

Winter Term 2026/27

Selected Topics in Deep Learning for Audio, Speech, and Music Processing

Lecture

Introduction to Music Processing

Stefan Balke, Andreas Brendel, Ben Maman, Meinard Müller

Music

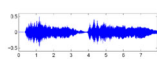


Music Information Retrieval (MIR)

Sheet Music (Image)



CD / MP3 (Audio)



MusicXML (Text)

```
<musicxml>
  <note>
    <pitch>
      <staff>1
    </pitch>
  </note>
</musicxml>
```

Dance / Motion (Mocap)



Music

MIDI



Singing / Voice (Audio)



Music Film (Video)



Music Literature (Text)

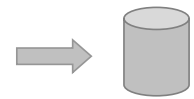


Music Retrieval



Audio ID

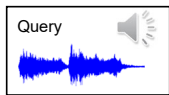
Database



Hit

Bernstein (1962)
Beethoven, Symphony No. 5

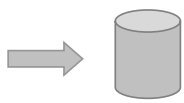
Music Retrieval



Audio ID

Version ID

Database



Hit

Bernstein (1962)
Beethoven, Symphony No. 5

Beethoven, Symphony No. 5:

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



Music Retrieval

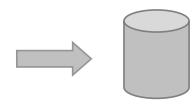


Audio ID

Version ID

Category ID

Database



Hit

Bernstein (1962)
Beethoven, Symphony No. 5

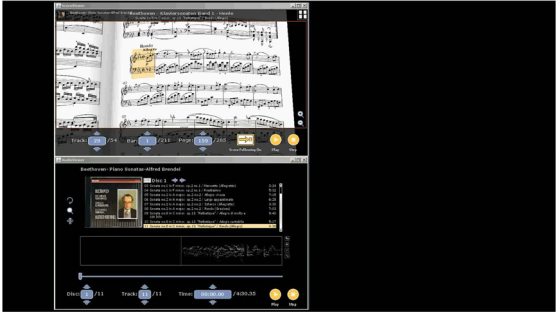
Beethoven, Symphony No. 5:

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

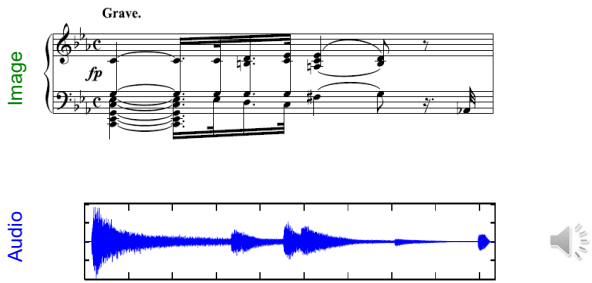
Beethoven, Symphony No. 9
Beethoven, Symphony No. 3
Haydn Symphony No. 94



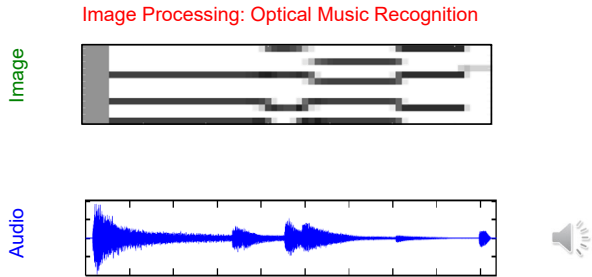
Music Synchronization



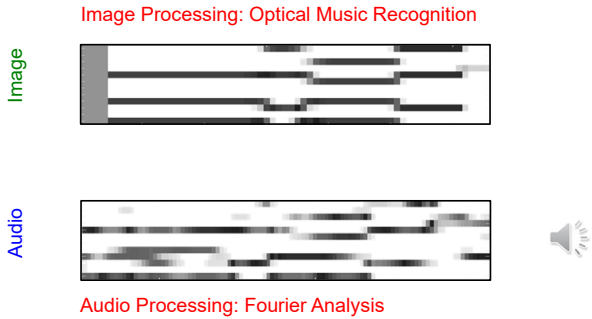
Music Synchronization: Image-Audio



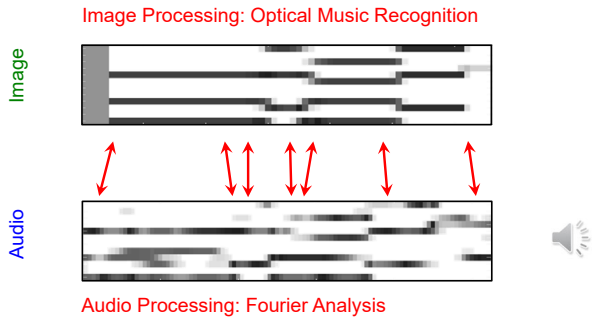
Music Synchronization: Image-Audio



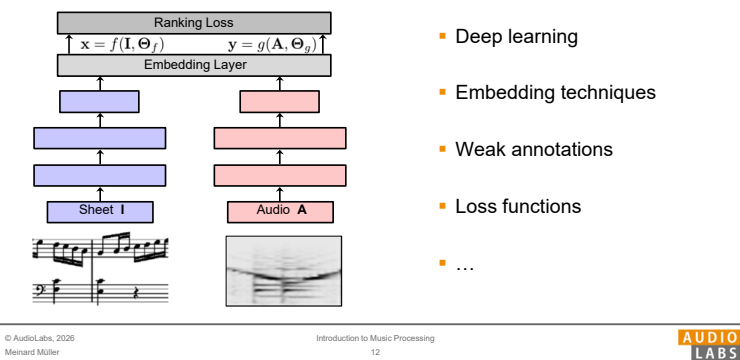
Music Synchronization: Image-Audio



Music Synchronization: Image-Audio



Music Synchronization: Image-Audio



Concert Band



Concert Band



Four-Voice Choir (SATB)
Drese: Jesu geh voran

Soprano (S)

Alto (A)

Tenor (T)

Bass (B)

Musical score for Four-Voice Choir (SATB) of "Drese: Jesu geh voran" with instrument icons for Soprano, Alto, Tenor, and Bass.

Four-Voice Choir (SATB)
Drese: Jesu geh voran

Soprano (S)

Alto (A)

Tenor (T)

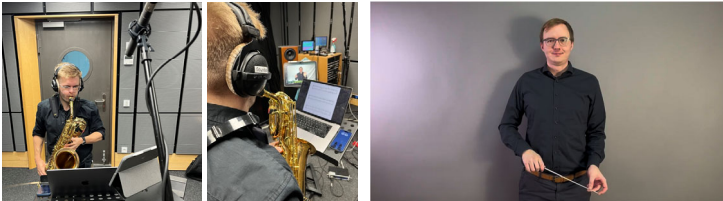
Bass (B)

Musical score for Four-Voice Choir (SATB) of "Drese: Jesu geh voran" with instrument icons for Soprano, Alto, Tenor, and Bass.

ChoraleBricks
Multitrack Dataset for Wind Music Research

- Dataset featuring 10 SATB chorales
- 193 isolated tracks with 13 instruments
- Recorded along conducting video for synchronization

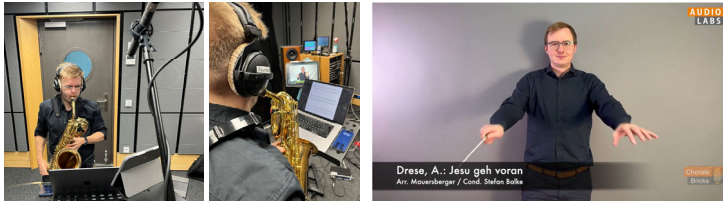
Balke, Berndt, Müller: ChoraleBricks: A Modular Multitrack Dataset for Wind Music Research. TISMIR, 8(1): 39–54, 2025



ChoraleBricks
Multitrack Dataset for Wind Music Research

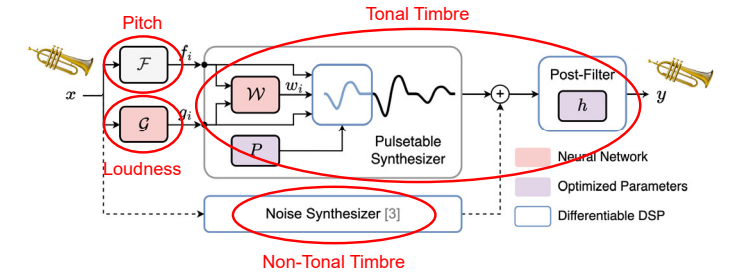
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Balke, Berndt, Müller: ChoraleBricks: A Modular Multitrack Dataset for Wind Music Research. TISMIR, 8(1): 39–54, 2025

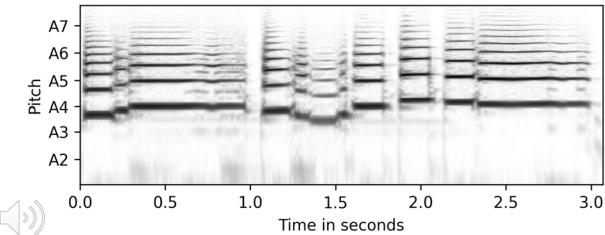


Differentiable Digital Signal Processing
Pulsetable Synthesis

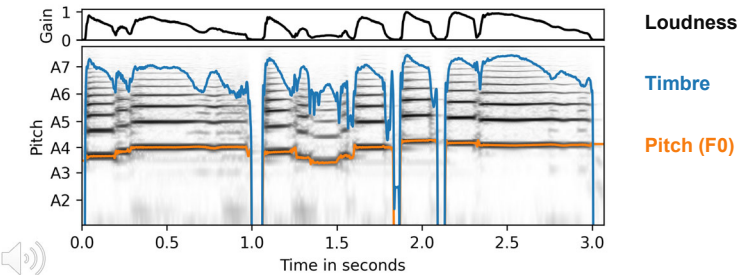
Dittmar, Zeiter, Balke, Schwär, Müller: PULSE-4T: Lightweight and Expressive Synthesis of Wind Instrument Playing. LBD ISMIR, 2025



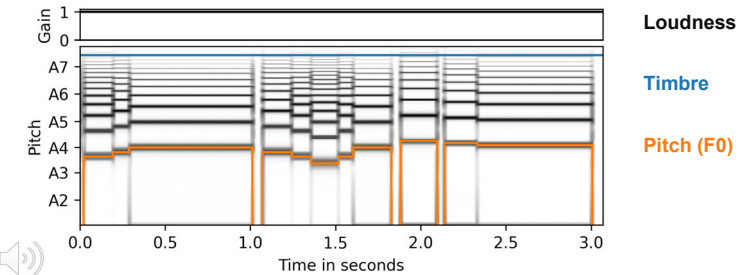
Wind Instrument Synthesis
Input Signal



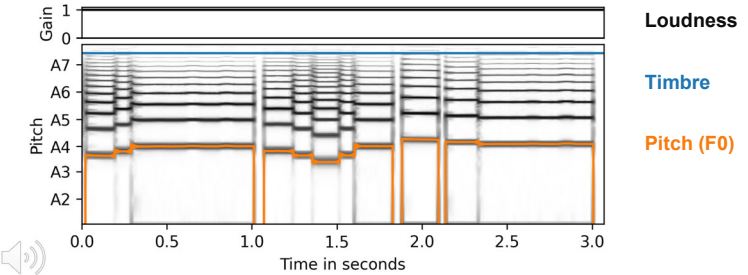
Wind Instrument Synthesis
Extract Control Signals



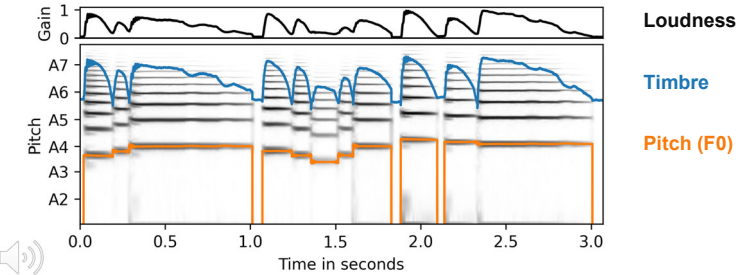
Wind Instrument Synthesis
Generated Control Signals



Wind Instrument Synthesis
Generated Control Signals with Pitch Fluctuations

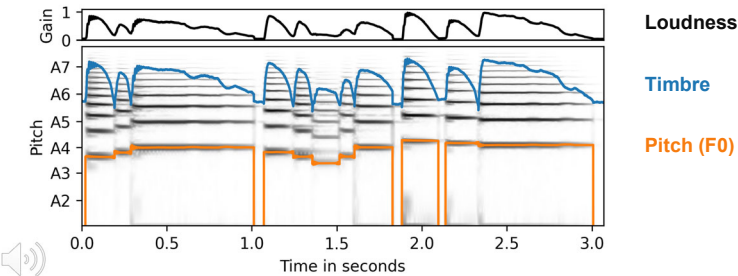


Wind Instrument Synthesis
Generated Control Signals with Pitch & Loudness Fluctuations



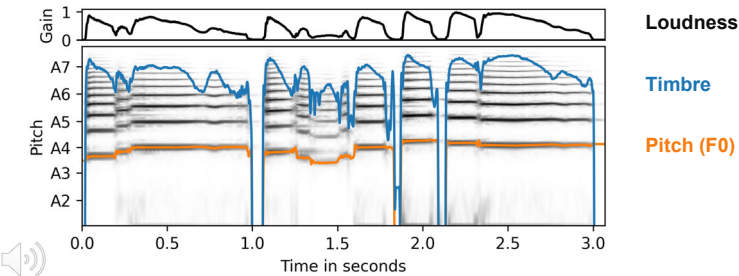
Wind Instrument Synthesis

Generated Control Signals with Fluctuations and Room Acoustics



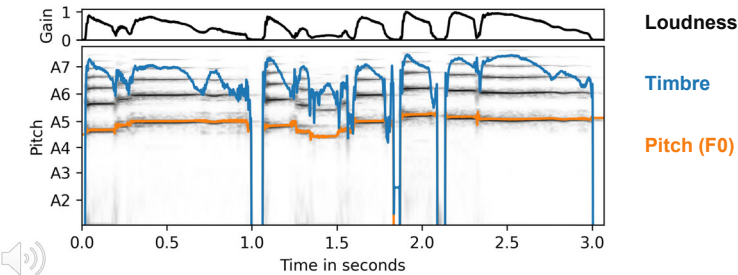
Wind Instrument Synthesis

Resynthesized Trumpet



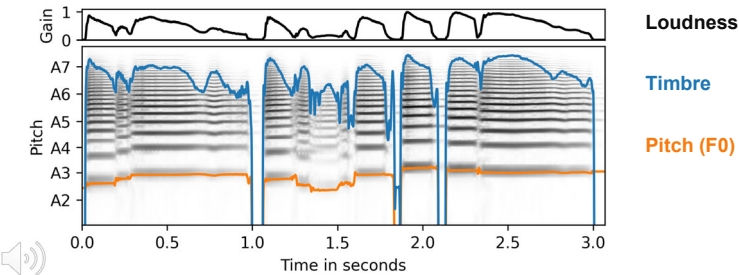
Wind Instrument Synthesis

Resynthesized Trumpet (One Octave Higher)



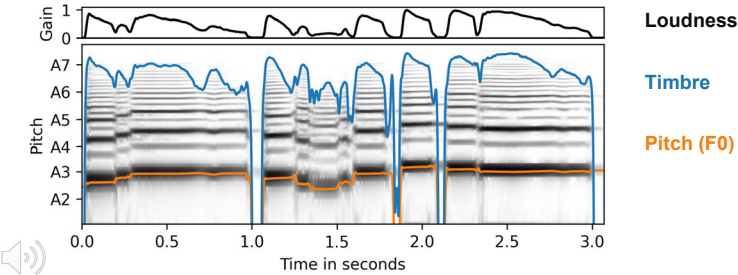
Wind Instrument Synthesis

Resynthesized Trumpet (One Octave Lower)



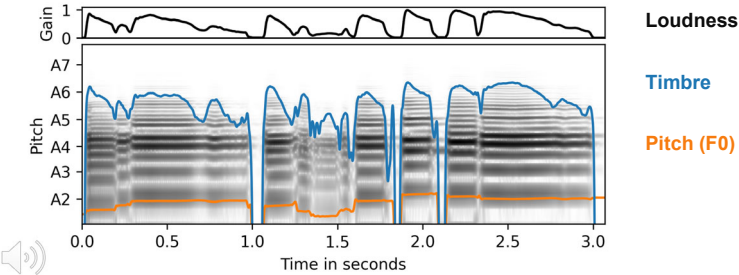
Wind Instrument Synthesis

Resynthesized Clarinet (One Octave Lower)



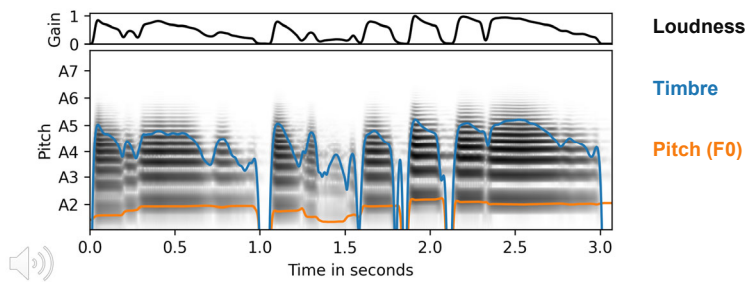
Wind Instrument Synthesis

Resynthesized Bassoon (Two Octaves Lower)



Wind Instrument Synthesis

Resynthesized Tuba (Two Octaves Lower)



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Introduction to Music Processing
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Fundamental Questions in Music Processing

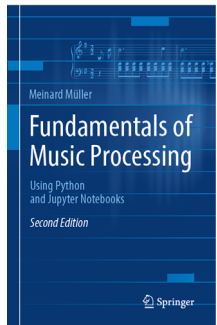
- What are musical representations?
- What are waveforms and digital signals?
- What does the Fourier transform reveal?
- What does the FFT compute?
- What is a spectrogram?
- Which signal properties are important for music?
 - How are frequency and pitch related?
 - How are intensity and loudness related?
 - What are harmonics, overtones, and timbre?
 - How can playing techniques such as vibrato be described?
- What constitutes a musical interpretation?

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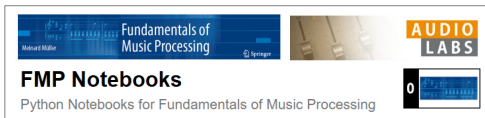
Introduction to Music Processing
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Fundamentals of Music Processing (FMP)



Meinard Müller
Fundamentals of Music Processing
Using Python and Jupyter Notebooks
2nd edition, Springer, 2021



<https://www.audiolabs-erlangen.de/FMP>

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