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BeatTheBeat
Music-Based Procedural Content Generation In a Mobile Game

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Contents

Introduction

influences:

- music games
- mobile games
- PCG

usual limitations of (most) music games:

- fixed sound track
- very limited interaction with music (e.g. tap beats)
- single (sequential) play

idea: use device music as source for adapting the game

Objectives

main objectives of this work:

- use music via (automated) feature extraction as source for game content creation, beyond simple reactive schemes
- establish well-structured board compositions via self-organized map, based on automatically derived features
- music-based personalization of game should be recognized by users, without being trivial ($\Rightarrow$ user study)

Types of Music Features

music features can be obtained from different sources:

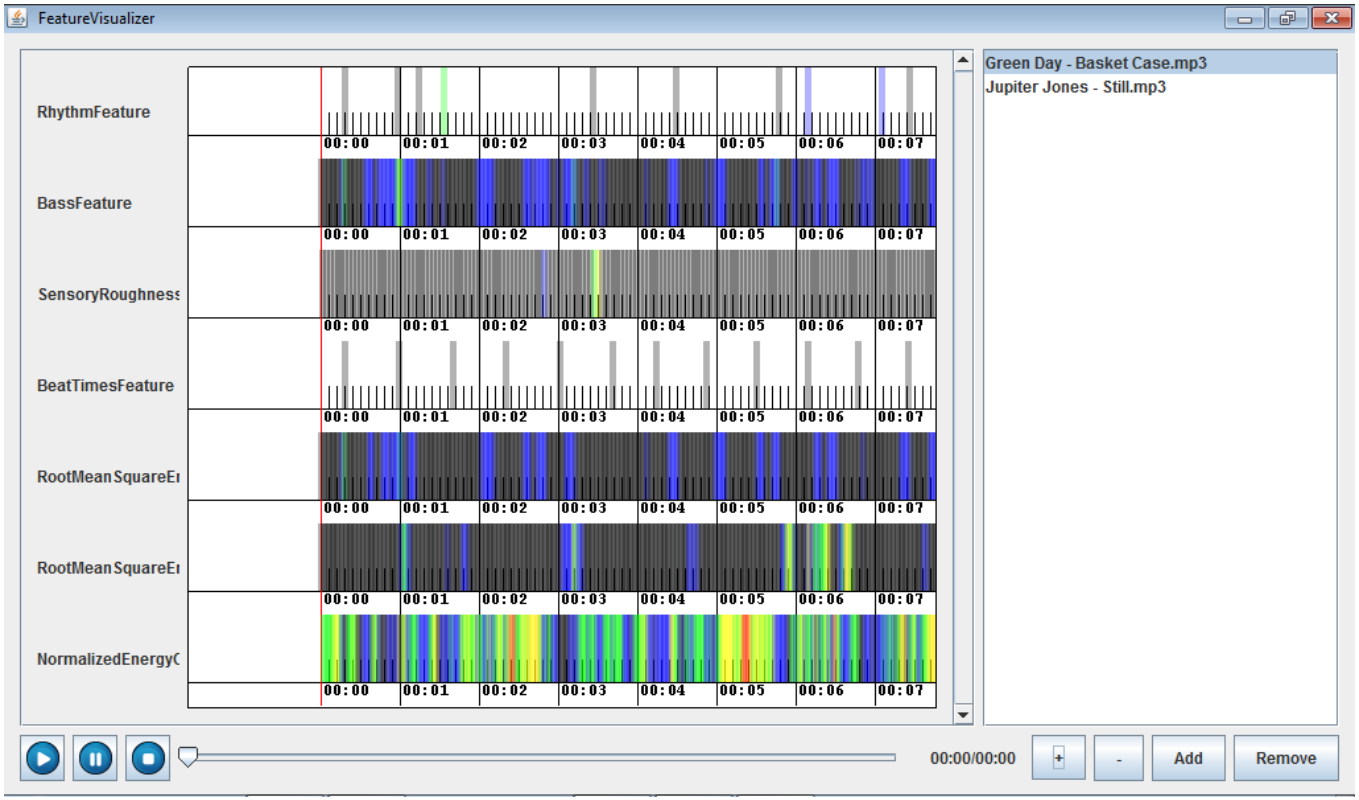
- compute from the audio signal: e.g. filter predefined frequency ranges
- symbolic features generated from the score: key, instruments, harmonic characteristics
- metadata from manually entered information: year, genre
- user tagging (as in last.fm) or similarity-based playlist characteristics

we use only the first as it is universally applicable, even for completely new music (could be composed by user during a game)

Our Feature Base

- root mean square provides a rough estimation of signal energy
- sub-band energy ratios (4 frequency bands)
- sensory roughness: average dissonance between all pairs of peaks of the spectrum
- average angle in phase domain, this is useful to distinguish between strong and weak percussive pulses
- beat per minute (BPM) measures tempo

Recombining Features



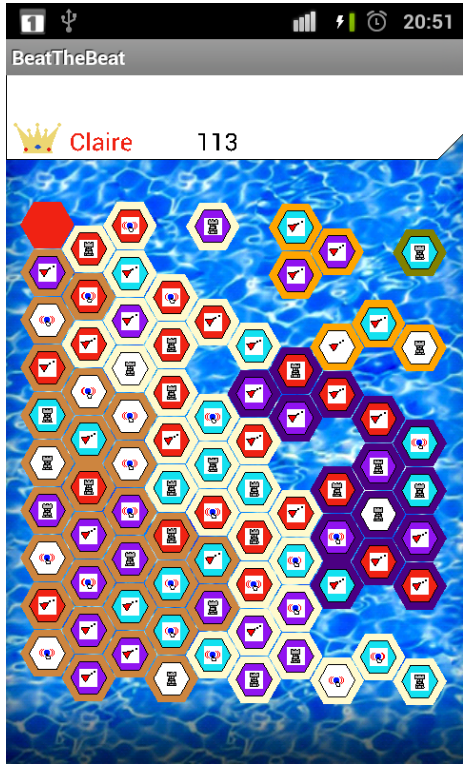
we add 2 more intuitive features as combinations of base features:

- bass energy (applies to your stomach)
- rhythm event (as unintentional moves, beats & loudness)

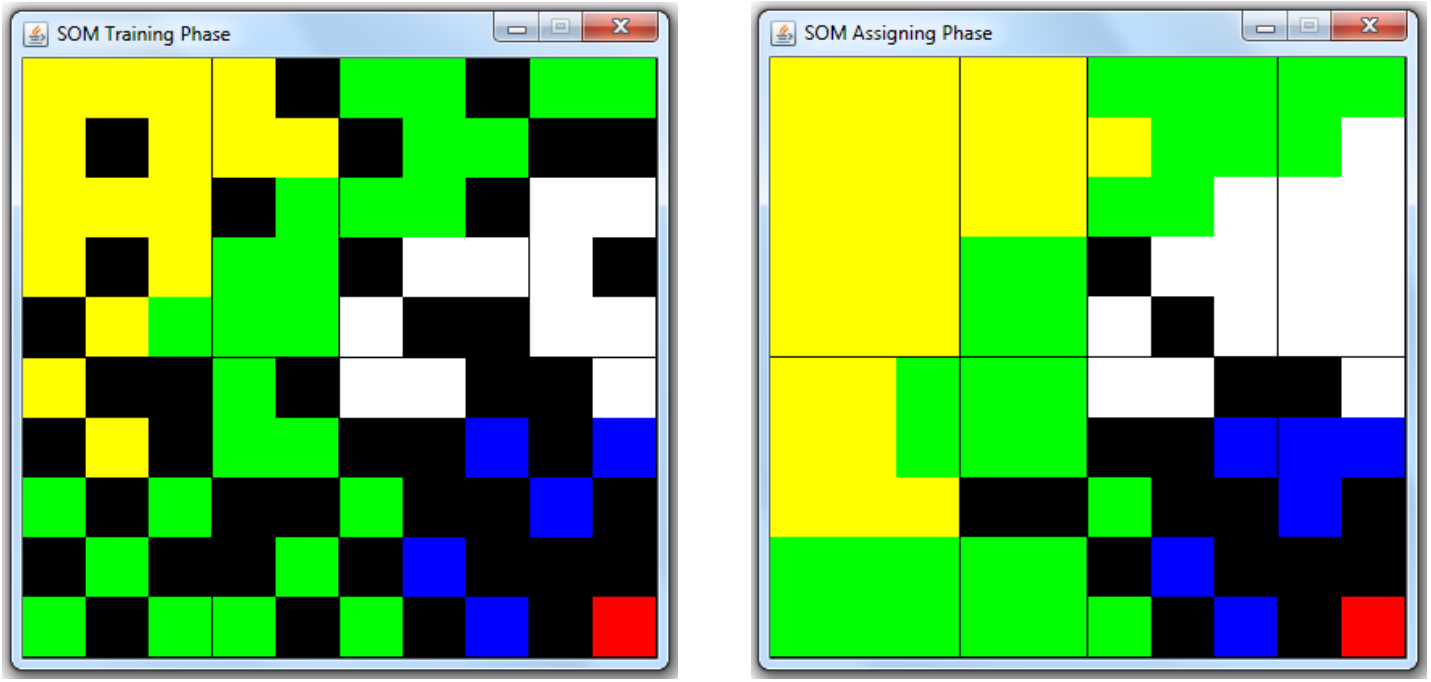
Game Concept

many players share a board of minigames

- each field stands for one song and one minigame (fixed)
- minigames are adjusted to 'their' song
- fields are controlled by achieving minigame high score
- overall points are computed from number of connected owned fields



SOM: Setting up the Board

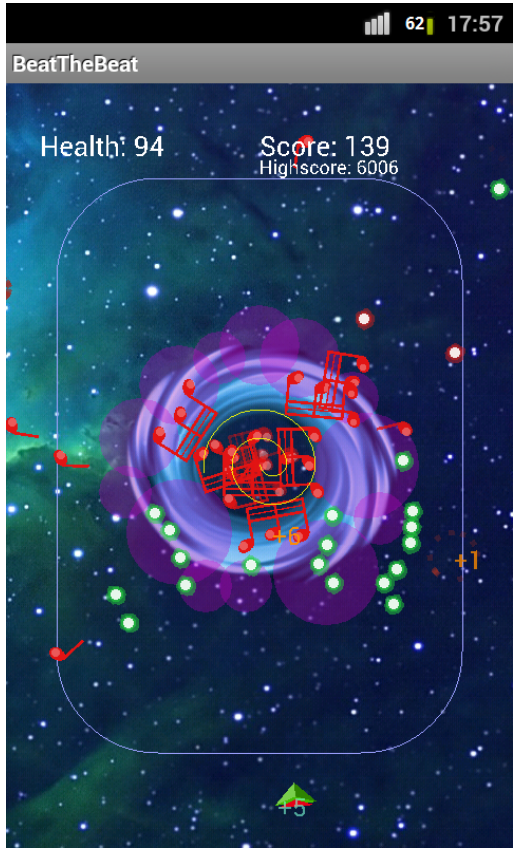


- colors from 5-means clustering (for visualization)
- left: after SOM training (some nodes connected to multiple songs)
- right: after assignment phase (correction heuristics applied)

Minigames: Music Fighter

simple shooter with enemies resembling properties of chosen song

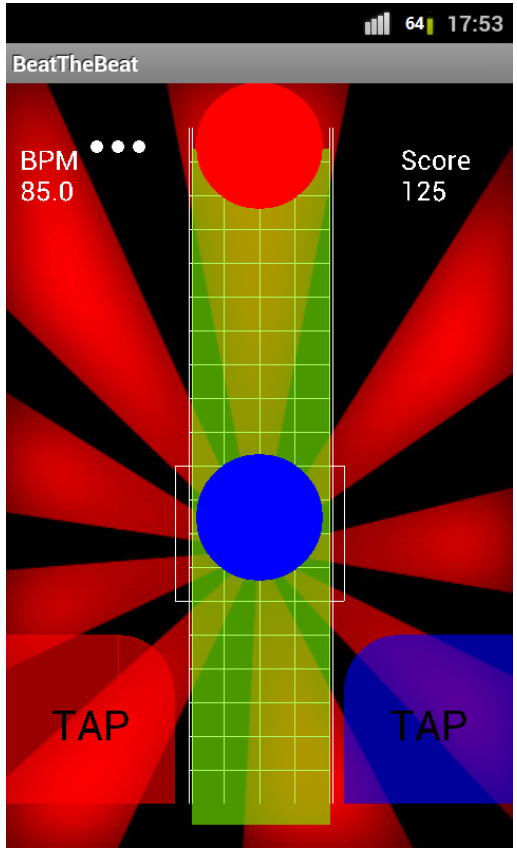
- game runs as long as song
- 5 different types of enemies
- enemy is generated when rhythm event occurs, up to 10
- bass feature level changes enemy behavior
- player cannot die but looses time when hit too often



Minigames: Tap by Tap

tapping game that uses rhythm events

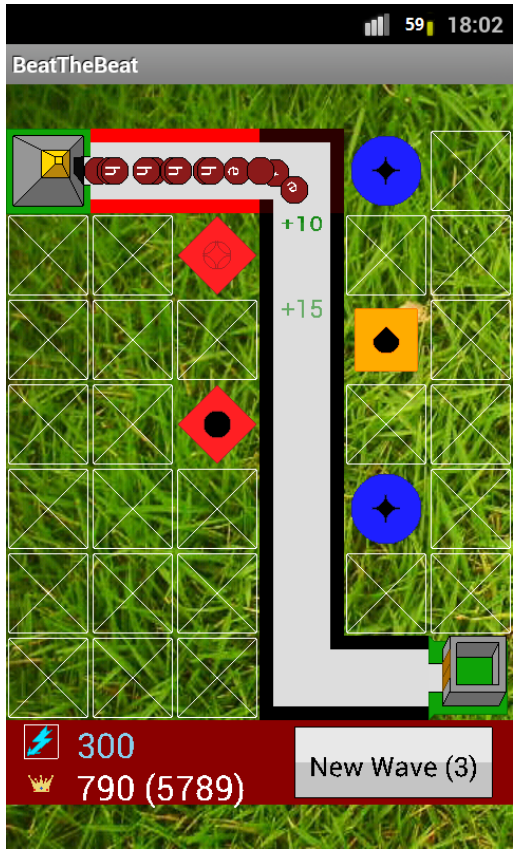
- relatively similar to existing tapping games
- increasing difficulty over time (tapping plus wiping into given direction)
- game ends with song or if 3 balls are missed



Minigames: Music Tower Defense

tower defense game with music-sensitive towers

- game runs until song ends or too many enemies reach exit
- available towers are sensitive to different music features (rhythm event, bass feature, sensory roughness)
- successful tower building has to take song properties into account
- player can increase difficulty (and score) by hitting 'new wave' button



User Study on Typ by Tap

- experimental setup: each user plays 3 songs of tap by tap (only first minute) in two versions
- one version uses correct features, one randomly selected ones (of 82 songs)
- user tries to recognize which feature set is correct

plays games	knows music well	users	correct	wrong
yes	yes	7	14	7
yes	no	7	14	7
no	yes	3	7	2
no	no	3	4	5
all	all	20	39	21

Lessons Learned...

- small study, so results to be considered with care
- people who neither listen to much music nor play games seem to make random decisions
- all other groups have around 2/3 chance for detecting the right parameter set
- this is actually not that bad, it should not be 100%

Take Home Message

- music is an interesting generational data source for PCG
- SOMs are good for easily create game boards out of dynamic components (e.g. songs)
- programming on different mobile devices is a HUGE difference!
- copyright issues make working with songs difficult
- open: how to play together on different individual boards?