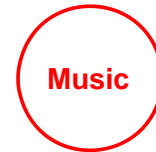


Lecture
Music Processing Analysis (MPA)

Overview

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International Audio Laboratories Erlangen
meinard.mueller@audiolabs-erlangen.de

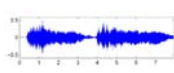


Music Processing

Sheet Music (Image)



CD / MP3 (Audio)



MusicXML (Text)

```
<?xml version="1.0" encoding="UTF-8" standalone="no" >
<!-- MusicXML file -->
<musicxml>
  <score>
    <part id="1" name="Voice" type="voice">
      <note duration="4" pitch="440" type="quarter" />
      <note duration="4" pitch="460" type="quarter" />
      <note duration="4" pitch="480" type="quarter" />
      <note duration="4" pitch="500" type="quarter" />
    </part>
  </score>
</musicxml>
```

Dance / Motion (Mocap)



MIDI



Singing / Voice (Audio)



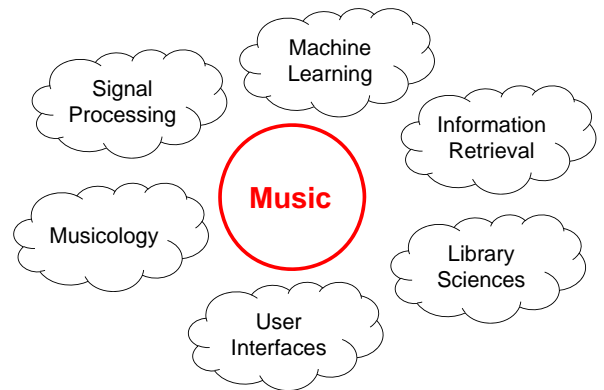
Music Film (Video)



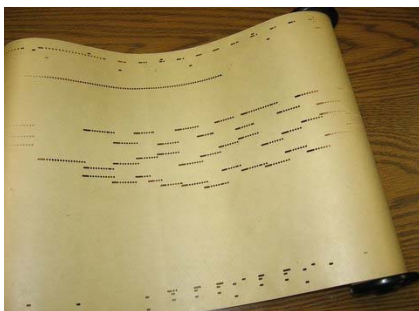
Music Literature (Text)



Music Processing



Piano Roll Representation



Player Piano (1900)



Piano Roll Representation (MIDI)

J.S. Bach, C-Major Fuge
(Well Tempered Piano, BWV 846)

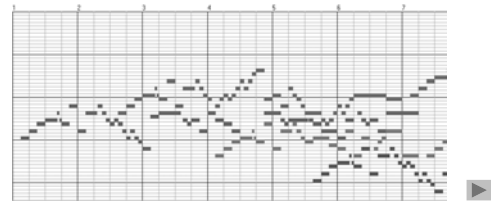


Piano Roll Representation (MIDI)

Query:



Goal: Find all occurrences of the query



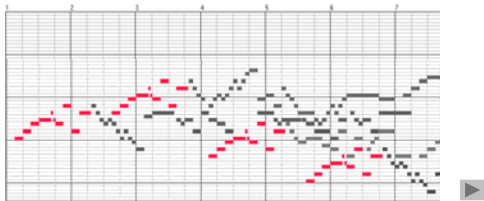
Piano Roll Representation (MIDI)

Query:



Goal: Find all occurrences of the query

Matches:



Music Retrieval

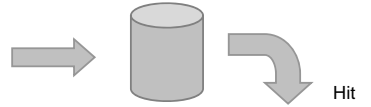


Audio-ID

Version-ID

Kategorie-ID

Database



Bernstein (1962)
Beethoven, Symphony No. 5

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

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



Music Synchronization: Audio-Audio

Beethoven's Fifth

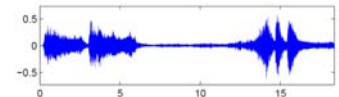


Music Synchronization: Audio-Audio

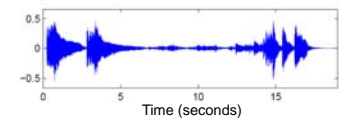
Beethoven's Fifth



Orchester
(Karajan)



Piano
(Scherbakov)



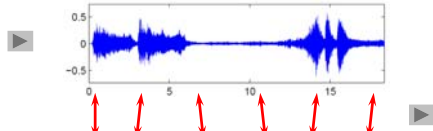
Time (seconds)

Music Synchronization: Audio-Audio

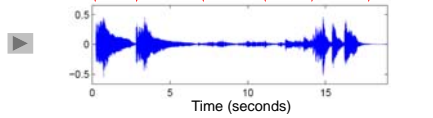
Beethoven's Fifth



Orchester (Karajan)



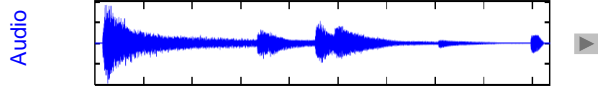
Piano (Scherbakov)



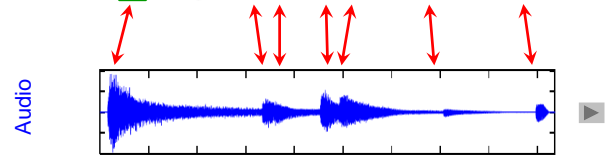
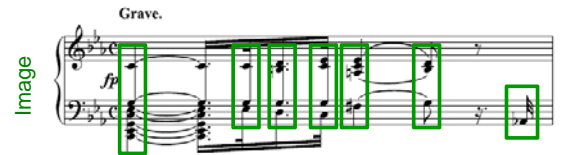
Application: Interpretation Switcher



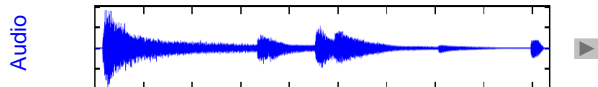
Music Synchronization: Image-Audio



Music Synchronization: Image-Audio

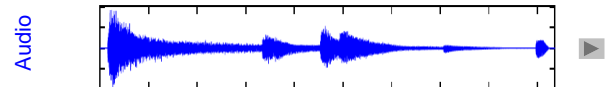
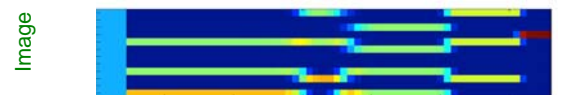


How to make the data comparable?



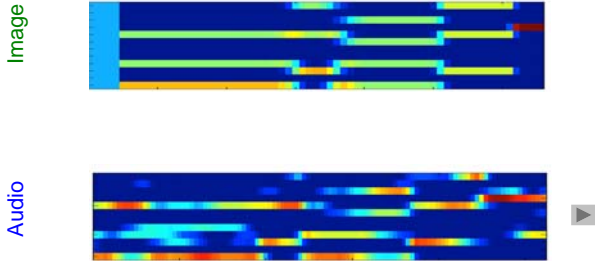
How to make the data comparable?

Image Processing: Optical Music Recognition



How to make the data comparable?

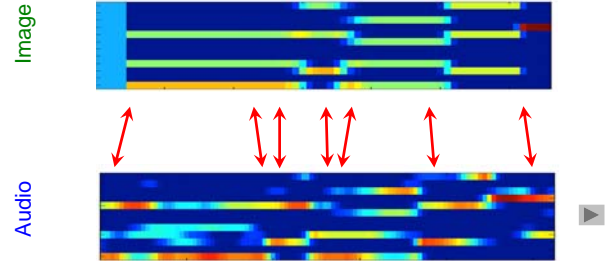
Image Processing: Optical Music Recognition



Audio Processing: Fourier Analyse

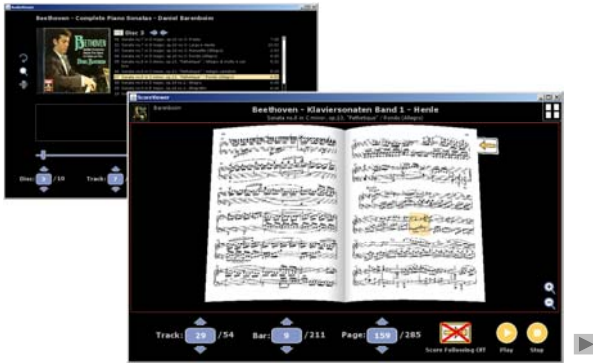
How to make the data comparable?

Image Processing: Optical Music Recognition



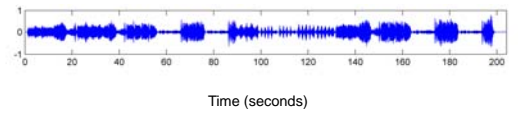
Audio Processing: Fourier Analyse

Application: Score Viewer



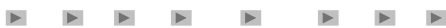
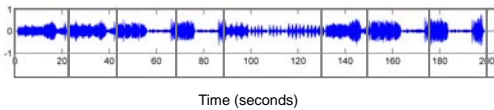
Music Structure Analysis

Example: Brahms Hungarian Dance No. 5 (Ormandy)



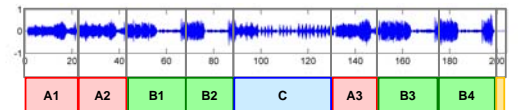
Music Structure Analysis

Example: Brahms Hungarian Dance No. 5 (Ormandy)



Music Structure Analysis

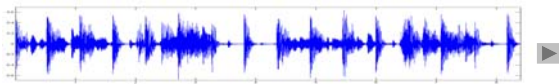
Example: Brahms Hungarian Dance No. 5 (Ormandy)



Tempo Estimation and Beat Tracking

Basic task: "Tapping the foot when listening to music"

Example: Queen – Another One Bites The Dust

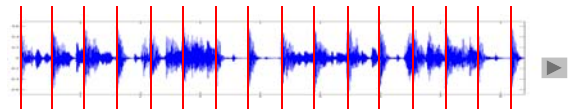


Time (seconds)

Tempo Estimation and Beat Tracking

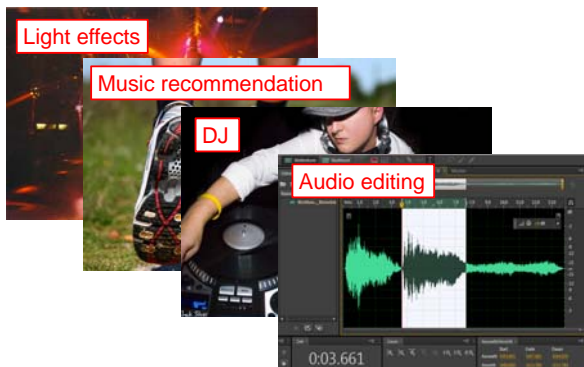
Basic task: "Tapping the foot when listening to music"

Example: Queen – Another One Bites The Dust

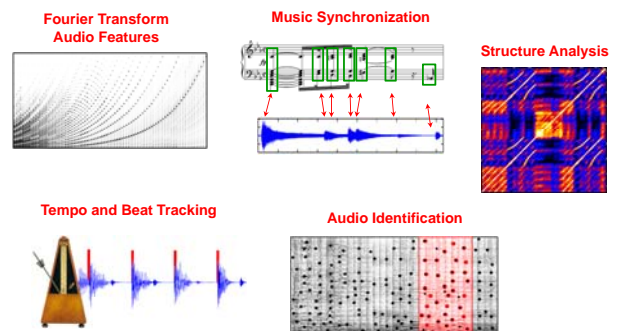


Time (seconds)

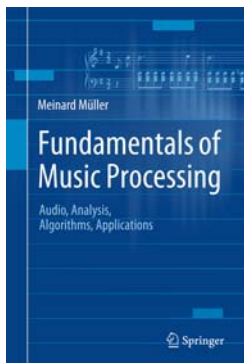
Tempo Estimation and Beat Tracking



Music Processing



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 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

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