Learning about music with MIR

WIMIR Workshop 2019
Delft, The Netherlands

Estefanía

Research Scientist
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Research Interests

- Sound source separation
- MIR in music education
- Computational musicology

Saxophone

Jakob

Research Scientist
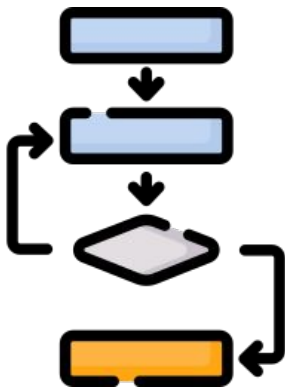Fraunhofer IDMT

Research Interests

- MIR in music education
- Machine Listening
- Semi-supervised Learning
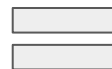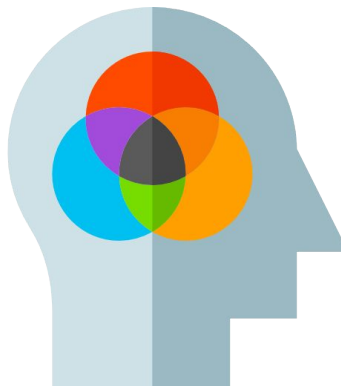
Bass guitar, Percussion

Goals

- Explore ways in which we can gain new knowledge about music using MIR techniques and human musical expertise.

MIR techniques

Human musical expertise

Music knowledge

*Icons by Freepik from www.flaticon.com

Our proposed workflow

Start with a research question

What does John Coltrane have in common with Cannonball Adderley?
What are the tuning characteristics of the harpsichord?
Which cues do musicians use to control ensemble intonation?
What characterizes lilt in Shetland fiddle music?

Find the most suitable data
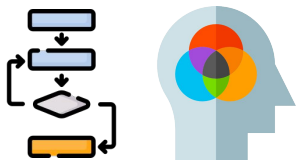
Audio files
Transcriptions
MIDI files
Scores
Videos

Our proposed workflow

Define the method to process the data

Do I need a computational tool for every step?
Are existing computational tools reliable enough?
Where is expert knowledge required?
Do my collaborators find the methods suitable and efficient?
Is this the most efficient yet reliable way of processing my data?
What are possible sources of error?

Analyze your results

Statistical analysis
Validate with users
Metrics
Error analysis

Our proposed workflow
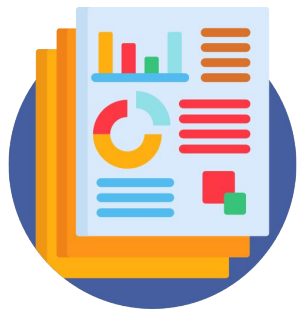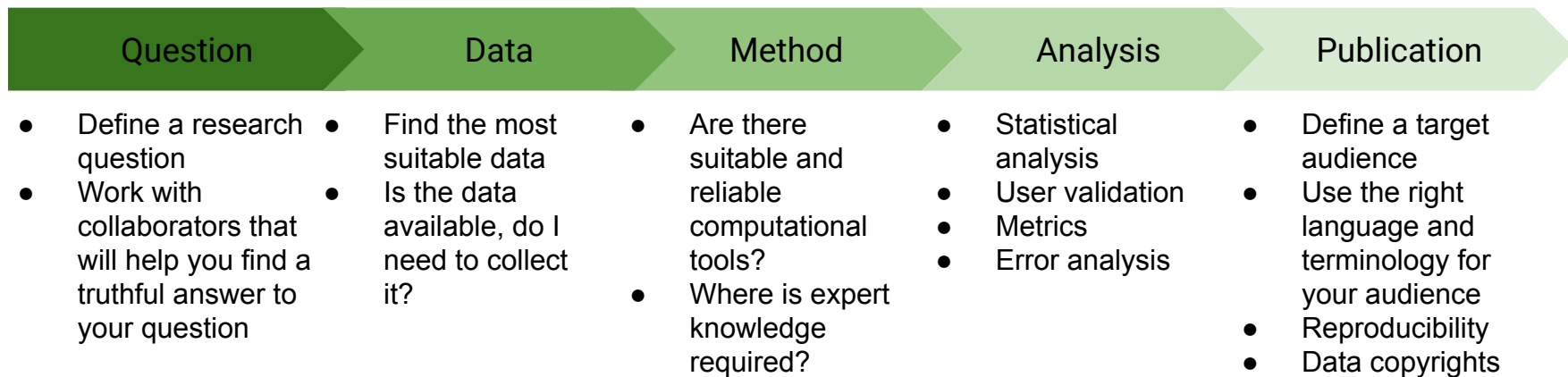

Report your findings

Who is my audience? Musicians, engineers, data scientists, artists?
How can I guarantee longevity for my research?
Is reproducibility an issue/requirement?
Are there any copyrights considerations with my data?

In summary

Question	Data	Method	Analysis	Publication
• Define a research question • Work with collaborators that will help you find a truthful answer to your question	• Find the most suitable data • Is the data available, do I need to collect it?	• Are there suitable and reliable computational tools? • Where is expert knowledge required?	• Statistical analysis • User validation • Metrics • Error analysis	• Define a target audience • Use the right language and terminology for your audience • Reproducibility • Data copyrights

Past experiences - Music Performance Analysis

Question: What characterizes lilt in Shetland fiddle music? [1]

Data: Fiddle recordings from the Tobar and Dulchais platform (here)

Method:

Transcriptions	MIDI-audio Sync	Beat-level analysis	Performance analysis

Lessons learned:

- MIDI-audio synch tools are reliable for this type of analysis
- There are characteristic patterns of beat duration, usually in the form of a long-short sequence
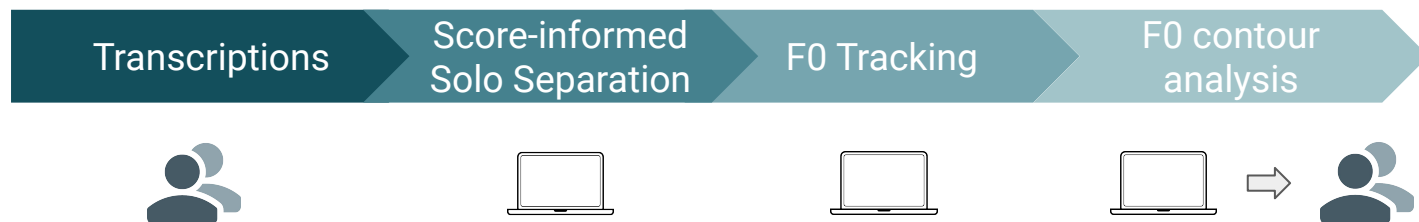
Past Experiences - Music Performance Analysis

Question: Are there intonation patterns in monophonic jazz improvisations? [2,3]

Data: Weimar Jazz Database (audio + manual melody transcriptions) (here)

Method:

Transcriptions → Score-informed Solo Separation → F0 Tracking → F0 contour analysis

Lessons learned:

- Score-informed F0 tracking is more promising for analysis of audio mixtures
- Intonation (sharp vs. flat), vibrato rate, and tone intensity (vs. pitch, duration, and position within a phrase) depend on the artist & instrument

Past Experiences - Feature Analysis

Question: What are the spectral characteristics of traditional Cauca Flutes?

Data: Field and studio recordings from the Músicas Regionales Archive, Colombia

Method:

| Partial Tracking | Partial Verification | Statistical Analysis | Instrument Characterization |

Lessons learned:

- Workflow needs to be optimized for a large-scale analysis
- Clear deviations from equal temperament observed

Past Experiences - Feature Analysis

Question: Are there distinctive features for jazz improvisation subsets (style, artist)? [4]

Data: Weimar Jazz Database (melody transcriptions + metadata) (here)

Method:

Transcriptions (choruses)	Feature Extraction	Data partitioning	Feature Selection
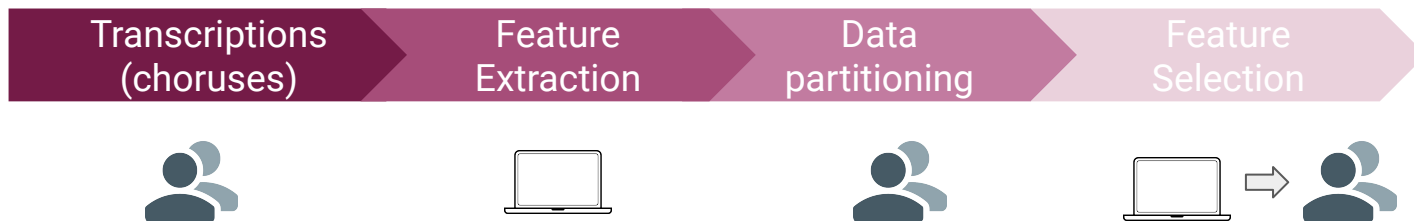
Lessons learned:

- Extensive metadata allow for various dataset partitions
- Symbolic features (pitch, intervals, rhythm, meter, lines) facilitate musicological interpretation of feature selection results

Available Tools

Feature Extraction

- Essentia
  - https://essentia.upf.edu/documentation/
- Madmom
  - https://madmom.readthedocs.io/en/latest/introduction.html
- Jazzomat tools (symbolic feature extraction & pattern mining)
  - https://jazzomat.hfm-weimar.de/download/download.html

Available Tools

Transcription

- Melodia VAMP plugin (Predominant f0 estimation)
  - https://www.upf.edu/web/mtg/melodia
- Silvet VAMP plugin (Polyphonic music transcription)
  - https://code.soundsoftware.ac.uk/projects/silvet
- Fraunhofer IDMT MusicBricks (Real-time pitch detection, music transcription, time stretching)
  - https://www.idmt.fraunhofer.de/en/business_units/m2d/musicbricks.html

Available Tools

Sound Separation

- Music Separation: OpenUnmix
  - https://open.unmix.app/#/

Segmentation

- Segmentation of field recordings Speech/Music: SEFIRE
  - http://lgm.fri.uni-lj.si/portfolio-view/sefire/

Machine Learning (Classification, Regression, etc.)

- Sci-kit Learn
  - https://scikit-learn.org/stable/

Available Tools

Various

- Sonic Visualizer Plugins
  - https://www.vamp-plugins.org/download.html
- Comp Music - MTG
  - https://github.com/MTG/pycompmusic
- Music21
  - http://web.mit.edu/music21/doc/index.html

References

[1] Cano, E. & Beveridge, Scott (2019). Microtiming Analysis in Shetland Fiddle Music. In Proceedings of the 20th Conference of the International Society for Music Information Retrieval ISMIR, Delft, The Netherlands.

[2] Abeßer, J., Frieler, K., Cano, E., Pfleiderer, M., & Zaddach, W.-G. (2017). Score-Informed Analysis of Tuning, Intonation, Pitch Modulation, and Dynamics in Jazz Solos. IEEE/ACM Transactions on Audio, Speech and Language Processing, 25(1), 168-177. doi: 10.1109/TASLP.2016.2627186

[3] Abeßer, J.,& Frieler, K. (2017). Score-informed audio analysis of jazz improvisation, in Pfleiderer, M., Frieler, K., Abeßer, J., Zaddach, W.-G., & Burkhard, B. (Eds.). Inside the Jazzomat. New Perspectives for Jazz Research. Mainz: Schott Campus (Open Access), pp. 97-129

[4] Pfleiderer, M., Abeßer, J. (2017). Statistical Feature Selection: Searching for Musical Style, in Pfleiderer, M., Frieler, K., Abeßer, J., Zaddach, W.-G., & Burkhard, B. (Eds.). Inside the Jazzomat. New Perspectives for Jazz Research. Mainz: Schott Campus (Open Access), pp. 85-95

References

- All material available here: https://github.com/jakobabesser/WIMIR_2019
  - Slides
  - Jupyter Notebook (Feature Selection for Jazz Improvisation)

Additional Material

- M. Pfleiderer et al.: "Inside the Jazzomat", Schott, 2017
  - In github project: /feature_selection_jazz/material/inside_the_jazzomat.pdf
  - Chapter "Statistical feature selection: searching for musical style" (p.85 ff)
  - Python code & data to reproduce experiments (audio & symbolic)
    - https://github.com/jazzomat/python/tree/master/publications/book_2017/

- MeloSpyGUI
  - Stand-alone software (Windows / MacOS / Linux) with GUI for symbolic feature extraction
    - Shippes with Weimar Jazz Database (jazz solos) & ESAC database (folk melodies)
  - https://jazzomat.hfm-weimar.de/download/download.html

Additional Material

- Feature Selection (Weimar Jazz Database) example: Benny Goodman vs. all
  - More long tones (rel. to the beat)
  - More long arpeggios (both ascending and descending)

Table 4: Significant features of improvisations played by Benny Goodman (8 choruses) compared to all other improvisation (1408 choruses).

Feature	Mean (class)	Mean (others)	Cohen's d	Sig.
durclass_rel_hist_04_long	0.156	0.028	1.55	***
pitch_median	72.312	65.360	1.39	***
avgtempo	264.900	194.667	1.00	**
mean_length_chromatic_descending	4.562	2.896	0.98	**
mean_length_chromatic_mixed	4.657	3.542	0.89	*
syncopicity	0.191	0.314	0.87	*
int_min	−14.250	−10.020	−0.78	*
mean_length_arpeggio_ascending	3.713	2.598	0.76	*
mean_length_chromatic_sequences	4.171	3.177	0.74	*
mean_length_arpeggio_descending	3.558	2.541	0.72	*