

Lecture

Music Processing Analysis (MPA)

Overview

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Music

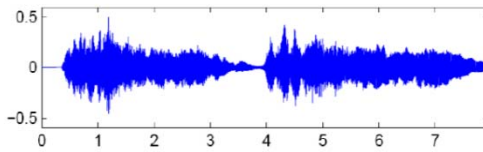


Music Information Retrieval (MIR)

Sheet Music (Image)



CD / MP3 (Audio)



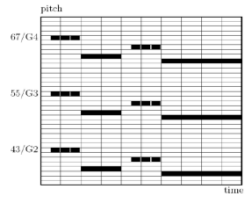
MusicXML (Text)

```
<note>
  <pitch>
    <step>E</step>
    <alter>-1</alter>
    <octave>4</octave>
  </pitch>
  <duration>2</duration>
  <type>half</type>
</note>
```

Dance / Motion (Mocap)



MIDI



Singing / Voice (Audio)



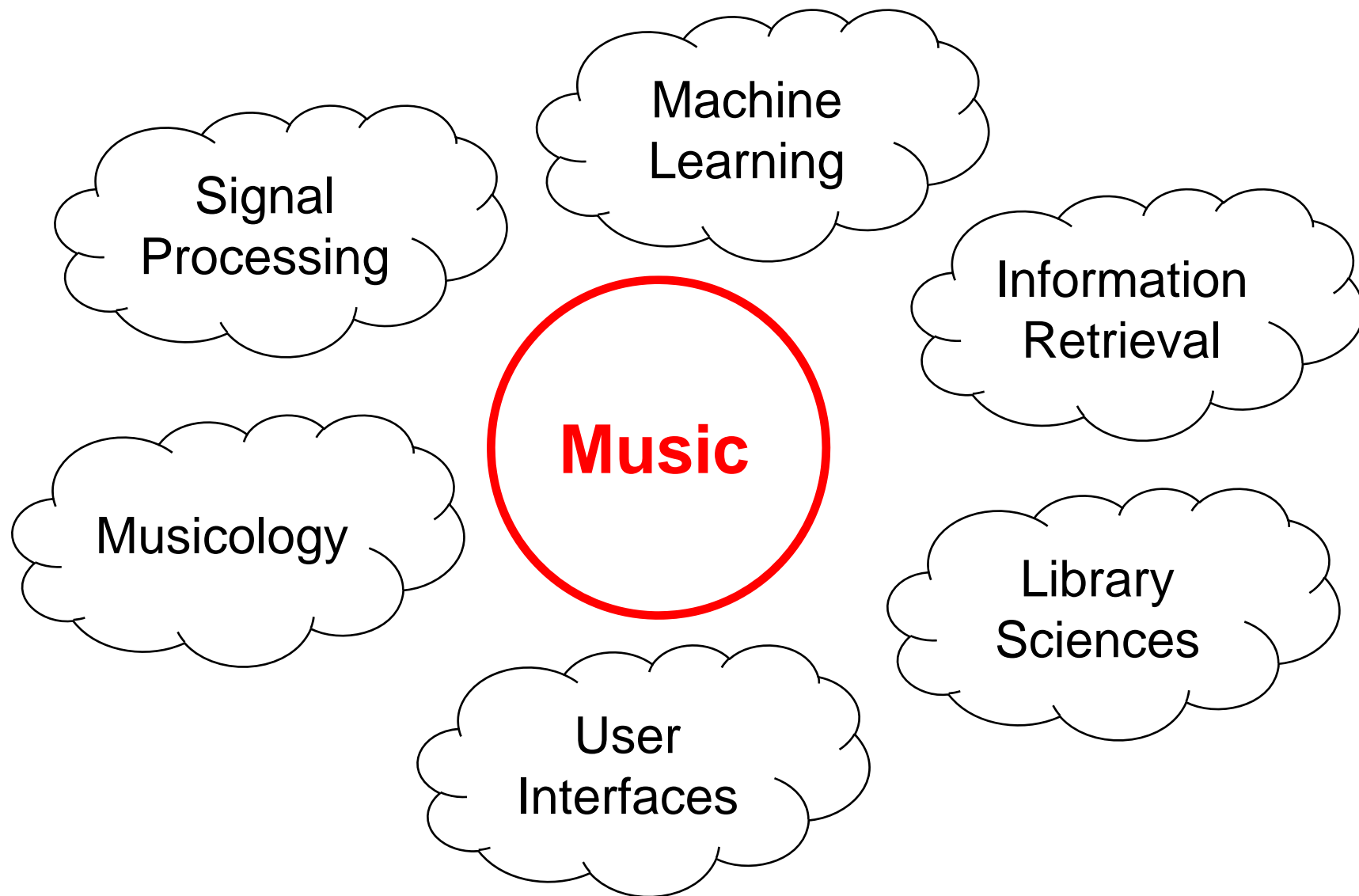
Music Film (Video)



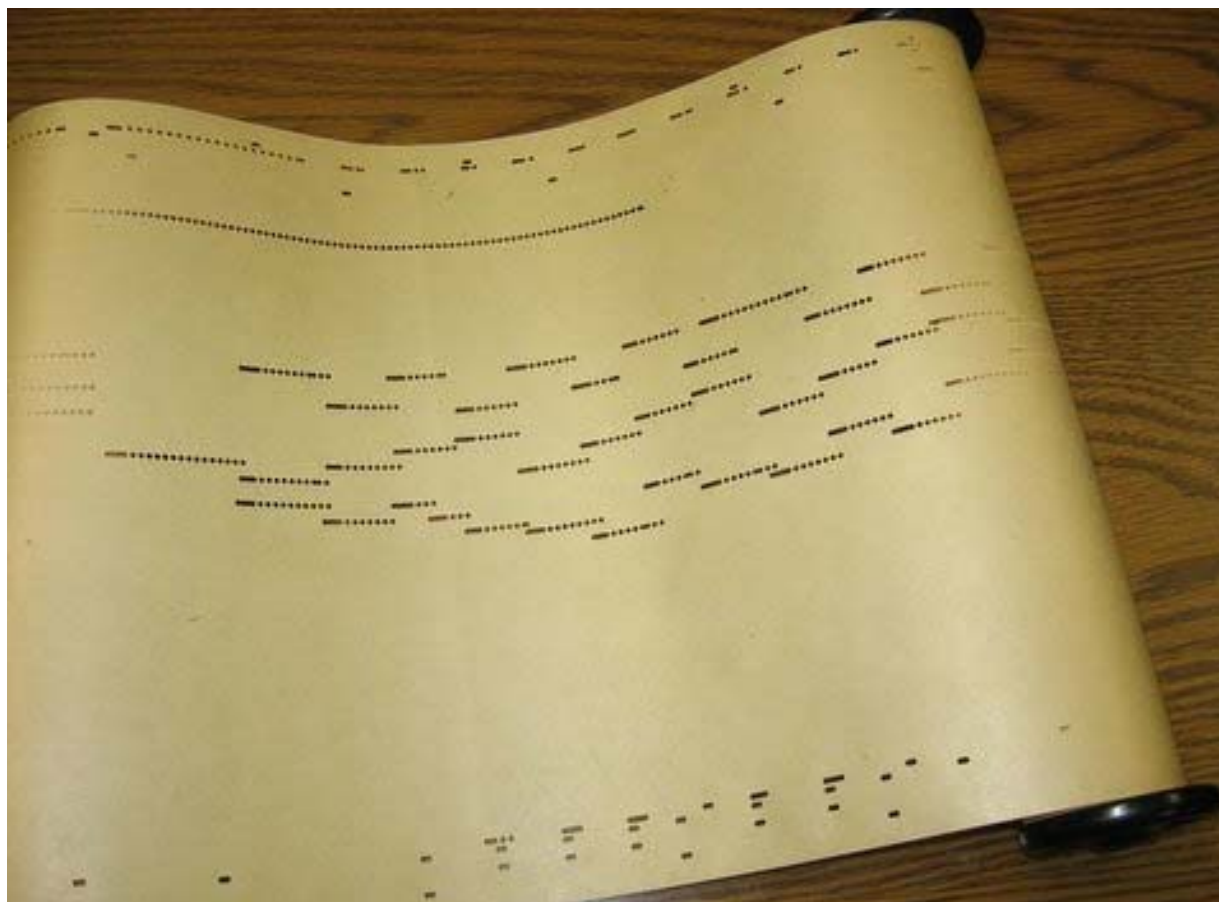
Music Literature (Text)



Music Information Retrieval (MIR)



Piano Roll Representation



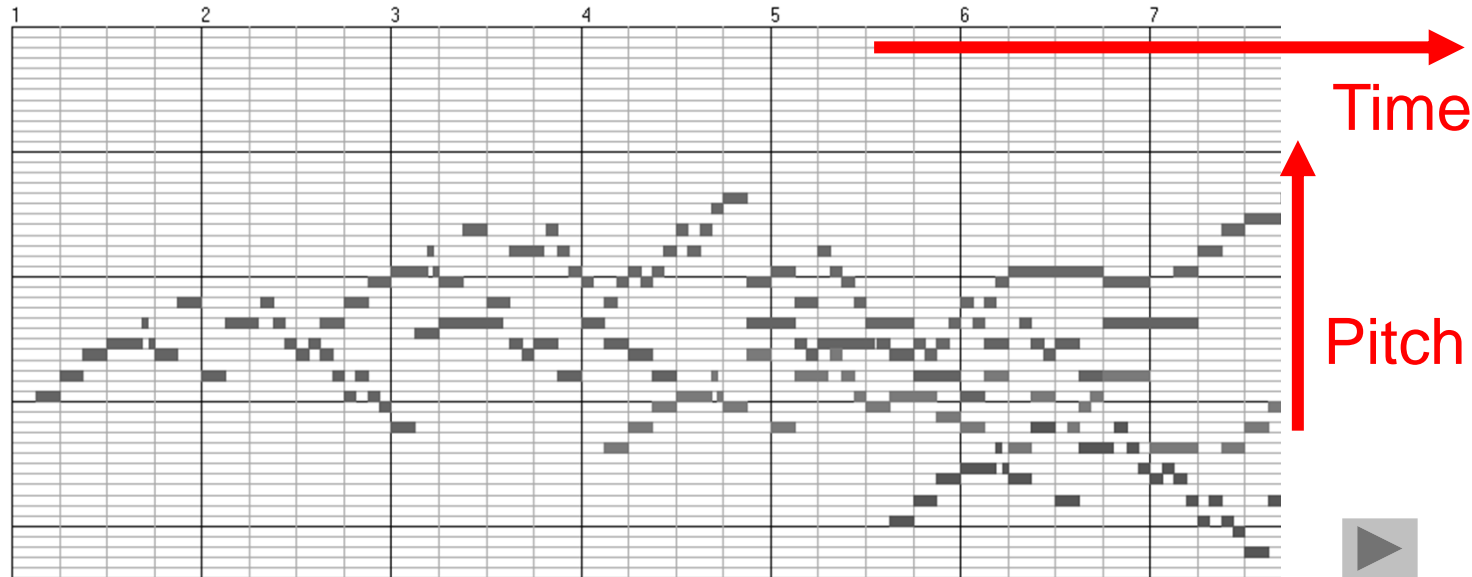
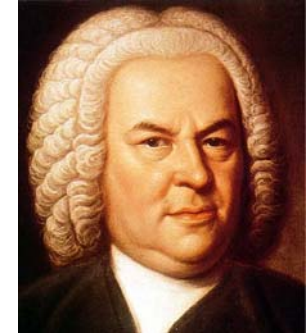
Player Piano (1900)



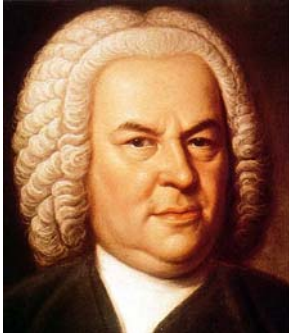
Piano Roll Representation (MIDI)

J.S. Bach, C-Major Fuge

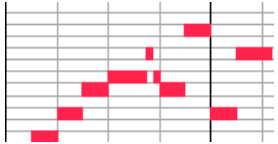
(Well Tempered Piano, BWV 846)



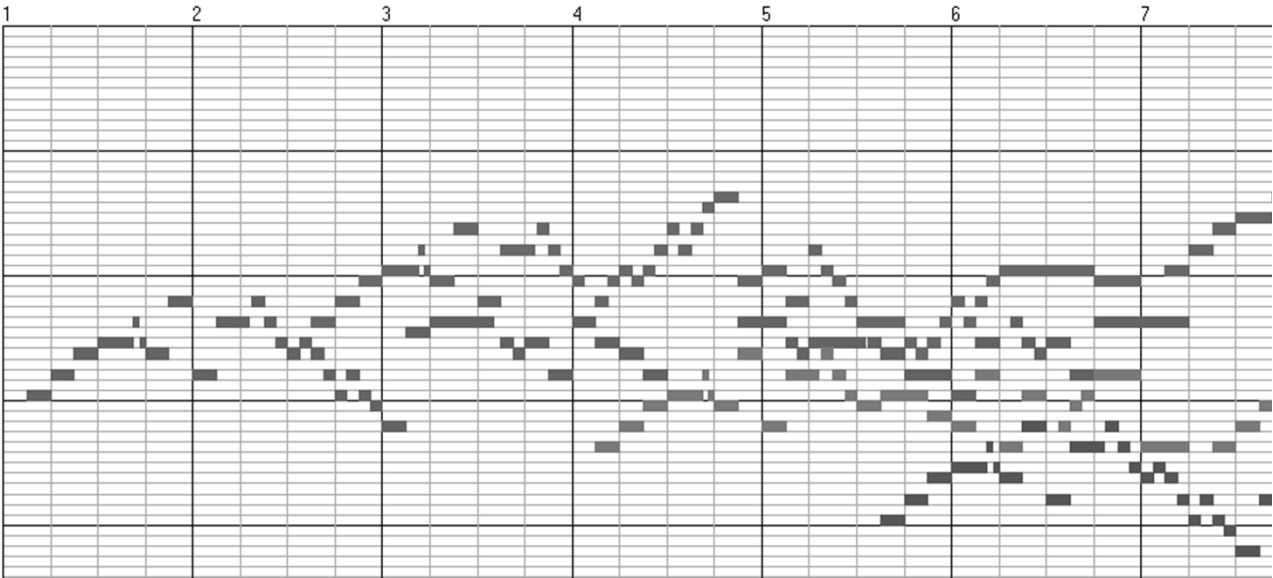
Piano Roll Representation (MIDI)



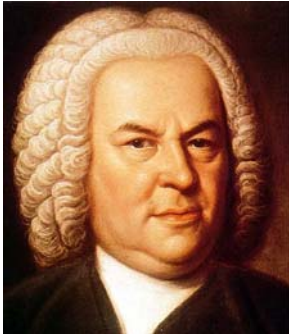
Query:



Goal: Find all occurrences of the query



Piano Roll Representation (MIDI)

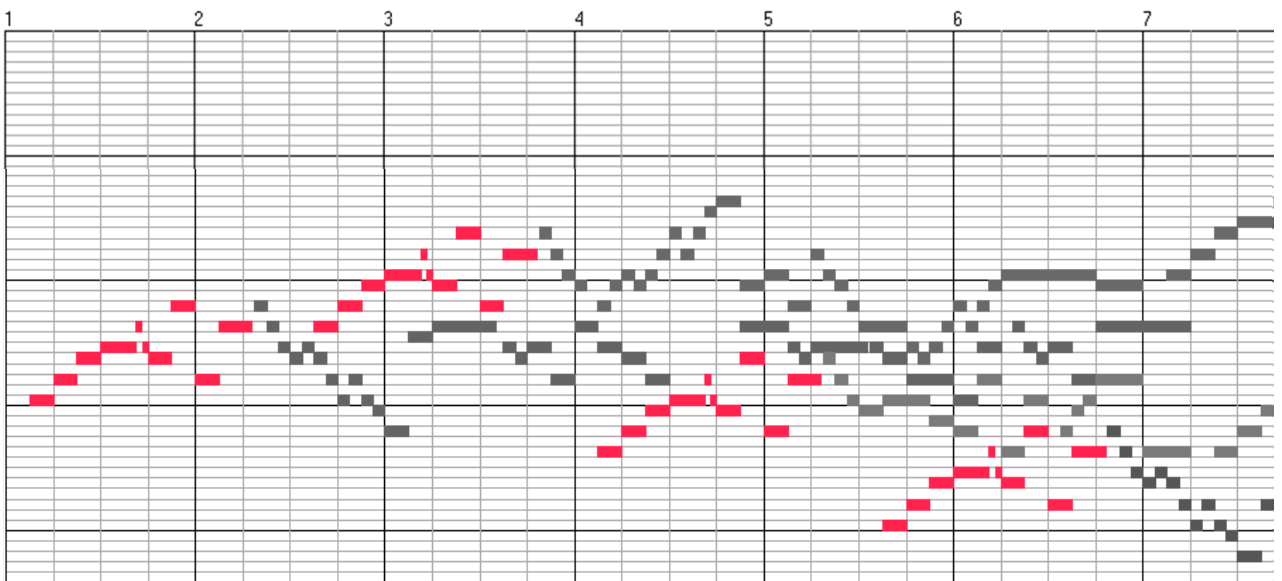


Query:

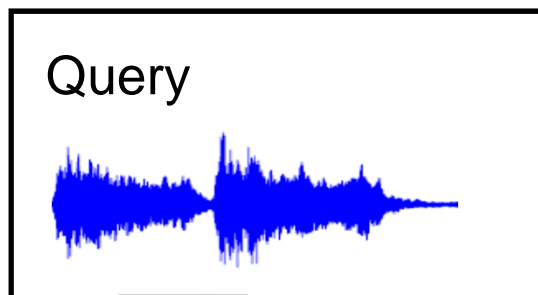


Goal: Find all occurrences of the query

Matches:



Music Retrieval

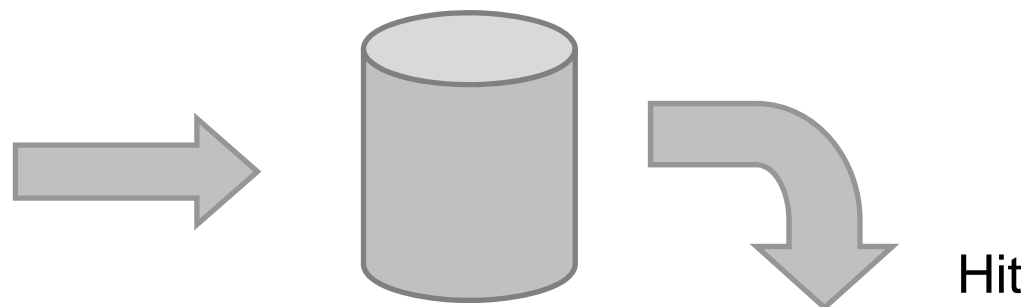


Audio-ID

Version-ID

Category-ID

Database



Bernstein (1962)
Beethoven, Symphony No. 5

Beethoven, Symphony No. 5:

- Bernstein (1962)
- Karajan (1982)
- Gould (1992)

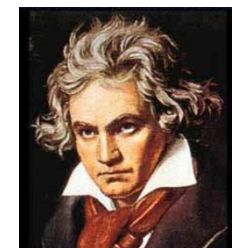


- Beethoven, Symphony No. 9
- Beethoven, Symphony No. 3
- Haydn Symphony No. 94



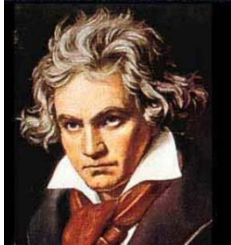
Music Synchronization: Audio-Audio

Beethoven's Fifth

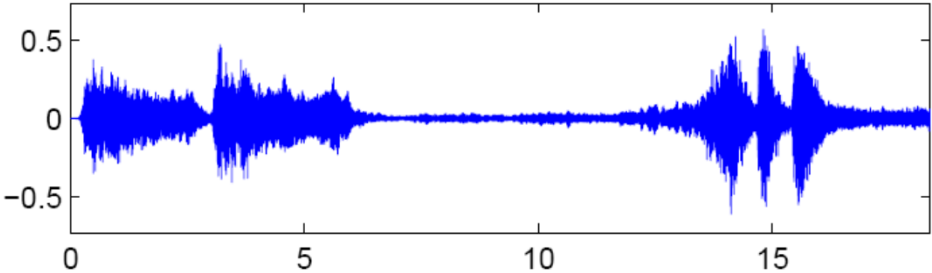


Music Synchronization: Audio-Audio

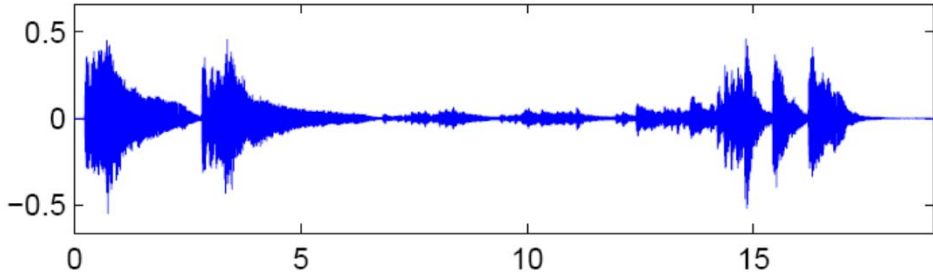
Beethoven's Fifth



Orchester
(Karajan)



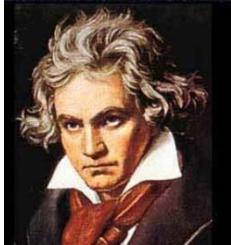
Piano
(Scherbakov)



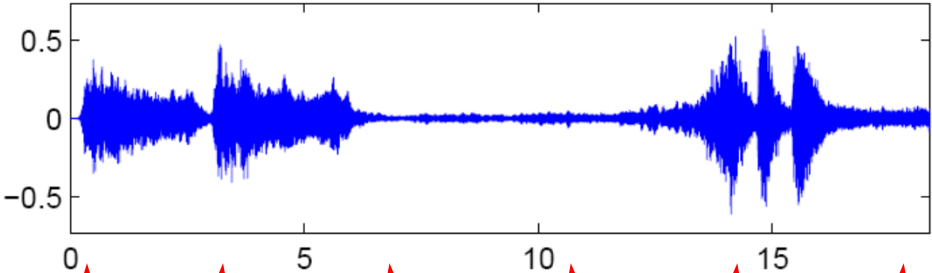
Time (seconds)

Music Synchronization: Audio-Audio

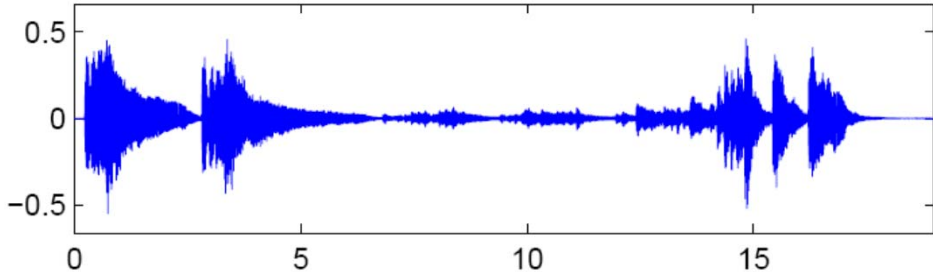
Beethoven's Fifth



Orchester
(Karajan)



Piano
(Scherbakov)



Time (seconds)

Application: Interpretation Switcher



Music Synchronization: Image-Audio

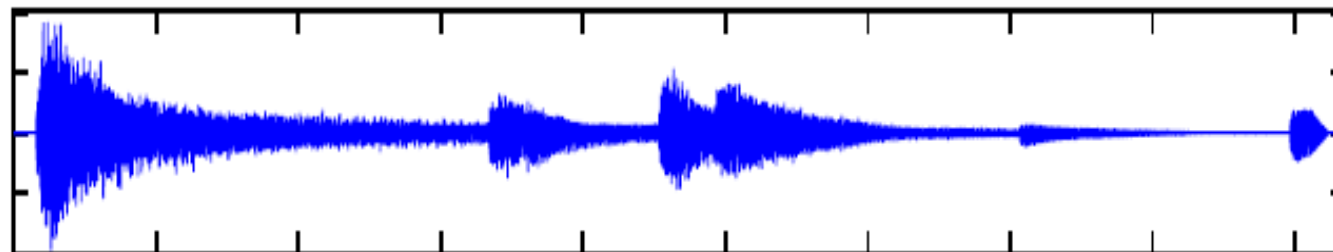
Image

Grave.

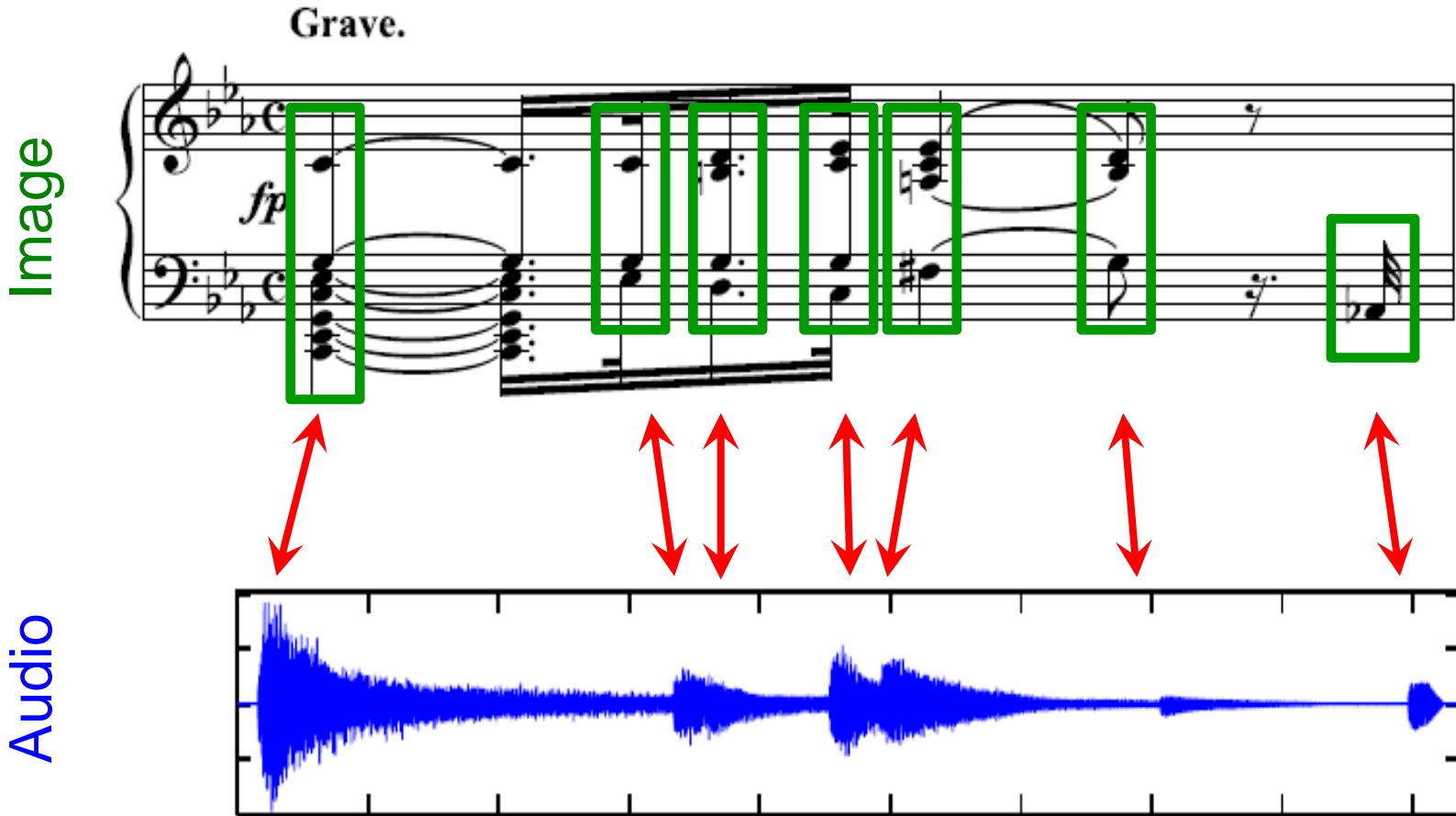


The image shows a musical score for piano, marked "Grave." and "fp". The score is written in G major (one sharp) and common time (C). It consists of two staves: a treble clef staff and a bass clef staff. The music features a slow, somber tempo with a focus on sustained chords and melodic lines. The first staff begins with a treble clef, a key signature of one sharp (F#), and a common time signature (C). The second staff begins with a bass clef, the same key signature, and a common time signature. The music is marked "fp" (fortissimo piano) and "Grave." (grave). The score includes various musical notations such as notes, rests, and dynamic markings.

Audio



Music Synchronization: Image-Audio

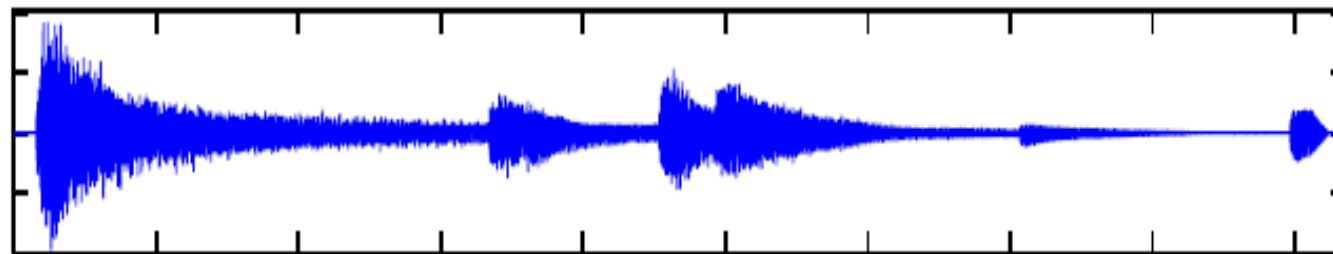


How to make the data comparable?

Image



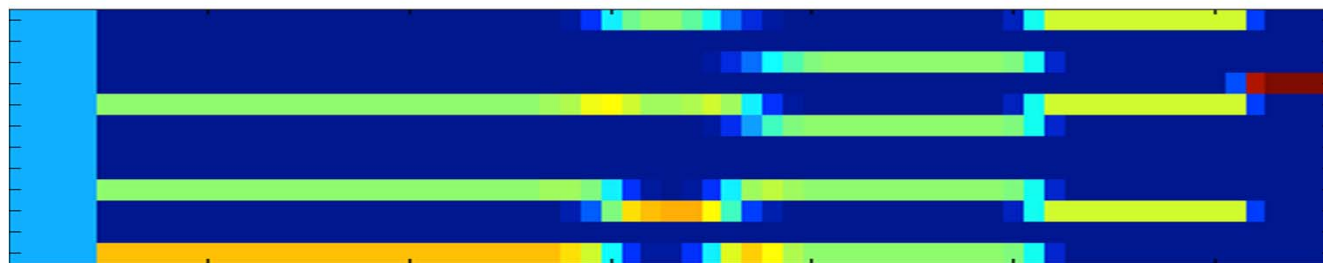
Audio



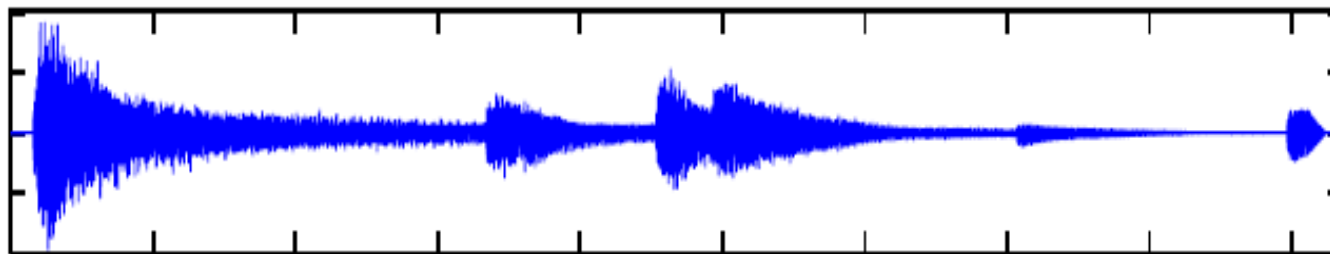
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



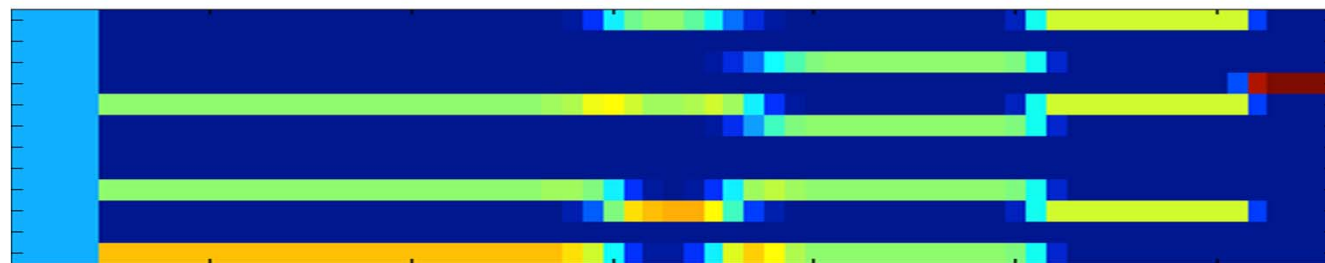
Audio



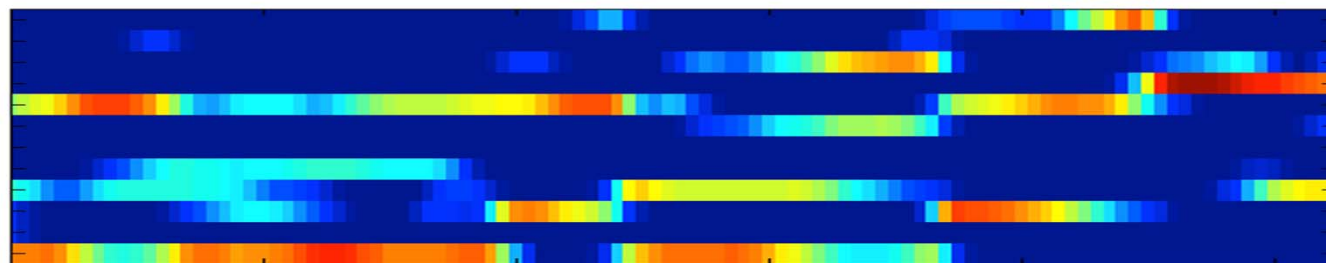
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



Audio

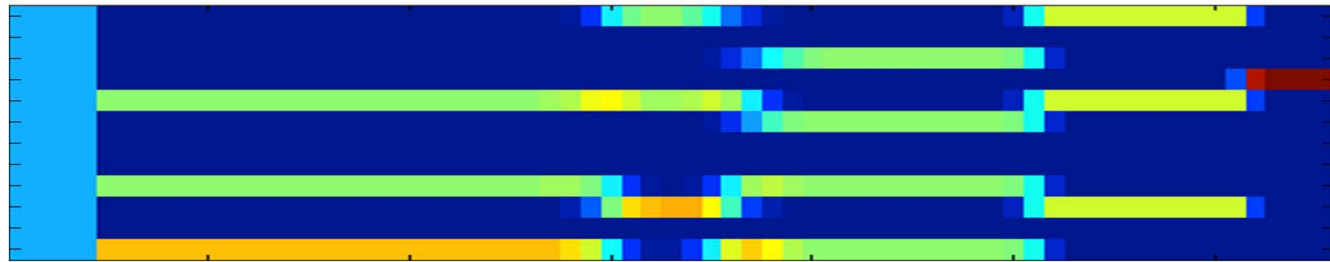


Audio Processing: Fourier Analysis

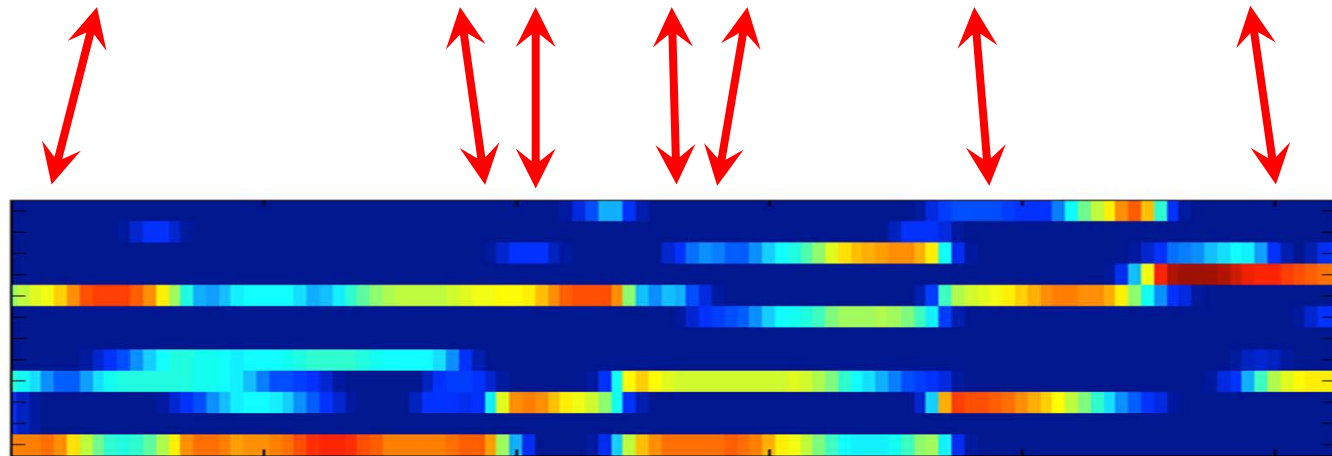
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



Audio



Audio Processing: Fourier Analysis



Application: Score Viewer

The screenshot displays two windows from a music application. The top window, titled "ScoreViewer", shows a digital score for "Beethoven - Klaviersonaten Band 1 - Henle". The score is for "Sonata no.8 in C minor, op.13 'Pathétique' / Rondo (Allegro)". The score is displayed in a multi-staff format with a yellow highlight on the first measure of the Rondo section. The interface includes navigation controls for Track (29 / 54), Bar (1 / 211), and Page (159 / 285), along with "Score Following On", "Play", and "Stop" buttons.

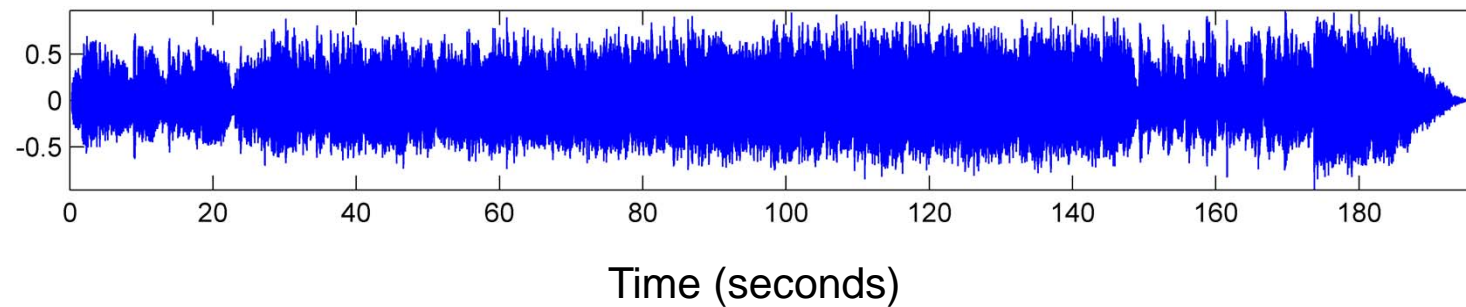
The bottom window, titled "AudioViewer", shows a playlist for "Beethoven - Piano Sonatas-Alfred Brendel". The playlist is for "Disc 1" and lists 11 tracks. Track 11, "Sonata no.8 in C minor, op.13 'Pathétique' / Rondo (Allegro)", is selected and highlighted. The interface includes navigation controls for Disc (1 / 11), Track (11 / 11), and Time (00:00.00 / 4:30.35), along with "Play" and "Stop" buttons.

Track	Duration
03 Sonata no.1 in F minor, op.2 no.1 / Menuetto (Allegretto)	3:24
04 Sonata no.1 in F minor, op.2 no.1 / Prestissimo	5:32
05 Sonata no.2 in A major, op.2 no.2 / Allegro vivace	7:15
06 Sonata no.2 in A major, op.2 no.2 / Largo appassionato	6:28
07 Sonata no.2 in A major, op.2 no.2 / Scherzo (Allegretto)	3:30
08 Sonata no.2 in A major, op.2 no.2 / Rondo (Gravioso)	7:03
09 Sonata no.8 in C minor, op.13 "Pathétique" / Allegro di molto e con brio	9:40
10 Sonata no.8 in C minor, op.13 "Pathétique" / Adagio cantabile	5:17
11 Sonata no.8 in C minor, op.13 "Pathétique" / Rondo (Allegro)	4:30



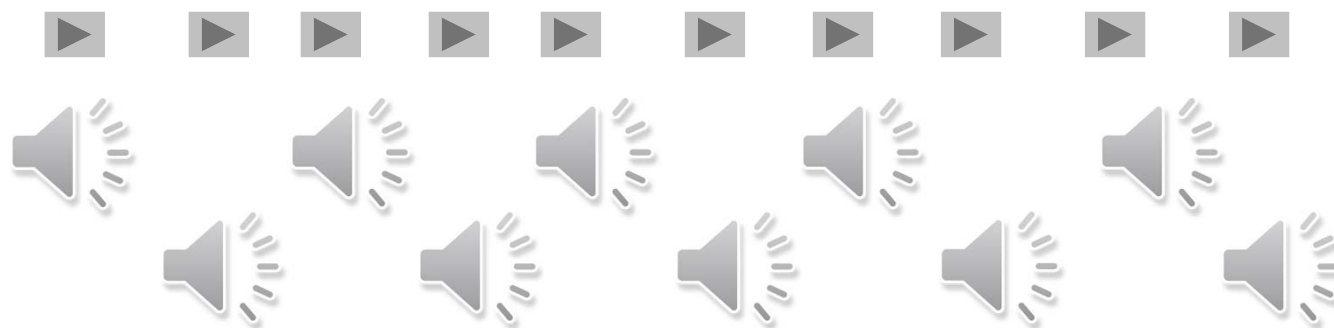
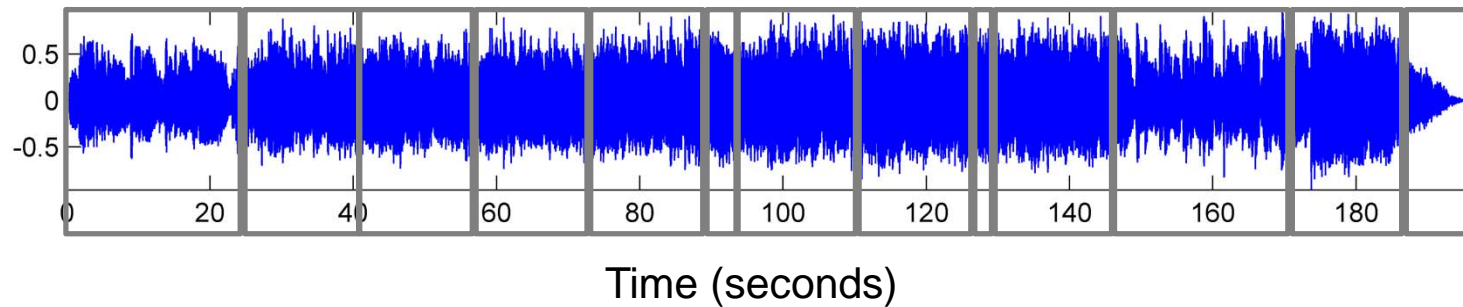
Music Structure Analysis

Example: Zager & Evans “In The Year 2525”



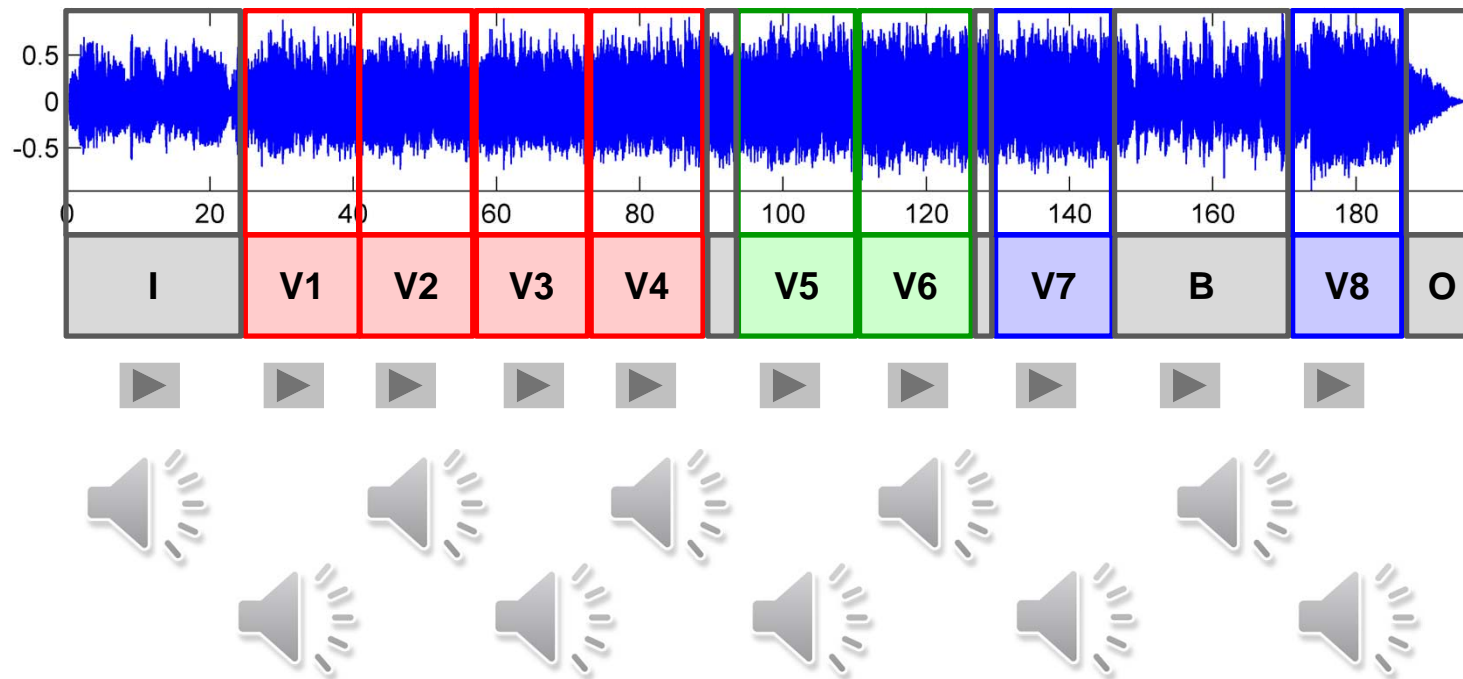
Music Structure Analysis

Example: Zager & Evans “In The Year 2525”



Music Structure Analysis

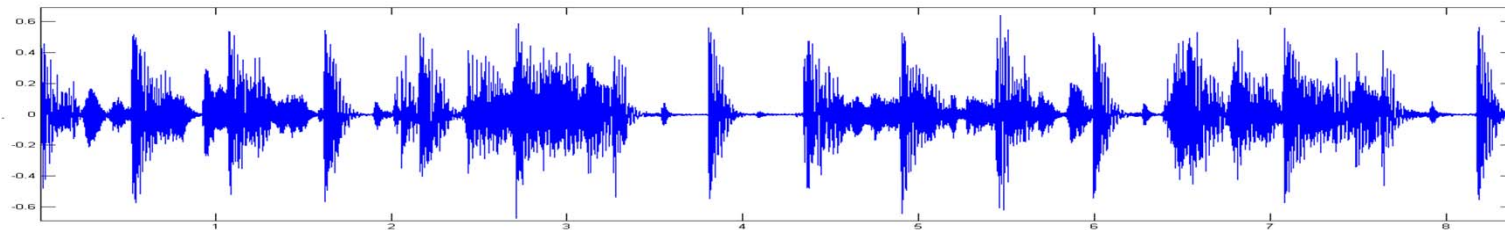
Example: Zager & Evans “In The Year 2525”



Tempo Estimation and Beat Tracking

Basic task: “Tapping the foot when listening to music”

Example: Queen – Another One Bites The Dust

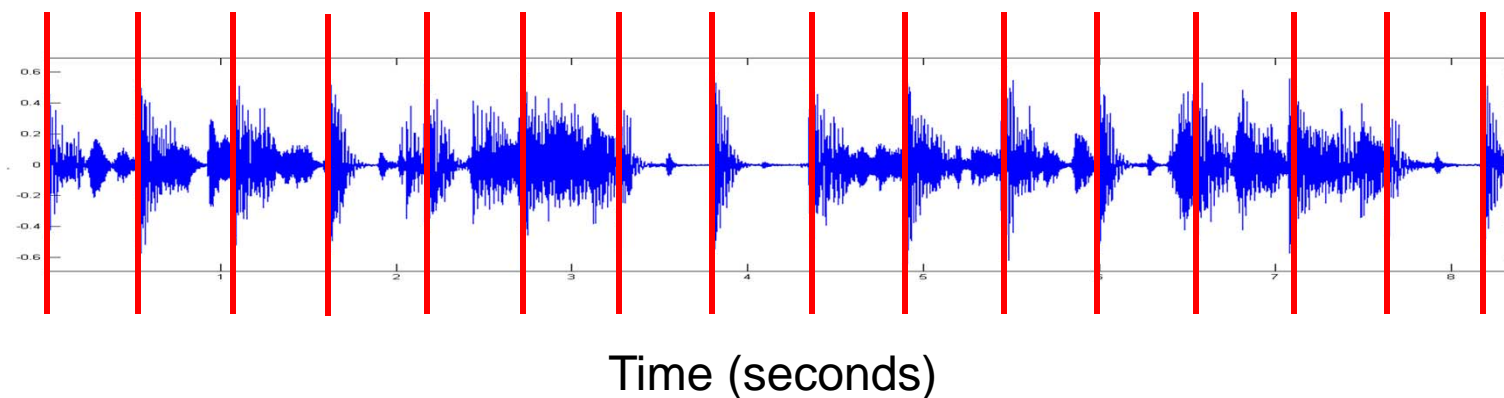


Time (seconds)

Tempo Estimation and Beat Tracking

Basic task: “Tapping the foot when listening to music”

Example: Queen – Another One Bites The Dust



Tempo Estimation and Beat Tracking

Light effects

Music recommendation

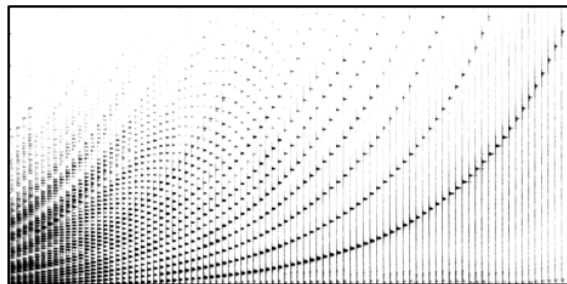
DJ

Audio editing

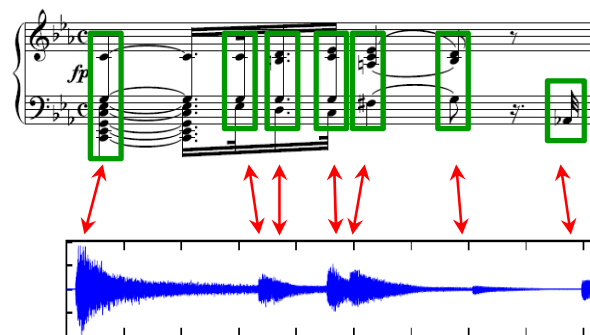


Music Processing

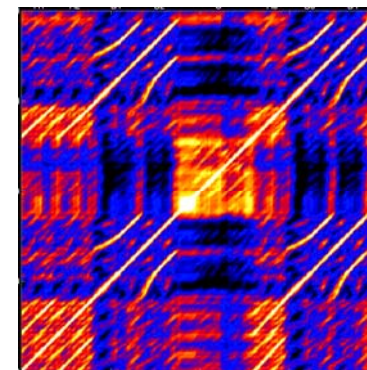
Fourier Transform
Audio Features



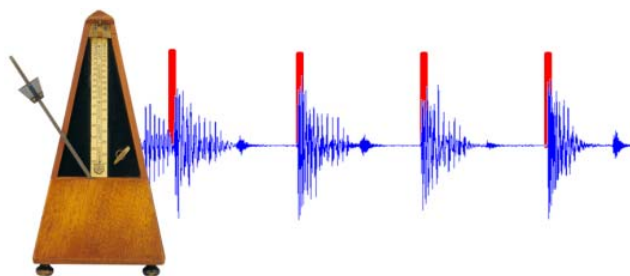
Music Synchronization



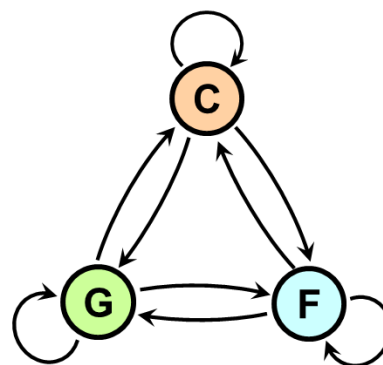
Structure Analysis



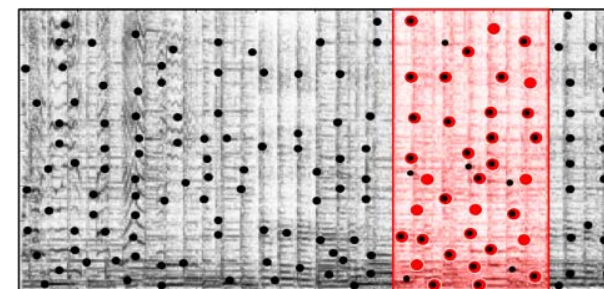
Tempo and Beat Tracking



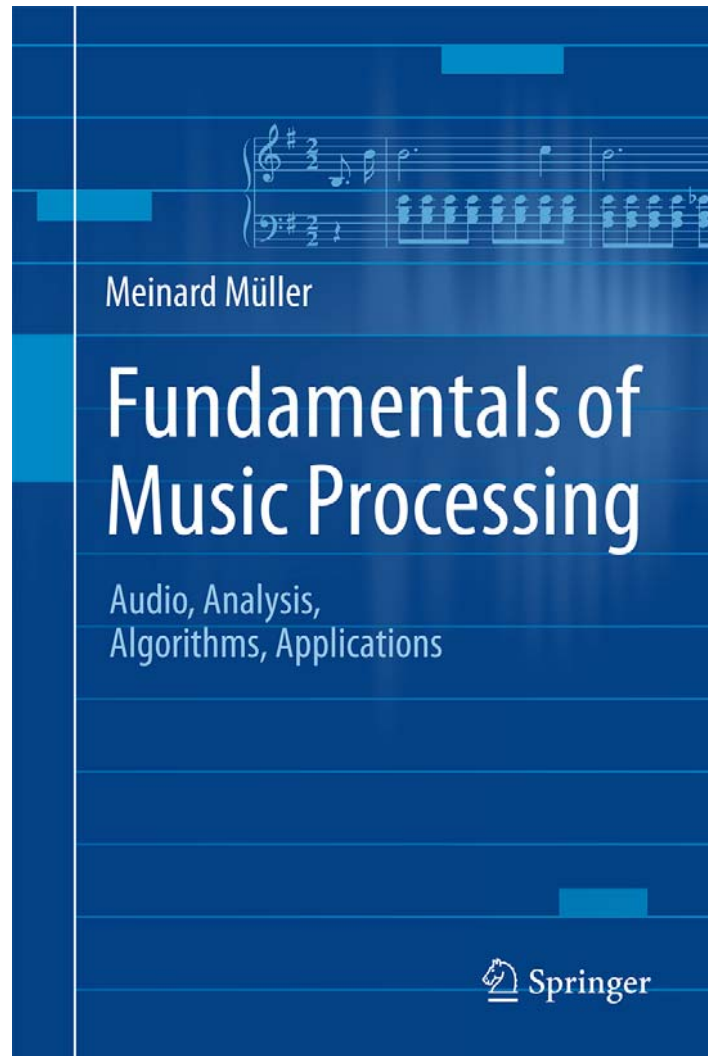
Chord Recognition



Audio Fingerprinting



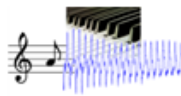

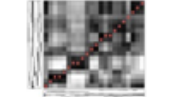


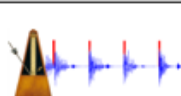
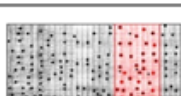
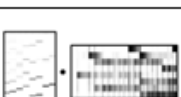
Book: Fundamentals of Music Processing



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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