Music Information Retrieval
Introduction, Technology, and Applications

alexander lerch
introduction
about alexander lerch

- **education**
  - Electrical Engineering (Technical University Berlin)
  - Tonmeister (University of Arts Berlin)

- **professional**
  - Assistant Professor at the [Georgia Tech Center for Music Technology](http://www.gatech.edu)
  - previous: CEO at zplane.development

- **research focus**
  - music information retrieval, audio content analysis
  - intelligent music software
introduction

music technology

- what is **music technology**
  - technology for creating, assessing, and consuming music

- technology has influenced music for a long time
  - new styles and genres
    - crooning (microphone & amplification)
    - rock (electric guitar)
    - hip-hop (sampling)
  - music production technology
    - recording & reproduction quality
    - new audio effects
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Music information retrieval overview

- **MIR**: analysis and automatic extraction of *any kind of information* from the audio signal
  - *score info*: melody, structure, instruments, chords, composer, ...
  - *performance info*: tempo, tuning, artist, ...
  - *production info*: sound engineer, equipment, ...
  - *complex high-level info*: style, mood, ...
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music information retrieval
interdisciplinarity

• machine learning and artificial intelligence
  • data-driven approaches:
    classification, regression, clustering

• signal processing
  • rule-based approaches:
    transforms, pattern recognition

• perception and cognition
  • psycho-acoustics, perception of mood or similarity

• music theory
  • rules and expectations:
    structure and repetition, chord progressions
music information retrieval
related tasks & fields

- **audio forensics**: crime scene reconstruction, crime detection
- **context/activity detection**: indoor/outdoor, meeting/working out
- **environmental monitoring**: noise pollution analysis
- **acoustic fault detection**: machine diagnosis through sound
- **speech & natural language processing**: time-domain signal, high level meaning with structural properties
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differences to other fields

analysis of music data in some ways unique:

- image & video:
  - no/low res time domain
  - 2-dimensional data
  - objects don’t superpose but mask each other

- environmental audio:
  - many non-pitched sources
  - no structure, sources uncorrelated

- speech:
  - low-complexity signal
  - language models and meaning comparably clearly defined
music information retrieval

history & growth

- **ISMIR**: International Society for Music Information Retrieval (est. 2008)

- **academia**
  - increasing number of publications
  - increasing number of society members
  - rising impact factor of conference

- **industry**
  - increasing number of high profile conference sponsorships
  - sponsoring research
  - growing number of start-ups
  - aggressive hiring
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General uses:

- **learn:**
  - academic *gain of knowledge*

- **listen:**
  - allow browsing and discovery

- **produce:**
  - enhance music production intelligently

- **educate:**
  - support music students interactively

- **create:**
  - generate new content
music information retrieval
application examples

- **fingerprinting**: identify songs playing
- **recommendation systems**: playlist generation, music similarity
- **automatic music coach**: computer-assisted practice
- **performance generator**: render scores like a human
- **music generation**: generate sound tracks, elevator music
### Music Information Retrieval

**Application Examples**

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Georgia Tech research examples: drum transcription

- **goal:**
  detect all drum events

- **usage:**
  rhythm analysis/modification

- **approach:**
  Non-Negative Matrix Factorization

- **advantages:**
  - low number of training samples
  - computationally efficient
  - competitive results
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- **goal:**
  assess and rate student music performances

- **approach:**
  feature design/learning & regression

- **challenges:**
  - subjective human assessments
  - different musical scores
  - technical vs. artistic proficiency
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**goal:**
robot that can compose, improvise, and interact

**approach:**
symbolic generation with DNNs

**challenges:**
- very style dependent
- learned model hard to understand/interpret
- evaluation nearly impossible

youtube.be/l9OUbqWHOSk
music information retrieval
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[YouTube video](https://youtu.be/l9OUbqWHOSk)
MIR: young field with many interesting research questions

- **unsolved tasks**, e.g.
  - music transcription
  - source separation
  - music generation

- **current approaches** only work to a certain degree
  - feature learning
  - DNN architectures (CNN, RNN, etc.)
  - user-adaptivity, online learning

- **challenges**
  - meaning in music: understanding high level concepts
  - domain knowledge: how to enhance data-driven approaches
  - data: how to deal with unlabeled/weakly labeled data

- **potential**
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other project examples:
- sample detection
- instrument recognition
- style transfer
- concert stitching
- . . .

Georgia Tech Center for Music Technology:
- BS, MS, & PhD programs
- research intensive
- some funded student GRA positions
- industry partners, good job placement
thank you!

contact

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