Multimedia Systems

1. Introduction to SMC

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FEUP

Agenda

1. Introduction to SMC
2. Know you
3. Make Groups
4. Practical Guide G1

What is Sound and Music Computing (SMC)?

Sound and Music Computing (SMC) research approaches the whole sound and music communication chain from a multidisciplinary point of view. By combining scientific, technological and artistic methodologies it aims at understanding, modelling and generating sound and music through computational approaches.

This definition is generally considered to include all types of sounds and human communication processes except speech. Speech research has its own aims and methodologies and is outside the SMC field.

from:Sound and Music Computing Network (2007)

What is Sound and Music Computing (SMC)?

Disciplines

- Music Composition
- Musicology
- Music Performance
- Physics/Acoustics
- Mathematics
- Psychology
- **Engineering**

from:Sound and Music Computing Network (2007)

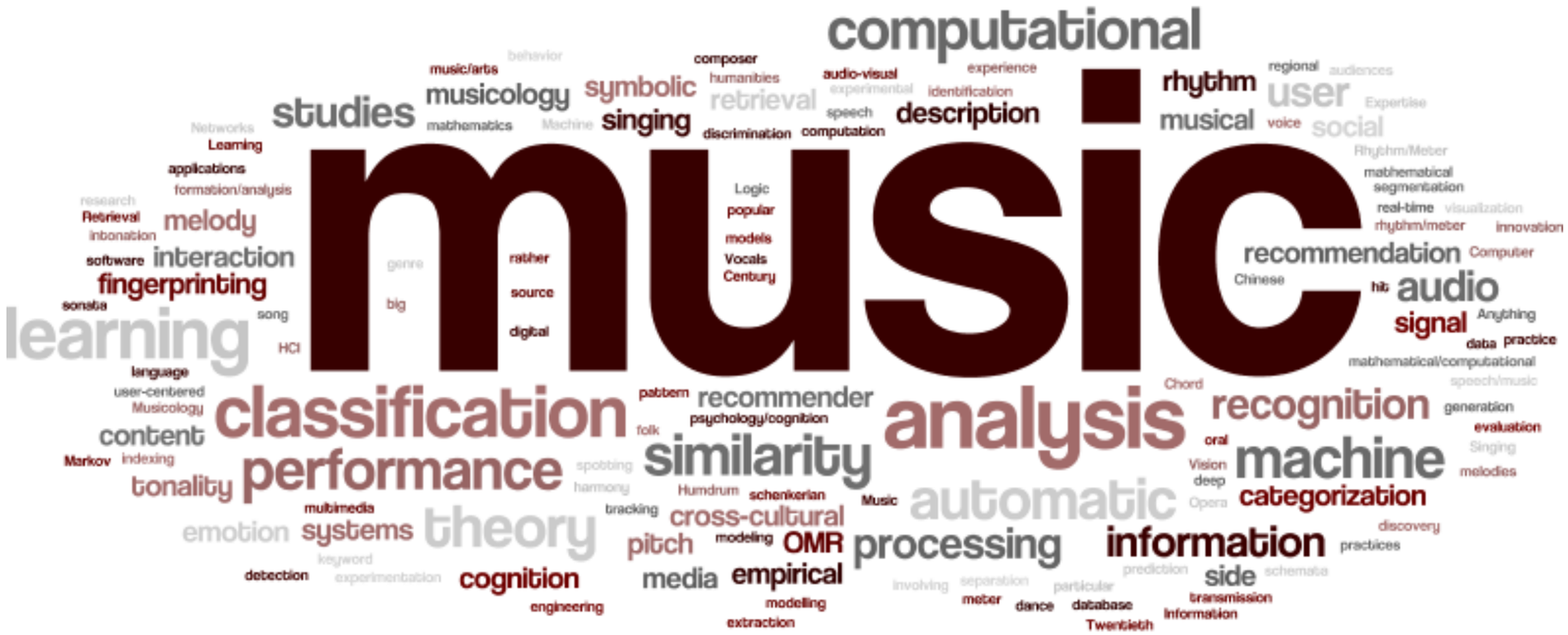
What is Sound and Music Computing (SMC)?

Areas of Application

- Digital Music Instruments
- Music Production
- **Music Information Retrieval**
- Digital Music Libraries
- Interactive Multimedia Systems
- Auditory Interfaces
- Augmented Action and Perception

from:Sound and Music Computing Network (2007)

What is Music Information Retrieval (MIR)?



from:Women in Music Information Retrieval

What is MIR?

Music Information Retrieval aims at extending the understanding and usefulness of music data, through the research, development and application of computational approaches and tools.

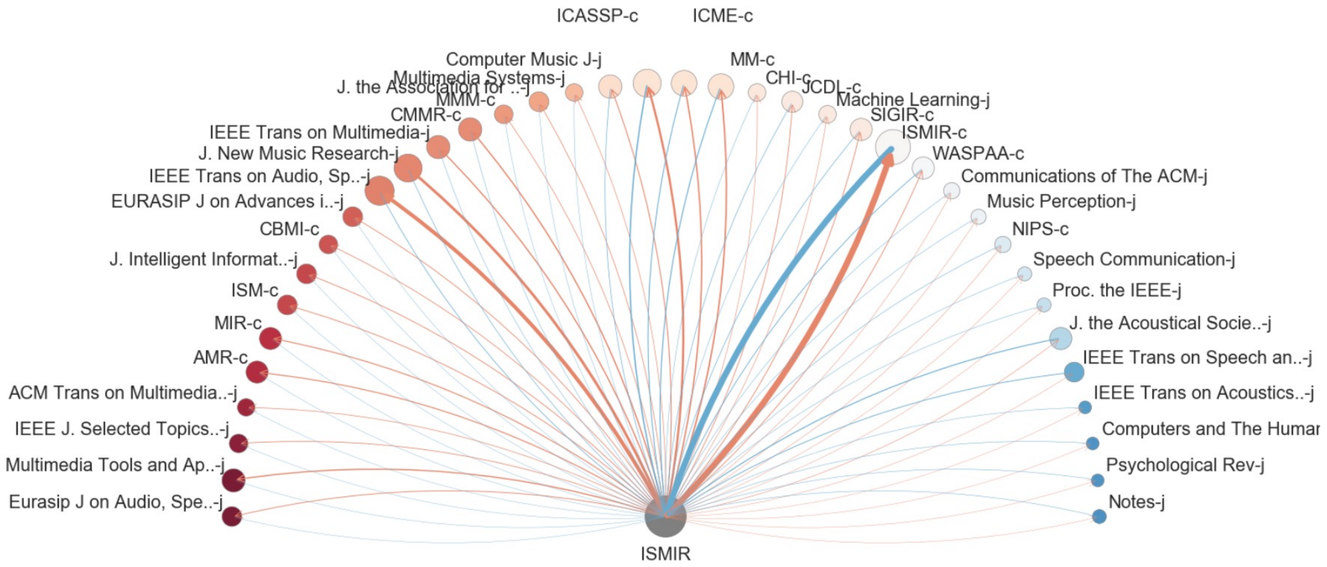
from: (Bello) MIR Lecture Notes - *New York University*

*MIR is the **interdisciplinary** science of retrieving information from music. Those involved in MIR may have a background*
*in musicology, psychoacoustics, psychology, academic music study, signal processing, informatics, machine learning, optical music recognition, computational intelligence or some combination of these. MIR is a small but growing field of research with many real-world **applications**.*

from: Wikipedia

What is MIR?

- Main event: International Society for Music Information Retrieval conference (ISMIR)
- ISMIR has been running since 1999
- **Highly** multidisciplinary: Electronic Engineering, Library and Information Science, Computer Science, Music/Musicology, Psychology, Law
- Papers and sessions at other conferences: ICASSP, ICMC, SMC, DAFx, NIME, WASPAA, CMMR, AES, etc.



What is MIR?

Ever-changing: ***Music Informatics Research?***

Feature Engineering —> Machine Learning —> Deep Learning

System-Centred —> User-Centred

Evaluation

What is MIR?

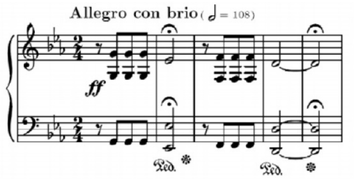
Music Information Retrieval Evaluation eXchange (MIREX) since 2008

- 2018:Audio Classification (Train/Test) Tasks
  - Audio US Pop Genre Classification
  - Audio Latin Genre Classification
  - Audio Music Mood Classification
  - Audio Classical Composer Identification
- 2018:Audio K-POP Mood Classification
- 2018:Audio K-POP Genre Classification
- 2018:Audio Fingerprinting
- 2018:Multiple Fundamental Frequency Estimation & Tracking
- 2018:Set List Identification
- 2018:Audio Melody Extraction
- 2018:Audio Onset Detection
- 2018:Audio Beat Tracking
- 2018:Audio Key Detection
- 2018:Audio Downbeat Estimation
- 2018:Real-time Audio to Score Alignment (a.k.a Score Following)
- 2018:Audio Cover Song Identification
- 2018:Audio Chord Estimation
- 2018:Automatic Lyrics-to-Audio Alignment
- 2018:Drum Transcription
- 2018:Patterns for Prediction
- 2018:Audio Tempo Estimation
- 2018:Music and/or Speech Detection

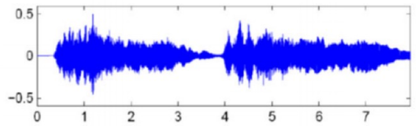
What is MIR?

Music Information

Sheet Music (Image)



CD / MP3 (Audio)



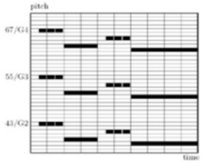
MusicXML (Text)

```
<note>
  <pitch>
    <step>E</step>
    <alter>-1</alter>
    <octave>4</octave>
  </pitch>
  <duration>2</duration>
  <type>half</type>
</note>
```

Dance / Motion (Mocap)

Music

MIDI



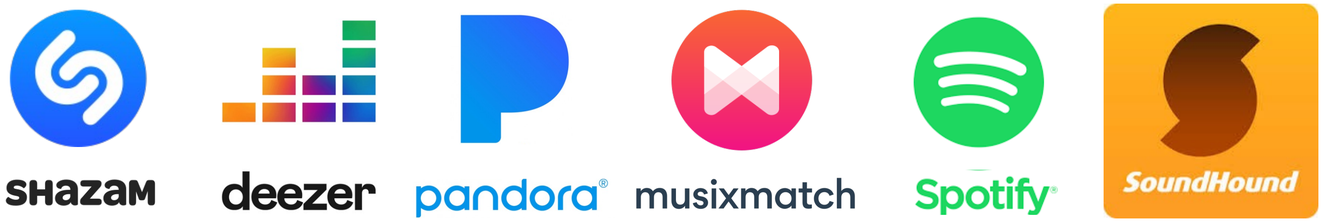
Singing / Voice (Audio)

Music Film (Video)

Music Literature (Text)

What is MIR?

Applications



Music fingerprinting/melody identification: ***Shazam, Gracenote, SoundHound***

Music Recommendation and Playlist generation: ***YouTube, Google, Last.fm, Pandora, Spotify***

Score Following: *SmartMusic, RockBand*

Music Interaction: *Chordify*

Pro Tools: *Melodyne, Autotune*

Others: *Smule, Native Instruments, ROLI, Steinberg*

SM

MIR Components

I. Introduction to Sound

- Audio Signal Fundamentals
- The Auditory System
- Digital Audio

II. Sound and Music Computing

- Sound and Music Analysis
- Sound and Music Descriptors

III. Music Information Retrieval

- Timbre
- Melody and Harmony
- Rhythm
- MIR Evaluation

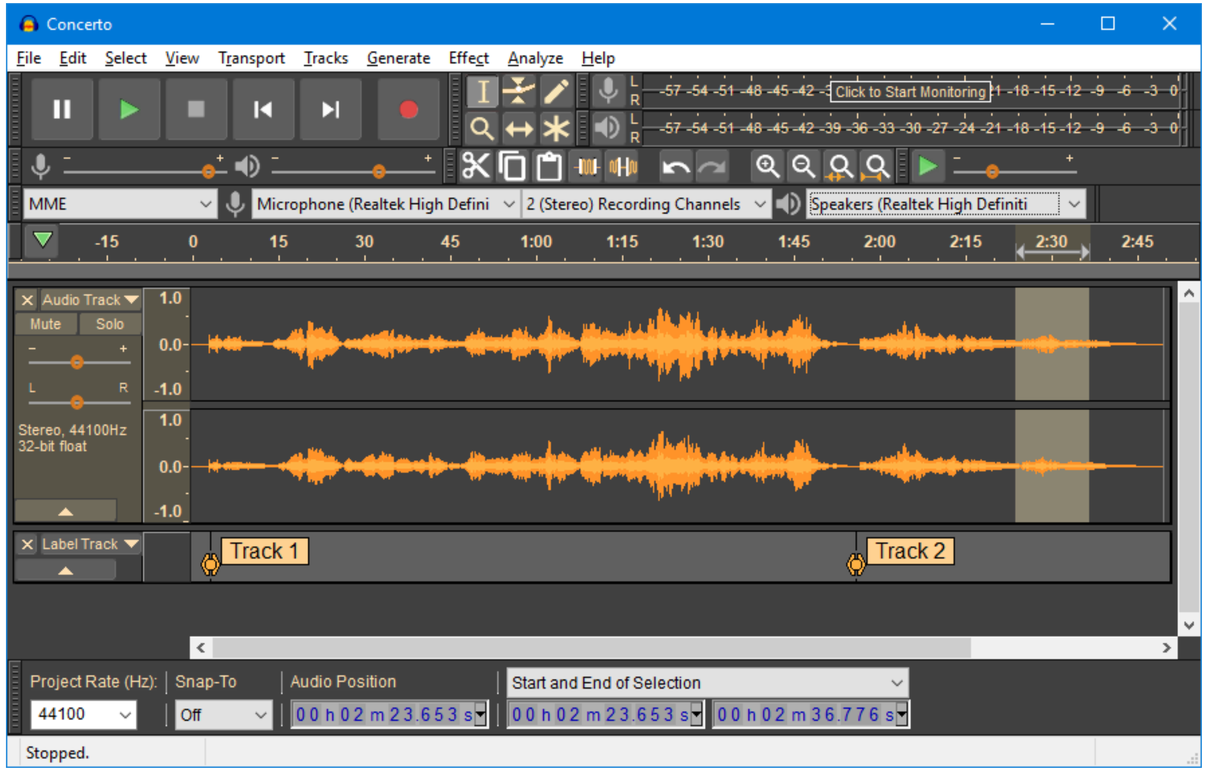
IV. Applications

- Deep Learning for MIR
- Music Mashup
- Source Separation
- Music Identification (Fingerprinting)
- Etc.

SM

Software Tools

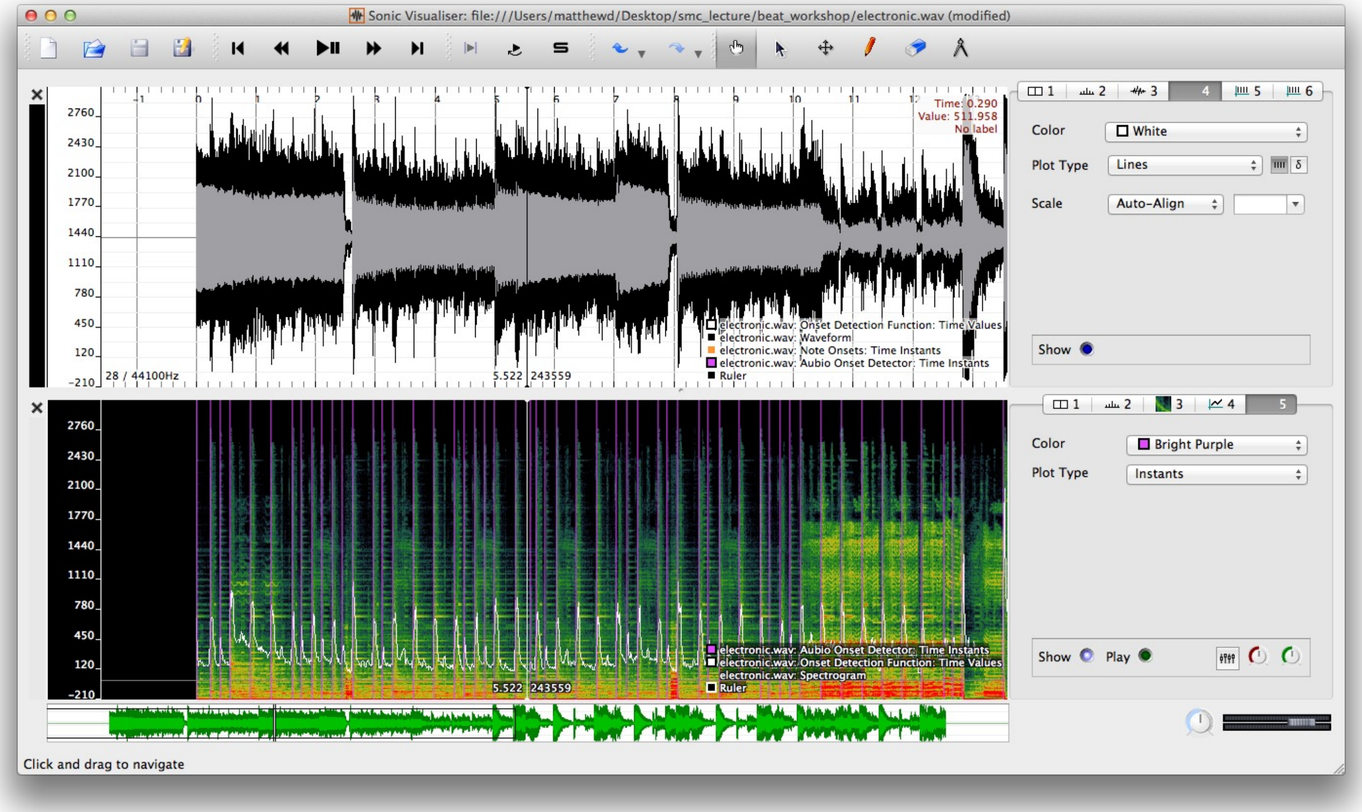
Audacity



SM

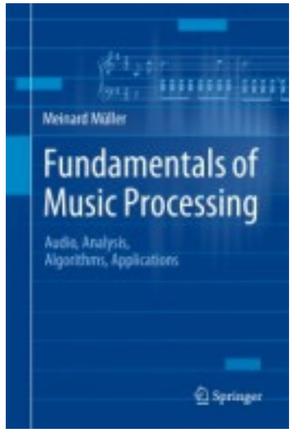
Software Tools

Sonic Visualiser



SM

Software Tools



Meinard Müller

Fundamentals of Music Processing

Audio, Analysis, Algorithms, Applications

ISBN: 978-3-319-21944-8

Springer, 2015

Chapter	Title
B	Basics
0	Overview
1	Music Representations
2	Fourier Analysis of Signals
3	Music Synchronization
4	Music Structure Analysis
5	Chord Recognition
6	Tempo and Beat Tracking
7	Content-Based Audio Retrieval
8	Musically Informed Audio Decomposition

In [1]:

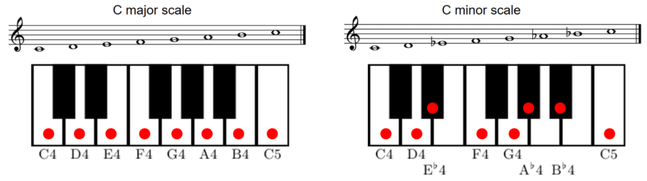
```
import numpy as np
import IPython.display as ipd

def generate_sinusoid_pitches(pitches=[69], dur=0.5, Fs=4000, amp=1):
    """Generation of sinusoids for a given list of MIDI pitches

    Notebook: C1/C1S1_MusicalNotesPitches.ipynb

    Args:
        pitches: List of MIDI pitches
        dur: Duration (in seconds) of each sinusoid
        Fs: Sampling rate
        amp: Amplitude of generated signal

    Returns:
        x: Signal
        t: Time axis (in seconds)
    """
    N = int(dur * Fs)
    t = np.arange(N) / Fs
    x = []
    for p in pitches:
        freq = 2 ** ((p - 69) / 12) * 440
        x = np.append(x, np.sin(2 * np.pi * freq * t))
    x = amp * x / np.max(x)
    return x, t

dur = 1
Fs = 22050

pitches = [36,48,60,72,84,96,108]
x, t = generate_sinusoid_pitches(pitches=pitches, dur=dur, Fs=Fs, amp=0.5)
print('Pitch class C = {..., C1, C2, C3, C4, C5, C6, C7, ...}', flush=True)
ipd.display(ipd.Audio(data=x, rate=Fs))
```

```
Pitch class C = {..., C1, C2, C3, C4, C5, C6, C7, ...}
```

▶ 0:00 / 0:07

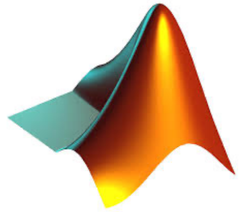
Musical Scales

In order to describe music using a finite number of symbols, one needs to discretize the space of all possible pitches. This leads to the notion of a **musical scale**, which can be thought of as a finite set of representative pitches. Because of the close octave relationship of pitches, scales are generally considered to span a single octave, with higher or lower octaves simply repeating the pattern. A musical scale can then be specified by a division of the octave space into a certain number of scale steps. The elements of a scale are often simply referred to as the **notes** of the scale and are ordered according to their respective pitches. The following figure illustrates the case of a C major scale and a (natural) C minor scale.



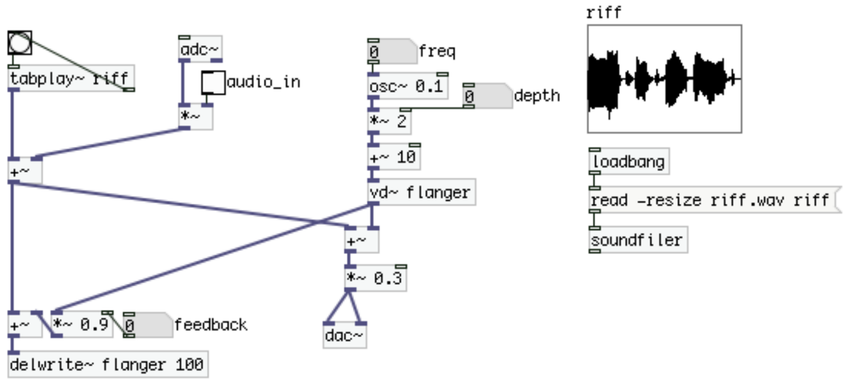
SM

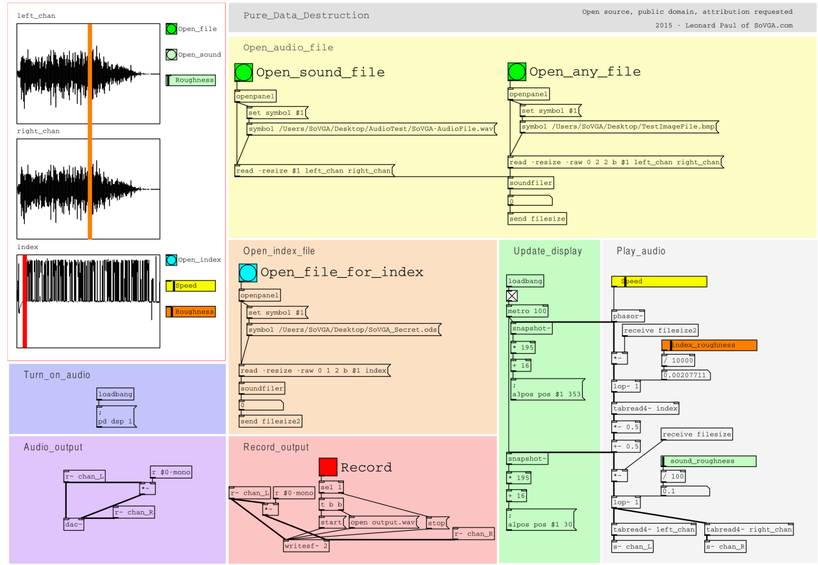
Software Tools (Optional)



Matlab

Pure Data





2. Know You

- Name

- What’s your relation with Sound and Music?

- How are your programming skills?

- What do you expect from SMUL?

3. Groups

Fill in the following spreadsheet with your group details (check Moodle/Labs/**Class1**)

2 elements/group

4. Practical Guide G1

- Follow Instructions from Moodle/Guides/G1

- *Start now. Complete until next Practical Class*

- *Do not download miniconda or anaconda during the class!*

End.