Introduction:
Music, sound and games

Anja Volk

Sound and Music Technology,
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Recap last lecture

- Introduction course structure and general topics
- Introduction research UU in Music Information Retrieval
- Domain knowledge: What are musical features?
- Start on music and games: What is the role of sound and music in games?

Today

- Overview: Student presentations and projects
- Introduction of resources in Music Information Retrieval
- Intro music, sound and games

Reminder student presentations: What I expect presenters to do

- 10- 15 minutes presentation followed by 5 minutes of discussion
  - your responsibility to keep discussion going
- in your presentation
  - summarize paper; discuss main contribution(s)
  - put in context of other research (before and after)
  - what domain knowledge is needed to understand the paper and how to acquire it
  - critical evaluation
  - what research questions / opportunities follow from it?
- Load your slides into Google drive folder under folder "Slides student presentations"

Exam

- date: 30 Jan
- 35% of final grade
- about
  - lectures
  - literature discussed in lectures
  - literature presented by students

Projects

- 35% of grade is for a small project
- in pairs
- 3 options
  - Module A – Anticipatory cues in the game BlocksJourney
  - Module B – Music classification based on feature extraction and musical patterns
  - Module C- Automatic generation of folk tunes
- Or something else of your choice

Project option A

- **Anticipatory cues in the game BlocksJourney**

- Topic: Influence on tempo in anticipatory cues on player performance
- Based on a game developed during SMT course 2016 and a recent bachelor thesis
- How can sound and music be used to support players by giving anticipatory cues to important game events?
- Hypotheses: how does tempo influence the effectiveness of anticipatory cues?

Project option A

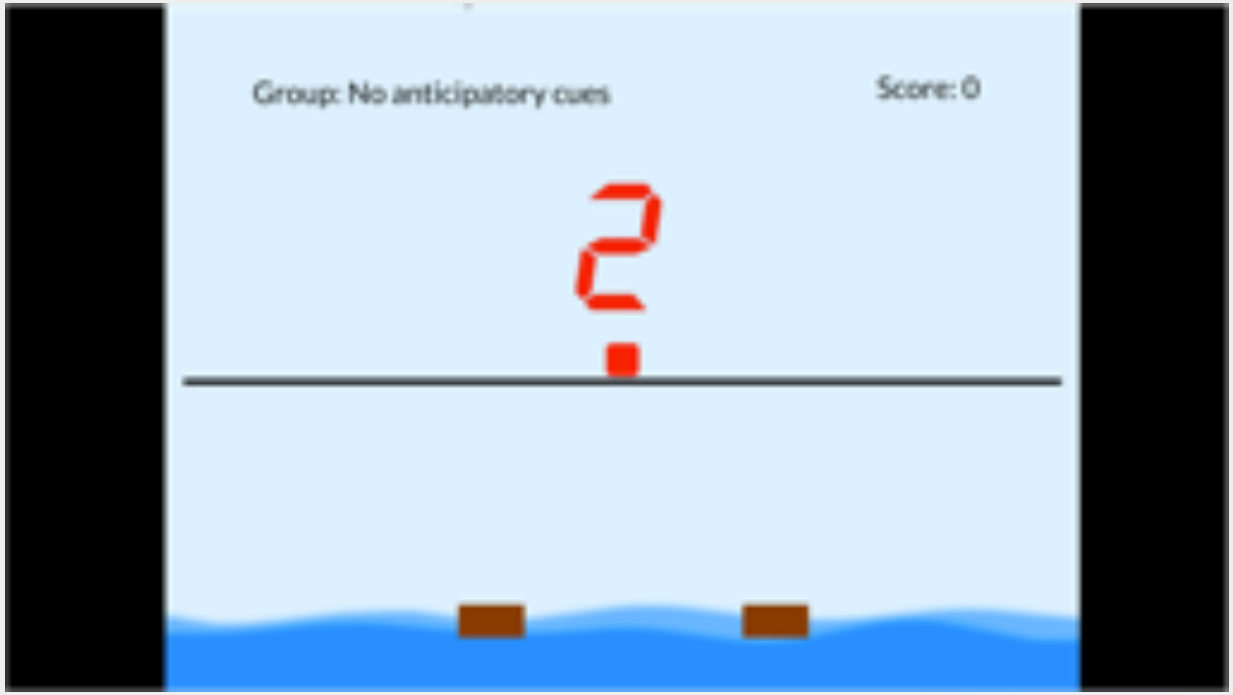
- **Anticipatory cues in the game BlocksJourney**
- Bachelor thesis tested 4 different scenarios

Project option A

- **Anticipatory cues in the game BlocksJourney**

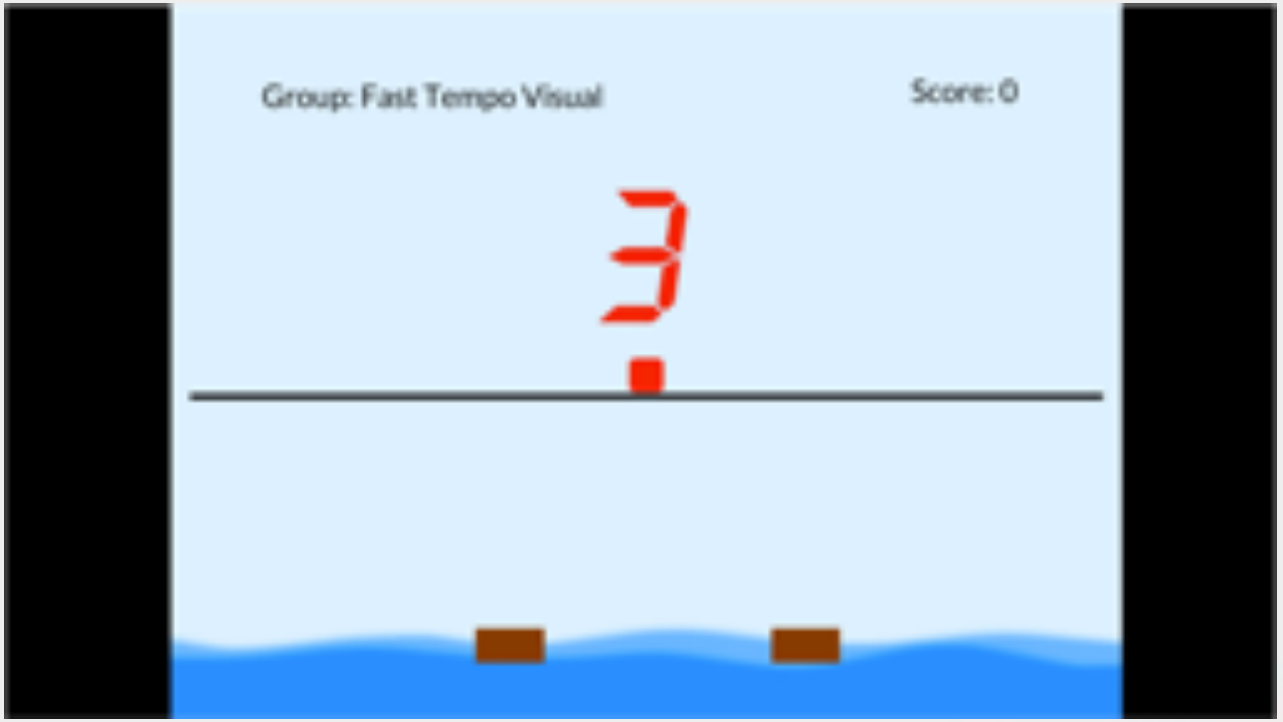
Project option A

- **Anticipatory cues in the game BlocksJourney**
  - no anticipatory cues



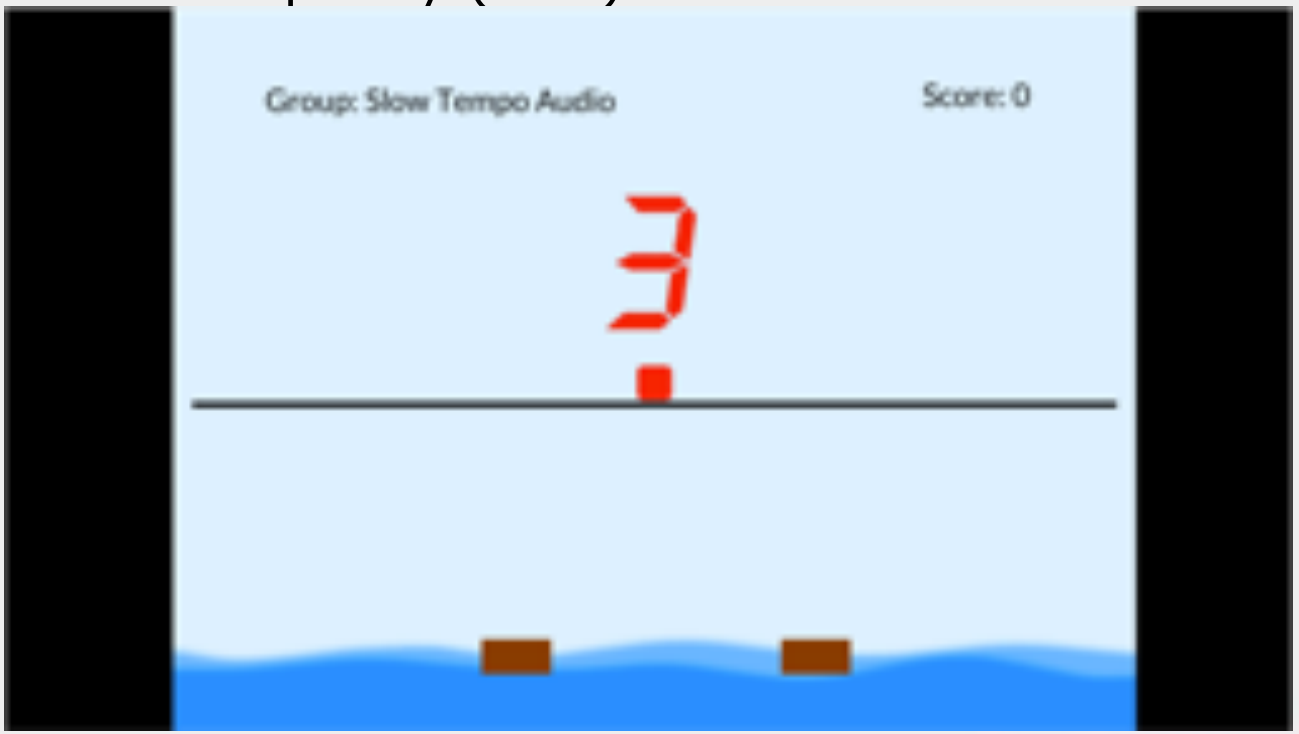
Project option A

- **Anticipatory cues in the game BlocksJourney**
  - visual anticipatory cues



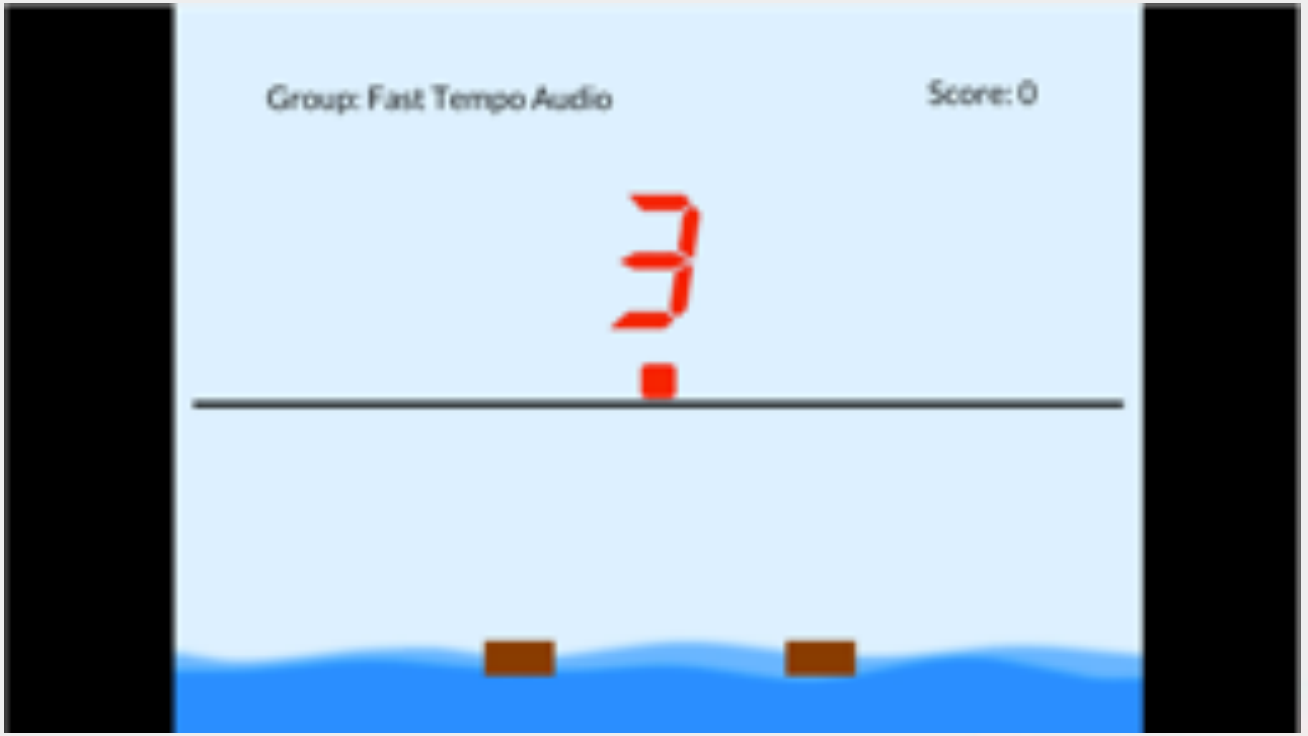
Project option A

- **Anticipatory cues in the game BlocksJourney**
- audio anticipatory (slow) cues



Project option A

- **Anticipatory cues in the game BlocksJourney**
  - audio anticipatory (fast) cues



Project option A

- **Anticipatory cues in the game BlocksJourney**
- Bachelor thesis tested 4 different scenarios
  - All hypotheses had to be rejected
  - Conclusion suggests future work on testing what went "wrong", or whether hypotheses were wrong altogether
- Your task: analyse the game yourself, come up with ideas what "went wrong", come up with new hypotheses, modify the game, test it
- Game code available on Github, Bachelor thesis on Google drive, folder "Project Options"

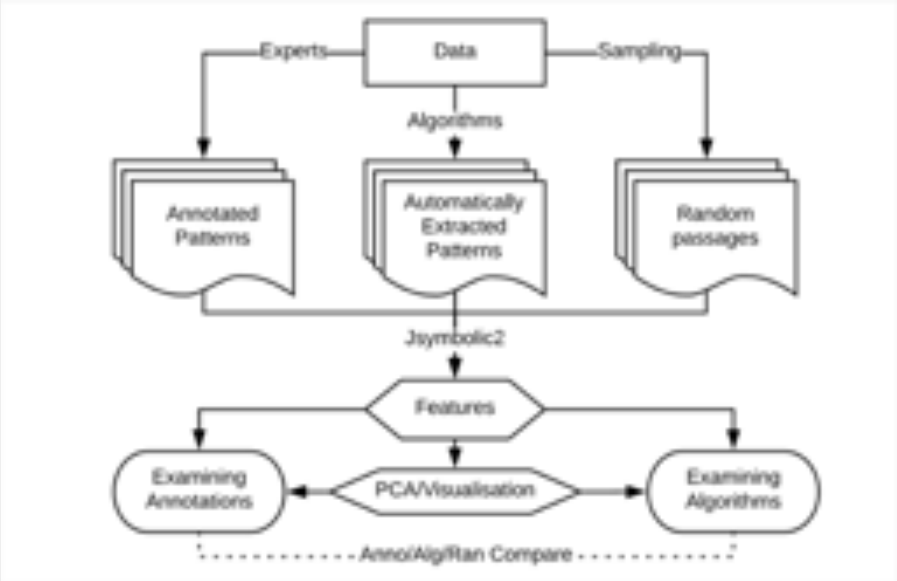
Project option B

- **Music classification task based on musical features and patterns**

- In this project you will use well-established tools to extract high dimensional musical features (and potentially design your own features)
- employ different classification and clustering machine learning algorithms
- examine and analyse the classification and clustering results
- We offer different corpora:

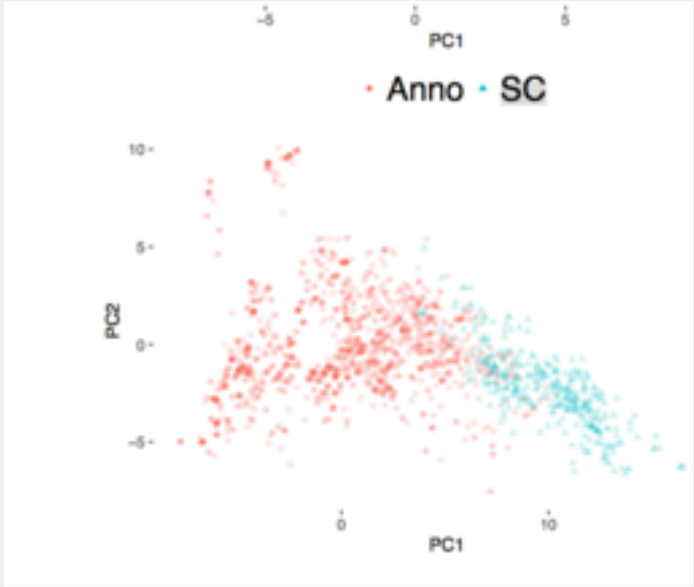
Project option B

- **Music classification task based on musical features and patterns**
  - Example: humanly annotated patterns vs. algorithmically detected patterns



Project option B

- **Music classification task based on musical features and patterns**
  - Example: humanly annotated patterns vs. algorithmically detected patterns



Project option B

- **Music classification task based on musical features and patterns**
  - Example: humanly annotated patterns vs. algorithmically detected patterns

Original → Classified ↓	Alg	Ran	Anno
Alg	1595(±7.4)	17.2(±4.6)	24.8(±8.4)
Ran	8.3(±2.7)	1597(±2.8)	5.0(±2.2)
Anno	54.1(±9.9)	42.6(±2.7)	1627(±10.0)

Project option B

- **Music classification task based on musical features and patterns**

- **Dutch folk song collection "Onder de groene Linde"** (MTC-ANN), part of a collection of 9000 Dutch folk songs hosted by the Meertens Institute in Amsterdam.
  - Groups of similar melodies classified into tune families
  - Repeated patterns are important for establishing similarity
  - Annotated patterns of melodies belonging to the same tune family
  - By using jSymbolic features (McKay et al, 2018) for characterising the digitized annotated patterns, you aim to classify a melody into the correct tune family and analyse what features contribute the most to the classification.

Project option B

- **Music classification task based on musical features and patterns**
- **Ragtime data-set RAG of 11.000 MIDI files**
  - What musical features distinguish early vs. late Ragtime?

Project option B

- **Music classification task based on musical features and patterns**
- **Ragtime data-set RAG of 11.000 MIDI files**
  - What musical features distinguish early vs. late Ragtime?
  - Previous research: different rhythmical patterns
  - Your task: employ JSymbolic tool box for expanding this previous research by including features that also address the pitch dimension, and ask questions about different characteristics in different groups of Ragtime, for instance earlier vs. later rags.
  - Suggestion: work on a subset of rags we provide (see Google drive)

Project option B

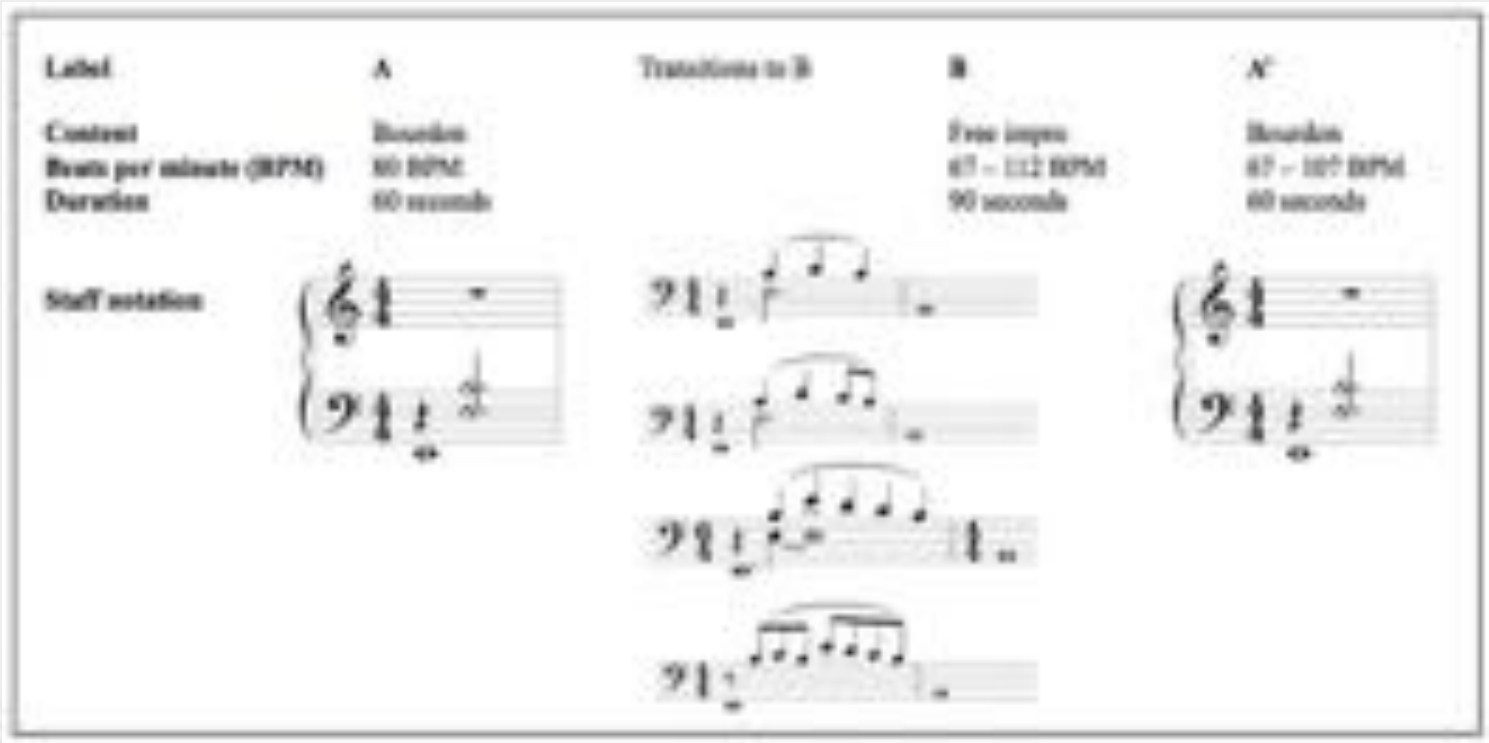
- **Music classification task based on musical features and patterns**
- **Irish folk tunes and automatically generated folk tunes mimicking the Irish style**
  - Your task is to compare tunes from the MIDI collections from the *folkrnn* model and thesession.org (original Irish folk tunes). The *folk-rnn* model has been trained on over 23.000 traditional tunes from the online crowd-sourced repository, http://thesession.org.,
  - *Example* https://soundcloud.com/oconaillfamilyandfriends
  - Use classification using features to discover differences and commonalities between original songs from thesession.org and the computer-generated songs with *folk-rnn.*

Project option B

- **Music classification task based on musical features and patterns**
- **Context: Music Therapy**

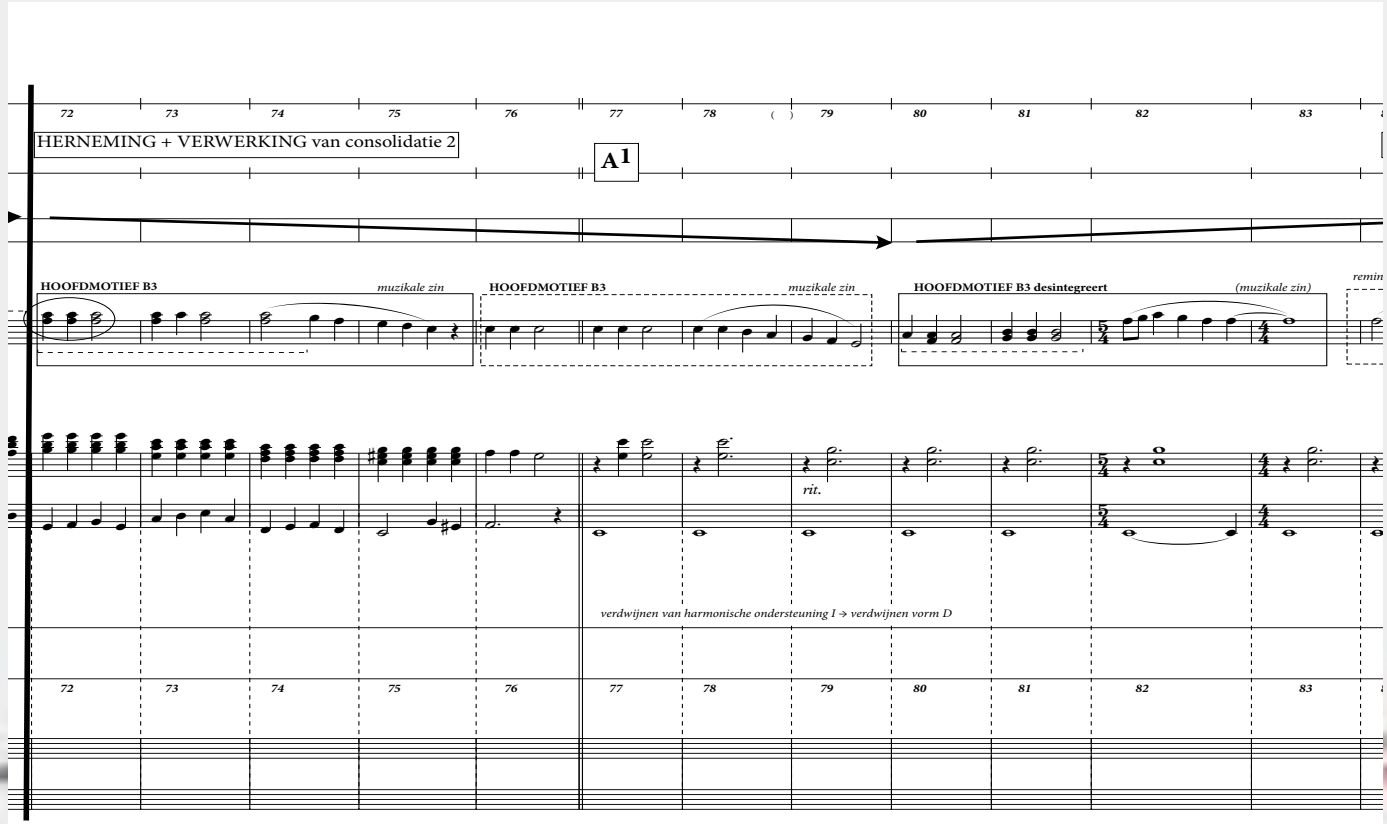
Project option B

- **Music classification task based on musical features and patterns**
- **Context: Music Therapy**



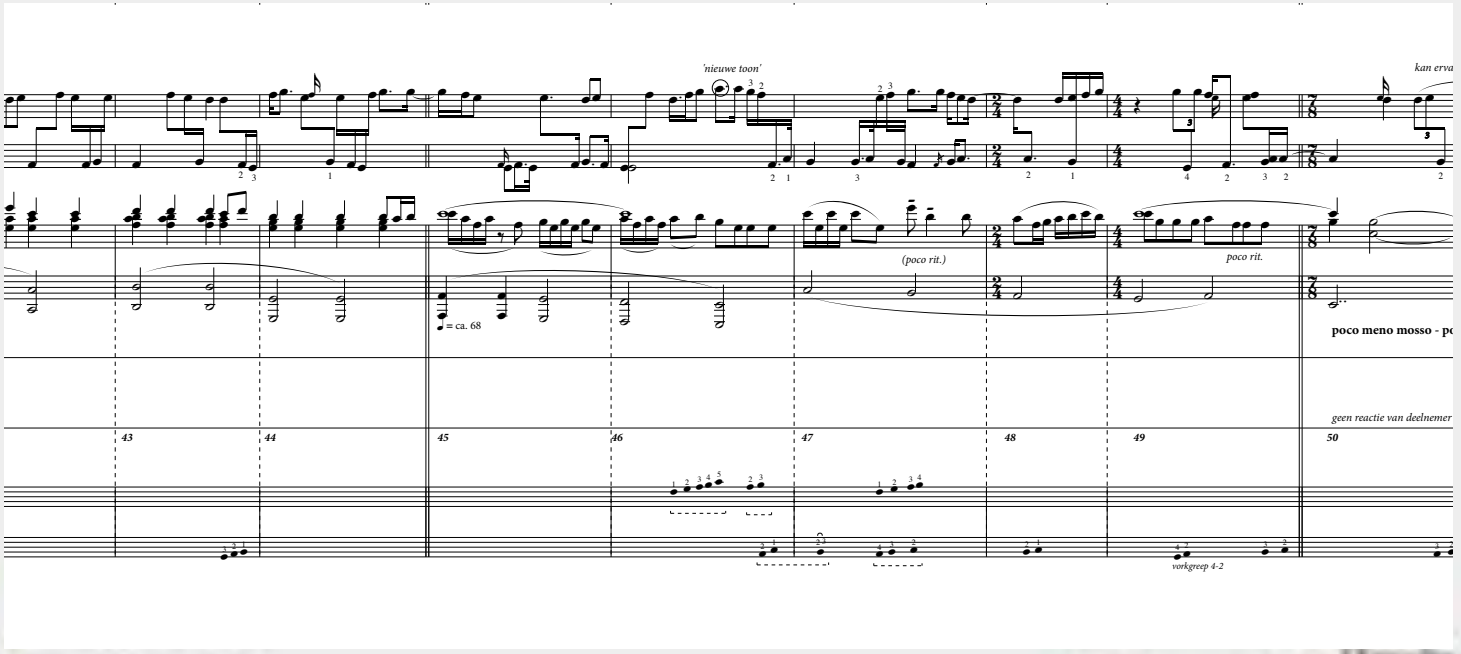
Project option B

- **Music classification task based on musical features and patterns**
- **Context: Music Therapy**



Project option B

- **Music classification task based on musical features and patterns**
- **Context: Music Therapy**



Project option B

- **Music classification task based on musical features and patterns**
- **Context: Music Therapy**
  - Your task: use computational methods to investigate part B of the improvisation, in how far the client is able to repeat certain elements of musical structure and to vary them to determine whether client is ready for group therapy
  - 14 MIDI files of piano improvisations, along with annotations from music therapists when patterns are repeated, along with a classification which of these improvisations indicate that the patient is ready for group therapy
  - How much repetition, variation or randomness can you find in the improvisations?
  - Jsymbolic features
  - Haskell

Project option C

participate in the first Eurovision AI Song Contest in 2020!

- **Automatic music generation: Deep learning folk songs**
  - you will use a successful recurrent neural network approach, the so-called *folk-rnn* model, using a long short-term memory (LSTM) network trained to model textual sequences of music transcriptions https://github.com/IraKorshunova/folk-rnn
  - folk-rnn model has been trained on over 23.000 traditional tunes from the online crowd-sourced repository, http://thesession.org, containing mostly music from Ireland and the UK. These tunes are encoded in the so-called ABC transcription. (http://abcnotation.com/)
  - Example performances:

https://www.youtube.com/watch?v=YZ2jb0ksOm4&list=PLdTpPwVfxuXpQ03F398HH463SAE0vR2X8

https://www.youtube.com/watch?v=NiUAZBLh2t0&feature=youtu.be

Project option C

- **Automatic music generation: Deep learning folk songs**
  - you will train the model on a collection of 18.000 tunes from the Netherlands, consisting of 9.000 Dutch folk songs (from the collection *Onder de groene linde*) from the 20th century, and of 9.000 instrumental tunes from Dutch sources of the 18th century.
  - After training the network and generating new tunes, you will then find ways of evaluating the newly generated tunes, in how far they differ stylistically from the generated tunes of the model trained on the Irish folk songs.
  - For extracting features from the tunes you can use the jSymbolic 2.2 tool box (McKay et al, 2018).

Project options

- Concise description of these projects on Google drive, folder “Project options”

Write short research proposal

1. topic and motivation
2. research problem
3. method
4. expected results
5. planning
6. relevant literature

- length: 2-3 pages

All project options offer different options, please choose one and be concrete in your research proposal!

1. topic and motivation

- what is the research about
- context: state of the art, related work
- 2-4 paragraphs

Important: use the project as a chance to dive into details!

2. research problem

- the concrete research question you want to answer
- inportant requirements
  - must deliver scientific knowledge
  - must be answerable using an appropriate scientific method
  - practically feasible (limited size)
  - if your aim is to create a novel application or service, make sure it is rigorously evaluated
- feasibility: in the context of this course it is more important to design research well than to perform it exhaustively. The research results may have an exploratory or preliminary nature

3. method

- how are you going to solve the question?
  - depends on type of problem
  - valid method for solving the question
  - e.g. empirical approach, modelling, implementing/testing…
- what do you need to do so?
  - examples: data, software, test subjects…
- how will you show the validity of your solution?
  - examples: retrieval evaluation measures, statistics…

4. expected results

- what conclusions do you expect to draw?
- what products will the project deliver?
  - e.g. data, software, methods…
  - presentation(s), report(s)

Project planning

- what activities are needed?
- when do you plan to do so?
  - week-by-week is OK
  - deadlines for deliverable(s): distribute these more or less evenly over time
- contingency plan(s)
  - what to do if an essential step fails?

Relevant literature

- list of scientific publications you used to prepare the proposal (project proposals give starting point)
- represent the state of the art, mention main competitors
- not yet full bibliography

Avoid typical pitfalls in research proposal

- Do not rely only on the suggested literature only!
  - Go and find more, which is relevant to your specific topic
  - Consult also Literature-site of the course
- Be as specific as possible as to what you want to achieve
  - Not:”We perform listening test”. Instead: In the listening tests, we will ask the participants the following questions.
- Give arguments why your chosen methodology answers your research question!

Project fact sheet

- teams of 2 students (project options A and B), teams of 2 or 3 students of option C, register in Blackboard https://uu.blackboard.com/, find the course, find under the menu item *Collaboration*
- submit short project description (2-3 pages)
  - Tuesday 3 Dec 2019, midnight, Blackboard: use ISMIR-style template from https://ismir2019.ewi.tudelft.nl/?q=call-for-papers
  - Find ”InstructionsResearchProposal” in folder “Project options” listing a summary of the requirements for the proposal
  - Submit in Blackboard under the menu item “Assignment”
- Individual discussion: 10-12-2018
- final presentations on 21th and 23th January
  - report: ISMIR-style conference paper, 6 pages
  - submit, with code and data, last week, to Blackboard, deadline t.b.a.

Project

- Your chance to dive deeper into one topic

Today

- Overview: Student presentations and projects
- Introduction of resources in Music Information Retrieval
- Intro music, sound and games

What is Music Information Retrieval?

- Downie 2004:
  - a multidisciplinary research endeavor that strives to develop innovative content-based searching schemes, novel interfaces, and evolving networked delivery mechanisms in an effort to make the world's vast store of music accessible to all
- Emerged in 1960s, maturing since late 1990s
- Research communities (Futrelle and Downie 2002)
  - computer science, information retrieval
  - audio engineering, digital sound processing
  - musicology, music theory
  - library science
  - cognitive science, psychology, philosophy
  - law

Motivation for MIR research

- Music is meaningful to people
  - movement, ritual, emotion, social identity etc.
  - what it means is a hard problem
  - *how to find suitable music?*
- Incredible amount of music exists
  - 10s of millions of pieces
  - iTune store: over 5.000.000 items
  - people often have large music collections
  - *how to retrieve partly-remembered items?*
- Big industry
  - European digital music sector: 750 million €
  - *recommendation, managing rights, tracing plagiarism?*
- Many music professionals
  - performers, musicologists
  - *find music they need for work*
- For computer scientists: interesting, complex data

Practical matters

ISMIR

- International Society for Music Information Retrieval (ISMIR)
  - yearly conference since 2000; ISMIR 2019 in Delft
  - http://ismir.net/ for previous conferences
- all papers online at http://dblp.uni-trier.de/db/conf/ismir/index.html
- ISMIR-community mailing list at https://groups.google.com/a/ismir.net/forum/#!forum/community
  - strongly recommended to join this list

MIREX

- Evaluation of MIR methods at ISMIR Conferences comprising e.g.
  - Audio Classification (Train/Test) Tasks (4 different tasks)
  - Audio Cover Song Identification
  - Audio Tag Classification
  - Audio Music Similarity and Retrieval
  - Symbolic Melodic Similarity
  - Audio Onset Detection
  - Audio Key Detection
  - Real-time Audio to Score Alignment (a.k.a Score Following)
  - Query by Singing/Humming
  - Audio Melody Extraction
  - Multiple Fundamental Frequency Estimation & Tracking
  - Audio Chord Estimation
  - Query by Tapping
  - Audio Beat Tracking
  - Structural Segmentation
  - Audio Tempo Estimation
  - **Discovery of Repeated Themes & Sections**
- http://www.music-ir.org/mirex/wiki/MIREX_HOME

Resources

- generally, widely distributed
- no single entry point

- keep looking / asking around
- report interesting findings (or collect them on the Google Drive)

- many important resources mentioned in MIREX documentation
- http://ismir.net/resources.html

Some audio data sets

- Audio data are highly problematic because of Intellectual Property issues

- Million Song Dataset (MSD)
  - http://labrosa.ee.columbia.edu/millionsong/
  - no audio; tracks known
  - features extracted by http://the.echonest.com/
- Magnatune, http://magnatune.com/
  - music under Creative Commons license
- production music
  - http://allmusic.nl/ (c. 300k tracks), access for research negotiable
- musical heritage
  - folksongs, e.g. Nederlandse Liederenbank, http://www.liederenbank.nl/
  - complete corpus of recordings + annotations (7000 items)

Some symbolic data sets

- MIDI collections
  - lots of them, but generally lo- to mid-fi
  - http://www.classicalarchives.com/
- Essen folksong corpus (ESAC) http://esac-data.org/
  - over 20k songs from different countries
- MuseData corpus
  - c. 2000 classical compositions in high-quality encodings
- KERN scores, http://kern.ccarh.org/
  - classical works, '7,866,496 notes in 108,703 files'
  - ready for use with Humdrum toolkit
- J.S. Bach Chorales http://www.jsbchorales.net/
  - c. 450 works, widely used

Sample software

- Symbolic data
  - Humdrum toolkit, http://www.musiccog.ohio-state.edu/Humdrum/
  - Music21, http://web.mit.edu/music21/ (Python)
  - MIDI toolbox (Matlab), https://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/miditoolbox/
- Audio
  - Marsyas, http://marsyas.info/
  - MIRtoolbox (Matlab), https://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/mirtoolbox
  - Sonic Visualiser, http://www.sonicvisualiser.org/
- Both
  - JMIR (Java), http://jmir.sourceforge.net/index_ACE.html

Sample annotations

- Beatles chord transcriptions, http://code.soundsoftware.ac.uk/projects/c4dm-chord-transcriptions
  - important, but over-used
- Billboard data set, http://ddmal.music.mcgill.ca/billboard
  - musicological analyses of a carefully-prepared sample of songs from the *Billboard* charts from 1958-1991

Summary

- If you want to carry out a different project than the 3 options, there are several resources, but please plan early!

Introduction: Music, sound and games

- Introduction of module A
- Introduction today's lecture

Introduction: Music, sound and games

- Introduction of module A
- Introduction today's lecture

Course structure

- Main modules
  A. Sound and music for games
  B. Analysis, classification, and retrieval of sound and music for media
  C. Generation and manipulation of sound and music for games and media

Today

- Main modules
  A. Sound and music for games
  B. Analysis, classification, and retrieval of sound and music for media
  C. Generation and manipulation of sound and music for games and media

Today

- Main modules
  A. Sound and music for games
     - Different functions of sound and music within games

The importance of sound and music for games

Do you remember the first video game you were really into? I mean *really* into. You couldn't put the controls down, your eyes were bloodshot from staring for hours at the screen, and all you could feel was the game. **What was so hypnotic about it that kept you glued to the screen?** What was it that made your heart race with anticipation and your body tingle with expectation?

… the importance of music in such a media is often overlooked. Critics and players alike typically comment on what they consciously understand about a game: the story, the controls, the graphics. Nonetheless, at the very least, **music subconsciously** takes hold of the player and pulls him or her into the actual world of the game.

Douglas, Aaron (2002): Sound of Music: The Form, Function, and History in Video Games. http://www.stanford.edu/group/htgg/cgi-bin/drupal/?q=node/493

The importance of sound and music for games

We can ask **why sound has been ignored** so far in computer game research. … It is not possible to put it [sound] on the table in front of you and study it. Neither is it possible, as with film images, to pause the image and study its contents closely. … Sound is something that passes a person by without leaving any trace, except in memory, which again is untrustworthy. … Another reason for the lack of interest in sound in general is that sound is an **omnipresent feature** which is easy to forget exists at all. And as Arnt Maaso points out, we can never choose not to hear anything at all since we do not have any earlids …

Jørgensen, K. (2009): A Comprehensive Study of Sound in Computer Games: How Audio Affects Player Action. Mellen Press.

The importance of sound and music for games

The good thing about audio is that it tends no to be noticed that much.
This means we can affect the player in a powerful **subconscious** level.
The bad thing about audio is, well, that it tends not to be noticed much.
You will have to constantly convince people of the importance of investing in sound and music.

Stevens & Reybold (2013) *The Game Audio Tutorial: A Practical Guide to Sound and Music for Interactive Games*.

Different functions of sound and music for games

- Diegetic vs. extradiegetic (non-diegetic) sound
  - Classification first used in film sound theory (e.g. Chion 1994)
  - Later on introduced into game audio theory (e.g. Stockburger 2003)

Excerpt film: Closer (2004)

Different functions of sound and music for games

- Diegetic vs. extradiegetic (non-diegetic) sound
  - Classification first used in film sound theory (e.g. Chion 1994)
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Music switches its functions from extradiegetic to diagetic sound

Different functions of sound and music for games

- For more detailed analysis of music and meaning in this example check out our ISMIR-tutorial on musicology

http://ismir2011.ismir.net/tutorials/ISMIR2011-Tutorial-Musicology.pdf

Functions of film music

- Music masks extraneous noises
- Provides continuity between shots
- Directs attention to important features of the screen
- Induces mood
- Communicates meaning and furthers the narrative in ambiguous situations
- Enables the symbolization of past and future events (through leitmotifs)
- Heightens the sense of reality of or absorption in film
- Adds to the aesthetic affect of the film

Annabel Cohen (1999)

Different functions of sound and music for games

- Roos Vermeulen: Bioshock: Infinite
- https://www.youtube.com/watch?v=YicXBDQpoH0

Different functions of sound and music for games

- Emir Zeylan: Joker
  - https://youtu.be/U_8i7eDZiEws

Different functions of sound and music for games

- Kevin Westerbaan: The vanishing of ethan carter
- First example: https://youtu.be/fVjaabZ_Zo8?t=228
- Second example: https://youtu.be/fVjaabZ_Zo8?t=1145
- Third example: https://youtu.be/fVjaabZ_Zo8?t=5090

Different functions of sound and music for games

- Joep van der Velden: Red Dead Redemption

https://www.youtube.com/watch?v=AUXGW6sWYDY

Different functions of sound and music for games

- Dan Rijpkema: Game Journey
https://youtu.be/mU3nNT4rcFg

Different functions of sound and music for games

- Phoebe de Nooijer: Film “Friends”
- https://youtu.be/-4eB2qW0MlA
- https://youtu.be/4H6Ux3l75Rc

Different functions of sound and music for games

- Anne Kockx: Bridget Jones Diary
- https://www.youtube.com/watch?v=t8iTZm8-mbA

Different functions of sound and music for games

- Maxim Gehlmann: Lord of the Rings

https://www.youtube.com/watch?v=T39adGvJ2ak&feature=youtu.be

Next steps

- start thinking about a project you would be interested in
- check out all the other game and film examples of your fellow colleagues we could not discuss