Sound and Music Signal Analysis
Signal Processing for Interactive Systems
Course Introduction

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AALBORG UNIVERSITY
DENMARK

Agenda

Course overview

Lectures

Exercises and mini-project

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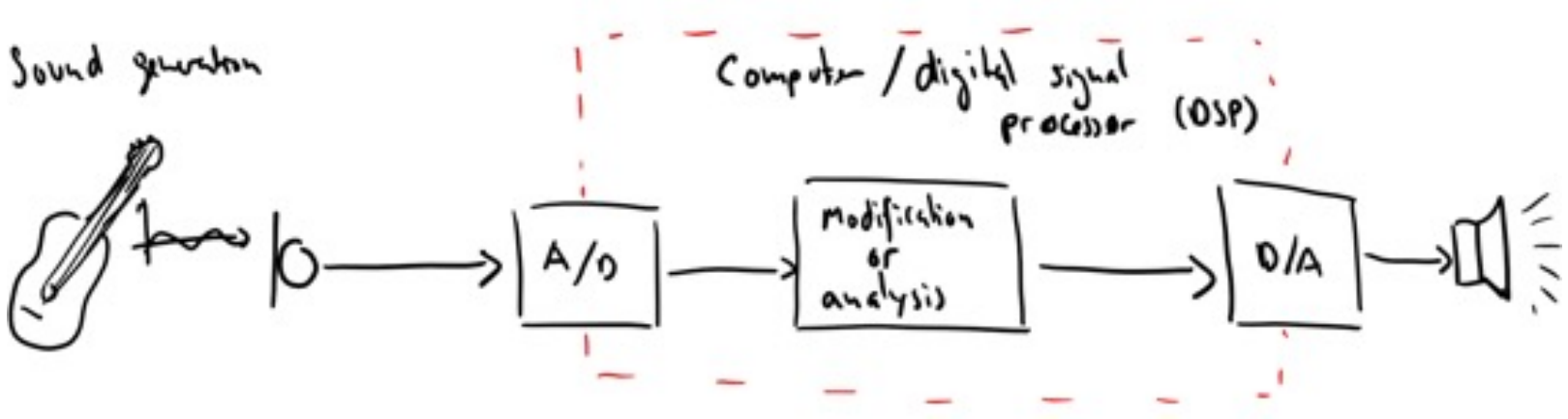


Three central aspects of the course:

1. What kind of models and **representations** are used for sound, music, and movement signals?
2. How do we analyze (i.e., extract information) from those representations.
3. Examples of applications involving the first two aspects.

Course overview

Structure

- 10 lectures (Mondays).
- 10 exercise sessions
- One mini project (1 ECTS): classical or *alternative* ways!
  - Hackathons, certificates, etc.
  - https://gen48.runwayml.com (now)
  - #TimbreTools Hackathon (16.2 Workshops, 23-25 Main Work)
  - Certificates from MATLAB Academy, Hugging Face, etc.
- Examination

Course overview

People

- Lecturer: Cumhur
  - Associate professor of sonic and embodied interaction
  - Multisensory Experience Lab, Aalborg University
- Teaching assistent (TA): Ernests Lavrinovitz
  1. M.Sc. Student
  2. TA'd Machine Learning and worked on BioX project

Course overview

Prerequisites

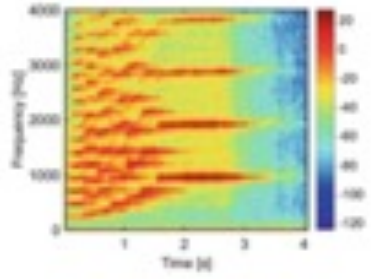
Basic signal processing Sampling, filtering, and frequency analysis

Basic mathematics: statistics, linear algebra etc.

Bilingual: Modern MATLAB / Python (librosa, 🤗, NumPy/SciPy)

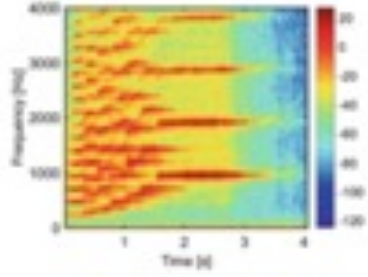
Think the course as an entry to deep learning (transformers) with signal **representations**.

7. The Fourier Transform



$$X_k = \frac{1}{N} \sum_{n=0}^{N-1} x_n e^{\mathrm{i} 2\pi k \frac{n}{N}}$$

7. The Fourier Transform



$$X_k = \frac{1}{N} \sum_{n=0}^{N-1} x_n e^{\mathrm{i} 2\pi k \frac{n}{N}}$$

To find the energy at a particular frequency, spin your signal around a circle at that frequency, and average a bunch of points along that path.

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Lectures

- Each lecture is divided into blocks
  - Whiteboard & slides
  - Computation (MATLAB, VSCode)
  - Exercises (mixed pen & paper and compute)
- Listen — think — code along — ask
- PLEASE bring pen and paper to every lecture

Lectures

Applications

Course centered around five application examples:

1. Spectrum analysor (lecture 1-3)
2. Audio and speech compression (lecture 4-5)
3. Instrument tuning (lecture 6-7)
4. Source separation (lecture 8-9)

The goal is to understand the fundamental models and methods used in these applications — not to come up with the perfect solution in every application.

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Exercises

- After each lecture, there is an exercise session
- Exercises can be found on Moodle
- PLEASE do the exercises and do them together — very important part of learning

Mini Project

- After the 10 lectures, you should work on an individual mini project
- The work load of the project is 1 ECTS (approx. 30 hours)
- You hand-in documentation (or certificate) and code to DE.

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Overview

1. Confirmation / construction of important topics
2. 20 minutes oral examination
   - 5 minutes presentation of the mini project
   - A question about / around your mini-project
   - A question from other topics.
   - 5 minutes for grading (7 point scale)
   - It is not possible to do the (re-)exams remotely without a study board approval.

Questions?

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Active break

Signal processing

- Audio processing is a branch of signal processing
- Signal processing is increasing infused by deep learning
- Many of the methods you learn here can be applied to many other signals than just audio signals (SPIS)