COMP.SGN.120 - Introduction to Audio Processing

Exercise 1

Week 45

The exercise is meant to give a basic introduction of audio manipulation with python, playing and plotting signals, and be familiar with frequency domain characteristics of different kinds of audio signals. Each problem is worth 1 point. **The submission should consist of a jupyter notebook, with the code and your observations**. There is an extra question, which is optional (no extra points), to test your skills.
Remember, all the exercises are related, you need to understand this one to successfully implement the following ones.

Problem 1: Create a synthetic signal as a sum of sinusoids. (1 point)

a) Create 4 sinusoids of 3 s length, with different amplitude, frequencies 100, 500, 1500, 2500 Hz, different phases, sampled at 8kHz. (Hint: how many samples the signal must have for 3 s length? take into account fs).
b) Play and plot the sinusoids
c) Add them up to x(t). Plot and play x(t). Write the signal to a wav file.
d) Apply DFT (you can use *scipy.fftpack.fft* function. Select the number of DFT points, e.g. 512)). Plot magnitude DFT. DFT has imaginary values $z = x + iy$, where the magnitude and phase angle of z correspond to the amplitude and phase angle of the given frequency.
e) Observe the components and relationship between nfft and frequency in Hz. Report your observation.

Problem 2: Read an audio and observe the spectrum. (1 point)

a) Read one of the provided audio files, play and plot the entire signal.
b) Plot signal between 0.5 and 1 s.

Do the following (c and d) in a loop (make it a function):
c) Read the next 100 ms of the signal. (Hint: take into account fs; even better, make this frame length a parameter so you can always change it to a different value). Plot the signal.
d) Apply DFT to this segment and plot the magnitude DFT.

The loop basically computes magnitude DFT for each of the 100 ms segments of the audio. You do not have to plot all the segments, only plotting the first segment and corresponding magnitude DFT is enough.

e) Do the same for the other audio and analyze the difference in spectrum between the two audio examples. How does the spectrum of these signals differ from that of sum of sinusoids?

Bonus problem:

In problem1 downsample the sum of sinusoids x(t) by a factor of 2 using *scipy.signal.resample*. Write the downsampled signal into wav file. Plot the magnitude DFT and compare it with DFT of x(t). Explain and report your observation.