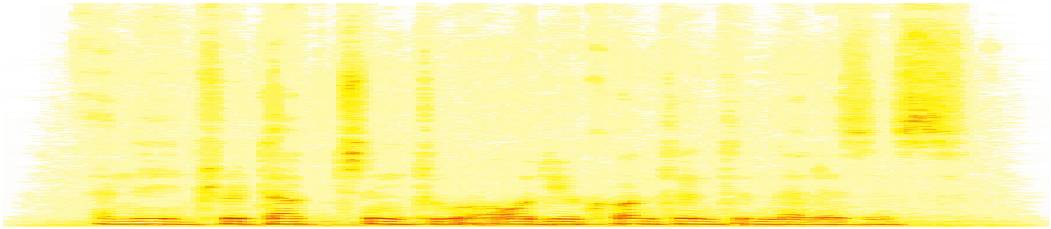
Introduction to Audio Content Analysis

Module 1.0: Introduction to MIR/ACA

alexander lerch



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introduction

overview

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corresponding textbook section

Chapter 1 — Introduction: pp. 1–6

- **lecture content**
  - audio content analysis
  - typical applications
  - audio content
  - processing steps in a typical ACA system

- **learning objectives**
  - list goals and applications in ACA
  - discuss typical forms of content in an audio signal
  - describe the typical signal flow in an ACA system

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audio content analysis — terminology

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- **goal**
  - analyze audio signal to extract information on musical content

- **terminology**
  - *music information retrieval (MIR)*:
    - analysis and retrieval of music data
    - includes both audio and symbolic data
  - machine listening & computer audition
    - focus on the recognition and understanding of music
  - computational auditory scene analysis (CASA)
    - focus on human perception & cognition, understanding of the auditory scene

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audio content analysis — research field

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- **interdisciplinary**
  - digital signal processing
  - machine learning / data mining
  - musicology
  - psycho-acoustics
  - ...
- ISMIR **community**
  - annual conferences
  - conference papers & Transactions
  - ISMIR-Community mailing list
  - MIREX: MIR Evaluation eXchange
- **related publication outlets**
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ISMIR

www.ismir.net

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applications

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- **organization** in large databases
  - search & retrieval, classification, similarity
- **interfaces** to search and retrieval
  - fingerprinting, query-by-humming systems
- music **visualization**
  - symbolic (bars, harmony, score, . . .), similarity mappings
- adaptive **processing**
  - adaptive effect parametrization or algorithm selection
- adaptive **interaction**
  - playlist generation, recommendation

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introduction
(commercial) examples

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- **recommendation**, playlist generation

- **fingerprinting**

- **score following**

- (multi-) **pitch detection**

audio content

sources

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what are the sources of (musical) audio content?

audio content

sources

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what are the sources of (musical) audio content?

1. **score**:
   - definition of musical ideas
   - "blue-print" of the music
   - *examples*: melody, key, harmony, rhythmic patterns, ...

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   - unique acoustic rendition
   - information in the score is interpreted, modified, added to
   - *examples*: (micro-)tempo, dynamics, intonation, ...

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   - unique acoustic rendition
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   - *examples*: (micro-)tempo, dynamics, intonation, ...
3. **production**:
   - aesthetic choices
   - editing & processing
   - *examples*: sound quality (EQ, microphone positioning), changes in timing and pitch

audio content

technical categories

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audio content can be structured into **5 technical basic categories:**

1. **timbral**: related to sound quality
   - *examples*: instrument(ation), playing technique, venue, audio processing, ...
2. **intensity-related**: related to musical dynamics
   - *examples*: accents, loudness, ...
3. **tonal**: related to pitch
   - *examples*: melody, chords, intonation, vibrato, ...
4. **temporal**: related to rhythm and tempo
   - *examples*: timing, meter, rhythmic patterns, ...
5. **statistical & technical**: related to signal properties
   - *examples*: amplitude distribution, number of zero crossings, ...

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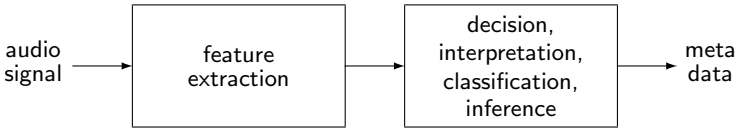
audio content analysis

system overview



feature extraction

- dimensionality reduction
- meaningful representation

classification

- map or convert feature to comprehensible domain

audio content analysis

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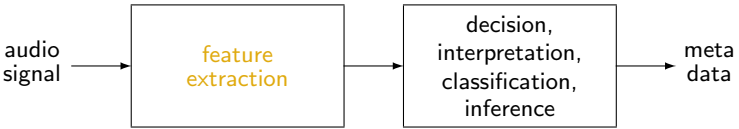

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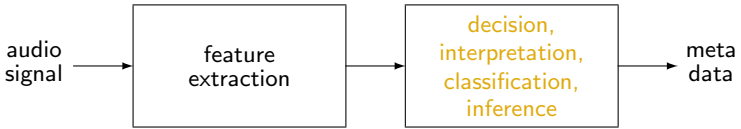

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summary

lecture content

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- music information retrieval and **audio content analysis**
  - aim at extracting data about the musical content from the music signal
- **audio content**
  - can relate to timbre, pitch, intensity, tempo and rhythm (but there is both lower level and higher level content)
  - is shaped by the musical ideas (score), the music performance, and the (studio) production
- the **flow chart of an ACA system** at its most fundamental level shows
  - a feature extraction step to extract meaningful descriptors
  - a classification or inference step to produce a "human" result