Visualization for Music IR

Tutorial II,part 2

ISMIR2005 London UK

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(Thanks to the authors of original contributions!)

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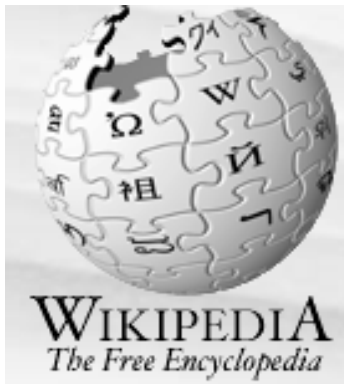


Information visualization

From Wikipedia, the free encyclopedia.

As a subject in computer science, **information visualization** is the use of interactive, sensory representations, typically visual, of abstract data to reinforce cognition.

Information visualization is a complex research area. It builds on theory in information design, computer graphics, human-computer interaction and cognitive science.

Practical application of information visualization in computer programs involves selecting, transforming and representing abstract data in a form that facilitates human interaction for exploration and understanding.

Important aspects of information visualization are the interactivity and dynamics of the visual representation. Strong techniques enable the user to modify the visualization in real-time, thus affording unparalleled perception of patterns and structural relations in the abstract data in question.

Although much work in information visualization regards to visual forms, auditory and other sensory representations are also of concern.

navigation

- Main Page
- Community portal
- Current events
- Recent changes
- Random article
- Help
- Contact us
- Donations

search

Go Search

Motivation:Support of MIR Tasks

- Search & find
- Annotate (e.g proper ID3tags)
- Explore
- Navigate
- Get recommendations
- Analyse
- Re-organize
- Mix, mash-up
- Knowledge Discovery
- etc.

Objects of desire

- Sound
- Song
- Artist
- Collection

  (Size!)

  (Portability!)

Actions of desire (preliminary findings)

- 95% wish a support for active music listening
- 89% are building personal collections
- 74% perform song identification

This actions should be supplied by metadata as following:

- 90% need correct titles
- 81% are interested in lyrics
- 75% are searching for artist information

The specific technical search & browsing actions should offer:

- 96% name of artist
- 92% name of song
- 74% partial lyrics
- 63% genre
- 62% recommendations of other users

[Lee&Downie, *Survey of music information needs, uses, and seeking behaviours: preliminary findings,* ISMIR2004]

Metadata

- Acoustic metadata
- Editorial metadata
- Contextual metadata
  - Cultural
  - Community-based
  - By usage
    - Player plug-ins
    - Mood, Preferences, Taste, Profile

Devices <-> Users

- Mobile devices
  - Small screens
  - Computational restrictions
  - Connectivity
- Standard devices
- Stationary devices
  - Large screens
  - Virtual Reality
  - Future HiFi systems

- Users
  - Single
  - Multiple
  - Novice, enduser
  - Expert, scientist

Basic questions

How to map a high-dimensional feature space onto 2D, 3D, animation, ... and beyond ?

Which should be easy to perceive and to perform human cognition upon ?

Answers

Human Computer Interaction (HCI)

Information Visualization (InfoVis)

Possible checklist

- Type of data ?
- Type of metadata ?
- Type of visualization ?
- Animation included ?
- Metapher ?
- Interaction ?
- Type of device ?
- Single vs. multiple users ?
- End-user vs. scientist ?

ISMIR and visualization

- ISMIR2000
  - ***Audio Information Retrieval (AIR) Tools***
    George Tzanetakis and Perry Cook
    (Dept. of Computer Science and Dept. of Music, Princeton University)

- ISMIR2001
  - ***Automatic Musical Genre Classification of Audio Signals***
    George Tzanetakis, Georg Essl and Perry Cook
    (Dept. of Computer Science and Dept. of Music, Princeton University)

ISMIR and visualization

- ISMIR2002
  - ***Toward Automatic Music Audio Summary Generation from Signal Analysis***

    Geoffroy Peeters, Amaury La Burthe and Xavier Rodet (IRCAM)
  - ***Using Psycho-Acoustic Models and Self-Organizing Maps to Create a Hierarchical Structuring of Music by Musical Styles***

    Andreas Rauber (Vienna University of Technology), Elias Pampalk (Austrian Research Institute for Artificial Intelligence) and Dieter Merkl (Vienna University of Technology)
  - ***On the use of FastMap for Audio Retrieval and Browsing***

    Pedro Cano, Martin Kaltenbrunner, Fabien Gouyou and Eloi Batlle (Universitat Pompeu Fabra)

ISMIR and visualization

- ISMIR2003
  - ***Exploring music collections by browsing different views***

    Elias Pampalk, Simon Dixon & Gerhard Widmer (Austrian Research Institute for Artificial Intelligence)
  - ***Quantitative comparisons into content-based music recognition with the self organising map***

    G.Wood and S. O'Keefe (University of York)

ISMIR and visualization

- ISMIR2004
  - ***VISUAL COLLAGING OF MUSIC IN A DIGITAL LIBRARY***
    David Bainbridge, Sally Jo Cunningham, J. Stephen Downie (University of Waikato, University of Illinois)
  - ***MIR IN MATLAB: THE MIDI TOOLBOX***
    Tuomas Eerola, Petri Toiviainen (Department of Music University of Jyväskylä, Finland)
  - ***A MATLAB TOOLBOX TO COMPUTE MUSIC SIMILARITY FROM AUDIO***
    Elias Pampalk (Austrian Research Institute for Artificial Intelligence)
  - ***VISUALIZING AND EXPLORING PERSONAL MUSIC LIBRARIES***
    Marc Torrens (MusicStrands Inc.), Patrick Hertzog(AI Lab., EPFL), Josep-Llu´ýs Arcos (IIIA, CSIC)
  - ***MAPPING MUSIC IN THE PALM OF YOUR HAND, EXPLORE AND DISCOVER YOUR COLLECTION***
    Rob van Gulik, Fabio Vignoli, Huub van de Wetering (Technische Universiteit Eindhoven, Philips Research Laboratories, Technische Universiteit Eindhoven)

ISMIR and visualization

- ISMIR2005
  - ***On Techniques for Content-Based Visual Annotation to Aid Intra-Track Music Navigation***

    Gavin Wood & Simon O'Keefe
  - ***Databionic Visualization Of Music Collections According To Perceptual Distance***

    Fabian Mörchen, Alfred Ultsch, Mario Nöcker & Christian Stamm
  - ***Discovering and Visualizing Prototypical Artists by Web-based Co-Occurrence Analysis***

    Markus Schedl, Peter Knees & GerhardWidmer
  - ***PlaySOM and PocketSOMPlayer, Alternative Interfaces to Large Music Collections***

    Robert Neumayer, Michael Dittenbach & Andreas Rauber
  - ***What You See Is What You Get: On Visualizing Music***

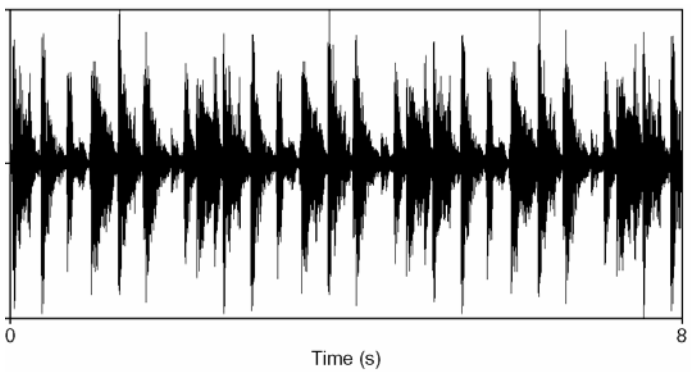
    Eric Isaacson
  - ***Visual Playlist Generation On The Artist Map***

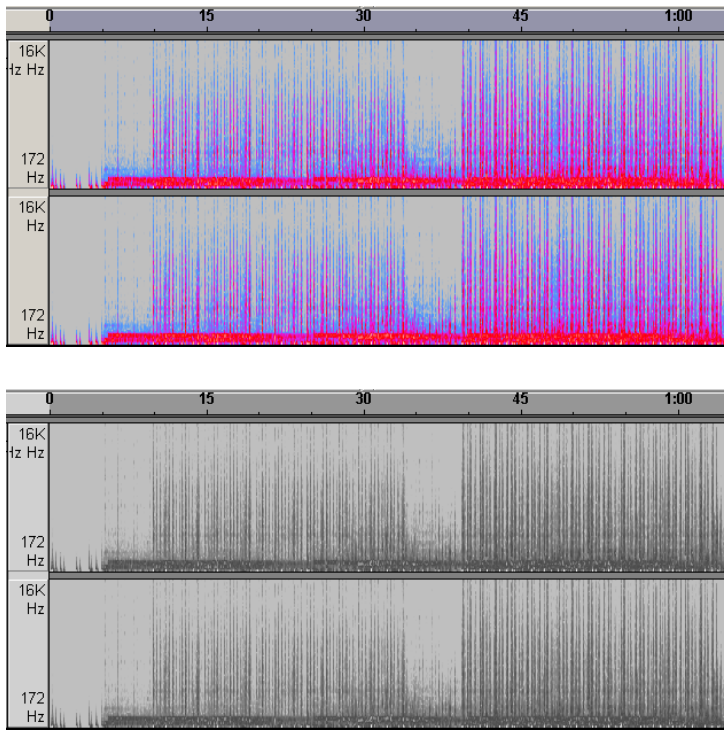
    Rob van Gulik & Fabio Vignoli
  - ***soniXplorer: Combining Visualization and Auralization for Content-Based Exploration of Music Collection***

    Dominik Lübbers

Individual sounds, songs

2D waveforms,spectrograms



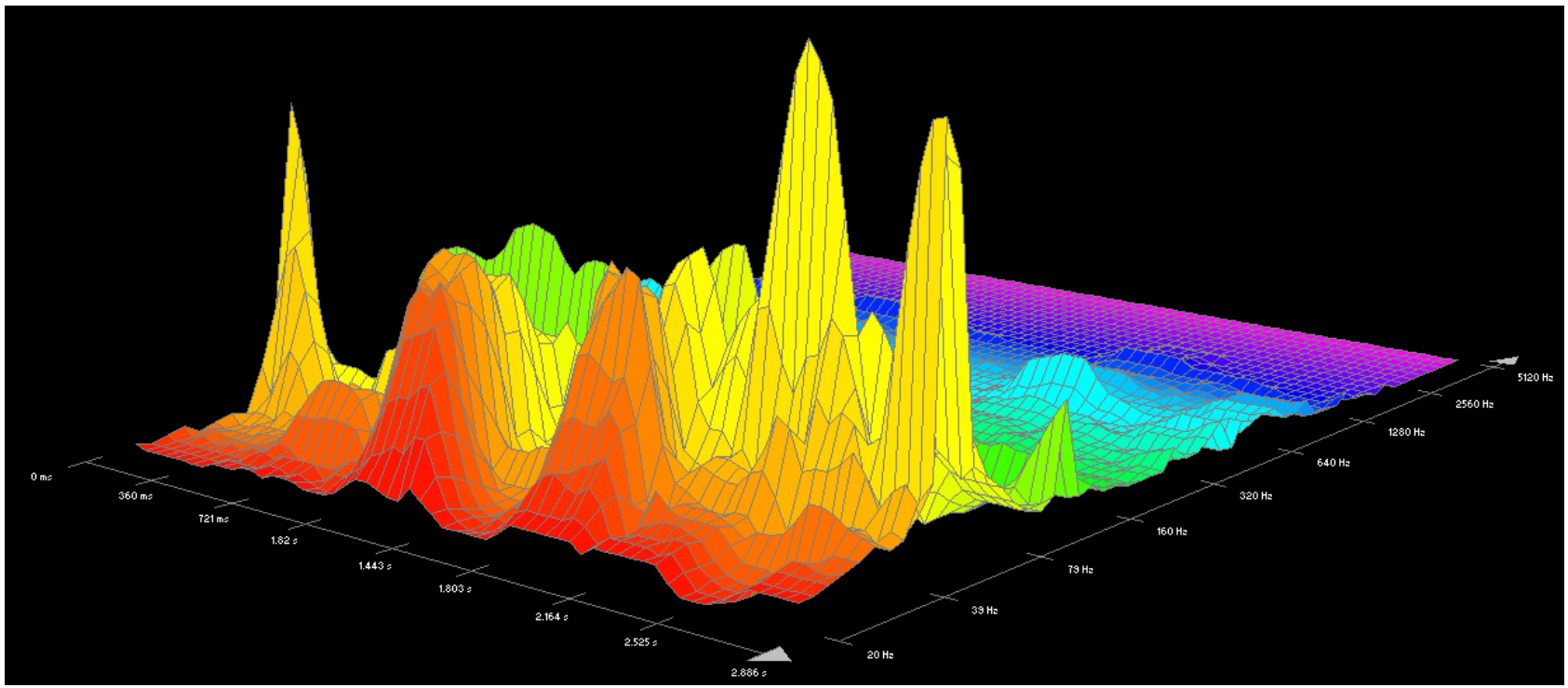


- Time from left to right, primary value of interest on y-axis, additional mapping of values on color or greyscale ranges

[Commercial software, open-source and freeware tools:

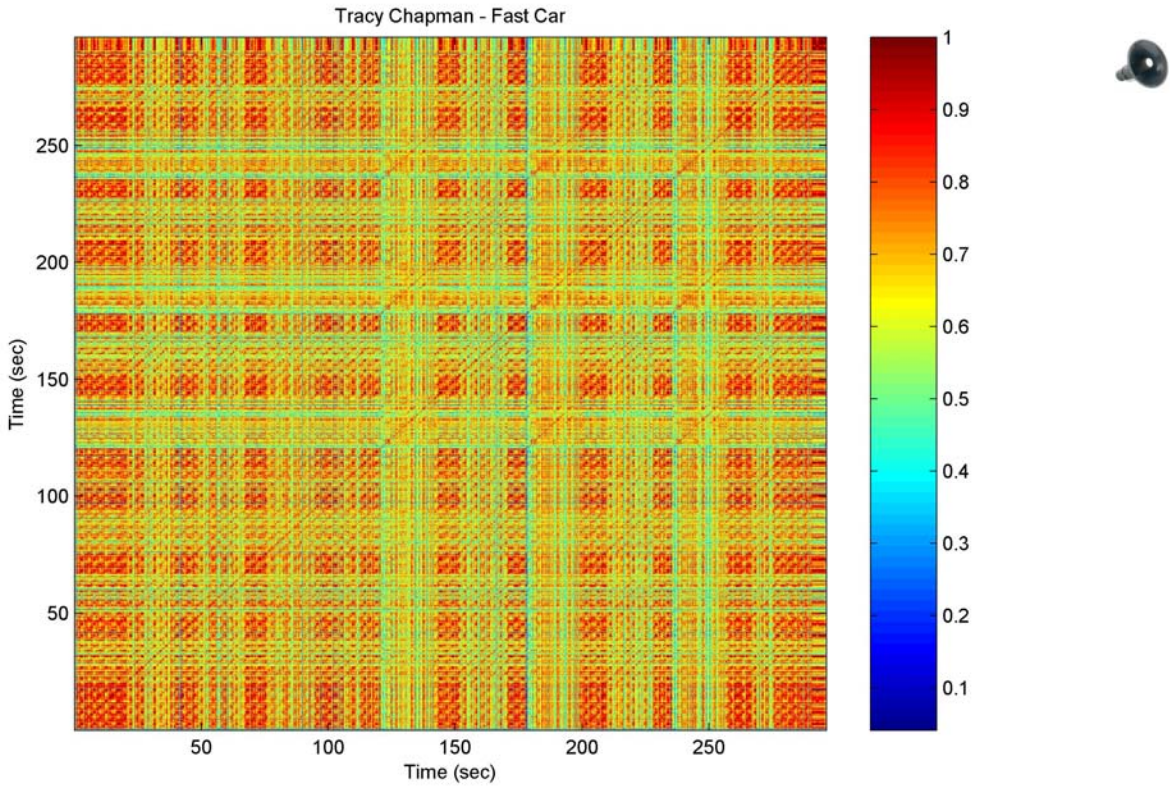
sndtools [Wang et al.,ICMC2005]*, Audacity, Matlab, Praat, etc.*]

3D spectrogram



- Color for indication of frequency bands ... too many degrees of freedoms in the software for visualization may lead to unintended results (here viewing angle!)

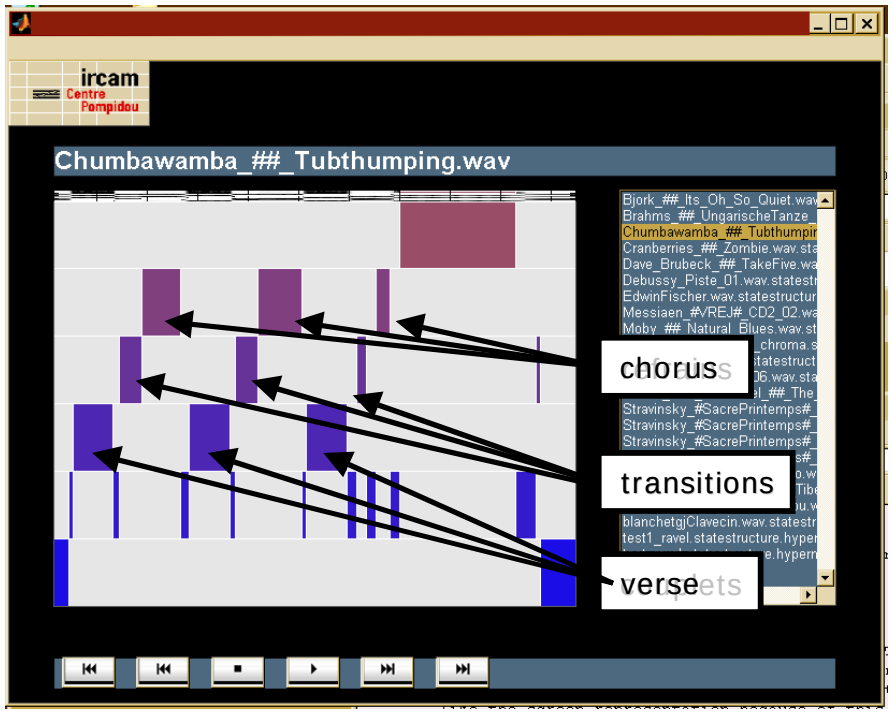
Self Similarity Matrix



- Analysis of song structure for repetitive elements

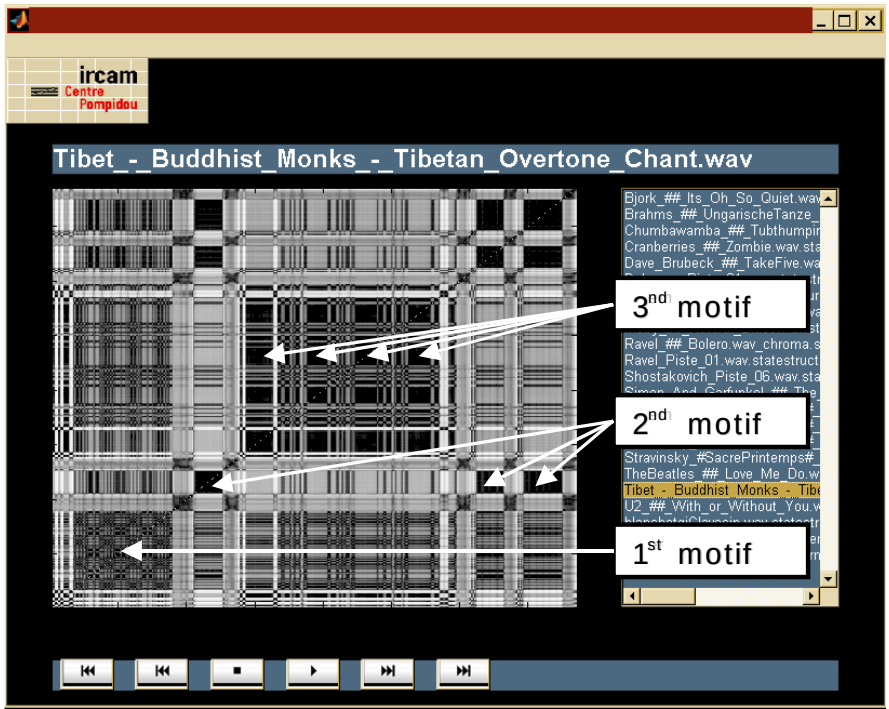
  [Foote, *Visualzing Music and Audio using Self-Similarity*, ACM Multimedia1999]

Analysis of structure



- "Media Player" prototype allowing to navigate through the temporal structure of a song, similar parts are indicated by same colors and height of the boxes [Peeters, *IRCAM*]

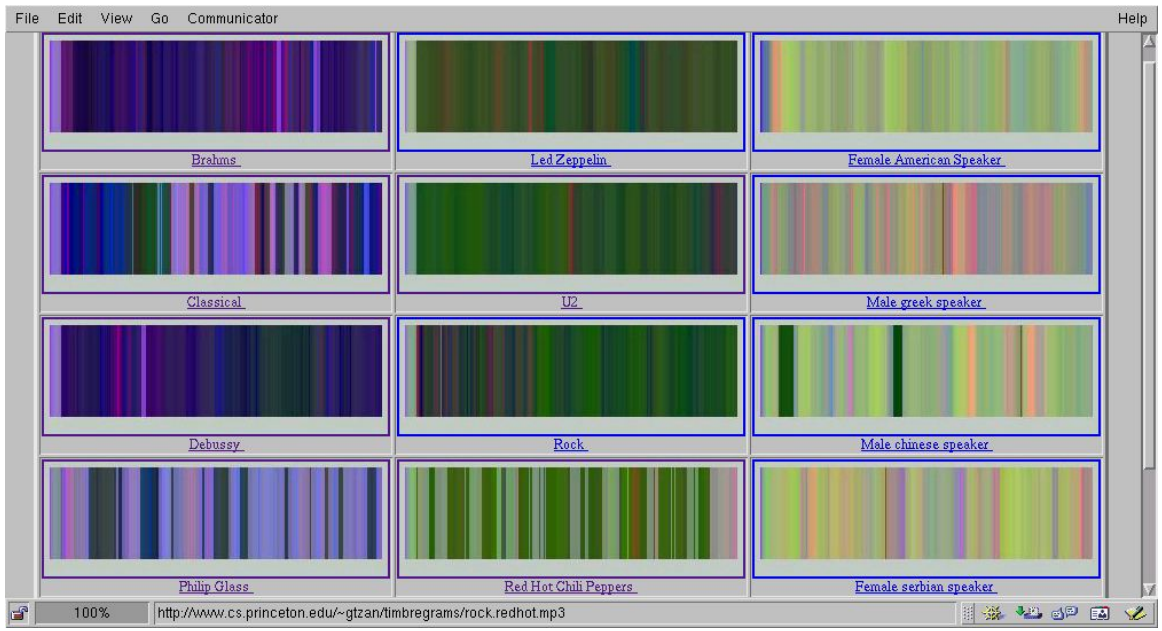
Analysis of structure



- temporal map representation of a 30 minutes long, similar parts are indicated by dark region [Peeters, *IRCAM*]

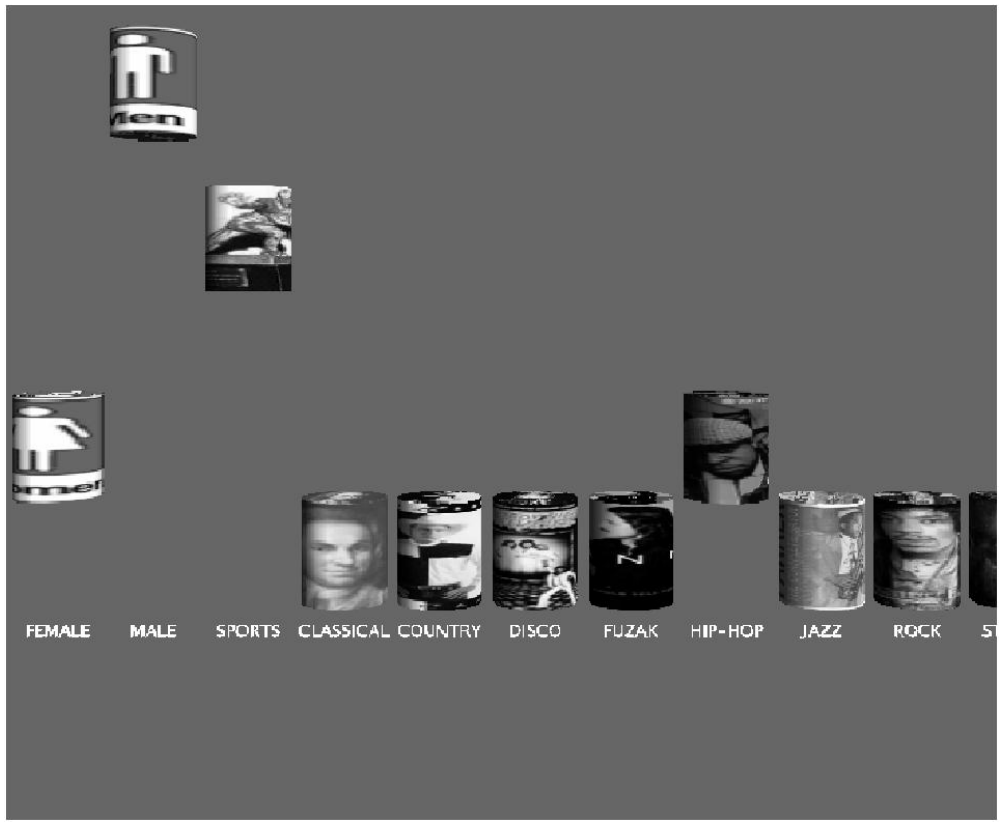
Relations in a collection of sounds, songs

TimbreGram



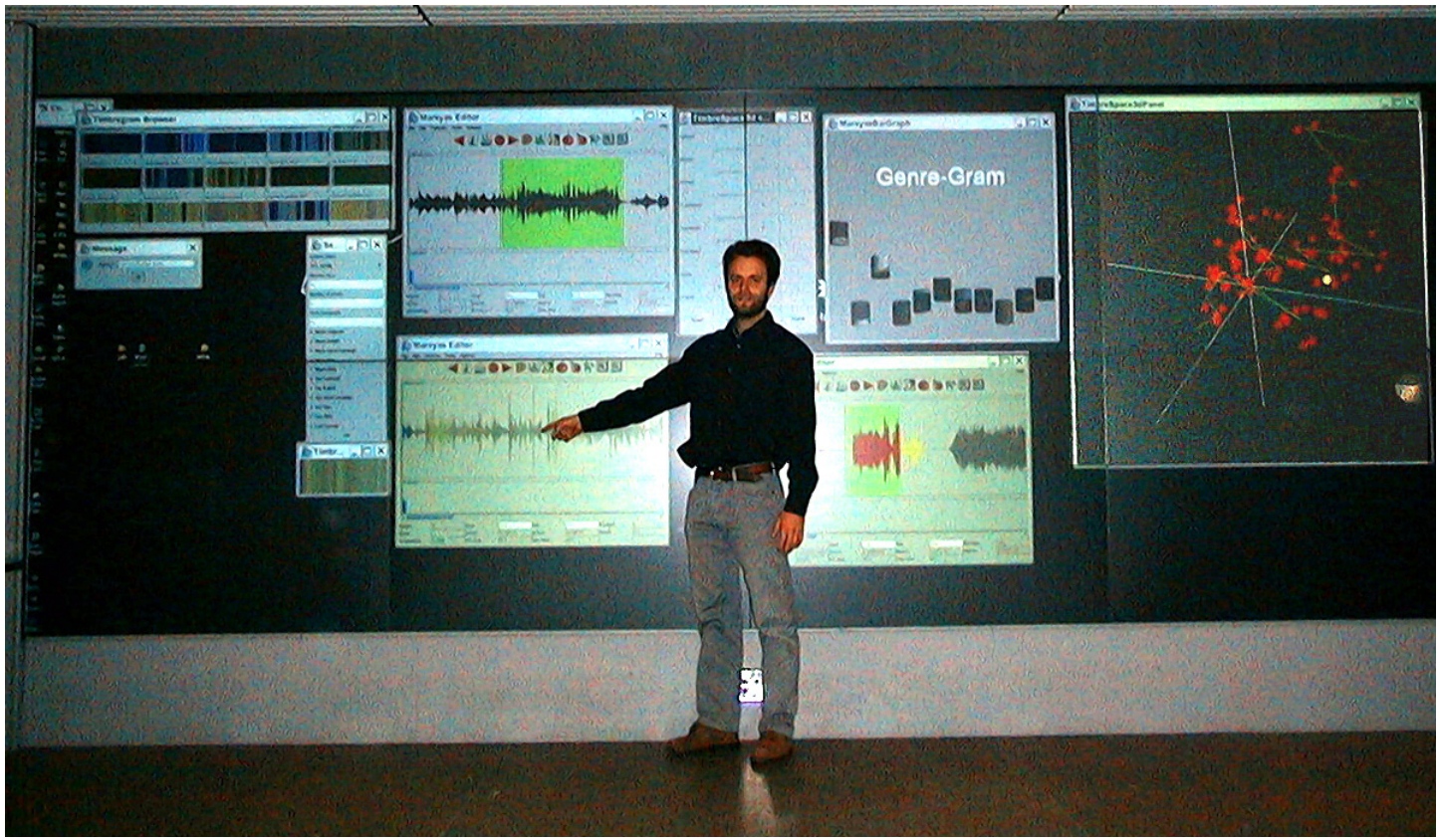
- Time series of feature vectors > PCA > RGB-colorspace
  [Tzanetakis et al. *3D graphics tools for sound collections*, DAFX2000]

GenreGram



- On-the fly genre classification > confidence values on y-axis, „image of genre“ as texture on 3D objects
  [Tzanetakis et al. *3D graphics tools for sound collections*, DAFX2000]

Powerwall of Tzanetakis



- Large-scale display presenting the different concepts

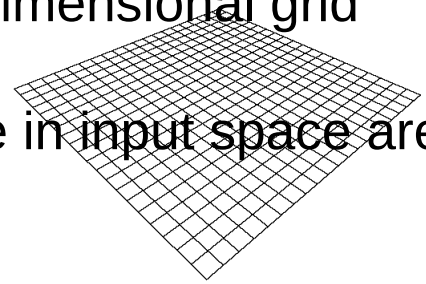
Clustering of a song collection and mapping on a 2D/3D visualization

Self Organizing Map (SOM) [Kohonen]

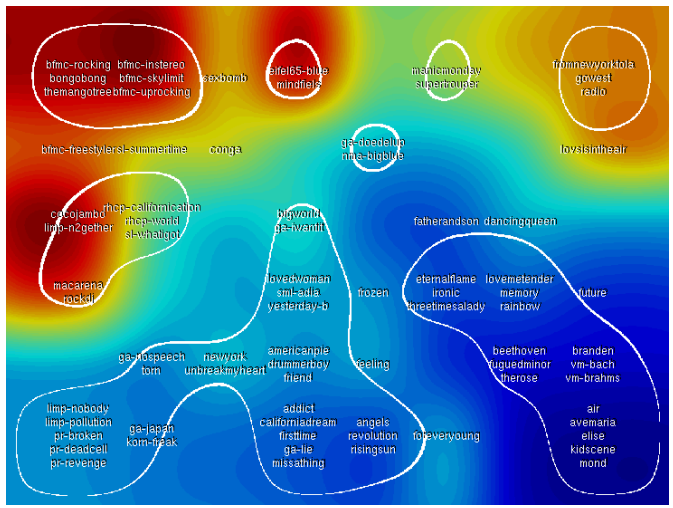
- Unsupervised, self-organized processing of data inspired by cortical maps in the human brain
- Non-linear projection of high dimensional data to low dimensional grid (usually 2D)
- Preservation of input space topology: data points close in input space are close on the map
- In contrast to

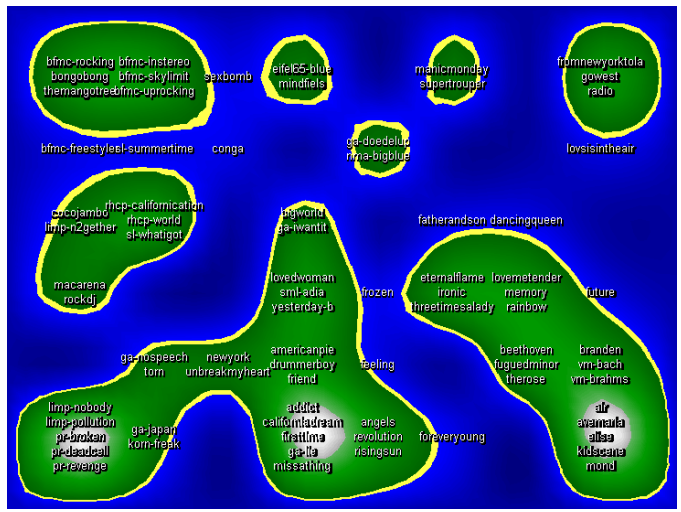
  MultiDimensionalScaling (MDS)

  PrincipalComponentAnalysis (PCA)
  - the original data space distances can be shown.
  - entangled clusters can be separated.
  - projection *and* clustering are provided.
- Visualization ? ->



Weathercharts, Islands of Music





- Component planes + color code of weatherchart
- Smoothed Data Histograms + color code relying on the metaphor of geographical map
- Get the tools for Matlab: SOM, SDH, GHSOM, MA !

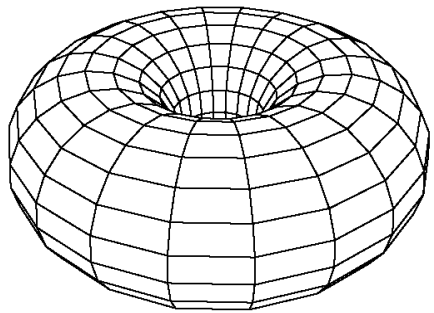
[Pampalk et.al, ISMIR2003, ISMIR2004]

[Open source tools, http://www.ofai.at/~elias.pampalk/, http://www.cis.hut.fi/projects/somtoolbox/]

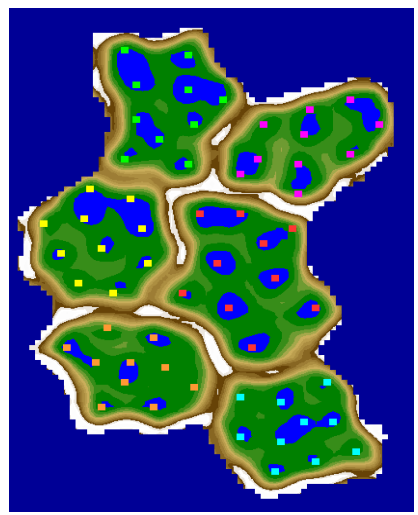
[Demo, http://www.ofai.at/~elias.pampalk/pam_02acmmm.zip]

Emergent SOM

- Many neurons
- Borderless toroid instead of planar topology to **remove** border effects, namely
  - Clusters in corners and along edges
  - Center space of map largely empty



- *U-Matrix/U-Map* visualize original distances in data space
- Metaphor of geographical map

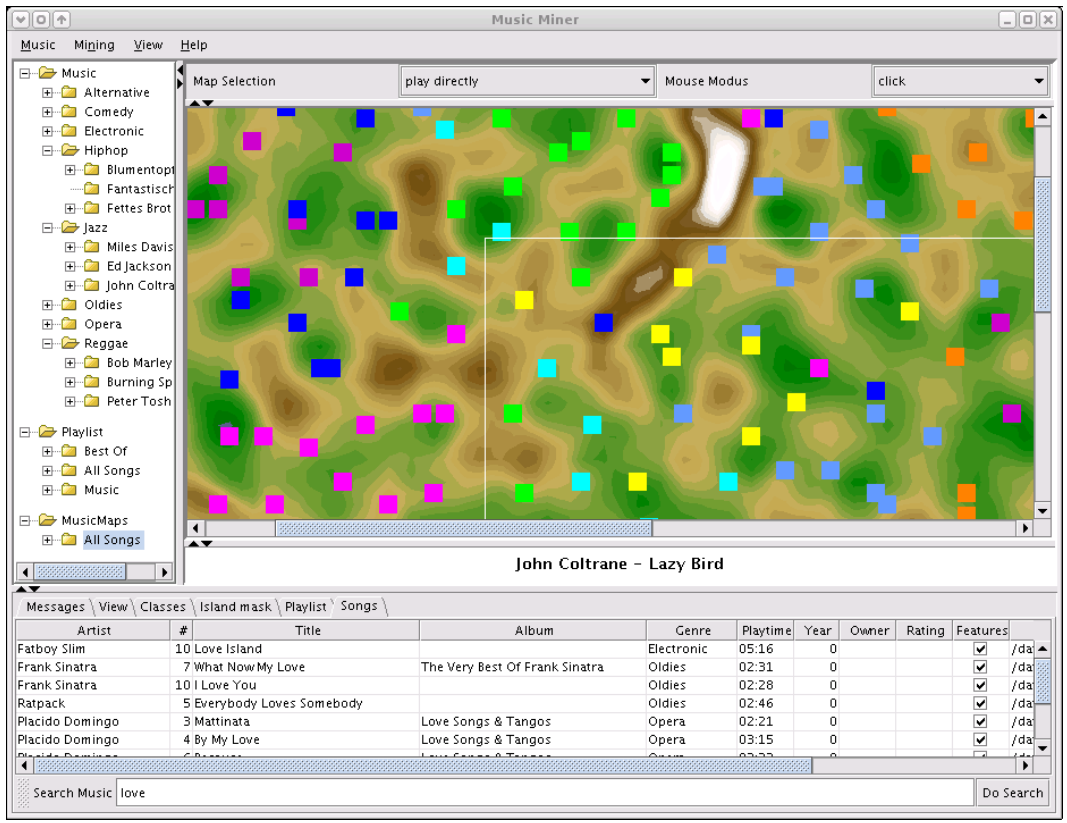


Valleys = clusters

Mountains = boundaries

[Möhrchen, Ultsch et al., *Databionic Visualization Of Music Collections According To Perceptual Distance,* ISMIR2005]

Visualization tool for ESOMs: MusicMiner



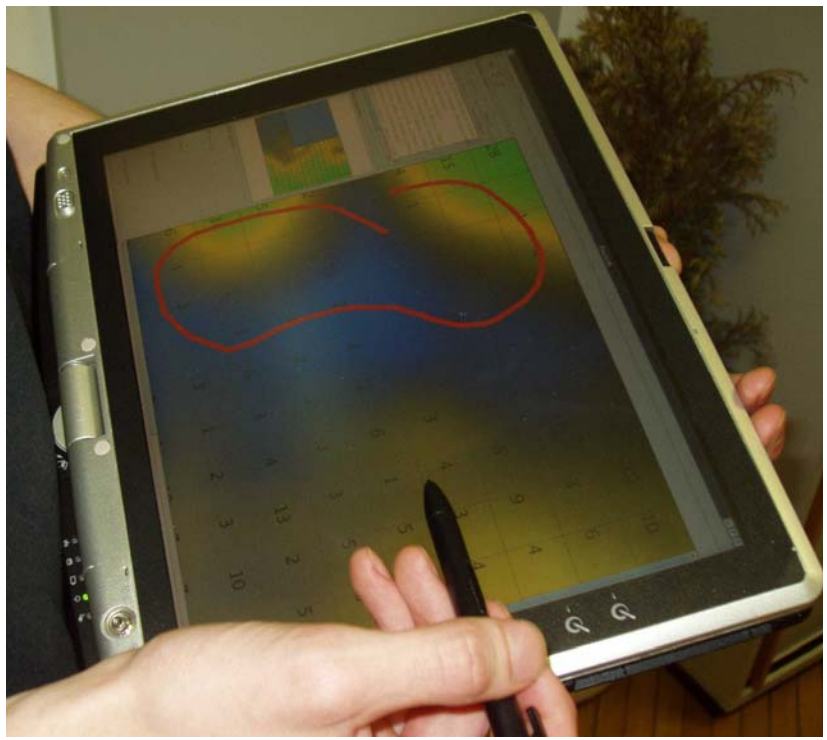
- Written in Java based on SQL database and Yale.

[Talk/Demo: Möhrchen, Ultsch et al., ISMIR2005(!)]

[Open Source http://musicminer.sourceforge.net]

Visualization of a collection of songs on small-scale devices

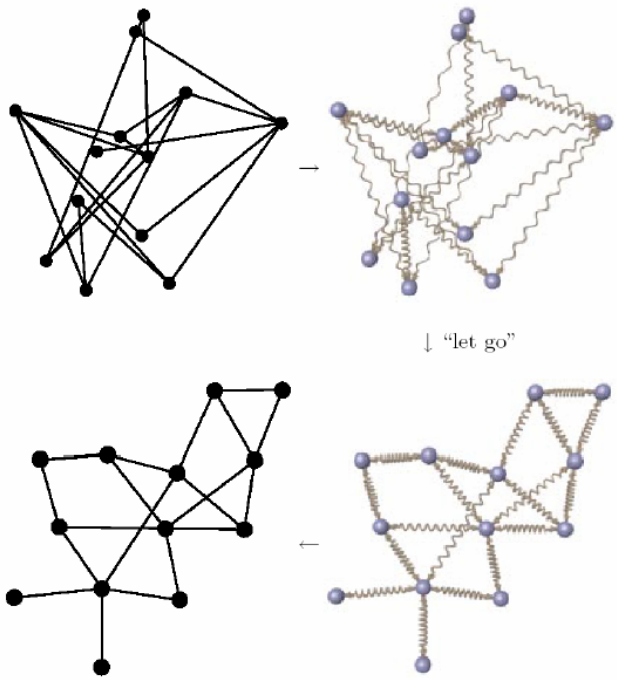
PlaySOM,PocketSOMPlayer

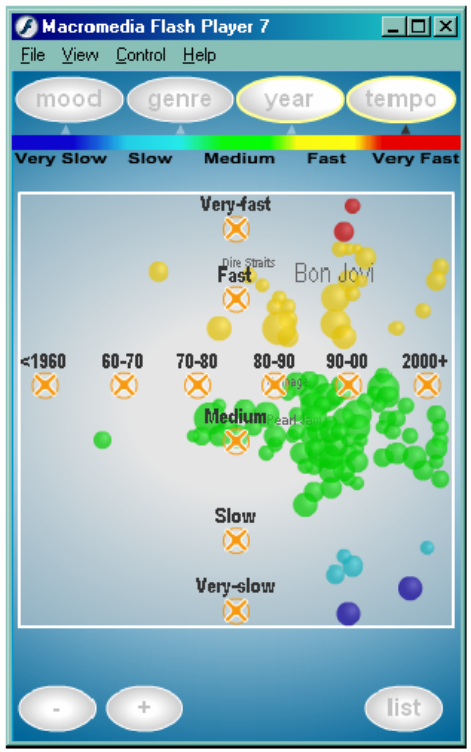


- SOM visualization and interaction framework

  [Neumayer, Lidy, Rauber, *Content-based organization of digital audio collections* , Fifth Workshop Interactive Musiknetwork2005], ISMIR2005(!)

Spring Embedder Algorithm



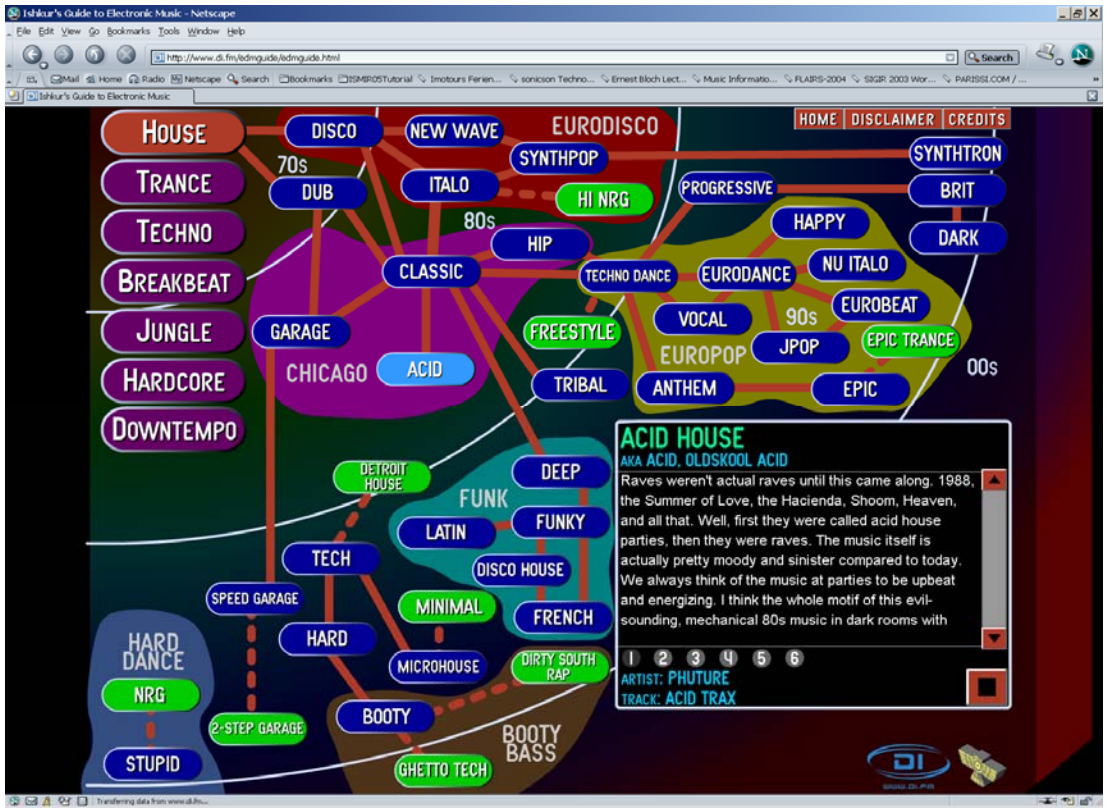


- Graph (node=artist, edge=similarity), context mapping on color, position, size (style, mood, tempo)

  [Vignoli et. al, *Mapping Music In The Palm Of Your Hand, Explore And Discover Your Collection*, ISMIR2004]

Exploration of relations in a collection of songs based on manual metadata

Ishkurs EDM Guide

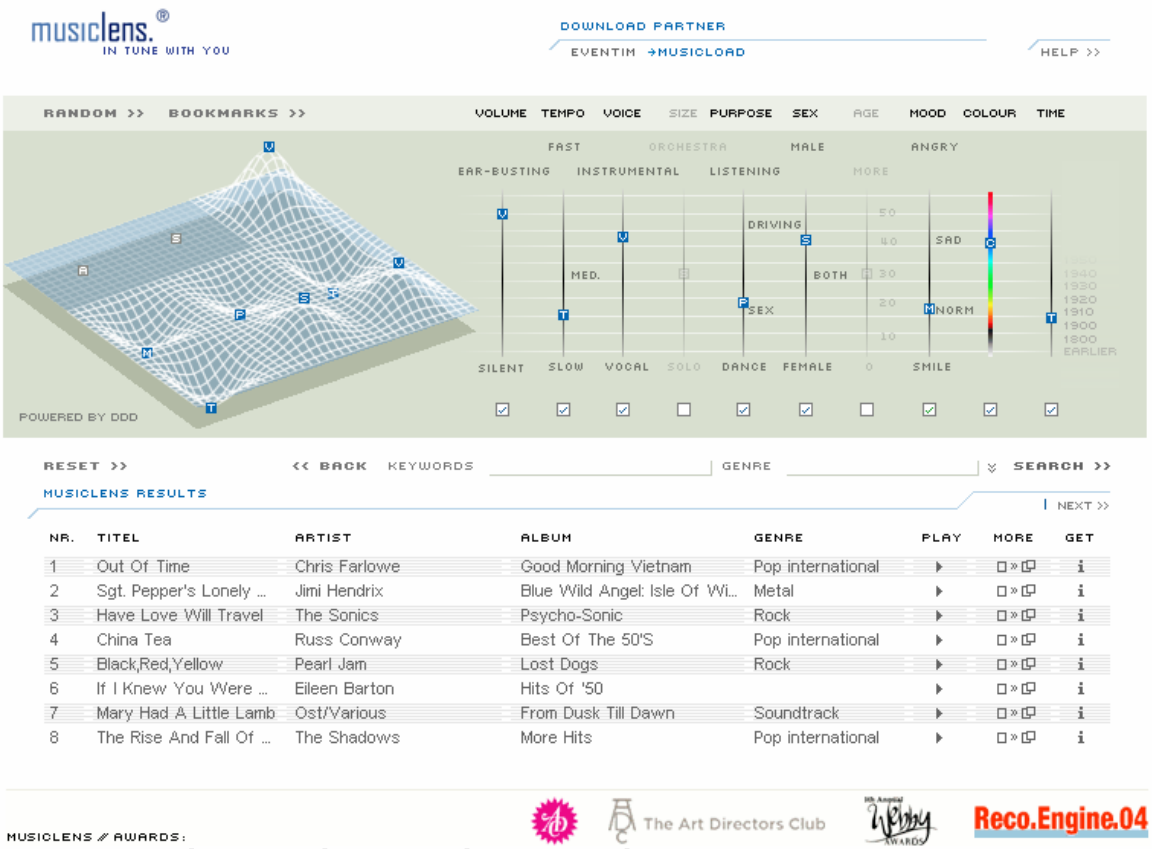


- Manual metadata, genre ontology, detailed expert knowledge on the history of electronic music

[Ishkur, 2005]

[Online Demo *http://www.di.fm/edmguide/edmguide.html*]

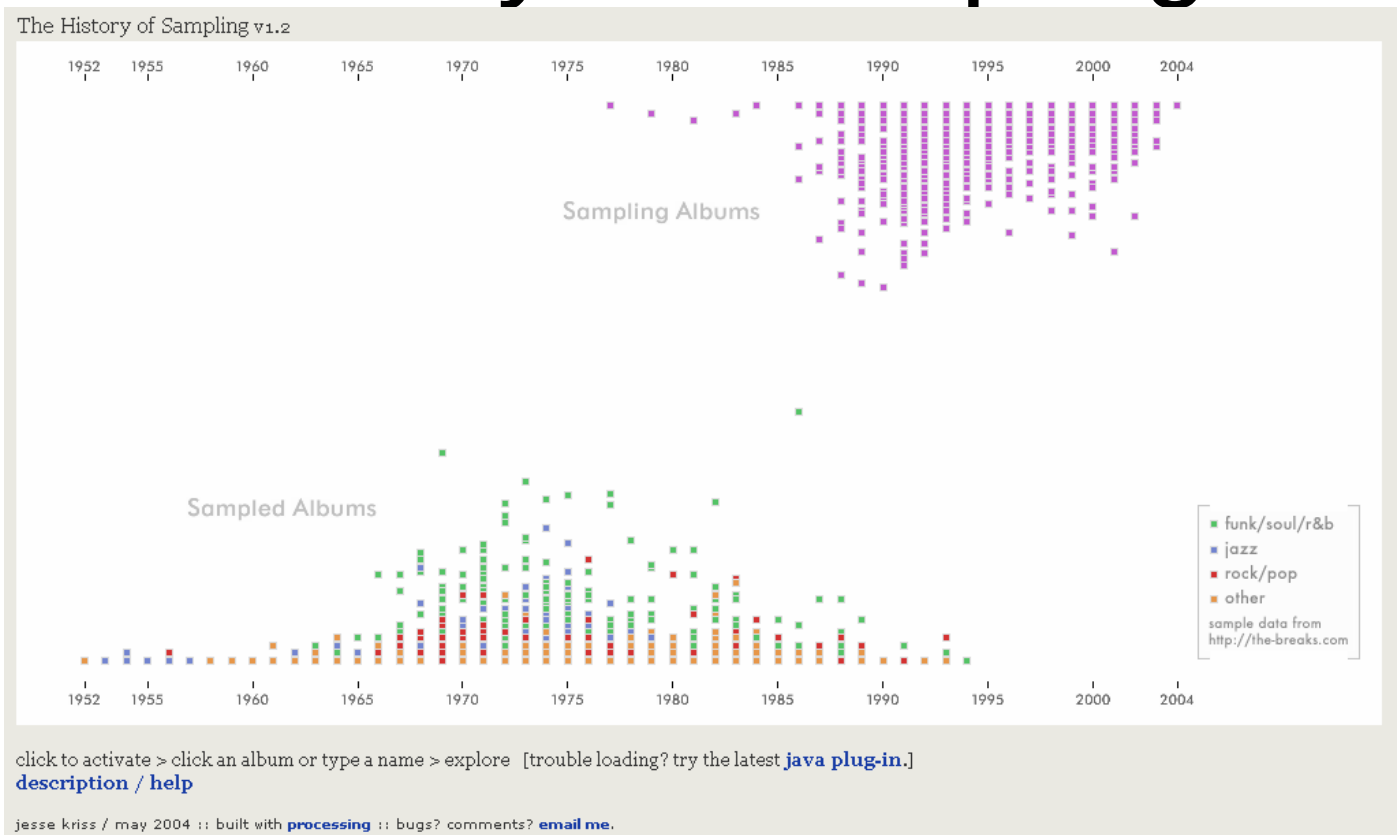
MusicLens



- Manual metadata, dynamic queries

[Online Demo *www.musiclens.de/contest/*]

History of Sampling



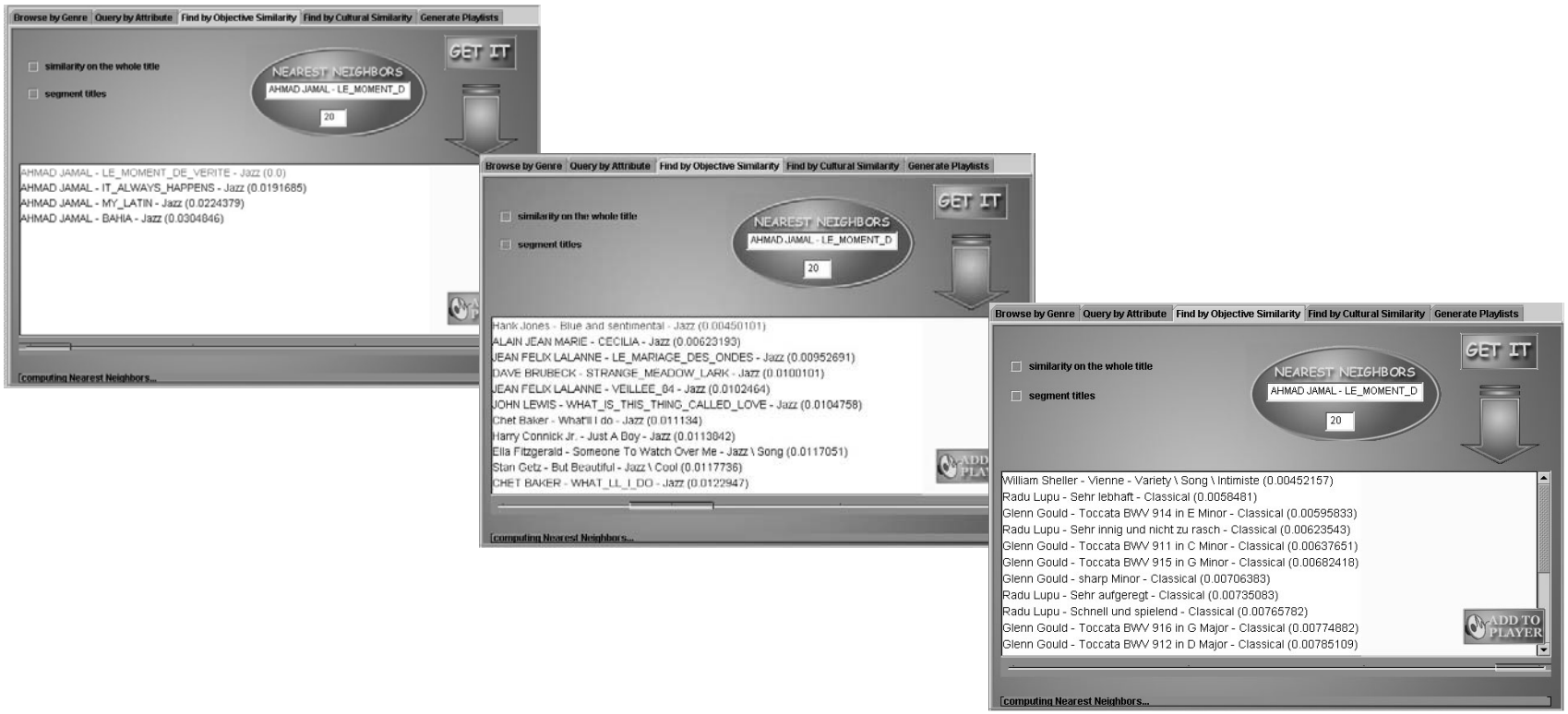
- „Edu-fun-tainment“, implemented with *Processing* (MIT medialab)

[Jesse Kriss, 2004]

[Online Demo *http://jessekriss.com/projects/samplinghistory/*]

User interaction to navigate a collection and recommendations (automatic metadata extraction)

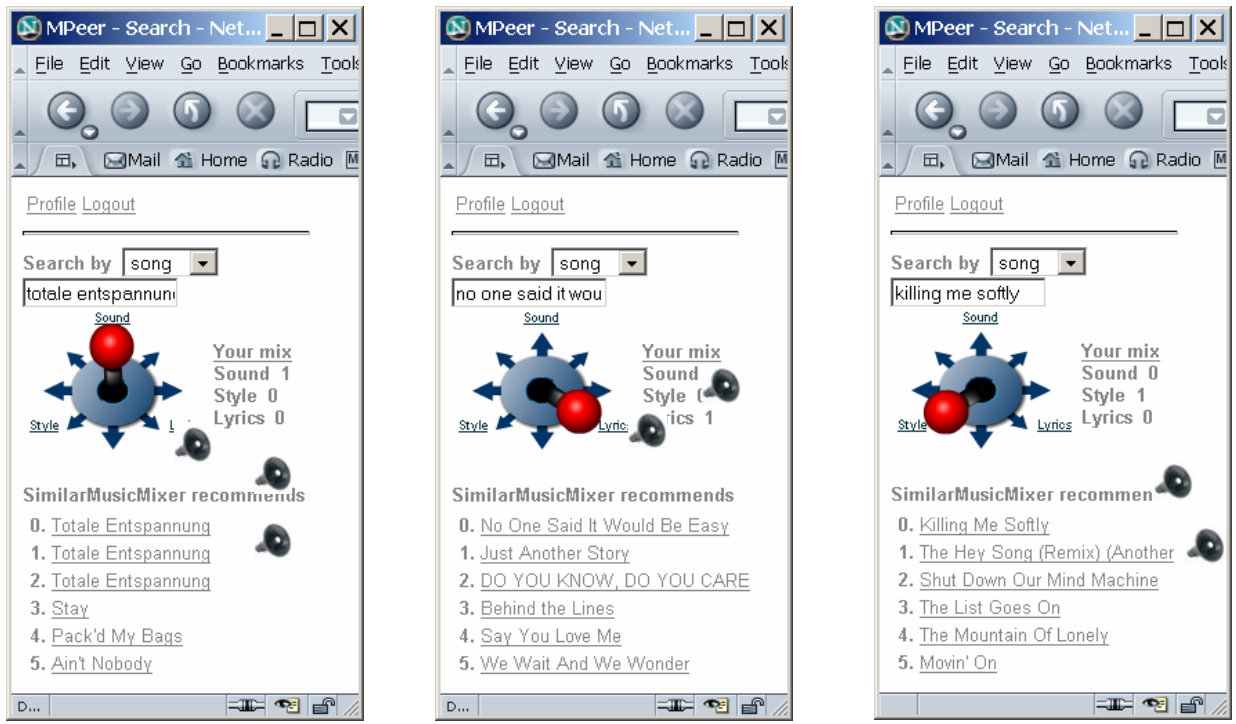
Aha-Slider



- Giving a slider to users to perform conservatory vs. exploratory browsing

  [Original idea by Pachet (Sony CSL)], integrated into MusicBrowser [Aucouturier&Pachet, ISMIR2002]

MPeer

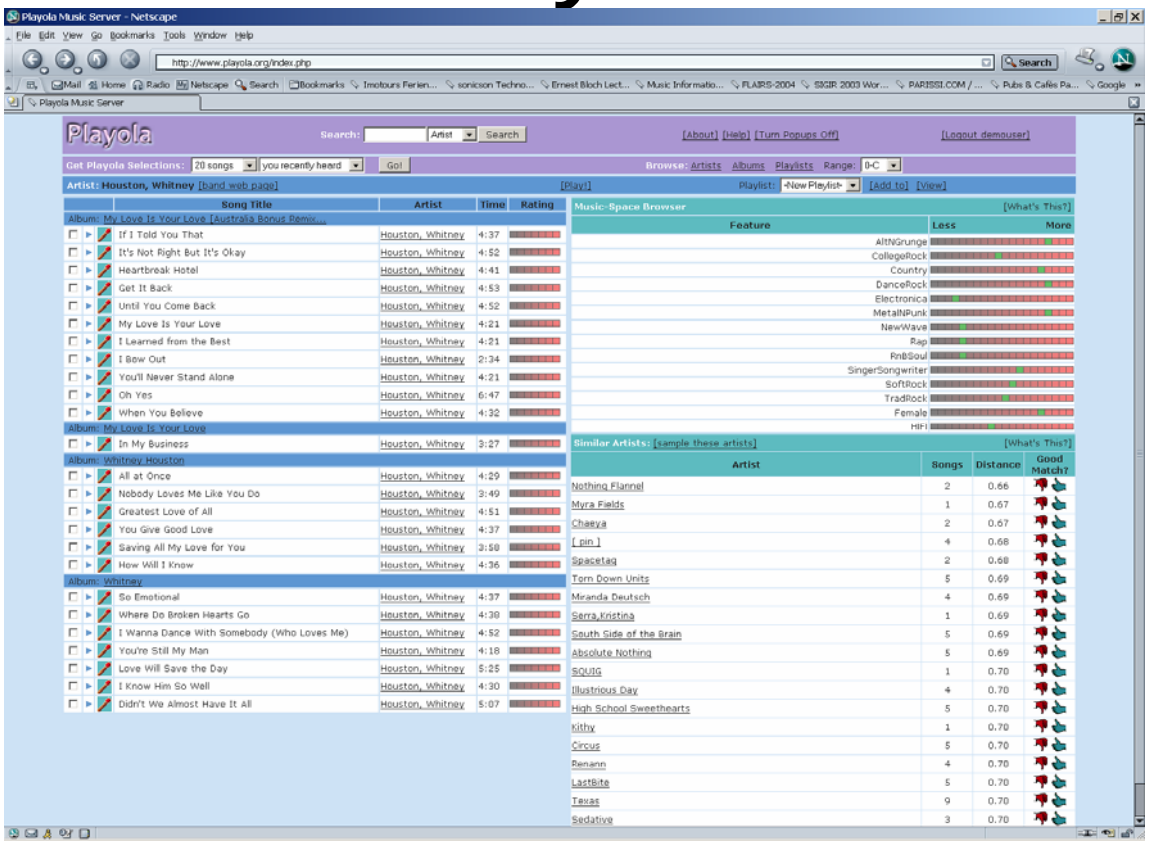


- Virtual joystick for mult-facet similarity

[Baumann, *Artificial Listening Systems*, Ph.D]

[Online Demo *http://mpeer.dfki.de*]

Playola



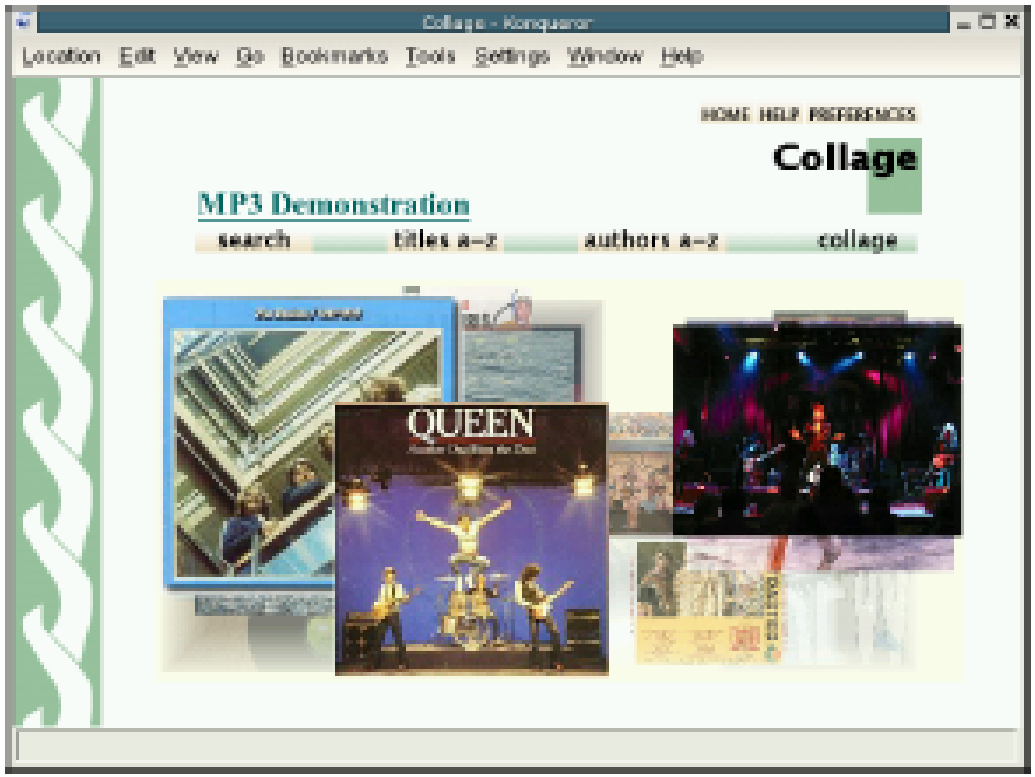
- Relevance feedback, genre sliders, personal playlists, future personal recommendations

  [Adam Berenzweig, Dan Ellis (Columbia), Steve Lawrence (NECI), and Brian Whitman (MIT)]

  [Online Demo *www.playola.org*]

Cultural, contextual metadata, „crossmedia“ MIR applications

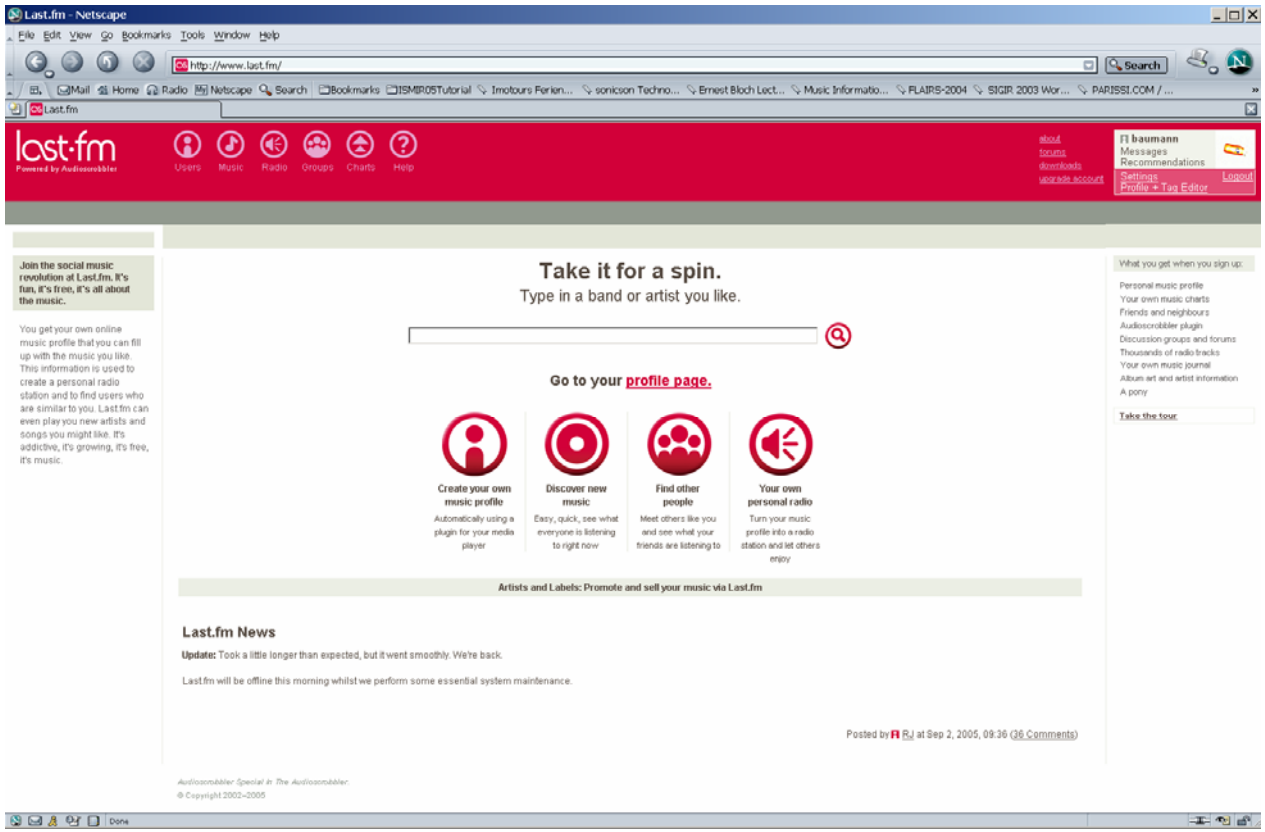
Visual Collaging



- „laid back“ instead of „sit forward“ seeking

  [Bainbridge et al., *Visual Collaging Of Music In A Digital Library*, ISMIR2004]

Audioscrobbler/ lastFM



- Implicit data acquisition by plugins at users, detection of similar users ->charts, recommendations

Relies on Collaborative Filtering [Shardanand&Maes, CHI95],

[Resnick et al., CSCW94], [Online Demo *www.lastfm.org*]

Unusual modes of querying, interaction

Beagle

- Querying in natural language

[Baumann et al.,*Super-convenience for non-musicans,* ISMIR2002]

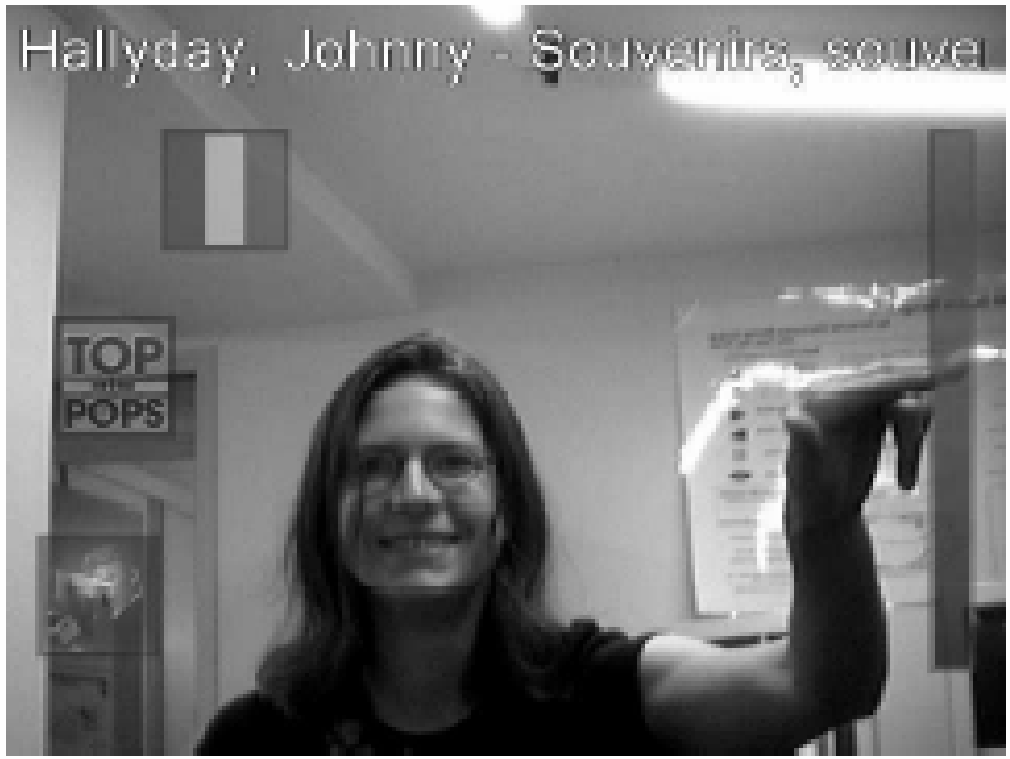
SpeechSpotting

- Speech input for partial queries

  [Goto, *Speech-Recognition Interfaces for Music Information Retrieval: 'Speech Completion' and 'Speech Spotter'*, ISMIR2004]

  [Videos *http://staff.aist.go.jp/m.goto/MIR/VIDEO/cellphone-ismir.mpg*]

Eye Tune



- Gestural input to MIR system with webcam

  [Pachet, F. *The HiFi of the Future: Toward new modes of Music-ing*, Proceedings of ICHIM 04, 2004]

„Klangwiese“

- Physical representation of MP3 collection

  [Baumann, *A Music Library in the palm of your hand: Experiments on Interface Culture ,* Contactforum Digital Libraries for Musical Audio,2005]

  [Web *www.dfki.uni-kl.de/mp3konzertarchiv*]

MusicShooter

- Gaming as an interface („joy-of-use paradigm“)

  [Baumann, *A Music Library in the palm of your hand: Experiments on Interface Culture ,* Contactforum Digital Libraries for Musical Audio,2005]

  [Downloads *www.dfki.uni-kl.de/mp3konzertarchiv*]

Thanks

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