INTERNATIONAL AUDIO LABORATORIES ERLANGEN

Ringvorlesung TechTalk
Philosophische Fakultät, FAU, WS 2019/20

Neue Wege für die Musikforschung mittels Digitaler Signalverarbeitung

Meinard Müller, Christof Weiß

International Audio Laboratories Erlangen
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Meinard Müller

- Mathematics (Diplom/Master)
  Computer Science (PhD)
  Information Retrieval (Habilitation)
  Bonn University
- Combinatorics (Postdoc)
  Keio University, Japan
- Senior Researcher
  Max-Planck Institute, Saarland
- Professor: Semantic Audio Processing
  Erlangen-Nürnberg University

Christof Weiß

- Physics Diploma
  Universität Würzburg
- Composition
  HfM Würzburg
- Ph. D. in Media Technology
  Fraunhofer IDMT, Ilmenau
- Postdoc in Music Processing & Composer
  AudioLabs / Erlangen-Nürnberg University
- 2018: KlarText award for science communication

Group Members

- Christof Weiß
- Frank Zalkow
- Michael Krause
- Sebastian Rosenzweig
- Hendrik Schreiber



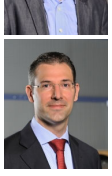


International Audio Laboratories Erlangen


AudioLabs – FAU

- Prof. Dr. Jürgen Herre
  Audio Coding
- Prof. Dr. Bernd Edler
  Audio Signal Analysis
- Prof. Dr. Meinard Müller
  Semantic Audio Processing
- Prof. Dr. Emanuël Habets
  Spatial Audio Signal Processing
- Prof. Dr. Frank Wefers
  Virtual Reality
- Dr. Stefan Turowski
  Coordinator AudioLabs-FAU



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Audio

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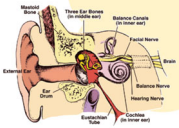
Audio Coding

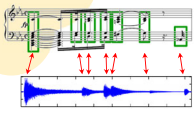
3D Audio

Virtual Reality

Audio



Psychoacoustics

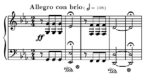


Music Processing

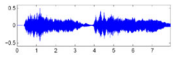
Music

Music Information Retrieval (MIR)

Sheet Music (Image)



CD / MP3 (Audio)



MusicXML (Text)

Dance / Motion (Mocap)

Music

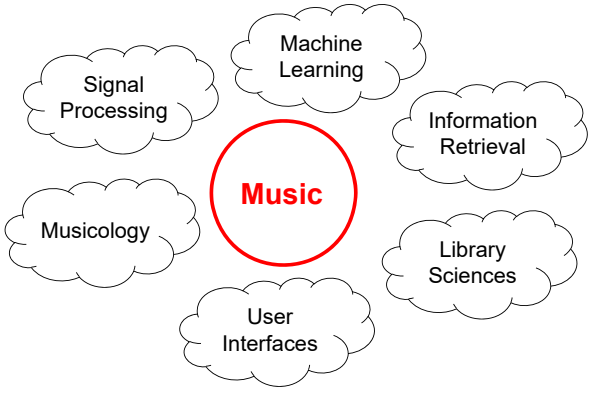
MIDI

Singing / Voice (Audio)

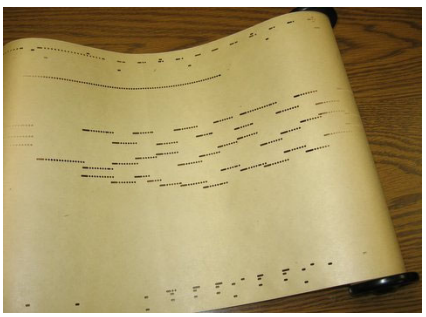
Music Film (Video)

Music Literature (Text)

Music Information Retrieval (MIR)



Piano Roll Representation

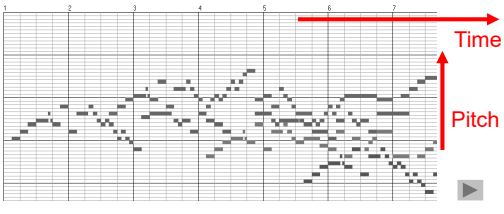


Player Piano (1900)

Piano Roll Representation (MIDI)

J.S. Bach, C-Major Fuge

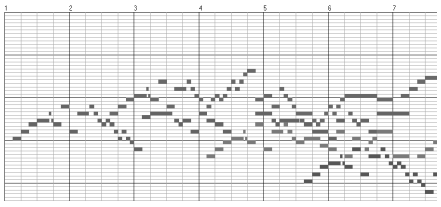
(Well Tempered Piano, BWV 846)



Piano Roll Representation (MIDI)

Query:

Goal: Find all occurrences of the query

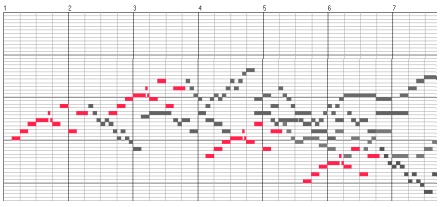


Piano Roll Representation (MIDI)

Query:

Goal: Find all occurrences of the query

Matches:



Music Retrieval

Database

Hit

Audio-ID

Bernstein (1962)
Beethoven, Symphony No. 5

Version-ID

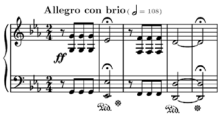
Beethoven, Symphony No. 5:
- Bernstein (1962)
- Karajan (1982)
- Gould (1992)

Category-ID

- Beethoven, Symphony No. 9
- Beethoven, Symphony No. 3
- Haydn Symphony No. 94

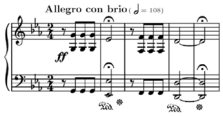
Music Synchronization: Audio-Audio

Beethoven's Fifth

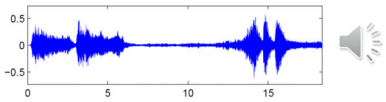


Music Synchronization: Audio-Audio

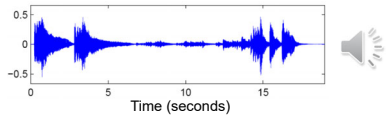
Beethoven's Fifth



Orchester (Karajan)

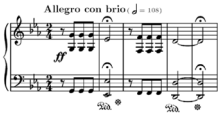


Piano (Scherbakov)

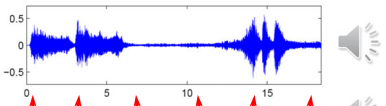


Music Synchronization: Audio-Audio

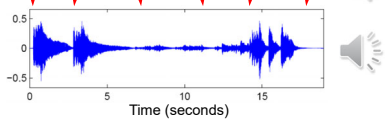
Beethoven's Fifth



Orchester (Karajan)



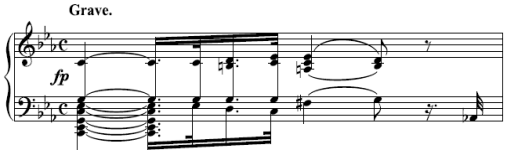
Piano (Scherbakov)



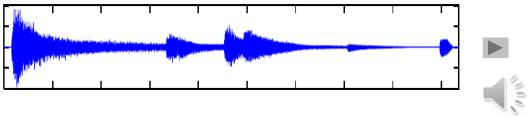
Application: Interpretation Switcher

Music Synchronization: Image-Audio

Image



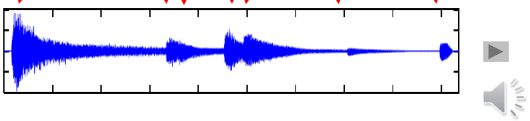
Audio



Music Synchronization: Image-Audio

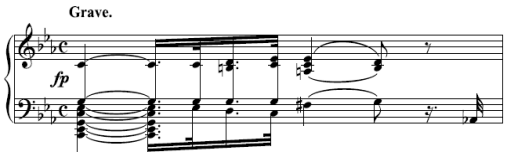
Image

Audio

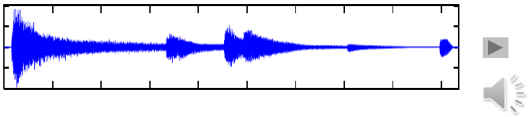


How to make the data comparable?

Image



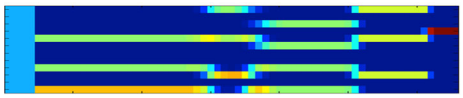
Audio



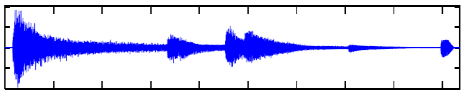
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



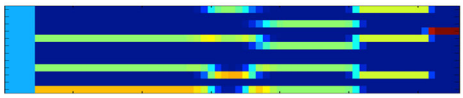
Audio



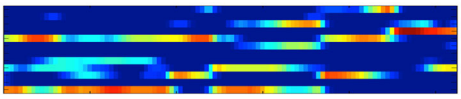
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



Audio

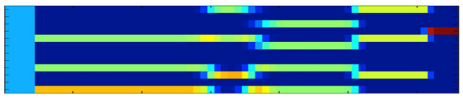


Audio Processing: Fourier Analysis

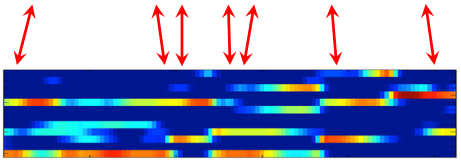
How to make the data comparable?

Image Processing: Optical Music Recognition

Image

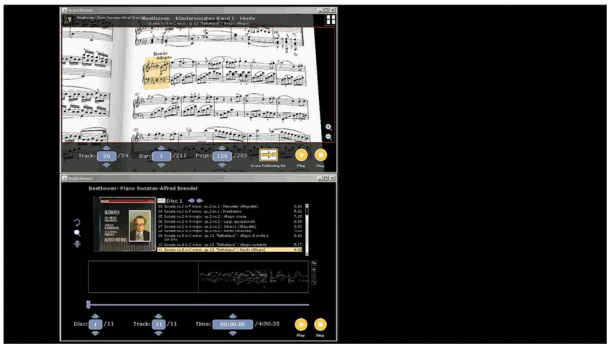


Audio



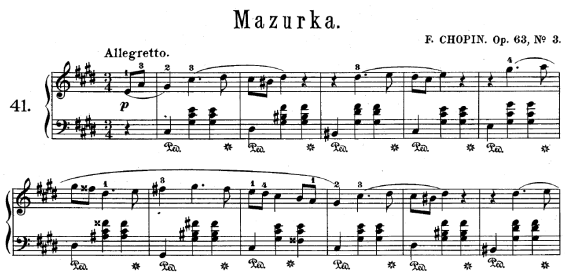
Audio Processing: Fourier Analysis

Application: Score Viewer



Why is Music Processing Challenging?

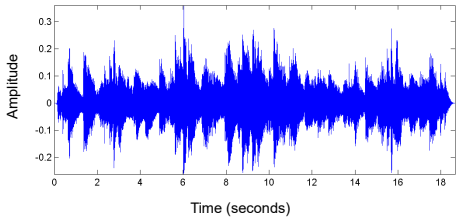
Example: Chopin, Mazurka Op. 63 No. 3



Why is Music Processing Challenging?

Example: Chopin, Mazurka Op. 63 No. 3

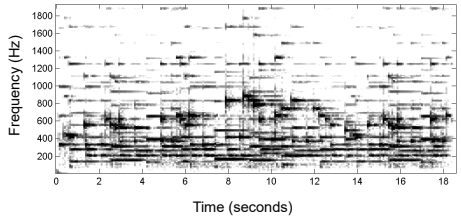
- Waveform



Why is Music Processing Challenging?

Example: Chopin, Mazurka Op. 63 No. 3

- Waveform / Spectrogram



Why is Music Processing Challenging?

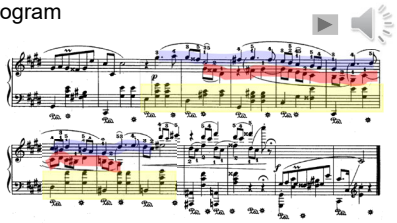
Example: Chopin, Mazurka Op. 63 No. 3

- Waveform / Spectrogram
- Performance
  - Tempo
  - Dynamics
  - Note deviations
  - Sustain pedal

Why is Music Processing Challenging?

Example: Chopin, Mazurka Op. 63 No. 3

- Waveform / Spectrogram
- Performance
  - Tempo
  - Dynamics
  - Note deviations
  - Sustain pedal
- Polyphony



Main Melody
Additional melody line
Accompaniment

Computational Analysis of Traditional Georgian Vocal Music

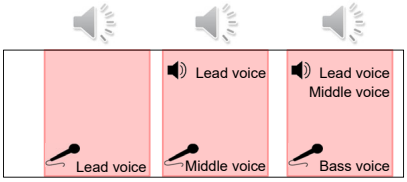
- Partner: Prof. Frank Scherbaum
  Potsdam University
- Duration: 2018 – 2021
- Objectives
  - Harmonic, tonal and performance analysis
  - New sensors (larynx microphones)
  - Digital humanities

https://www.audiolabs-erlangen.de/resources/MIR/2017-GeorgianMusic-Erkomaishvili
https://www.audiolabs-erlangen.de/resources/MIR/2018-ISMIR-LBD-ThroatMics

Traditional Georgian Vocal Music

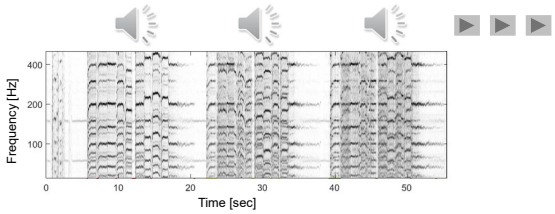
Which scale? Harmonic/melodic intervals? Singer interaction?

Traditional Georgian Vocal Music



- Master chanter: Artem Erkomaishvili
- Recordings of 100 songs (1966)
- Example song: Da sulisatsa (#87)

Traditional Georgian Vocal Music



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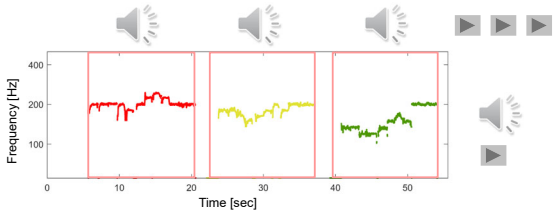
Traditional Georgian Vocal Music



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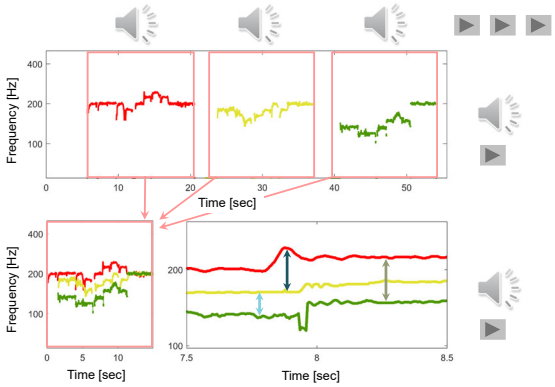
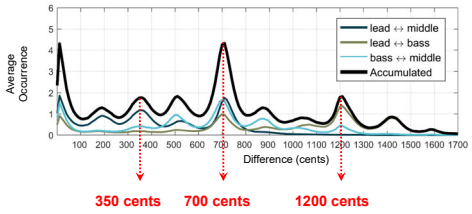
Traditional Georgian Vocal Music



Traditional Georgian Vocal Music



- Peak at 350 cents (between minor and major third)
- **Non-western temperament**

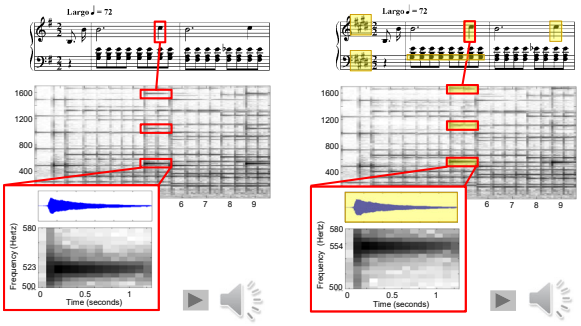
Automated Methods and Tools for Analyzing and Structuring Choral Music

- Partner: Carus-Verlag
- Duration: 2018 – 2021
- Objectives
  - Navigation, visualization, sonification of musical structures
  - Practicability & applications (music education, musicology)
  - Web-based prototypes for interactive interfaces

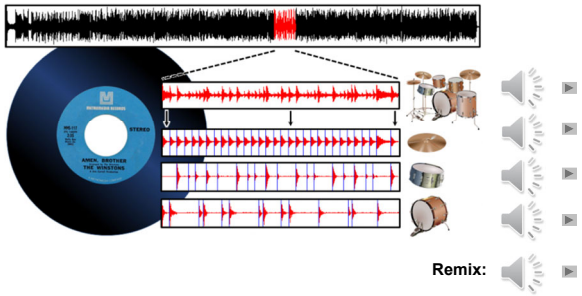
https://www.audiolabs-erlangen.de/resources/MIR/2018-ISMIR-LBD-Carus

Score-Informed Audio Decomposition

Application: Audio editing

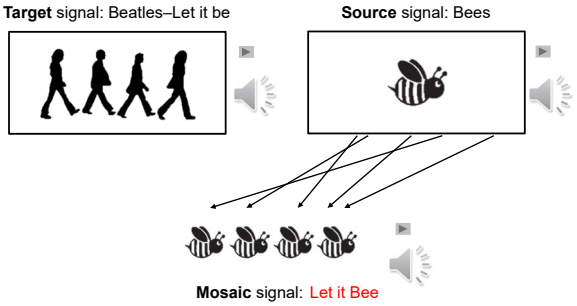


Informed Drum-Sound Decomposition



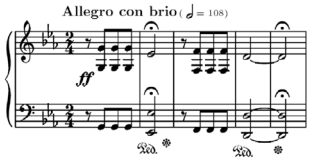
Literature: [Dittmar/Müller, IEEE/ACM-TASLP 2016]
Demo: https://www.audiolabs-erlangen.de/resources/MIR/2016-IEEE-TASLP-DrumSeparation

Audio Mosaicing



Literature: [Driedger/Müller, ISMIR 2015]
Demo: https://www.audiolabs-erlangen.de/resources/MIR/2015-ISMIR-LetItBee

Motivic Similarity

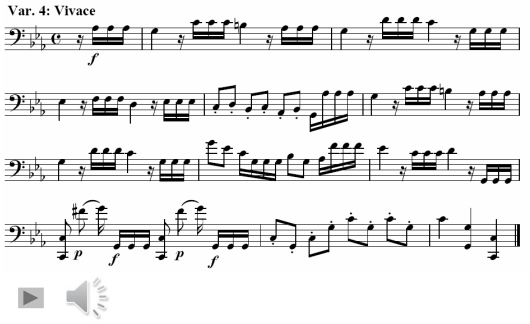


Beethoven's Fifth (1st Mov.)

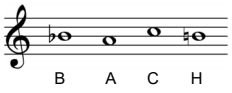
Beethoven's Fifth (3rd Mov.)

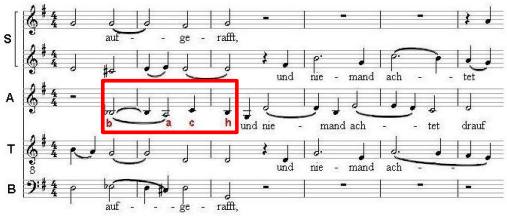
Beethoven's Appassionata

Motivic Similarity

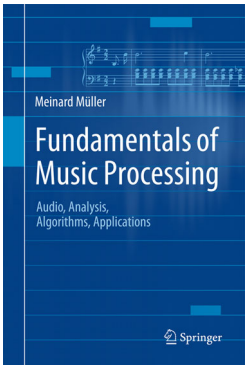


Motivic Similarity





Book: Fundamentals of Music Processing



Meinard Müller
Fundamentals of Music Processing
Audio, Analysis, Algorithms, Applications
483 p., 249 illus., hardcover
ISBN: 978-3-319-21944-8
Springer, 2015

Accompanying website:
www.music-processing.de

Book: Fundamentals of Music Processing

Chapter		Music Processing Scenario
1		Music Represenations
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

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FMP Notebooks

Python Notebooks for Fundamentals of Music Processing

- Introductions of MIR scenarios
- Textbook-like explanations and algorithms
- Python code examples
- Numerous illustrations and sound examples

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