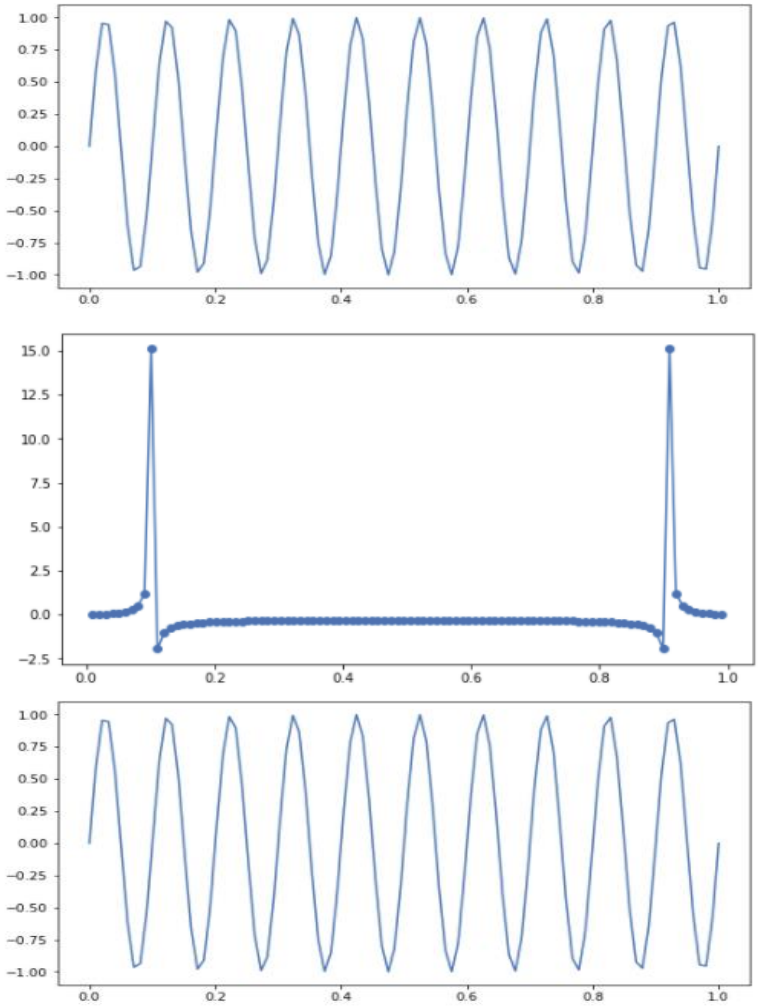
MODELLING AND RENDERING TECHNIQUES

FOURIER TRANSFORM

Discreate Fourier transform



Signal 10 Hz
sampling frequency 100 Hz

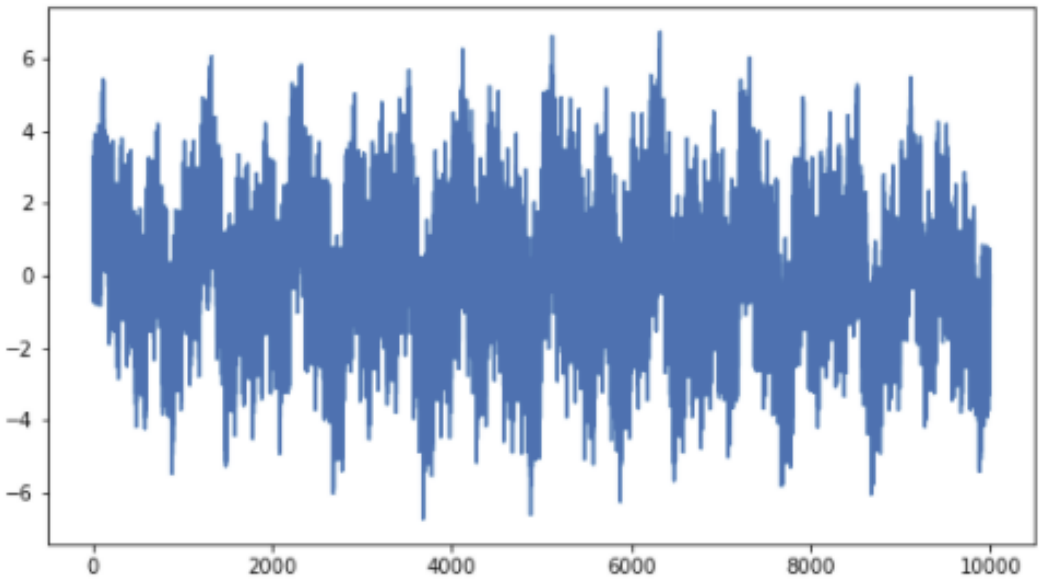
Discreate Fourier Transform

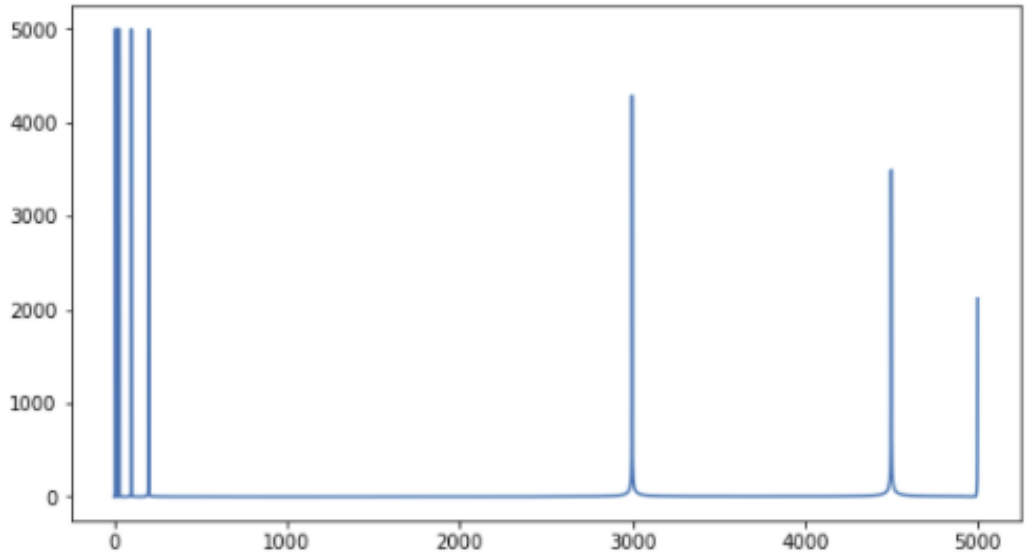
$$X(t) = \sum_{n=0}^{N-1} x(n) e^{-i2\pi kn/N}$$

Inverse transform

$$X(t) = \frac{1}{N} \sum_{n=0}^{N-1} X(n) e^{i2\pi kn/N}$$

- We created a signal containing one sinusoid of frequency 10 Hz.
- Fourier transform of the signal is displayed
  - We are using only abs(X) because results are complex numbers, and we care only about their magnitude.
  - We can see that X(t) is symmetrical so we can only use half
    $$X(t) = X(N - t)$$
  - That's why we can only see frequencies below fs/2 (fs is sampling frequency).
- Inverse transform of FT will reconstruct original signal.



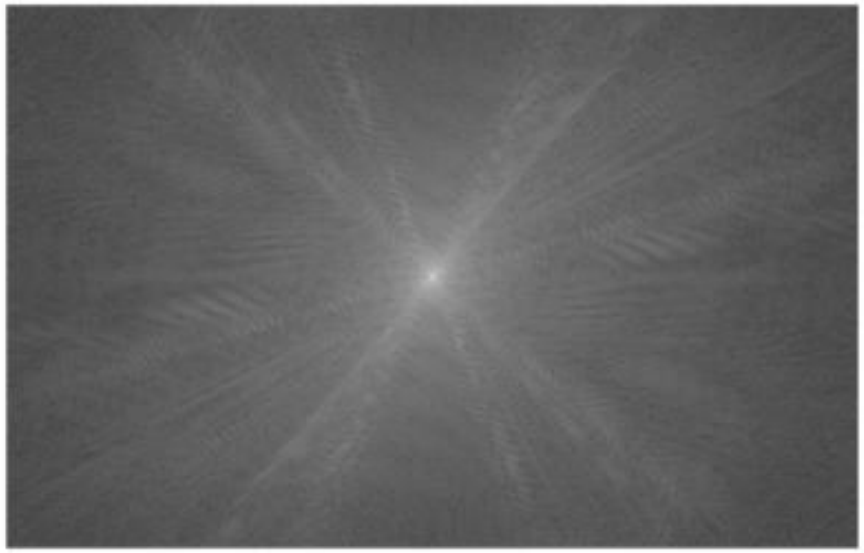


- We can determine frequencies contained in complex signals

2D FFT (Fast Fourier transform)

Fourier transform can be applied to 2D object

- In simplification we apply FT to rows and than again to columns
- For visualization frequency 0 is in the middle of image. Image is symmetric and has four identical segments

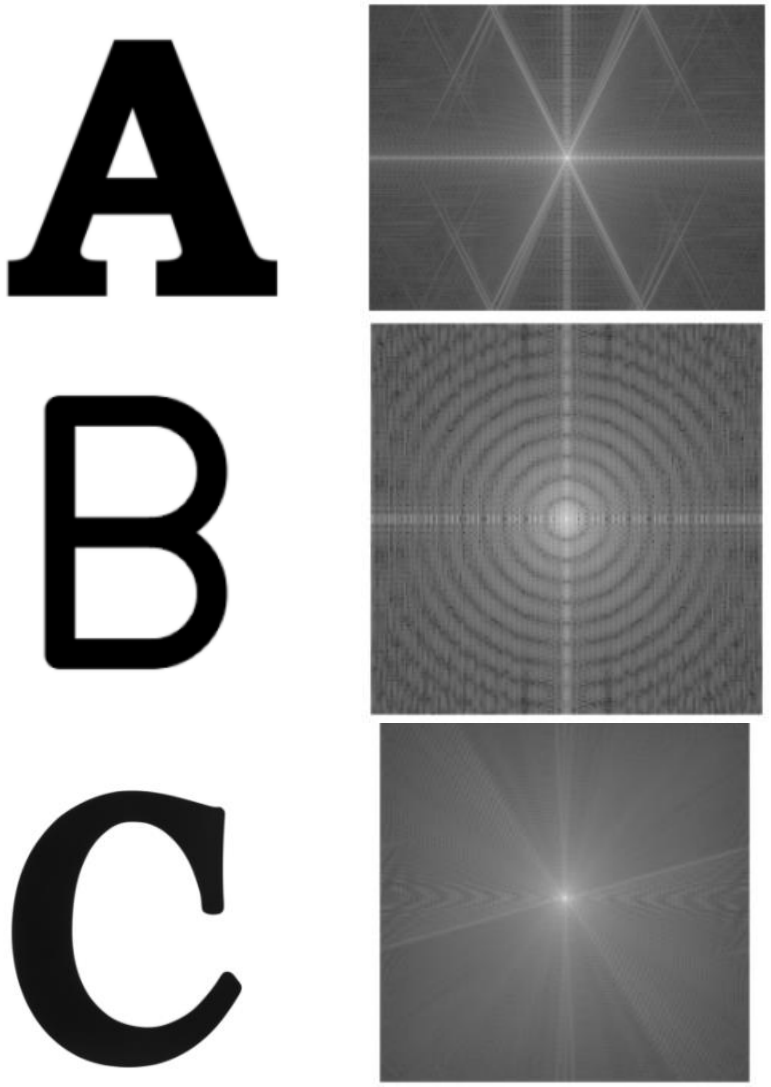


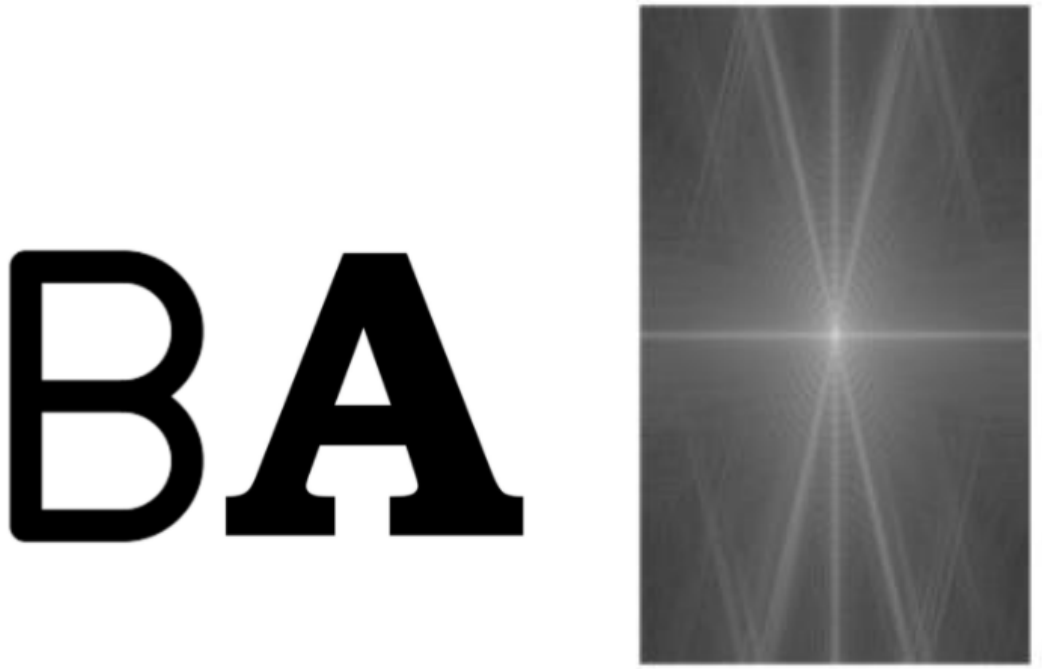
Finding object in image

Task is to find smaller image in the big picture

- Blue
  - Result of algorithm using faze correlation (one possible use of DFT)
- Green
  - Result of closest sum algorithm
  - We compute sum of subimages and the one with closest value to window image wins
- Red
  - Result of algorithm with maximum value
  - We go along image with object and we compute sum of product of image and object. Position with maximum value is the result.

Image classification





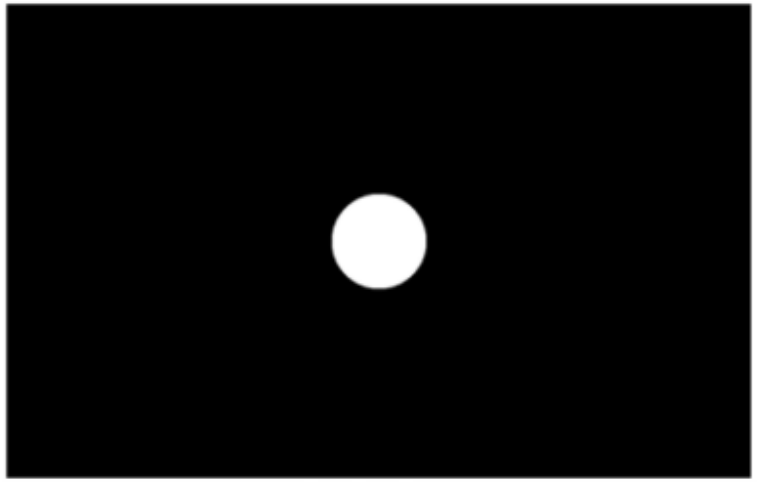
- In the Fourier transform picture we can clearly see that image contains Some characteristics of letter B and letter A

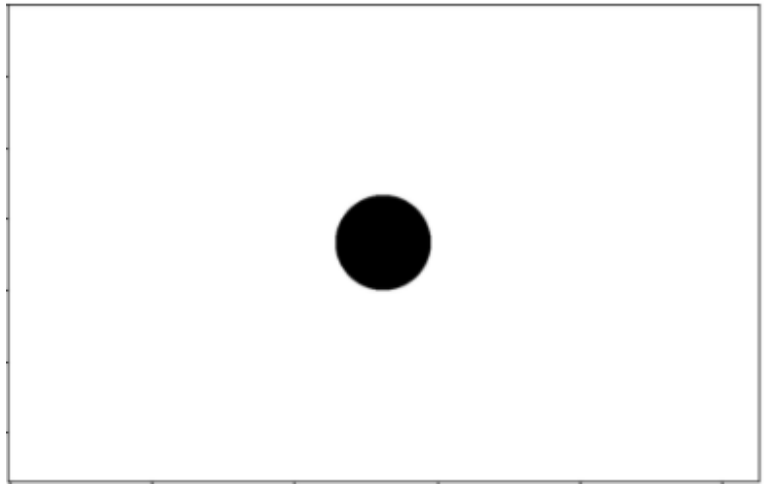
Filters

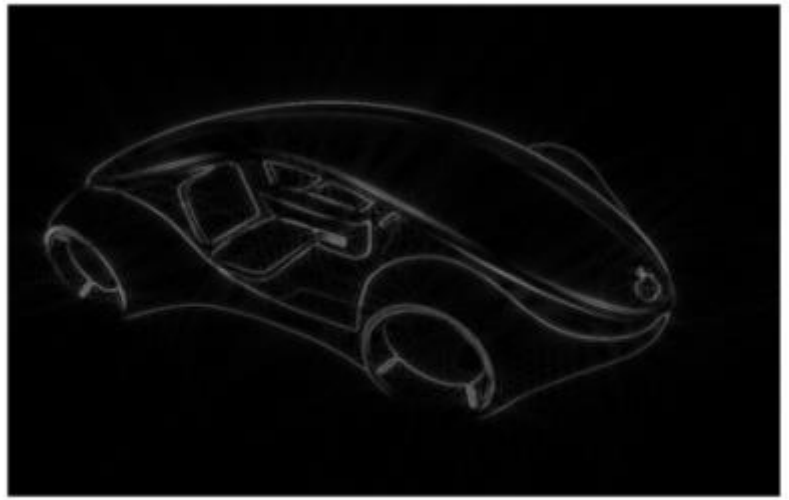
- We can create Filter using FT
- Filter will take only some frequencies from original image and reconstruct new image with them
- Proces:
  1. Create filter -> only use high/low frequencies
  2. Apply FT to image
  3. Multiply FT of image with filter
  4. IFFT result
- Two main types of filters:
  - High pass – we will see contours and corners of objects
  - Low pass – we will see blurred image, details will be lost

Low pass filter

High pass filter







Assignment

- Use High and low pass filter to one image
- Try to manipulate size of filters
- Send results

- Download assignment.ipynb
- Use colab.research.google.com to open assignment