

FYS-4096 Computational Physics, exercise 12

Return your solution to project `exercise12` under your GitLab group for this course by Friday 5 AM.

Tag the final version with `final` keyword, and make sure to include a file `problems_solved` in the repository. The `problems_solved`-file should be a comma separated list of problems you have solved.

Problem 1: DOOM (3 XP)

The Doom video game franchise was rebooted in 2016. Players take the role of an unnamed space marine as he battles demonic forces from Hell that have been unleashed by the Union Aerospace Corporation on a future-set colonized planet Mars.

Source: Wikipedia

The game's soundtrack has a unique theme for the boss `Cyberdemon` in Lazarus Labs, you can listen to the piece on Youtube.

I've obtained a slightly more high-quality version of the piece and extracted its sound waveform. You can download the waveform from tut.fi/fys/fys4096/doom_cyberdemon_2016_waveform.h5.

Your job is to calculate and plot the spectrogram, i.e., absolute value of the STFT of the piece. Analyze in detail a section from 20 to 25 seconds from the beginning of the piece. Plot the spectrogram using the 'inferno' colormap and decrease `datarange` maximum (`vmax`) of the colorbar gradually.

What do you find? How should your findings be interpreted?

Use `scipy.signal.stft` with **Blackman window function**. **Do not use the ready-made `scipy.signal.spectrogram`.**

Problem 2: Cross-correlations (2 XP)

You can find a `hdf5`-file containing three datasets showing the number of Google searches per week (normalized) for three keywords for the past few years at tut.fi/fys/fys4096/google_searches_hauki_jaatelo_ystavanpaiva.h5.

The keywords are

1. 'hauki' (pike)
2. 'jäätelö' (ice cream)
3. 'ystävänäpäivä' (Valentine's day)

Calculate and plot the cross-correlations between these time-series. What can you deduce?

Problem 3: Analyze the signal (5 XP)

Our voltmeter gave some unusual readings for an electric circuit we found in a cabinet in the physics department. I've saved the signal in the dataset `tut.fi/fys/fys4096/strange_signal.h5`.

Analyze the signal and describe your workflow and findings in `README.rst`. What is the origin of the signal?