INTERNATIONAL AUDIO LABORATORIES ERLANGEN

AUDIO LABS

Tutorial
Automatisierte Methoden der Musikverarbeitung
47. Jahrestagung der Gesellschaft für Informatik

Further Topics in MIR

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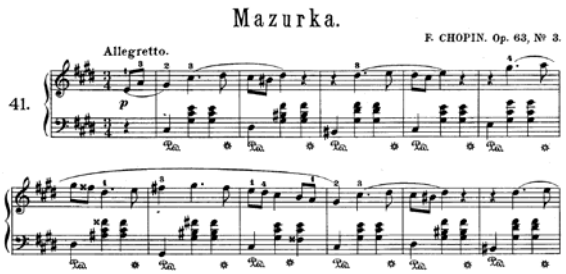
FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

Fraunhofer IIS

Why is Music Processing Challenging?

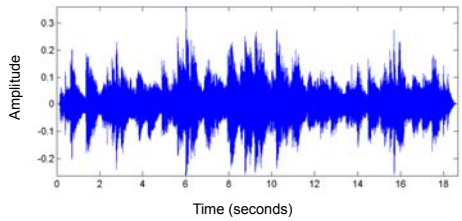
Example: Chopin, Mazurka Op. 63 No. 3



Why is Music Processing Challenging?

Example: Chopin, Mazurka Op. 63 No. 3

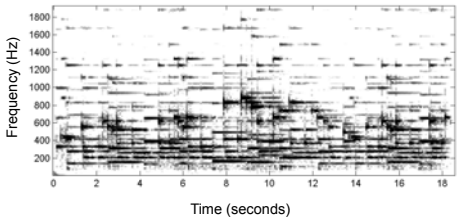
- Waveform



Why is Music Processing Challenging?

Example: Chopin, Mazurka Op. 63 No. 3

- Waveform / Spectrogram



Why is Music Processing Challenging?

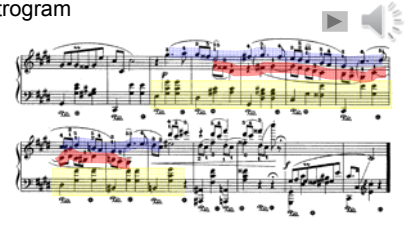
Example: Chopin, Mazurka Op. 63 No. 3

- 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

Source Separation

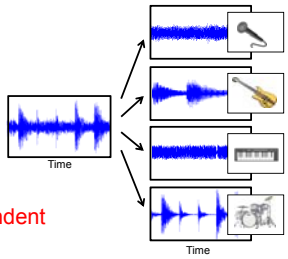
- Decomposition of audio stream into different sound sources
- Central task in digital signal processing
- “Cocktail party effect”

Source Separation

- Decomposition of audio stream into different sound sources
- Central task in digital signal processing
- “Cocktail party effect”
- Several input signals
- Sources are assumed to be statistically independent

Source Separation (Music)

- Main melody, accompaniment, drum track
- Instrumental voices
- Individual note events
- Only mono or stereo
- Sources are often highly dependent



Harmonic-Percussive Decomposition

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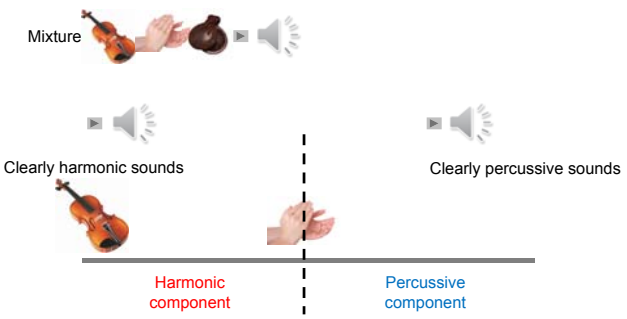

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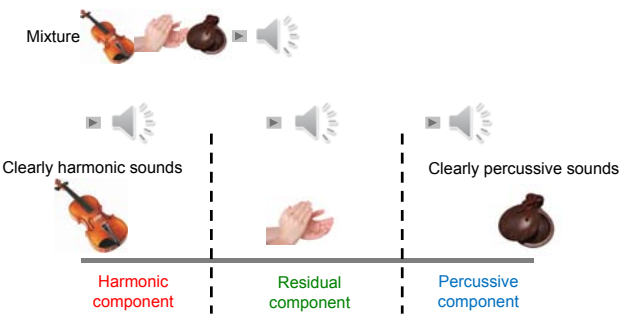

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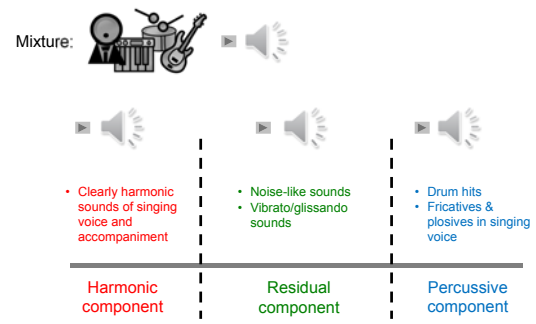
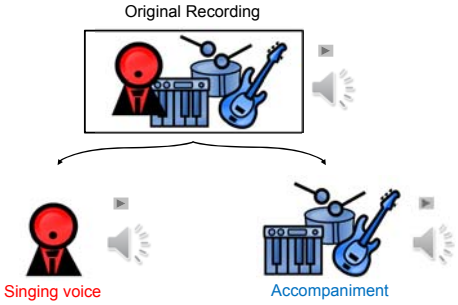


Literature: [Driedger/Müller/Disch, ISMIR 2014]
Demo: https://www.audiolabs-erlangen.de/resources/2014-ISMIR-ExtHPSep/

Singing Voice Extraction



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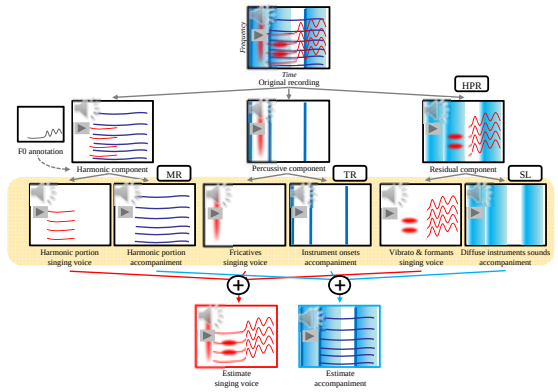
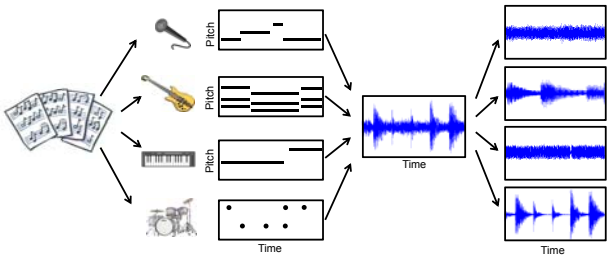


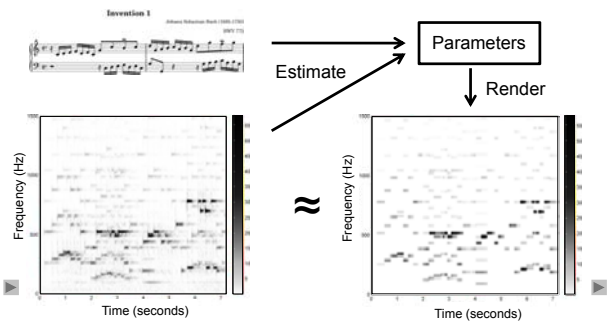
Score-Informed Source Separation

Exploit musical score to support separation process

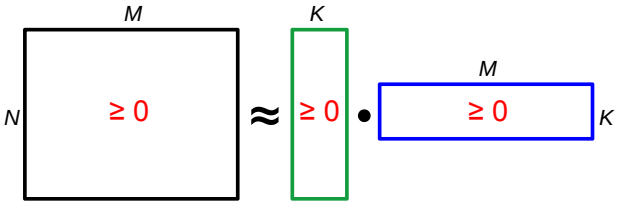


Parametric Model Approach

Rebuild spectrogram information



NMF (Nonnegative Matrix Factorization)



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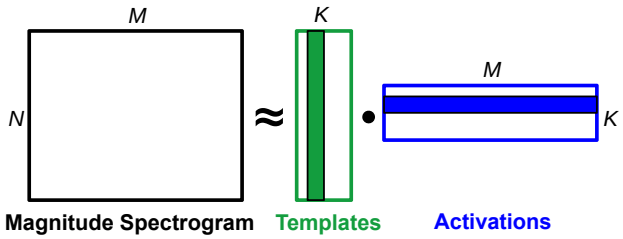
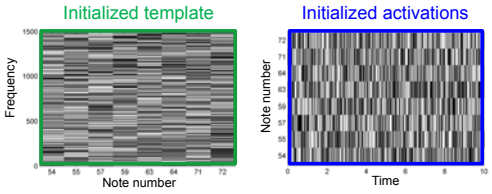


Templates: Pitch + Timbre — "How does it sound"

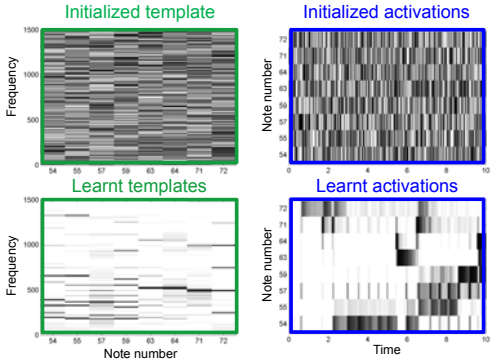
Activations: Onset time + Duration — "When does it sound"

NMF-Decomposition



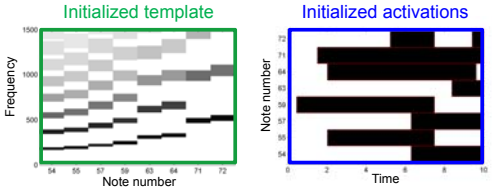
Random initialization

NMF-Decomposition



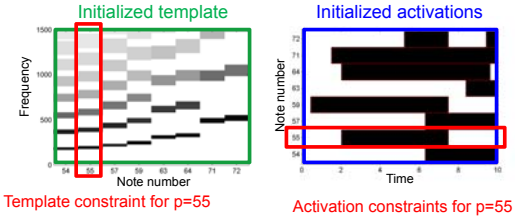
Random initialization → No semantic meaning

NMF-Decomposition



Constrained initialization

NMF-Decomposition

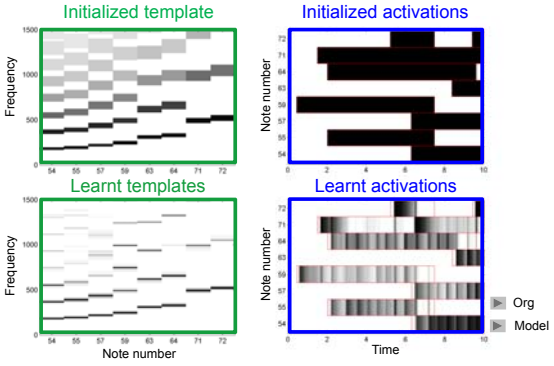


Template constraint for p=55

Activation constraints for p=55

Constrained initialization

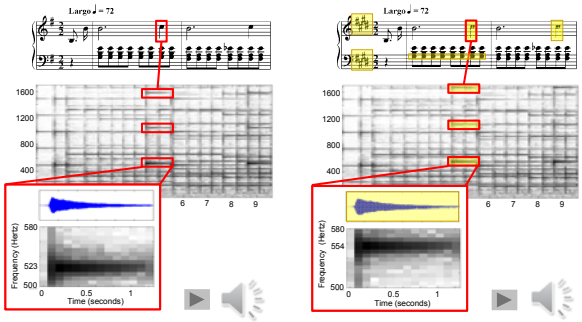
NMF-Decomposition



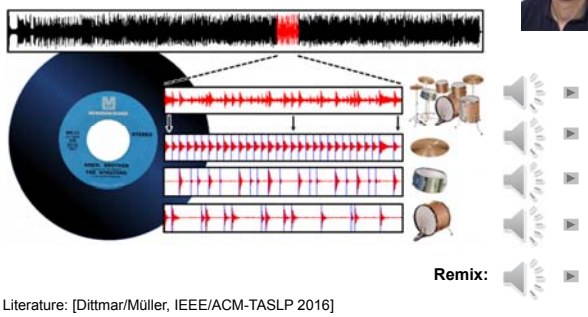
Constrained initialization → NMF as refinement

Score-Informed Audio Decomposition

Application: Audio editing



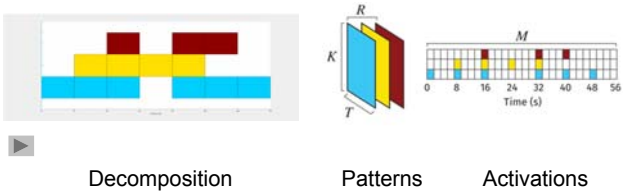
Informed Drum-Sound Decomposition



Remix:

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

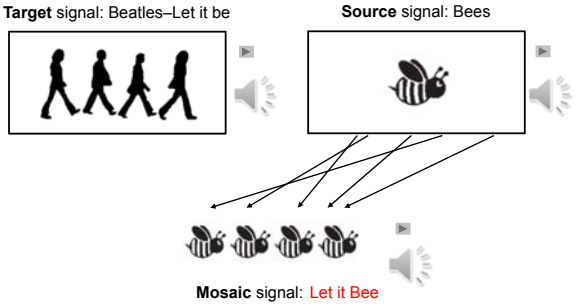
Loop Decomposition of EDM



Decomposition Patterns Activations

Literature: [López-Serrano/Dittmar/Müller, ISMIR 2016]
Demo: https://www.audiolabs-erlangen.de/resources/MIR/2016-ISMIR-EMLoop

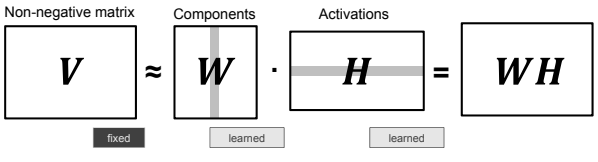
Audio Mosaicing



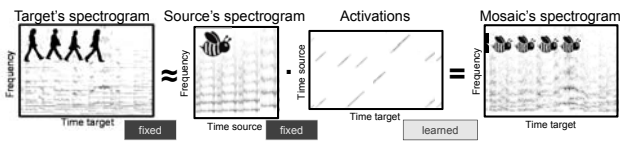
Literature: [Driedger/Müller, ISMIR 2015]
Demo: https://www.audiolabs-erlangen.de/resources/MIR/2015-ISMIR-LetItBee

NMF-Inspired Audio Mosaicing

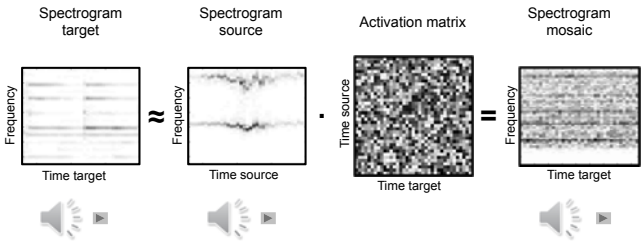
Non-negative matrix factorization (NMF)



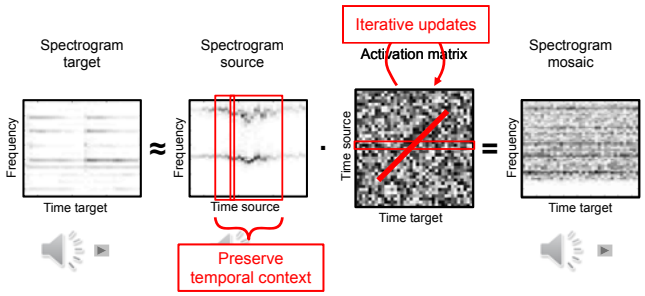
Proposed audio mosaicing approach



NMF-Inspired Audio Mosaicing

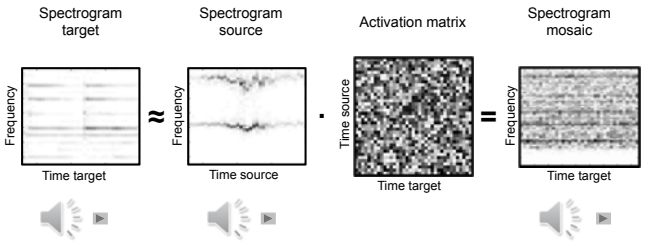


NMF-Inspired Audio Mosaicing



Core idea: support the development of sparse diagonal activation structures

NMF-Inspired Audio Mosaicing



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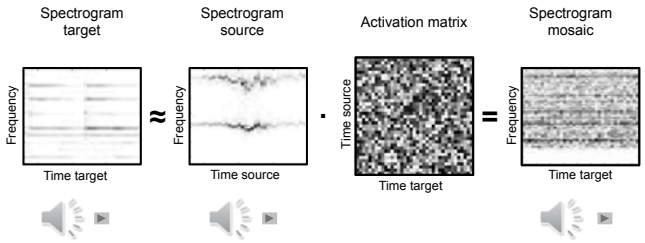
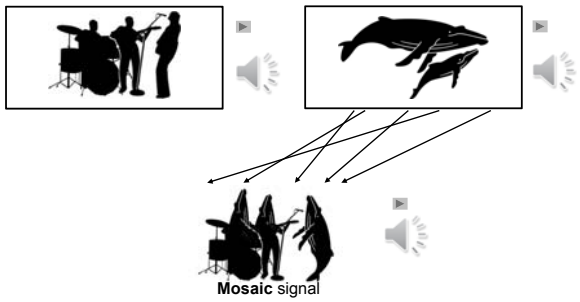


Audio Mosaicing

Target signal: Chic–Good times

Source signal: Whales

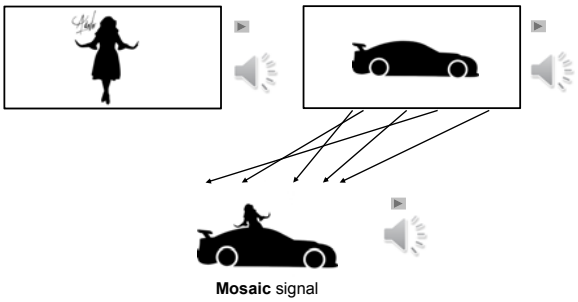


Mosaic signal

Audio Mosaicing

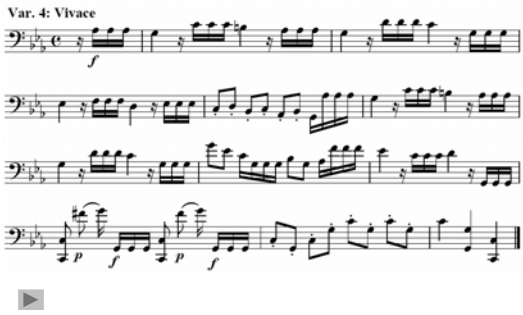
Target signal: Adele–Rolling in the Deep

Source signal: Race car



Mosaic signal

Motivic Similarity



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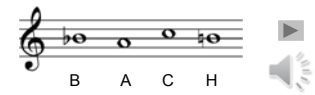
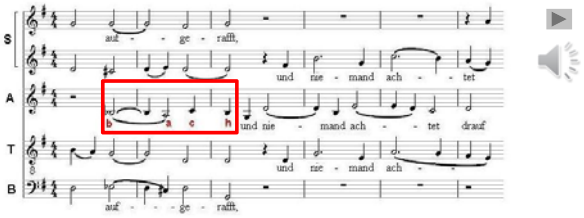
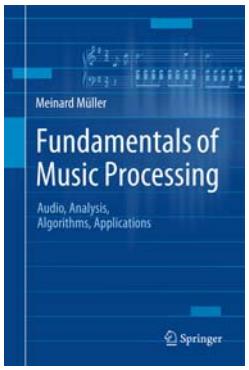




Summary

- Music information retrieval
- Audio decomposition techniques
- Machine learning
- Music applications & musicology
- Multimedia scenarios
- Web-based interfaces
- Teaching
- Academic training of students
- Fundamental research

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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