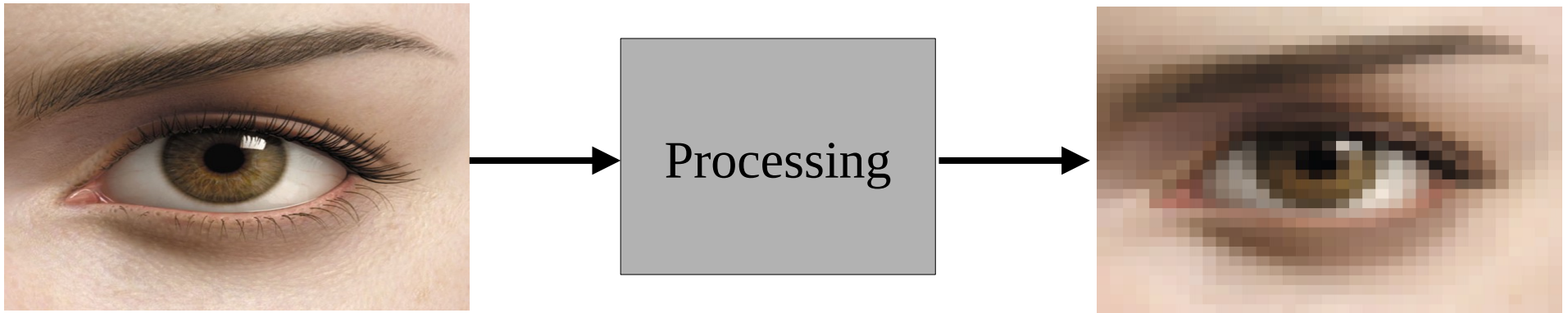
Motivation

What can we do with an image?

Image processing: **input:** image, **output:** image (modifying, improving the image, compressing...)

Image analysis: **input:** image, **output:** other data (plots, histograms, classification...)

Computer vision: **input:** image, **output:** other data (detection, classification...)



Example: image acquisition, digitalization, compression ...

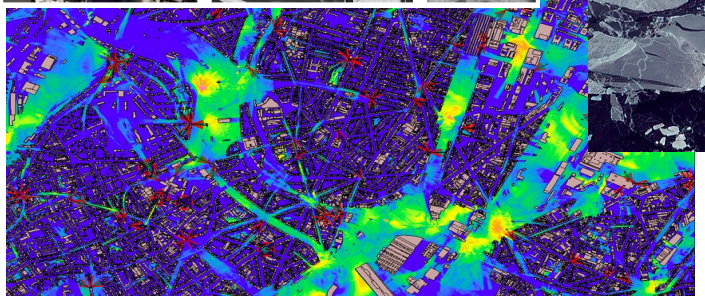
Motivation

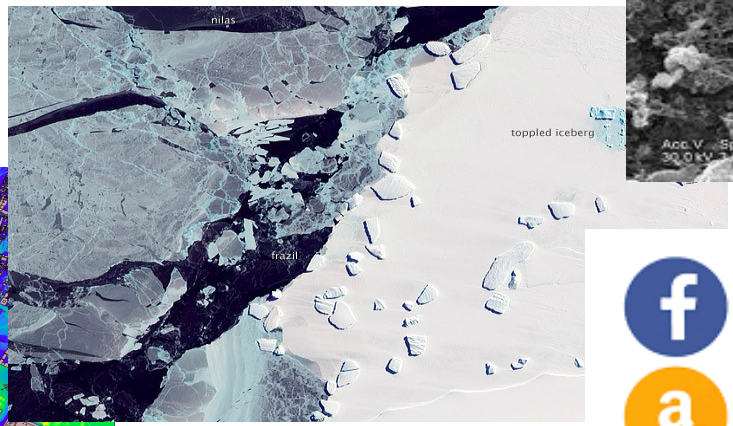
High level questions

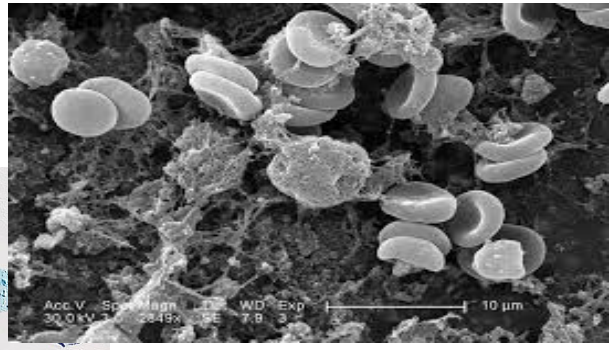
What is important in an image?

The color? A pixel? A group of pixels? An area?

Extract / highlight information from images, make it more visible

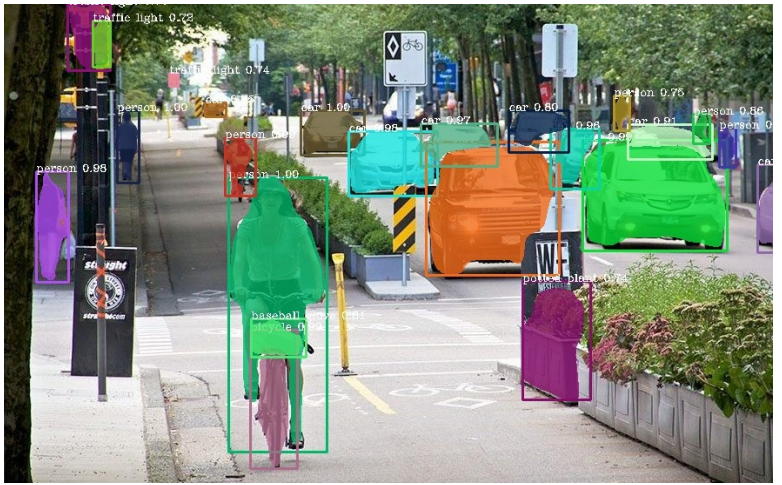






Motivation

The AI revolution



Object detection and segmentation
https://github.com/ayoolaolafenwa/PixelLib

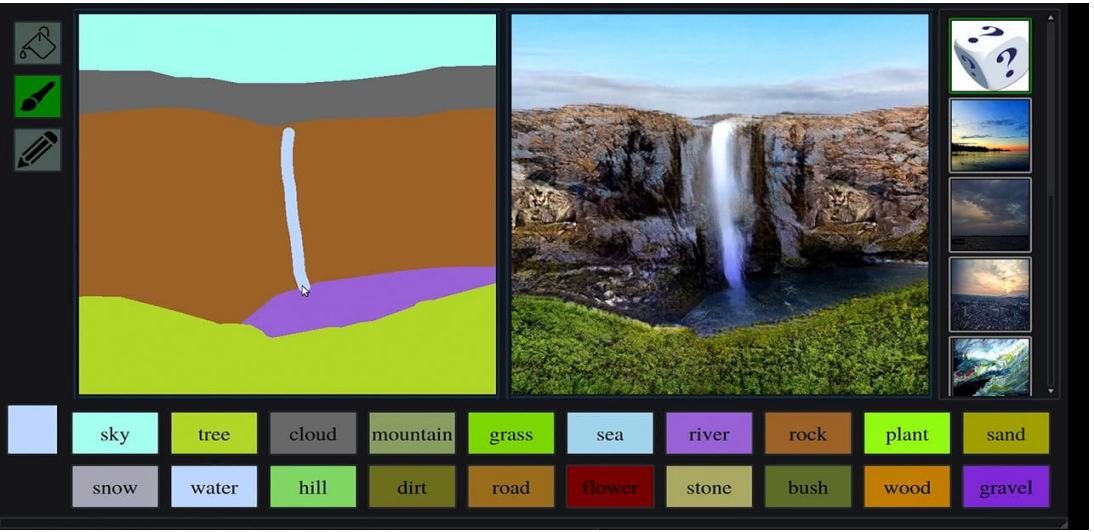


Image generation
Gaugan, Nvidia
http://gaugan.org/gaugan2/

https://segment-anything.com/

Motivation

The AI revolution

The generative models: diffusion models, stable diffusion
https://huggingface.co/spaces/stabilityai/stable-diffusion
https://www.reddit.com/r/StableDiffusion/
Inpainting / outpainting:
https://replicate.com/cjwbw/stable-diffusion-v2-inpainting
https://github.com/lkwq007/stablediffusion-infinity
AI art
https://www.nytimes.com/2022/09/02/technology/ai-artificial-intelligence-artists.html

The New York Times

THE SHIFT

An A.I.-Generated Picture Won an Art Prize. Artists Aren't Happy.

"I won, and I didn't break any rules," the artwork's creator says.

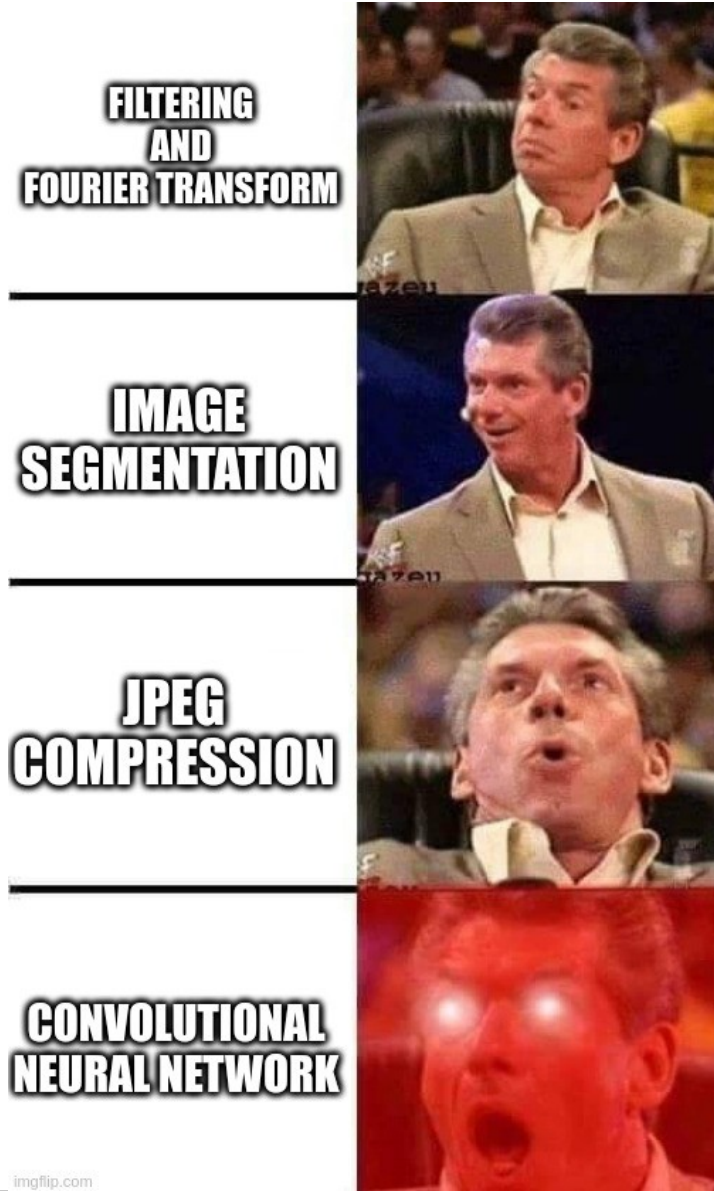
Super resolution:
https://ai.googleblog.com/2021/07/high-fidelity-image-generation-using.html

Motivation

What is in the course?

- Important theoretical concepts
- Key, most important, ideas for image processing, from simple filtering to neural networks
- At the end, a glimpse at AI for images but we can't go too deep

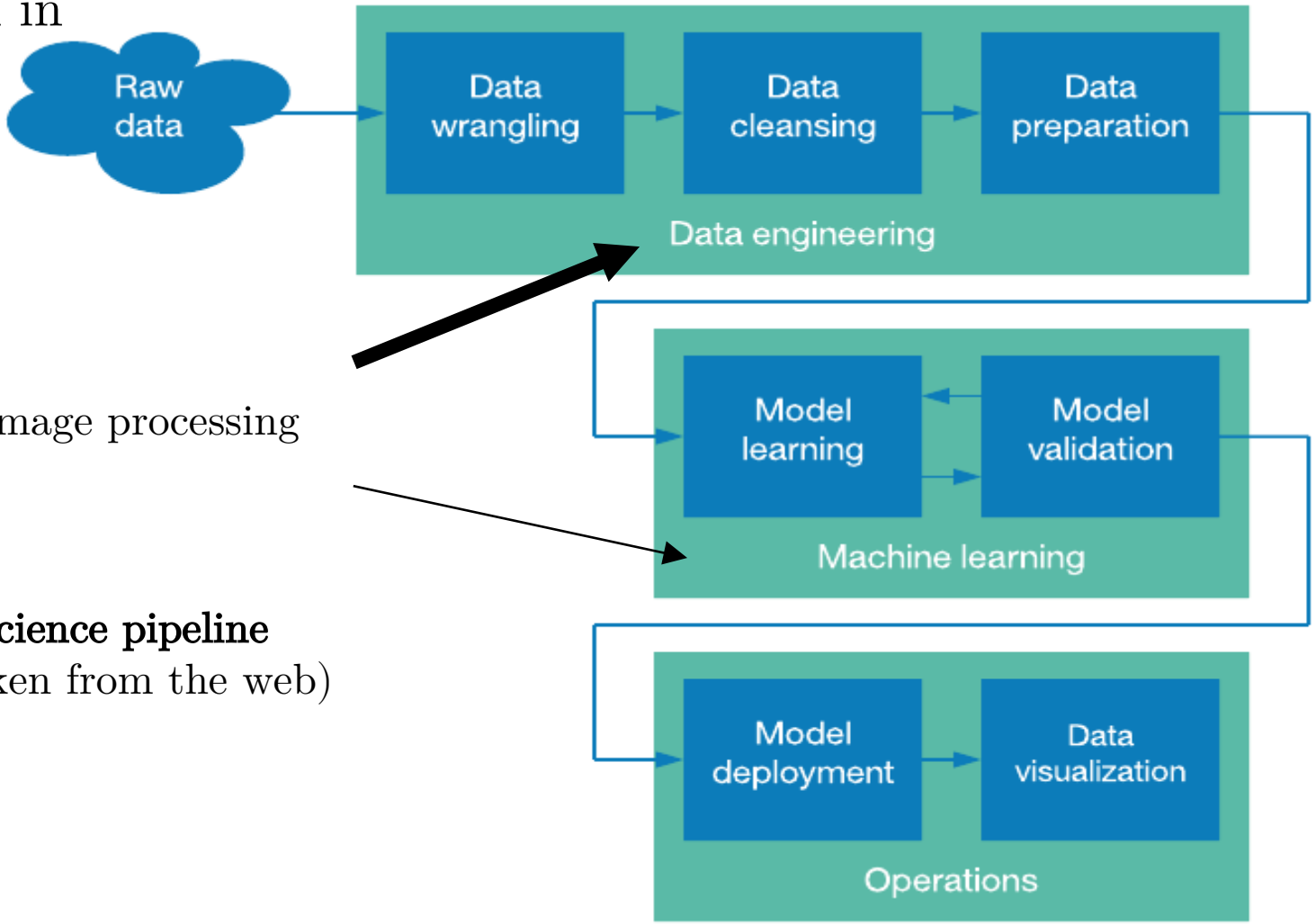
Purpose of the course:
Experts in image analysis, ready for AI and beyond



AI, machine learning and deep learning

- Digital image processing to a new level (revolution)
- Active research field
- Next step: FYS-3033 Deep Learning, INF-3993-3 Generative AI, FYS- 3012 Pattern Recognition, FYS-3032 Health Data Analytics, Machine Vision TEK-3601
- Research: https://machine-learning.uit.no/ https://www.visual-intelligence.no/

What will we learn in the course?



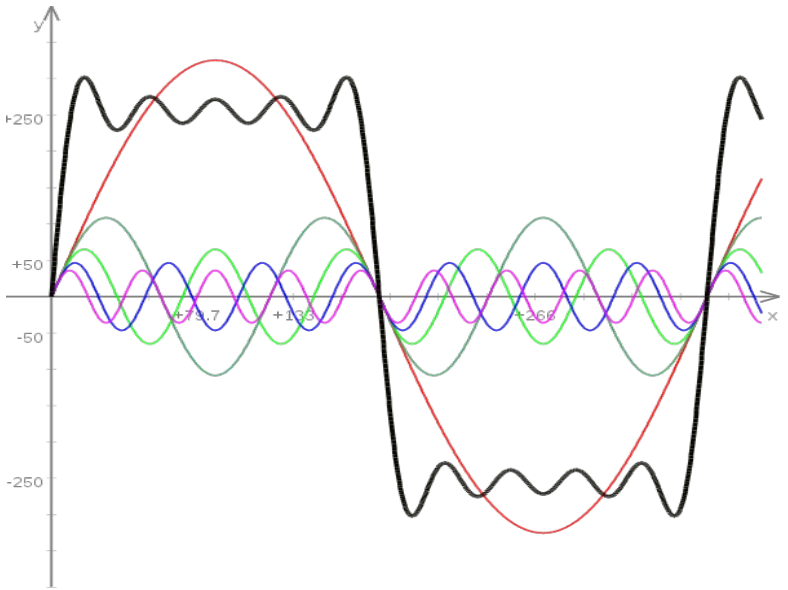
Digital image processing

Data science pipeline
(image taken from the web)

The course covers more than images

Important theoretical concepts

- Fourier Transform
- Filtering
- Linear / nonlinear transformations



Involved in many domains of engineering and science

We will deal with *mathematical and computer programming* aspects of digital image processing - recommended pre-requisites

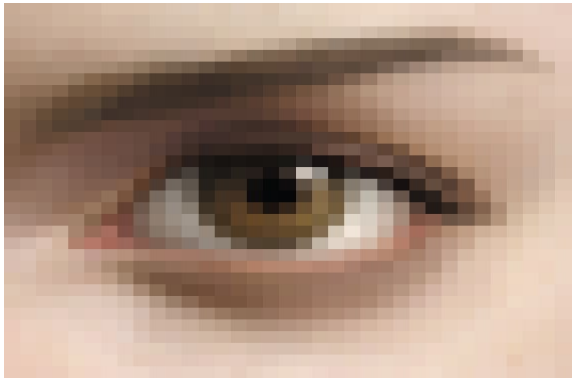
- Basic calculus (linear algebra, functions, Fourier transform)

- Basic programming (Python)

- *Signal Processing*

An image is:

- a matrix A
- a 2D function $f(x,y)$
- a random sample from a probability distribution p
- *A numpy array*



Examples of image processing

The following is taken from: **Peters, Richard Alan, II**, Lectures on Image Processing, Vanderbilt University, Nashville, TN, April 2008, Available on the web at the Internet Archive, http://www.archive.org/details/Lectures_on_Image_Processing.

Some basic image transformations

- gamma

- brightness

original

+ brightness

+ gamma

histogram mod

- contrast

original

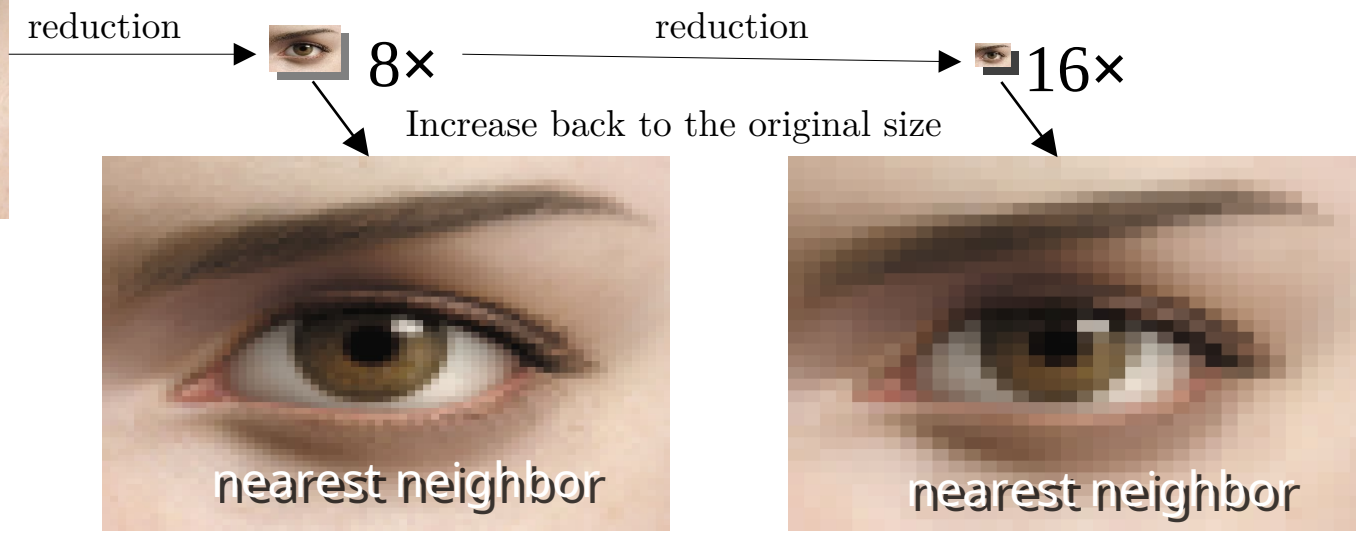
+ contrast

histogram EQ

Resampling / resizing images

Original image

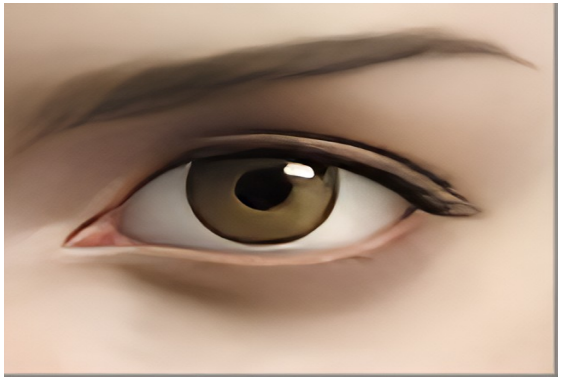
Upscaling a reduced image



Resampling (resizing large)

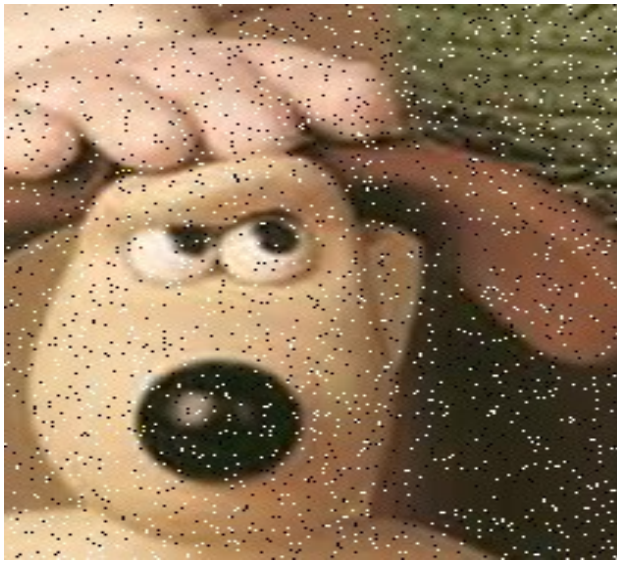
source / original

bicubic interpolation



ANN super-resolution

original



salt&pepper noise

median filter

blurred

original

sharpened

Some tools for image processing

Example: GIMP, Photoshop

Python module scikit-image
https://scikit-image.org/
and gallery
https://scikit-image.org/docs/stable/auto_examples/