IntroML

Exercise 01 - Sampling

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Agenda

1. Exercise 1 - Sampling Theorem

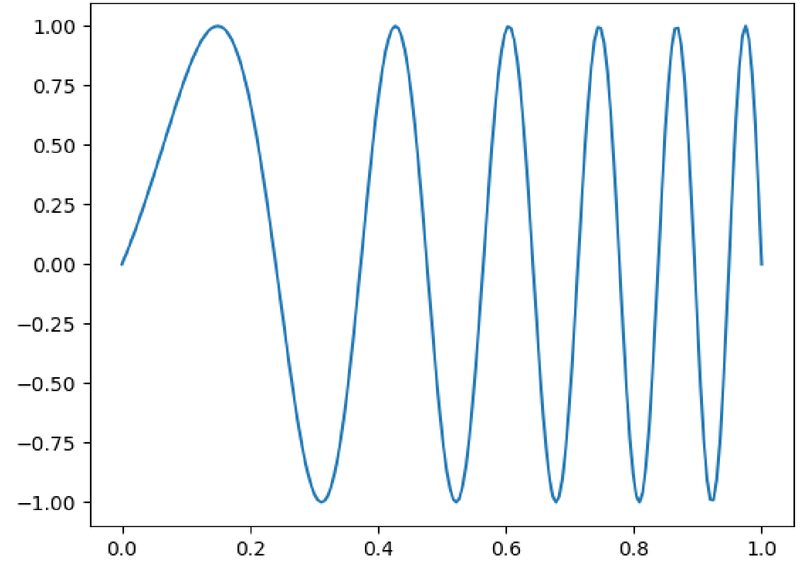
2. Exercise 2 - Fourier Decomposition

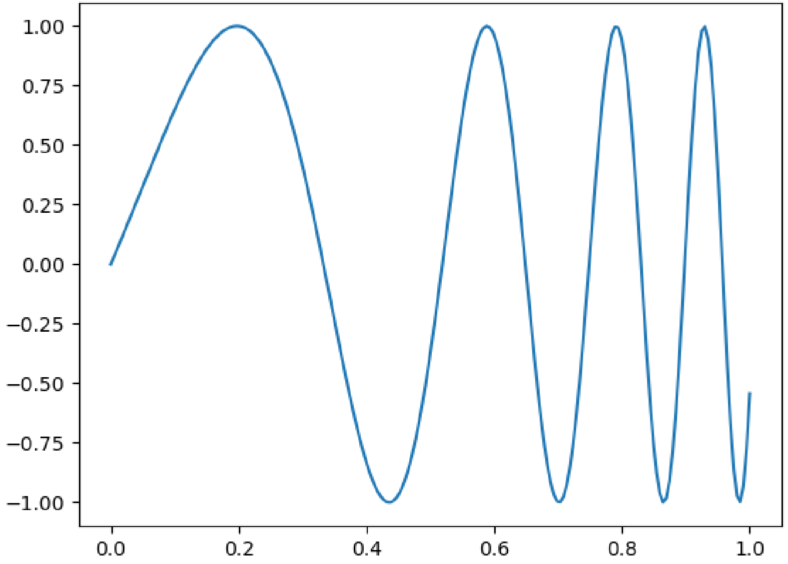
3. Exercise 3 - Tuning a Piano

Exercise 1 - Sampling Theorem

Chirp Signal

A chirp signal is a signal which frequency changes over time:





Chirp Signal

A chirp signal is a signal which frequency changes over time[1]:

- Linear:

$$x(t) = sin(2\pi(f_0 + \frac{c}{2}t)t)$$

  with linear chirp rate: $c = \frac{f_1 - f_0}{T}$

- Exponential:

$$x(t) = sin(\frac{2\pi f_0}{ln(k)}(k^t - 1))$$

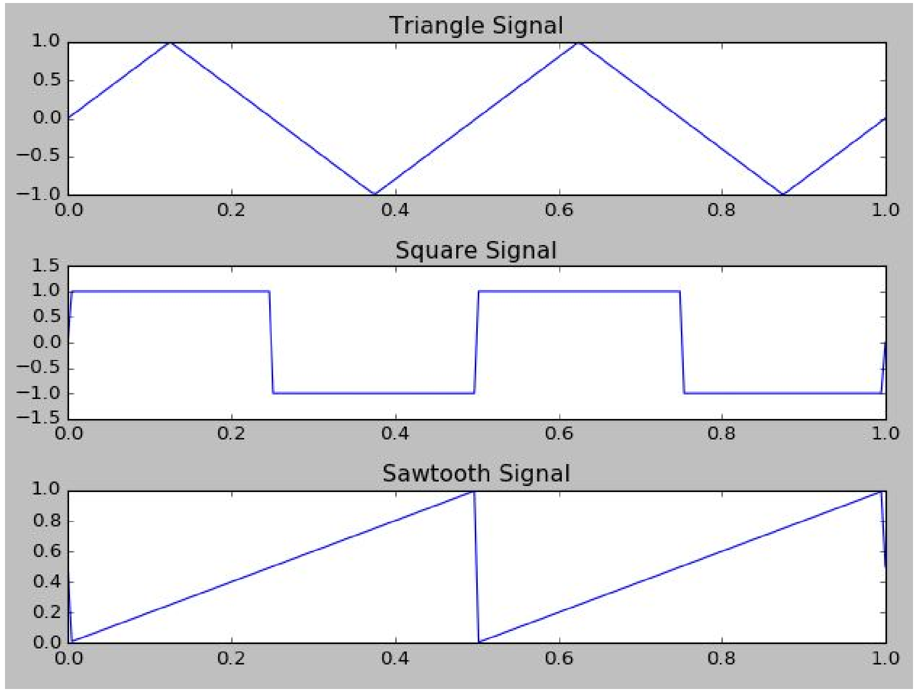
  with exponential chirp rate: $k = \frac{f_1}{f_0}^{\frac{1}{T}}$

[1] More Details: https://en.wikipedia.org/wiki/Chirp

Exercise 2 - Fourier Decomposition

Fourier Decomposition

Create specific Fourier Decomposition functions:



Fourier Decomposition

- Triangle Signal:

$$f_{\text{triangle}}(t) = \frac{8}{\pi^2} \sum_{k=0}^{\infty} (-1)^k \frac{sin\left(2\pi\left(2k+1\right)f\,t\right)}{(2k+1)^2}$$

- Square Signal:

$$f_{\text{square}}(t) = \frac{4}{\pi} \sum_{k=1}^{\infty} \frac{sin\left(2\pi\left(2k-1\right)f\,t\right)}{2k-1}$$

- Sawtooth Signal:

$$f_{\text{sawtooth}}(t) = \frac{A}{2} - \frac{A}{\pi} \sum_{k=1}^{\infty} \frac{sin(2\pi\,k\,f\,t)}{k}$$

Exercise 3 - Tuning a Piano

Tuning a Piano

Goal: Find the main Frequency in the audio signal

- Calculate Fourier Transform of Signal to see which frequencies are present (Use a library function like *np.fft.fft*)
- Set frequencies smaller than *min_freq* to 0
- Be careful when searching for and returning frequencies in your Fourier transform about the sample frequency of the signal: $f_n(n) = f * (n * T_s)$
- Compare the found frequencies to the Piano key frequencies: `https://en.wikipedia.org/wiki/Piano_key_frequencies`

Thank you for your attention!