

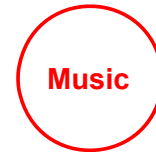
Lecture

Music Processing Analysis (MPA)

Overview

Meinard Müller

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

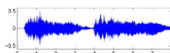


Music Information Retrieval (MIR)

Sheet Music (Image)



CD / MP3 (Audio)



MusicXML (Text)

```
<note>
  <pitch>
    <midi>C4
    <name>C4
    <octave>4
  </pitch>
  <duration>4
  </note>
```

Dance / Motion (Mocap)



MIDI



Singing / Voice (Audio)



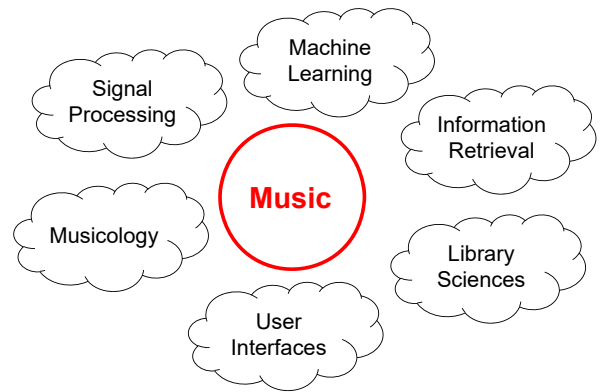
Music Film (Video)



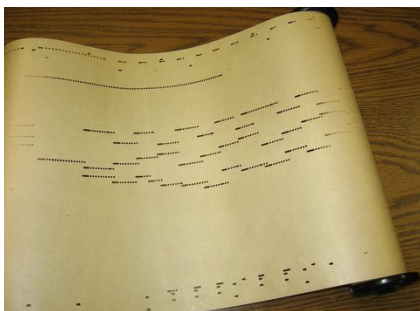
Music Literature (Text)



Music Information Retrieval (MIR)



Piano Roll Representation

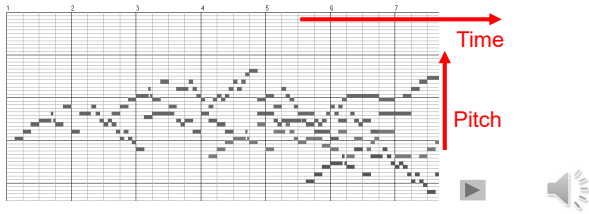


Player Piano (1900)



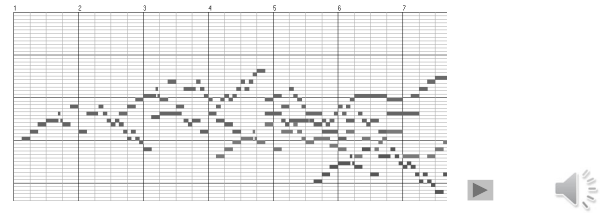
## Piano Roll Representation (MIDI)

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



## Piano Roll Representation (MIDI)

Query:   
Goal: Find all occurrences of the query

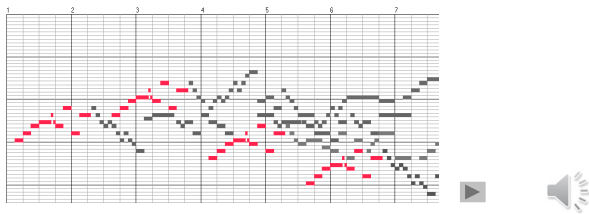


## Piano Roll Representation (MIDI)

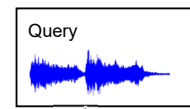
Query:   
Goal: Find all occurrences of the query



Matches:



## Music Retrieval

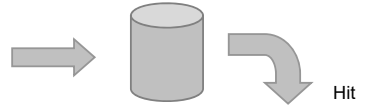


Audio-ID

Version-ID

Category-ID

Database



Hit

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

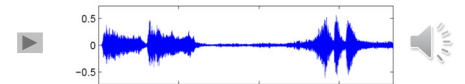


## Music Synchronization: Audio-Audio

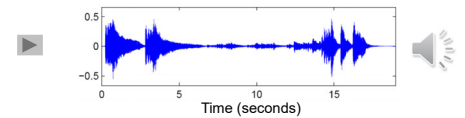
Beethoven's Fifth



Orchester  
(Karajan)



Piano  
(Scherbakov)

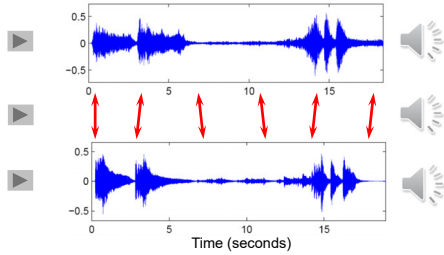


## Music Synchronization: Audio-Audio

Beethoven's Fifth

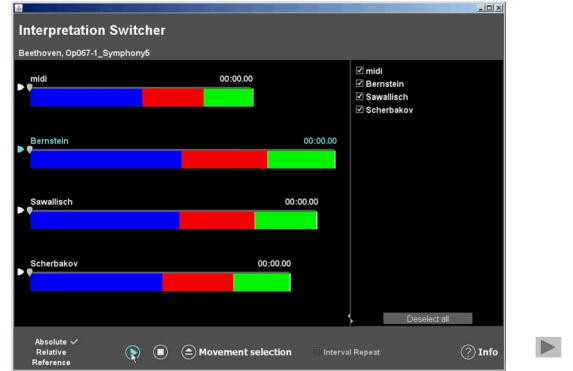


Orchester  
(Karajan)

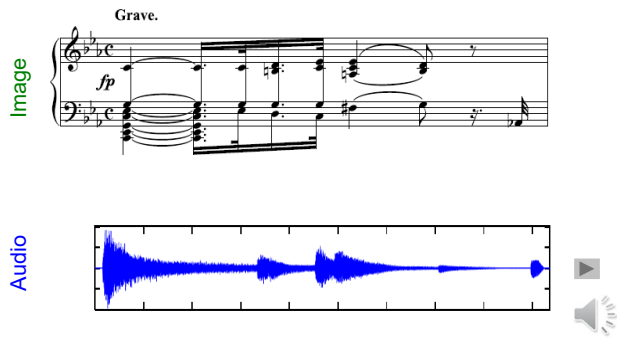


Piano  
(Scherbakov)

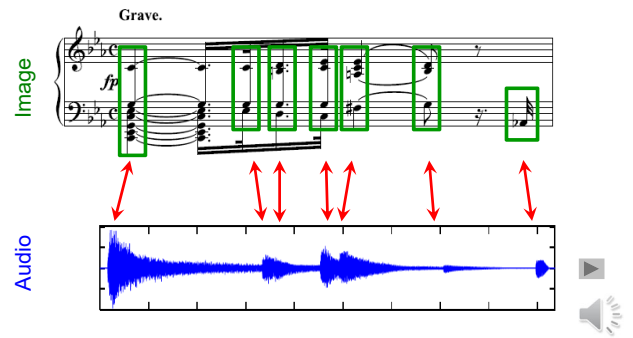
## Application: Interpretation Switcher



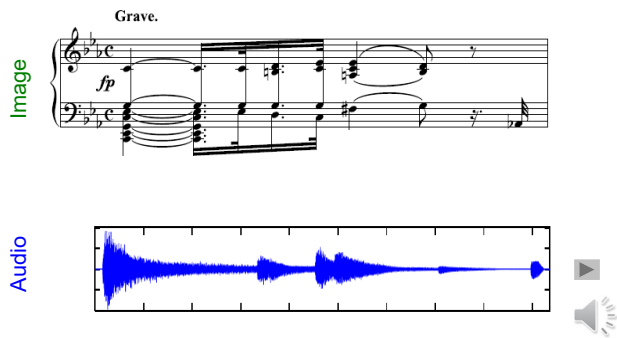
## Music Synchronization: Image-Audio



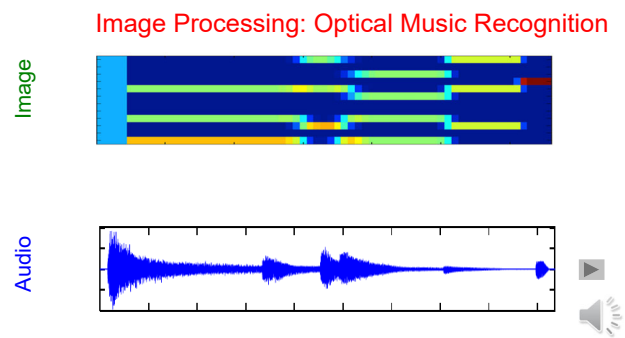
## Music Synchronization: Image-Audio



## How to make the data comparable?

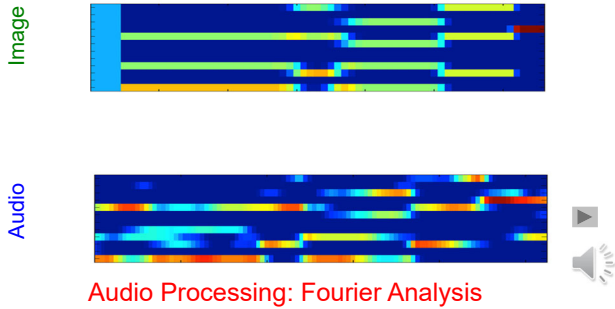


## How to make the data comparable?



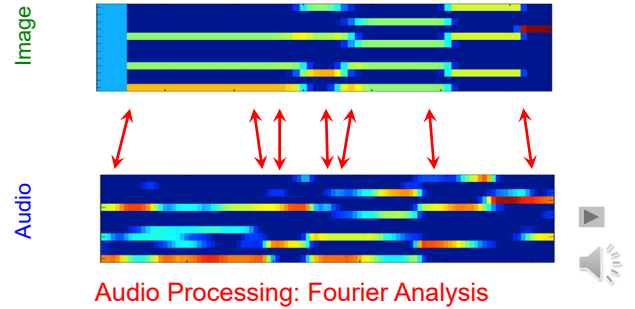
How to make the data comparable?

Image Processing: Optical Music Recognition

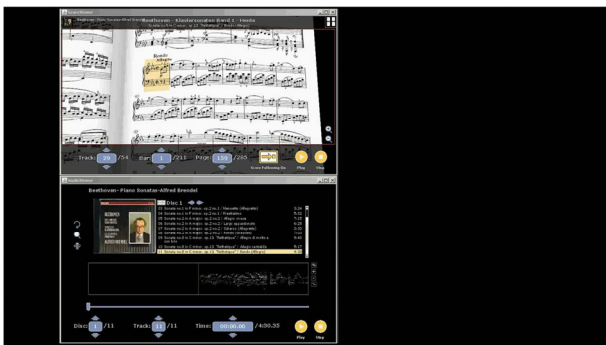


How to make the data comparable?

Image Processing: Optical Music Recognition

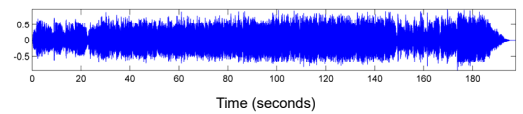


Application: Score Viewer



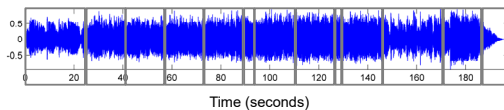
Music Structure Analysis

Example: Zager & Evans "In The Year 2525"



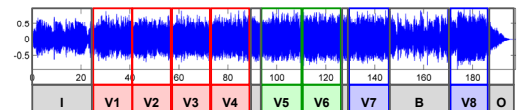
Music Structure Analysis

Example: Zager & Evans "In The Year 2525"



Music Structure Analysis

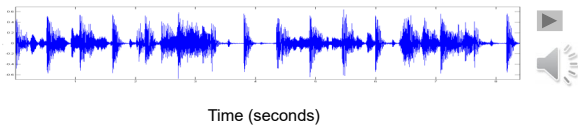
Example: Zager & Evans "In The Year 2525"



## Tempo Estimation and Beat Tracking

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

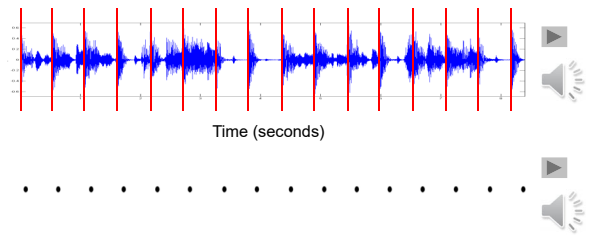
Example: Queen – Another One Bites The Dust



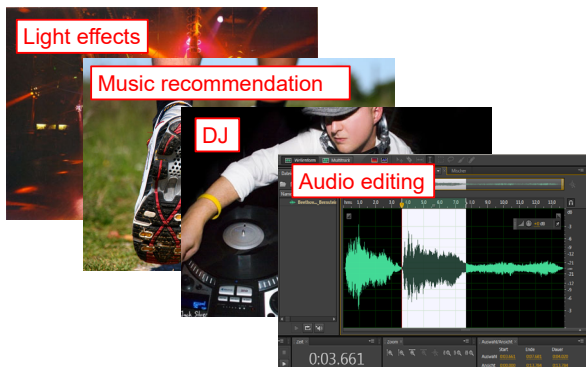
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Basic task: "Tapping the foot when listening to music"

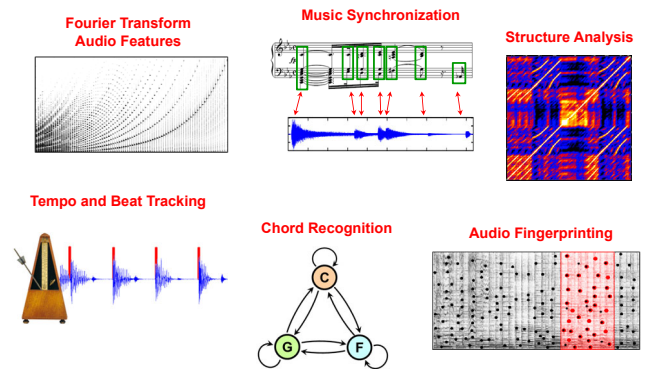
Example: Queen – Another One Bites The Dust



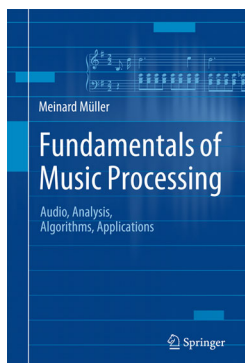
## Tempo Estimation and Beat Tracking



## 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](http://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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