# Intelligent Signal Processing Coursework for midterm

## Introduction

The midterm coursework for Intelligent Signal Processing consists of a series of four individual exercises. These exercises cover the first five topics of the course:

- Digitising, representing, and storing audio signals
- Editing and processing digital audio
- Frequency domain representations
- Extracting features from audio signals
- Speech recognition.

The exercises are strongly based on the subjects covered during the course, but also invite the student for further investigation.

It is recommended that the students carefully read all the sections of this document, both to ensure a good understanding of the coursework exercises, in addition to knowing what to submit.

## Exercise 1

**Description**

The goal of this exercise is to create a web-based audio application using p5.js and its library p5.sound that processes a pre-recorded sound file, sending the processed audio signal to the computer's speakers or audio output. Optionally, the user could also record the processed audio signal as a digital audio file on the computer's drive.

The application should include the following effects: *low-pass filter*, *waveshaper distortion*, *dynamic compressor*, *reverb* and *master volume*.

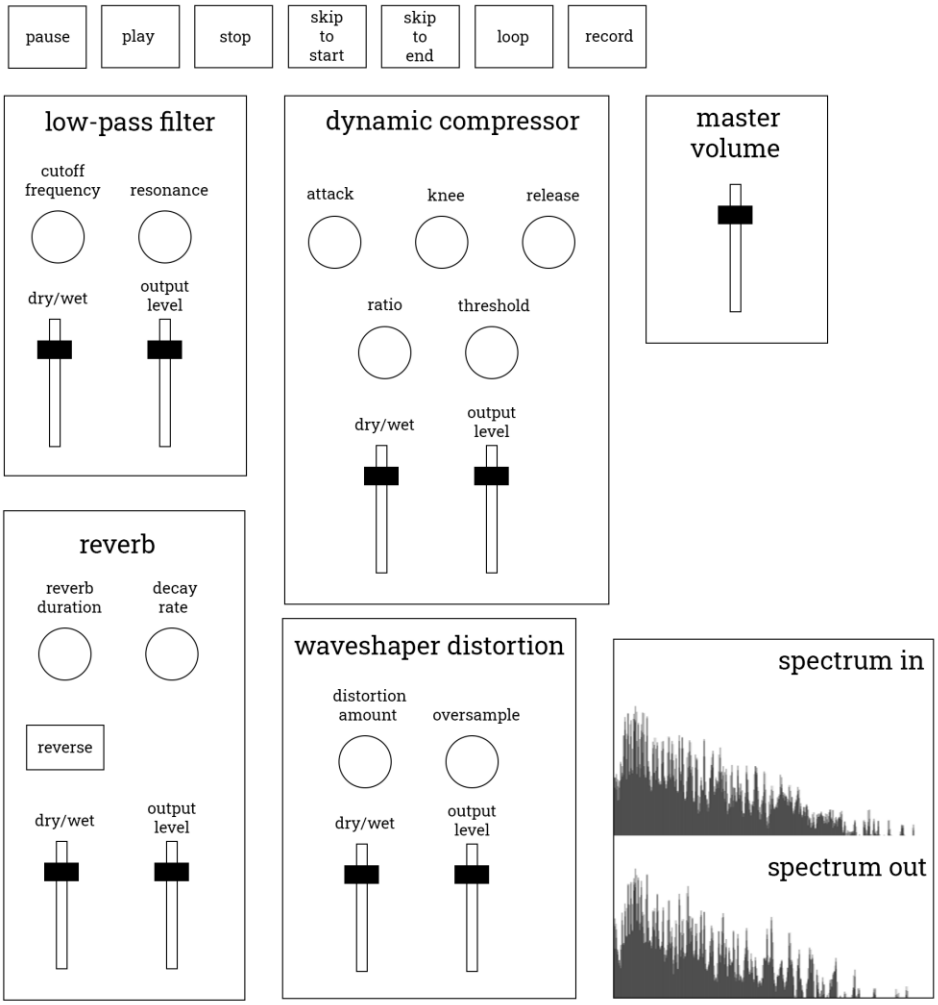


Figure 1. Schema of the GUI of the application.

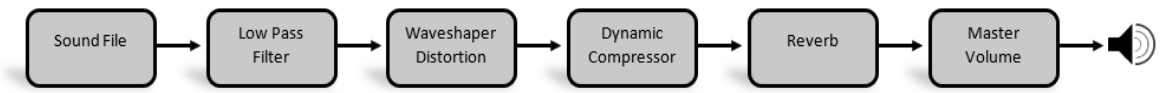


Figure 2. Internal signal flow of the application.

Regarding the pre-recorded sound file, you should record in Audacity these two lines from the poem *If*— by Rudyard Kipling:

If you can dream – and not make dreams your master;
If you can think – and not make thoughts your aim;

The audio must be recorded at an optimal recording level without clipping.

The recording must also be edited in Audacity, in order to remove possible silences at the beginning and end of the file. Finally, the recording must be normalised and saved as a WAV format, at 48 kHz and 24-bits.

The functionality of the application should meet the following requirements:

1. The application should include the playback controls and effects controls shown in Image 1.
2. Internally, the effects must be connected in a chain, as shown in Image 2.
3. The application should include a Record button that allows the user to start/stop recording the processed signal as a WAV file.
4. The application must display both the spectrum of the original sound and the spectrum of the processed sound.

Ideas for further development:

1. Enhance the filter effect by adding a *type selector* that allows the user to select between a *low-pass*, *high-pass* or *band-pass* filter.
2. Allow the user to select between the live microphone input and the pre-recorded audio file as the audio source for the application.
3. Configure a *delay* audio effect and add this to the audio chain before the *dynamic compressor*.

**List of deliverables**

For Exercise 1, you should submit in a ZIP file:

- The source code of the application *exercise 1*.
- A link to the application running in a web page using the Coursera static web page function.
- A screencast recording demonstrating that the application meets all the requirements and shows implementation of the further developments (maximum length of two minutes).
- A link to the application running in a web page using the Coursera static web page function.
- A written report in PDF format, approximately 500 words. This report must include:
    - A brief description of the processes of audio recording, editing, processing and saving in Audacity. This section must include at least two screenshots of Audacity showing both the original recorded voice, and the recorded voice after editing and normalising it.
    - A brief description of the main characteristics of each effect and how they have been programmed.
    - A brief analysis of the application discussing how the *low-pass filter* and the *master volume* effects affect the sound's spectrum. This should also be illustrated through screenshots.
    - A brief description of the further development implemented.

**Marking criteria**

| | Done? | Marks |
|---|---|---|
| The screencast recording has a maximum length of two minutes, and it demonstrates that the application meets all the requirements and shows the further developments implemented. | | 1 |
| The sound file has been satisfactorily recorded, edited, processed and saved. | | 1 |

| | | |
|---|---|---|
| The application includes the requested playback controls, and these have been satisfactorily implemented. In particular, the Record button allows the user to record the processed audio signal in WAV format. | | 1 |
| The effects have been connected in a chain. The chain is functioning properly, and the user can listen to the processed audio signal. | | 1 |
| The filters have been correctly configured, and include the requested controls. | | 1 |
| The written report includes a brief description of the processes of audio recording, editing, processing and saving in Audacity. | | 1 |
| The written report includes a brief description of the main characteristics of each effect and how they have been programmed. | | 1 |
| The written report includes a brief analysis of the application discussing how the low-pass filter and the master volume effects affect the sound's spectrum. | | 1 |
| The application includes further development. | | 2 |
| **Total** | | 10 |

# Exercise 2

**Description**

A famous DJ has contacted you to develop an interactive web-based application for visualising his music during its concerts. The application must be based on p5.js, p5.speech and the JavaScript audio feature extraction library Meyda.

Task 1

First, to evaluate your skills, you are asked to perform the following task. The DJ sends you three sounds (Ex2_sound1.wav, Ex2_sound2.wav and Ex2_sound3.wav) and you have to select Meyda audio features that could help represent these sounds visually in an appropriate manner. For example, if the 'brightness' of one of the sounds radically changes over time, to select an audio feature that measures the brightness of this sound could be a good choice from a perspective of producing visual impact.

To perform Task 1, you have to fill in the following table. You have to select three Meyda audio features for each sound and justify your selections.

| | **Meyda audio features** | **Justification** |
|---|---|---|
| **Sound 1** | | |
| | | |
| | | |
| | | |
| **Sound 2** | | |
| | | |
| | | |
| | | |