



ISMIR
2017, SUZHOU, CHINA

Tutorial T3
A Basic Introduction to Audio-Related
Music Information Retrieval

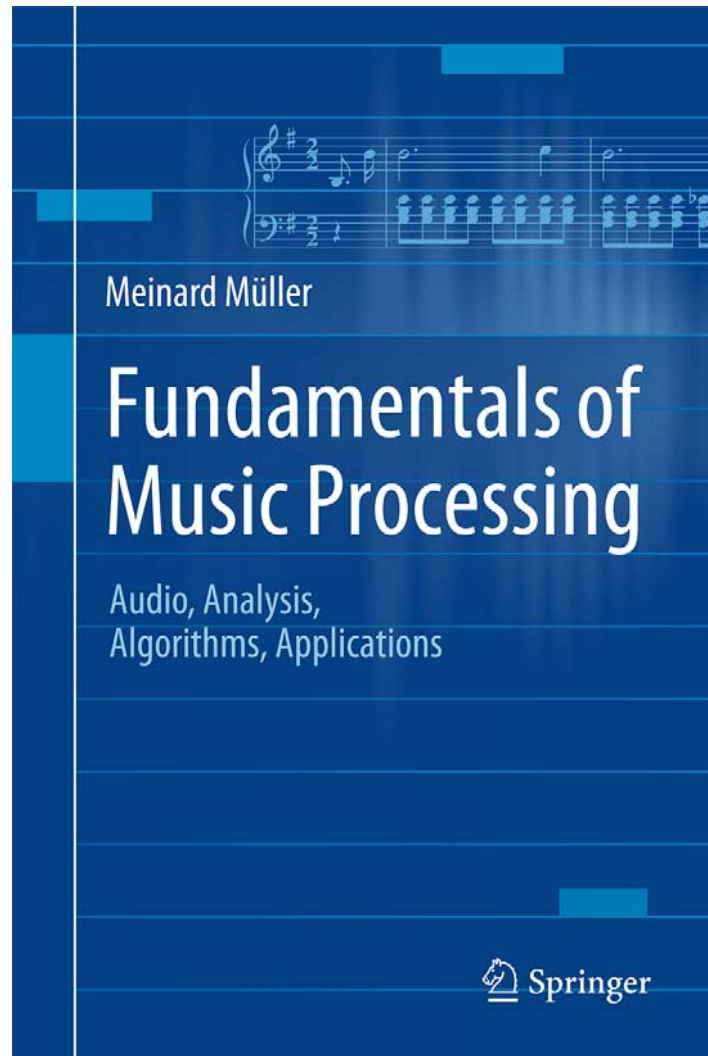
Music Representations

Meinard Müller, Christof Weiß

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meinard.mueller@audiolabs-erlangen.de, christof.weiss@audiolabs-erlangen.de

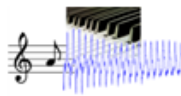

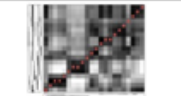
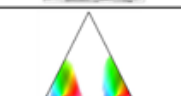

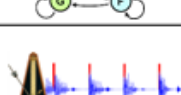


Book: Fundamentals of Music Processing



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

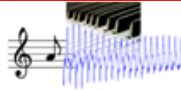

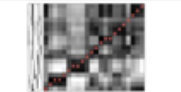
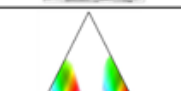

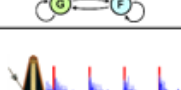


Book: Fundamentals of Music Processing

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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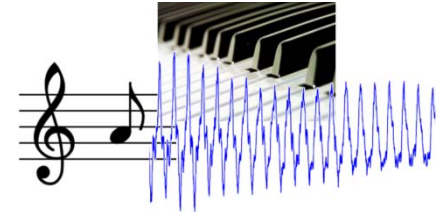
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Chapter 1: Music Representations

- 1.1 Sheet Music Representations
- 1.2 Symbolic Representations
- 1.3 Audio Representation
- 1.4 Further Notes



Musical information can be represented in many different ways. In Chapter 1, we consider three widely used music representations: sheet music, symbolic, and audio representations. This first chapter also introduces basic terminology that is used throughout the book. In particular, we discuss musical and acoustic properties of audio signals including aspects such as frequency, pitch, dynamics, and timbre.

Music

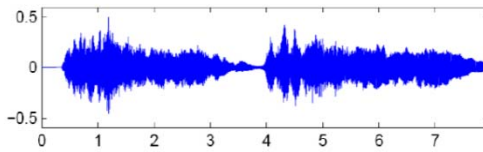


Music Information Retrieval (MIR)

Sheet Music (Image)



CD / MP3 (Audio)



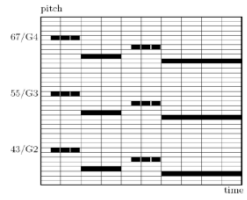
MusicXML (Text)

```
<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)



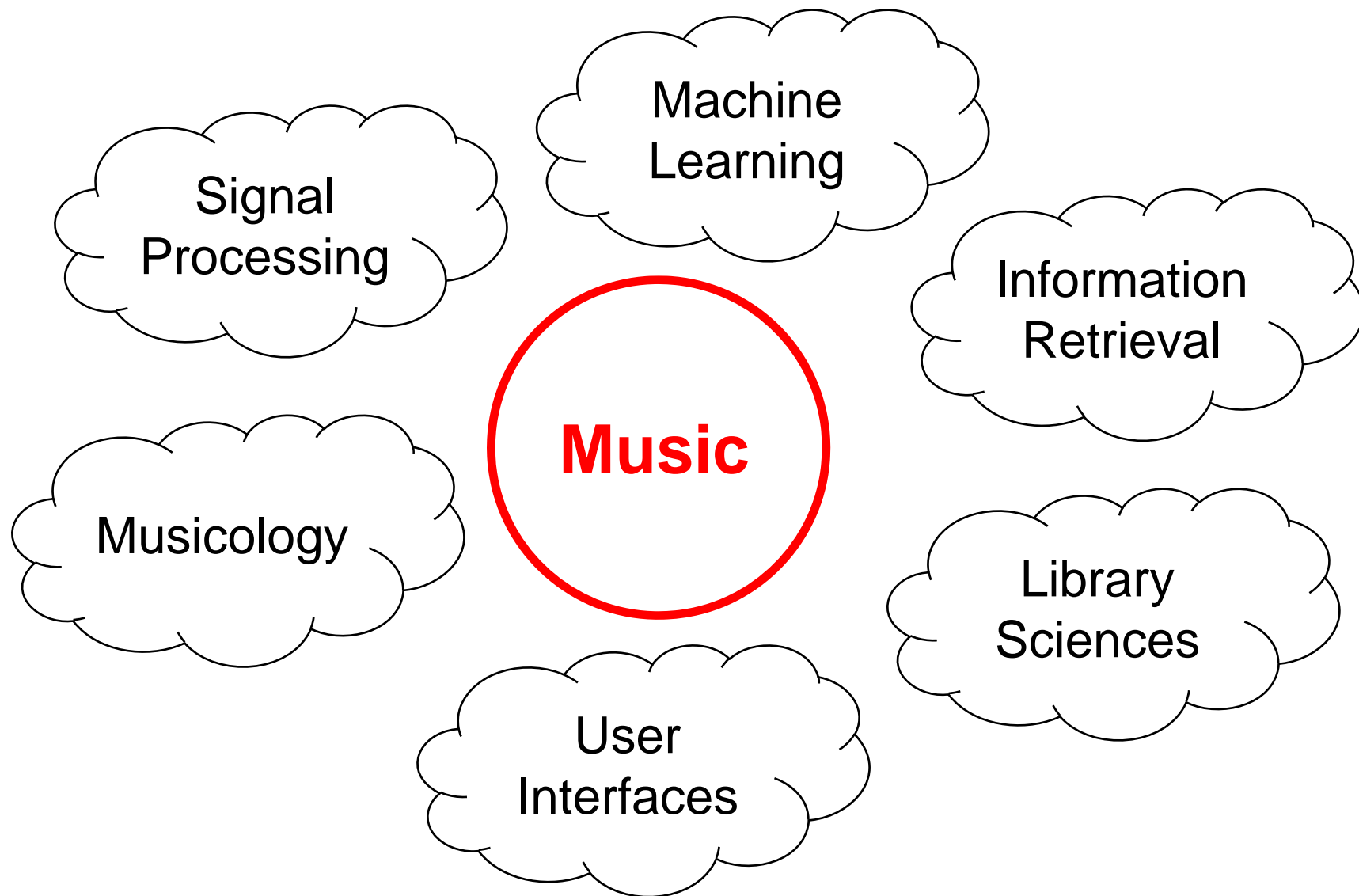
Music Film (Video)



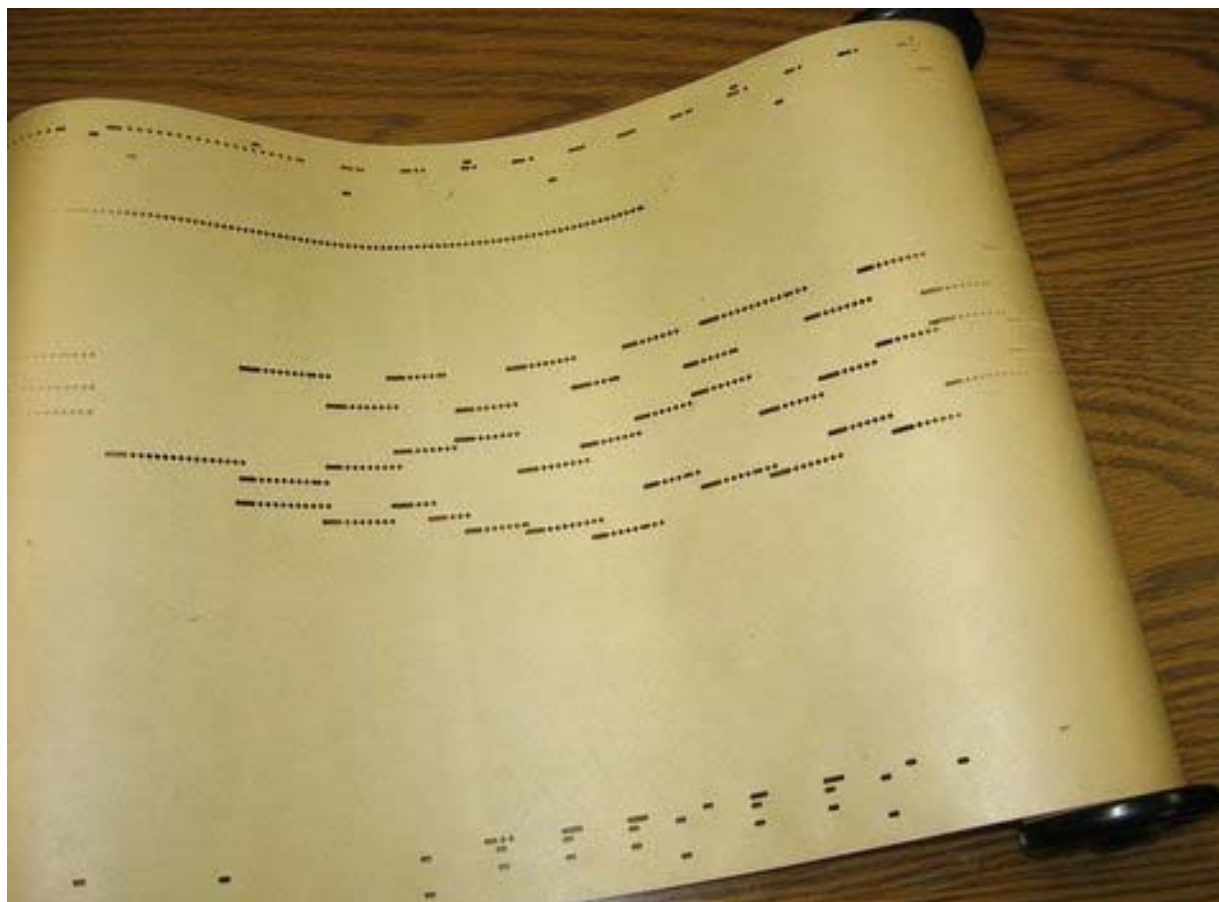
Music Literature (Text)



Music Information Retrieval (MIR)



Piano Roll Representation



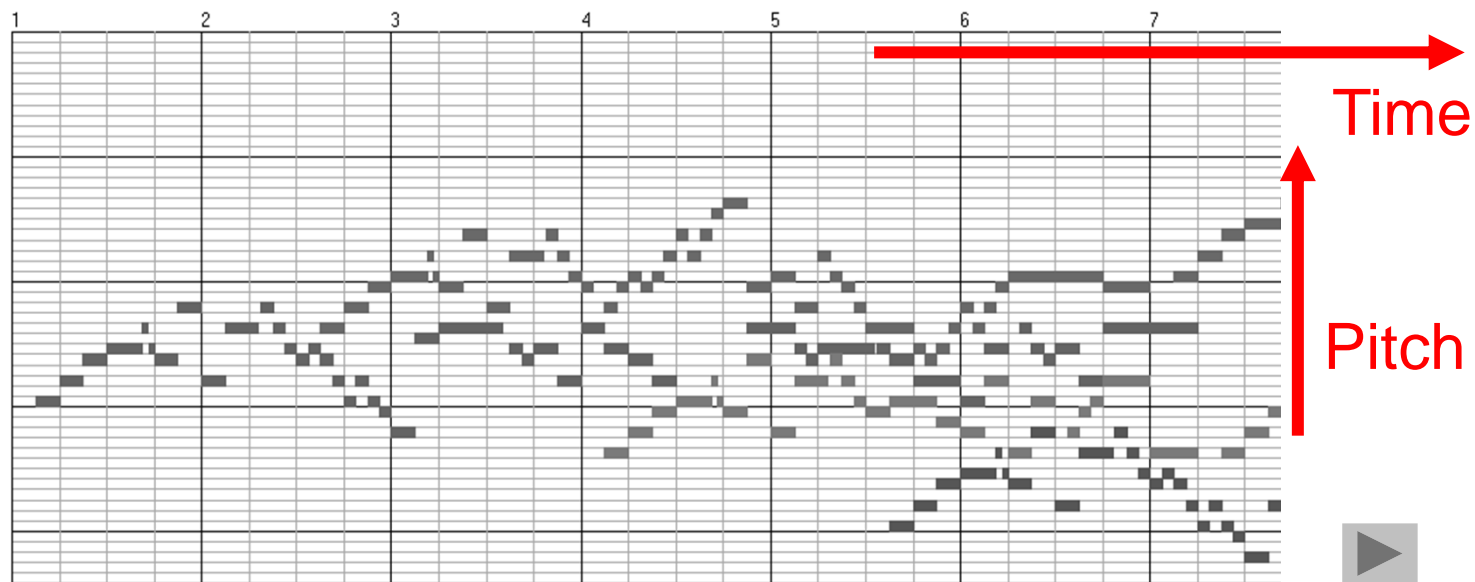
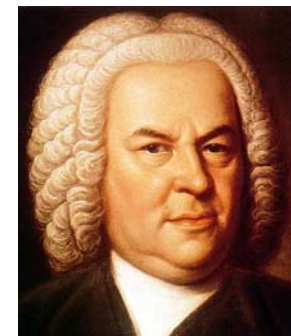
Player Piano (1900)



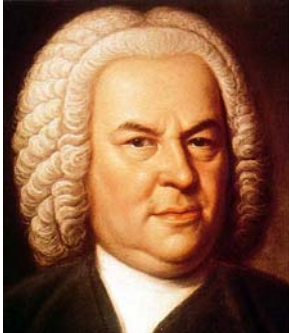
Piano Roll Representation (MIDI)

J.S. Bach, C-Major Fuge

(Well Tempered Piano, BWV 846)



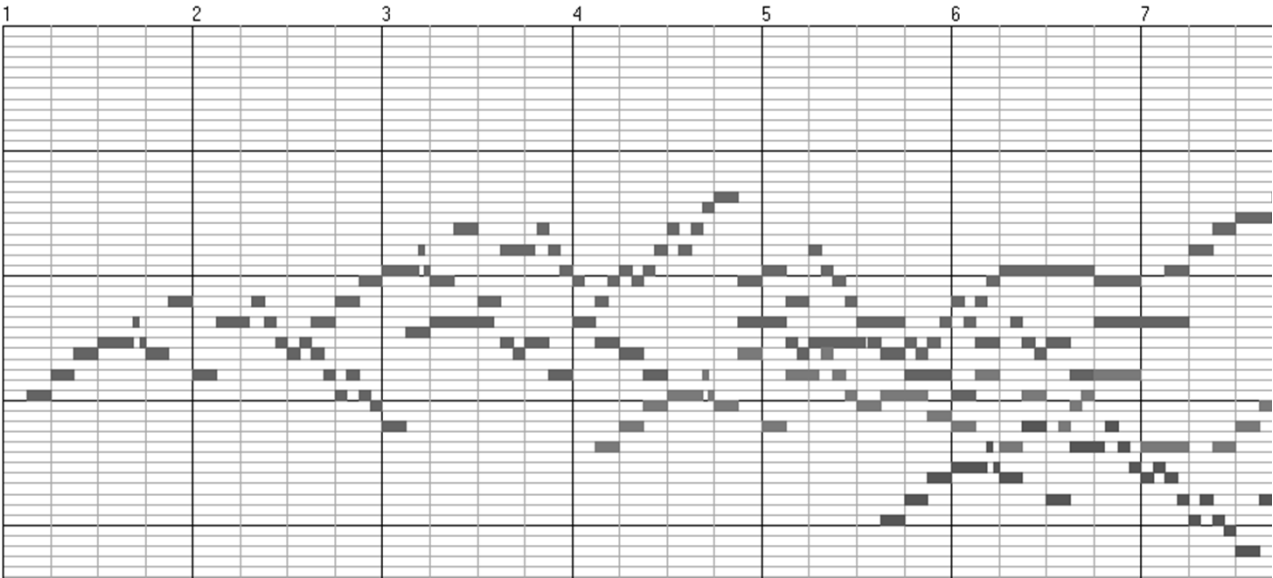
Piano Roll Representation (MIDI)



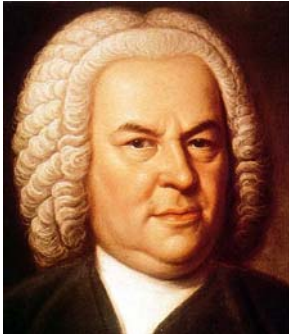
Query:



Goal: Find all occurrences of the query



Piano Roll Representation (MIDI)

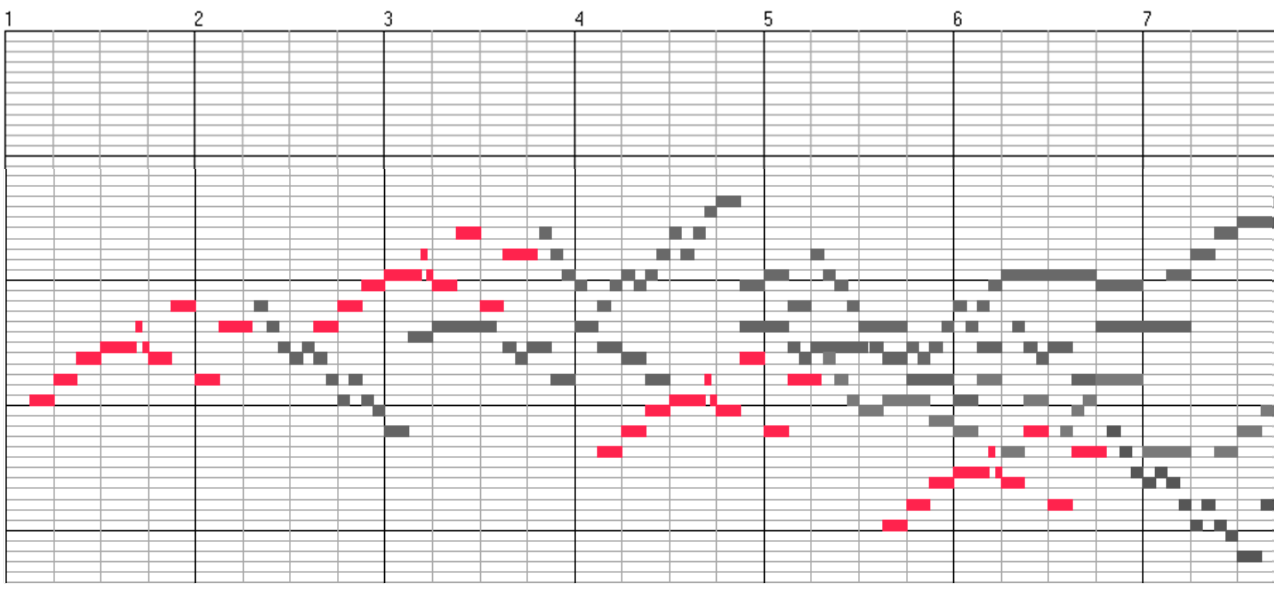


Query:

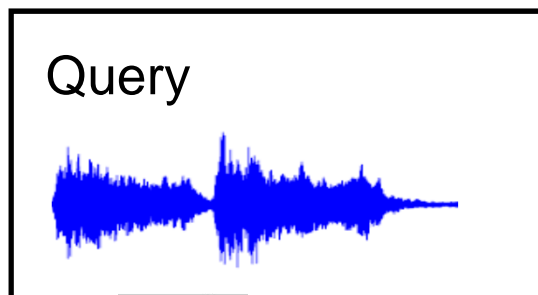


Goal: Find all occurrences of the query

Matches:



Music Retrieval

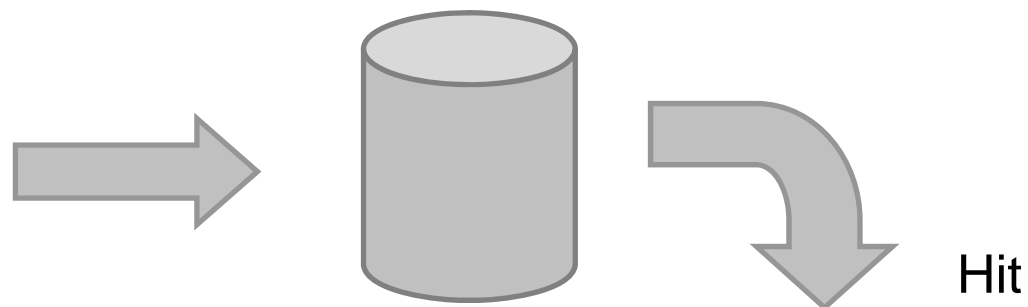


Audio-ID

Version-ID

Category-ID

Database



Bernstein (1962)
Beethoven, Symphony No. 5

Beethoven, Symphony No. 5:

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

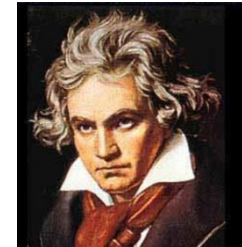


- Beethoven, Symphony No. 9
- Beethoven, Symphony No. 3
- Haydn Symphony No. 94



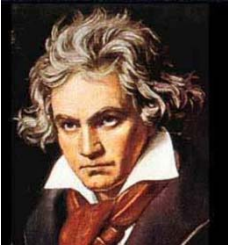
Music Synchronization: Audio-Audio

Beethoven's Fifth

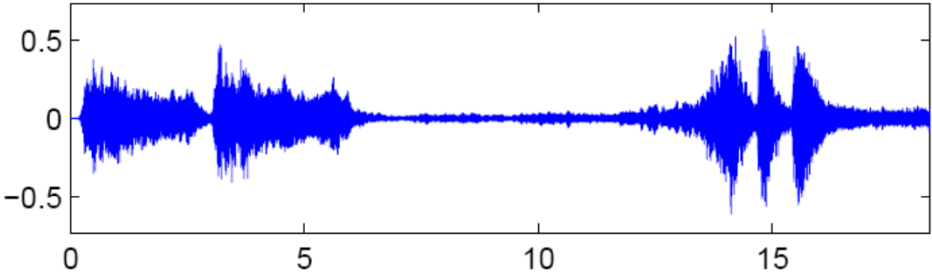


Music Synchronization: Audio-Audio

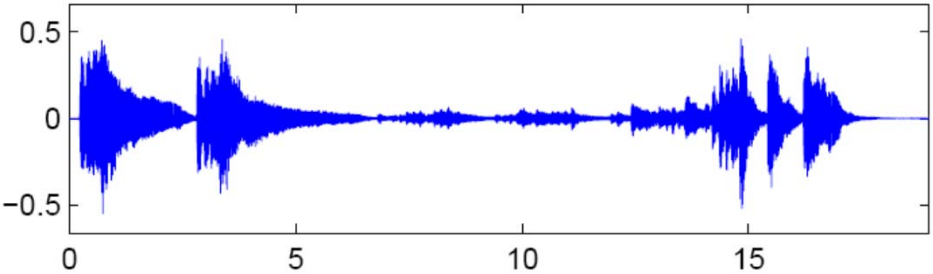
Beethoven's Fifth



Orchester
(Karajan)



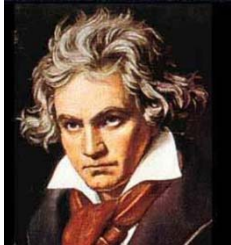
Piano
(Scherbakov)



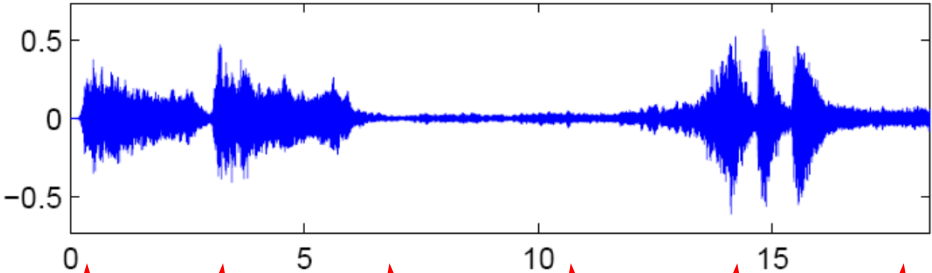
Time (seconds)

Music Synchronization: Audio-Audio

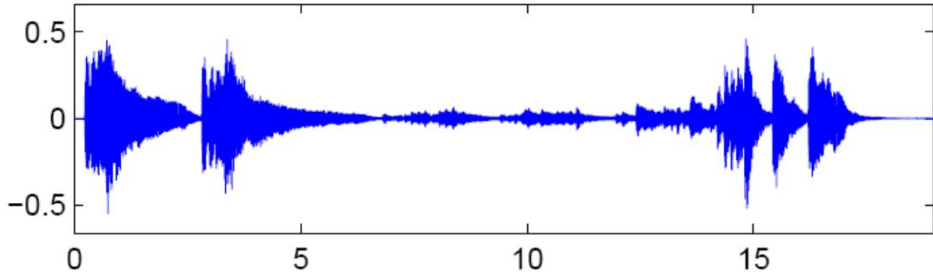
Beethoven's Fifth



Orchester
(Karajan)



Piano
(Scherbakov)



Time (seconds)

Application: Interpretation Switcher

Interpretation Switcher
Beethoven, Op067-1_Symphony5

midi 00:00.00

Bernstein 00:00.00

Sawallisch 00:00.00

Scherbakov 00:00.00

midi
 Bernstein
 Sawallisch
 Scherbakov

Deselect all

Absolute
Relative
Reference

Movement selection Interval Repeat

Info



Music Synchronization: Image-Audio

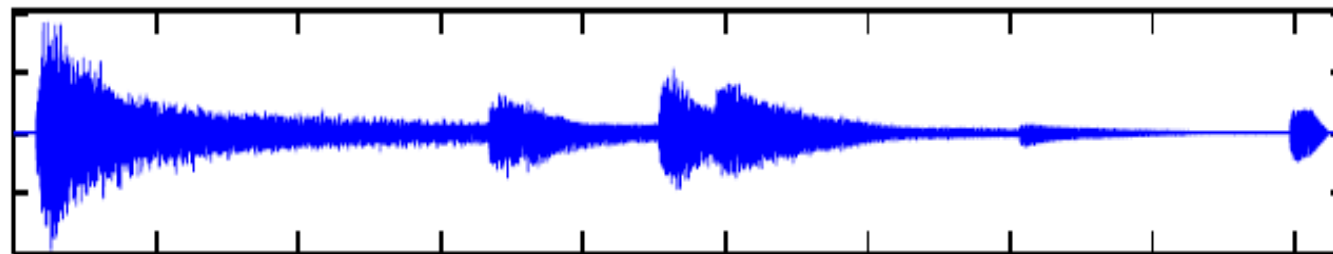
Image

Grave.

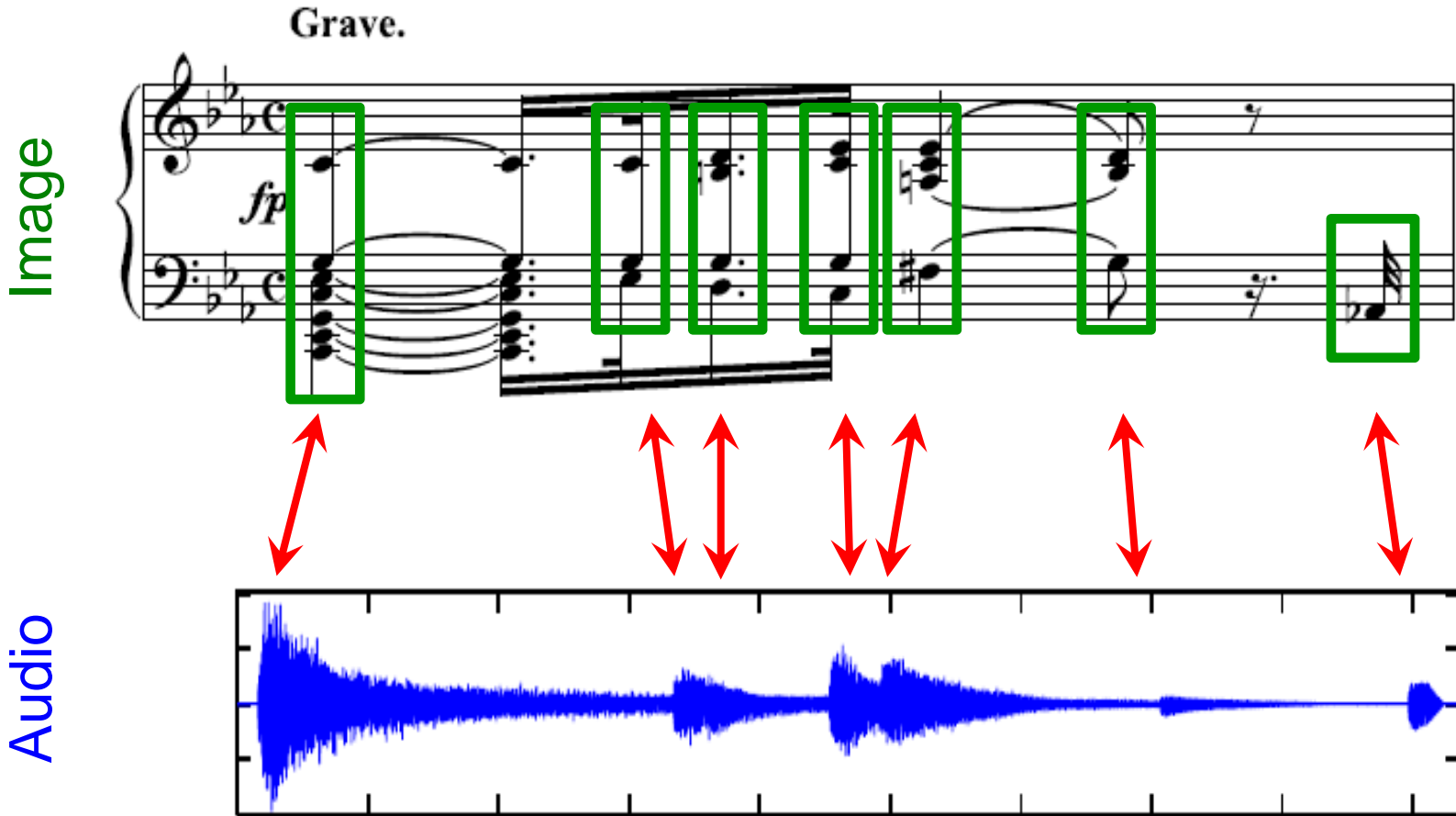


A musical score for piano, marked "Grave." and "fp". The score is written in G major (one sharp) and common time (C). It consists of two staves: a treble clef staff and a bass clef staff. The music features a slow, somber mood with a series of chords and melodic lines. The first staff begins with a treble 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 characterized by a slow tempo and a somber mood, with a series of 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 characterized by a slow tempo and a somber mood, with a series of chords and melodic lines.

Audio



Music Synchronization: Image-Audio

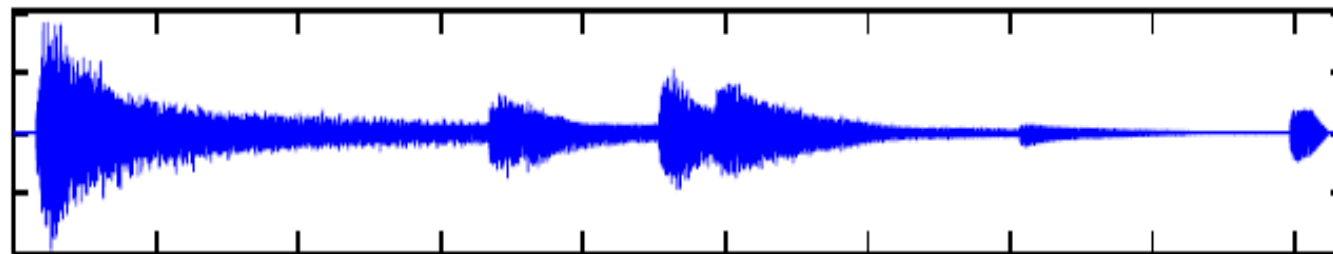


How to make the data comparable?

Image



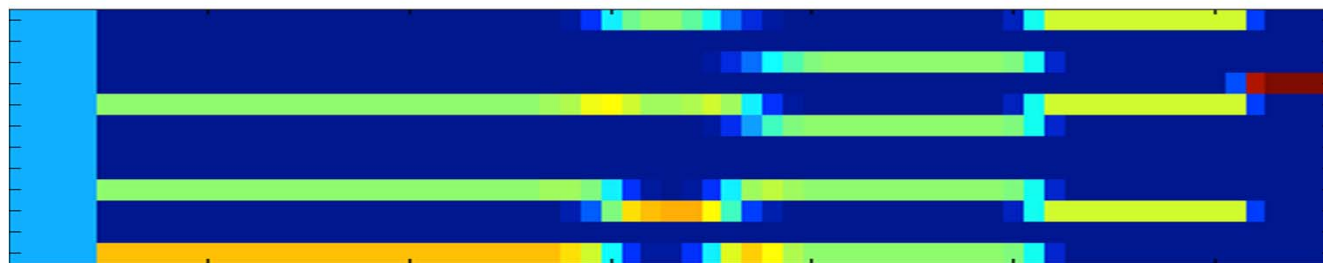
Audio



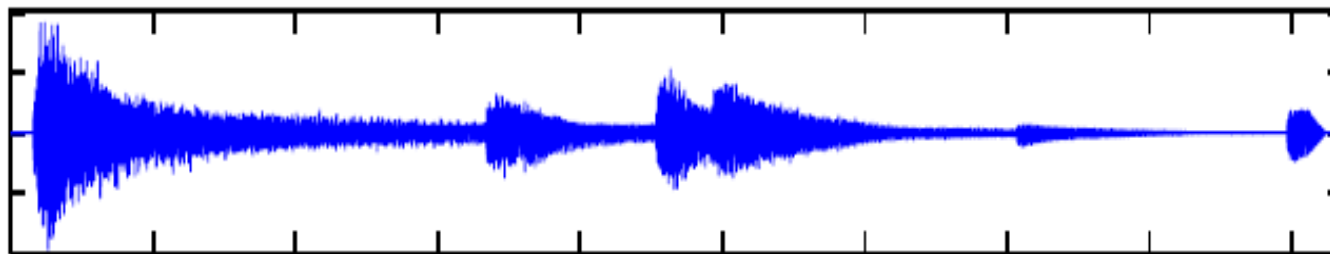
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



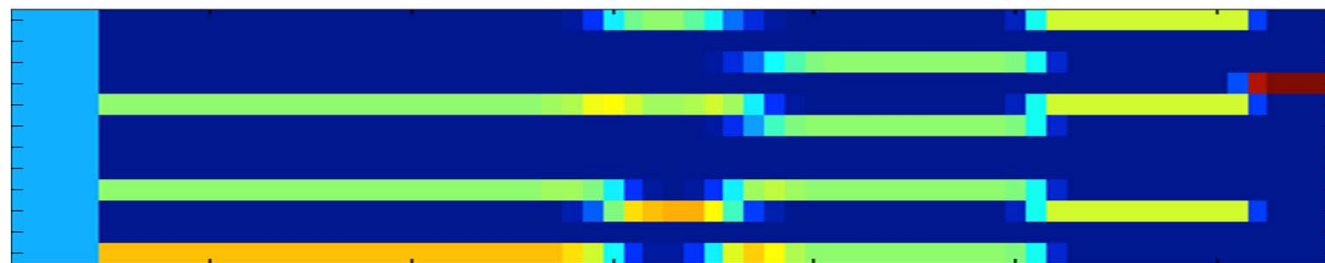
Audio



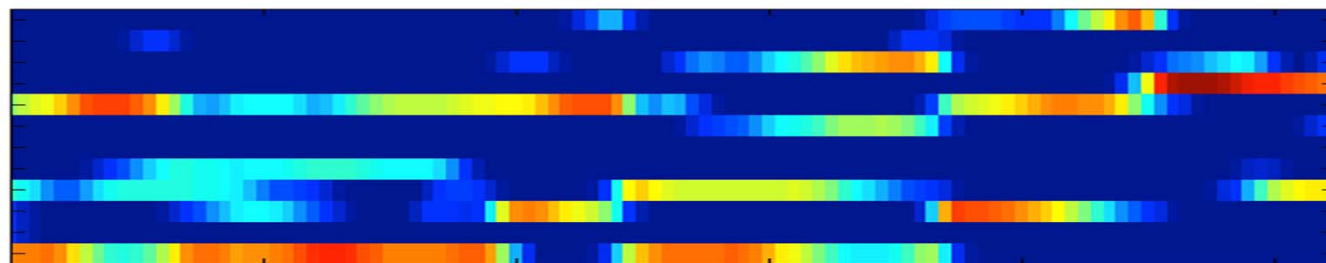
How to make the data comparable?

Image Processing: Optical Music Recognition

Image



Audio

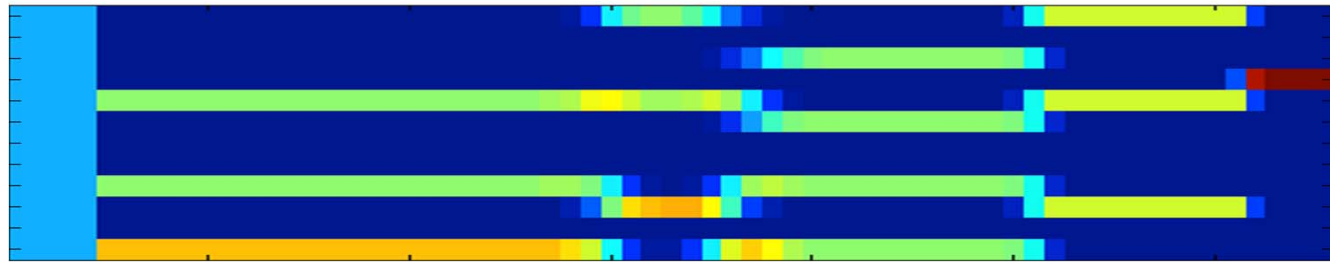


Audio Processing: Fourier Analysis

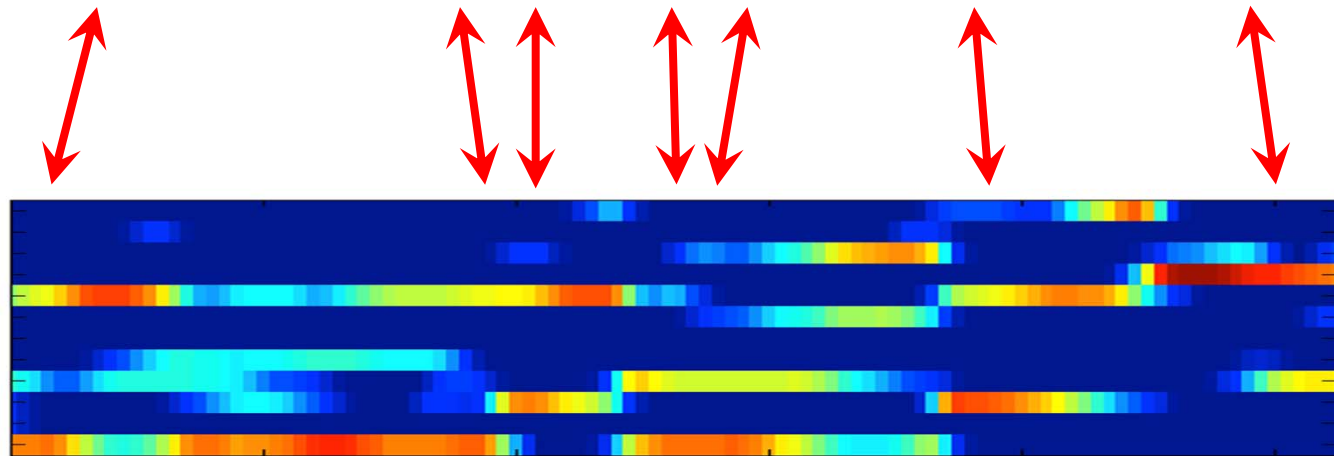
How to make the data comparable?

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's Piano Sonata no. 8 in C minor, op. 13, "Pathétique", Rondo (Allegro). The score is presented in a multi-staff format with a yellow highlight on the first measure of the Rondo section. Below the score, a control bar shows "Track: 29 / 54", "Bar: 1 / 211", and "Page: 159 / 285". It includes a "Score Following On" indicator, a "Play" button, and a "Stop" button.

The bottom window, titled "AudioViewer", shows a track list for "Beethoven - Piano Sonatas-Alfred Brendel". The list includes tracks 03 through 11, with track 11, "Sonata no. 8 in C minor, op. 13 'Pathétique' / Rondo (Allegro)", selected and highlighted. Below the track list, there is a waveform visualization and a progress bar. The control bar at the bottom shows "Disc: 1 / 11", "Track: 11 / 11", and "Time: 00:00.00 / 4:30.35". It also features "Play" and "Stop" buttons.



Music Representations

Allegro con brio ($\text{♩} = 108$)

The musical score is for a piano piece in 2/4 time, marked *ff* (fortissimo) and *Allegro con brio* with a tempo of 108 beats per minute. The key signature has two flats. The score shows the first few measures of the piece, with accents marked *Acc.* and asterisks on the notes in measures 4 and 6.

