Mining for the Meaning of Music

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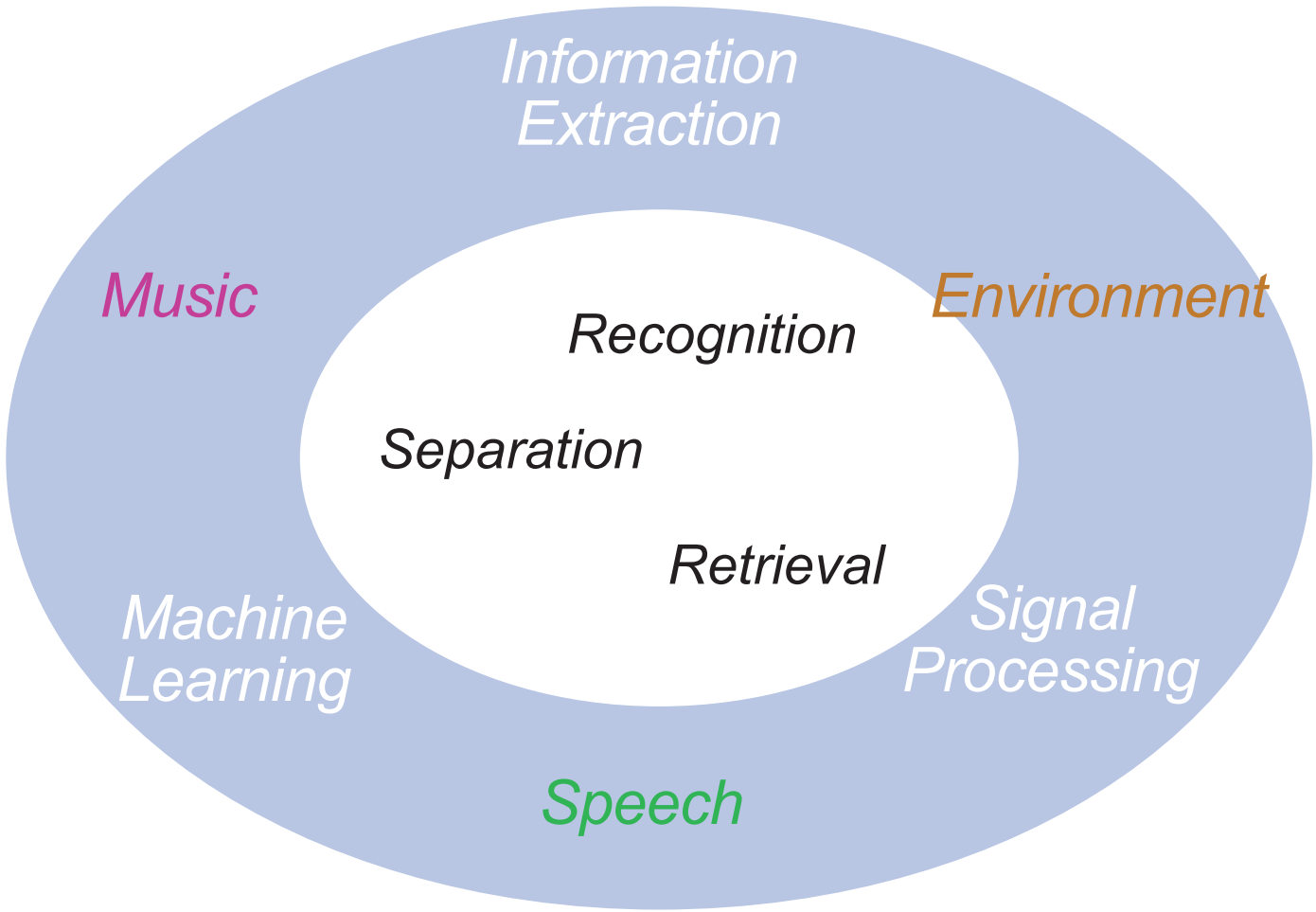
1. Motivation: What is Music?
2. Eigenrhythms
3. Melodic-Harmonic Fragments
4. Example Applications

LabROSA Overview



1. Motivation: What is music?

- What does music evoke in a listener's mind?

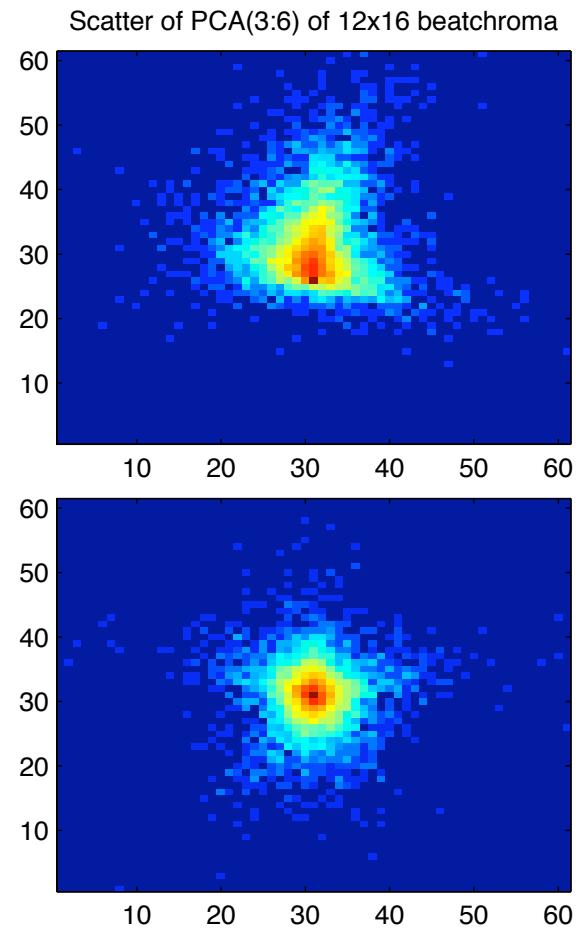
- Which are the things that we call "music"?

Oodles of Music

- What can you do with a million tracks?

Re-use in Music

- What are the most popular chord progressions in pop music?



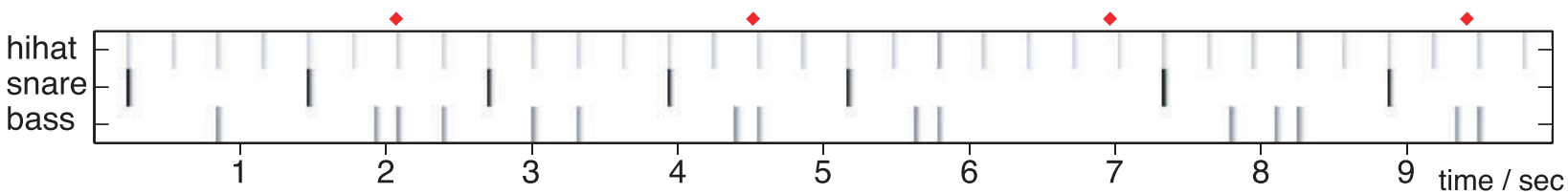
Potential Applications

- Compression
- Judgments / classification
- Manipulation

2. Eigenrhythms: Drum Track Structure

Ellis & Arroyo ISMIR'04

- To first order,
  all pop music has the same beat:



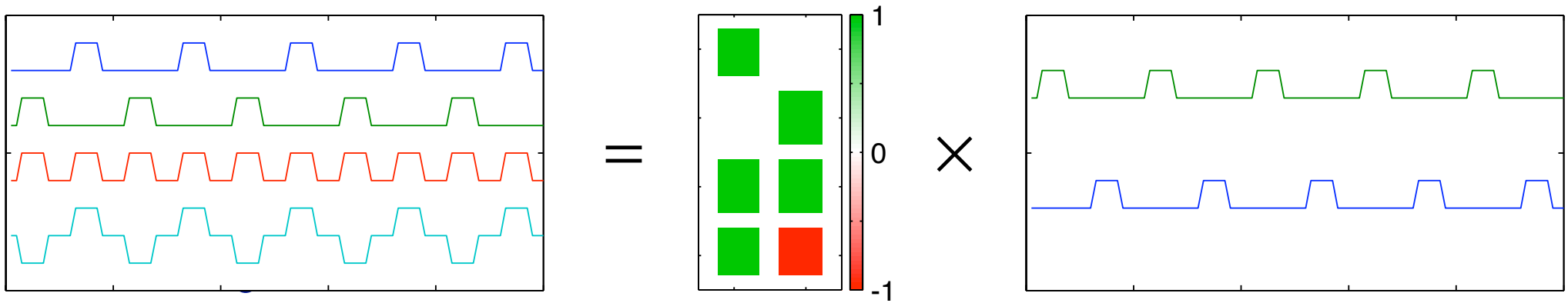
- Can we learn this from examples?

Basis Sets

- Combine a few basic patterns to make a larger dataset

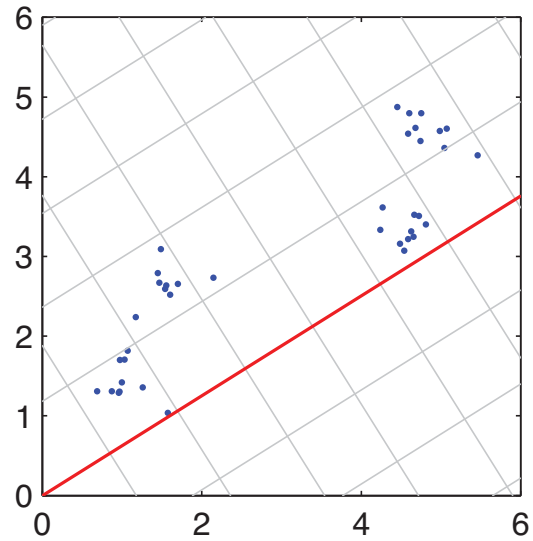
weights

data $X = W \times H$ *patterns*

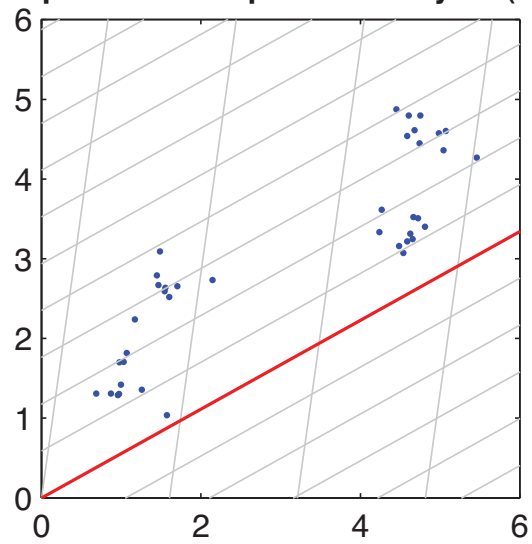


Different basis projections

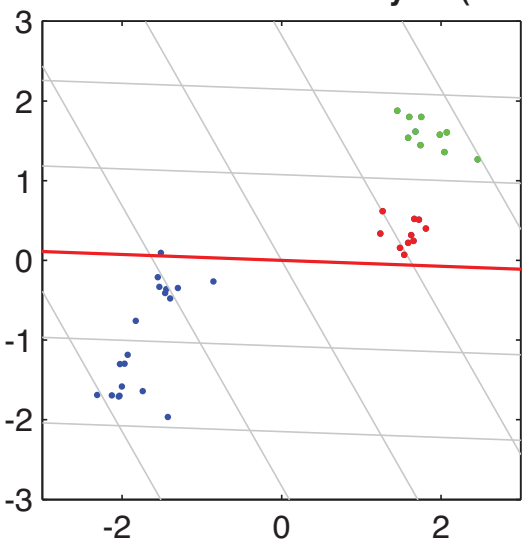
Principal Component Ananlysis (PCA)



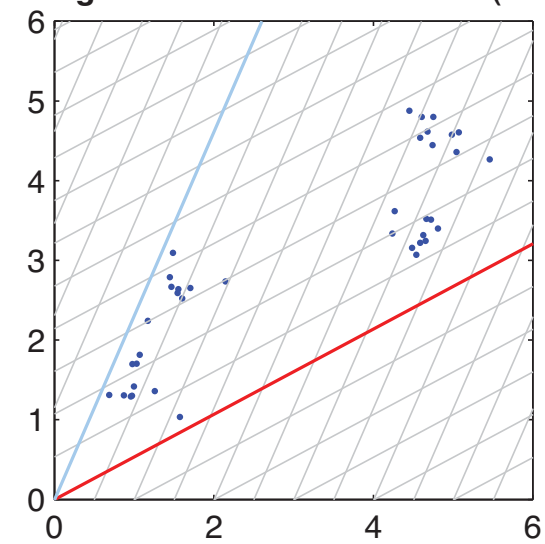
Independent Component Analysis (ICA)



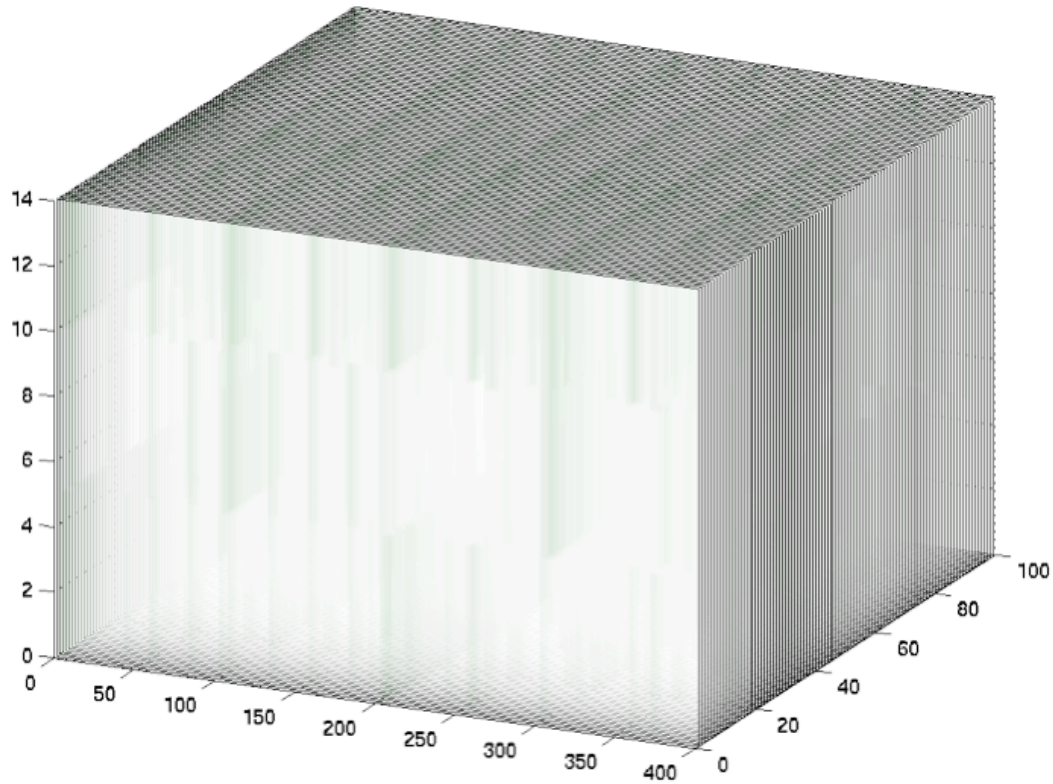
Linear Discriminant Analysis (LDA)



Nonnegative Matrix Factorization (NMF)

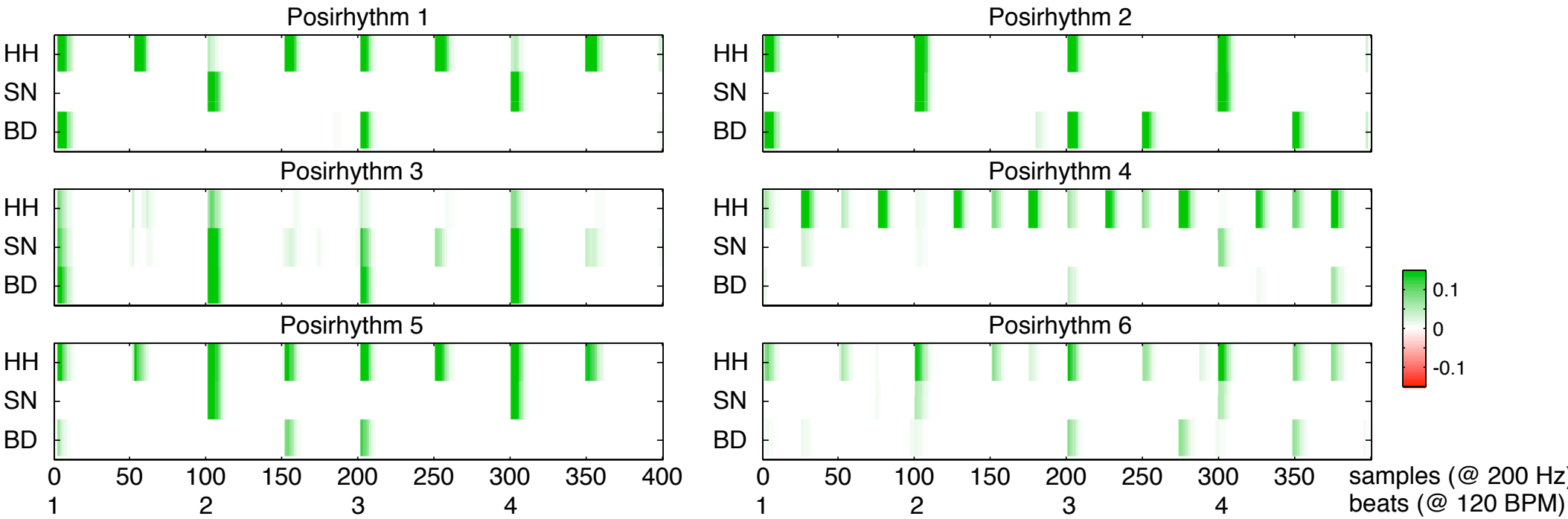


Drum Pattern Data



- Tempo normalization + downbeat alignment

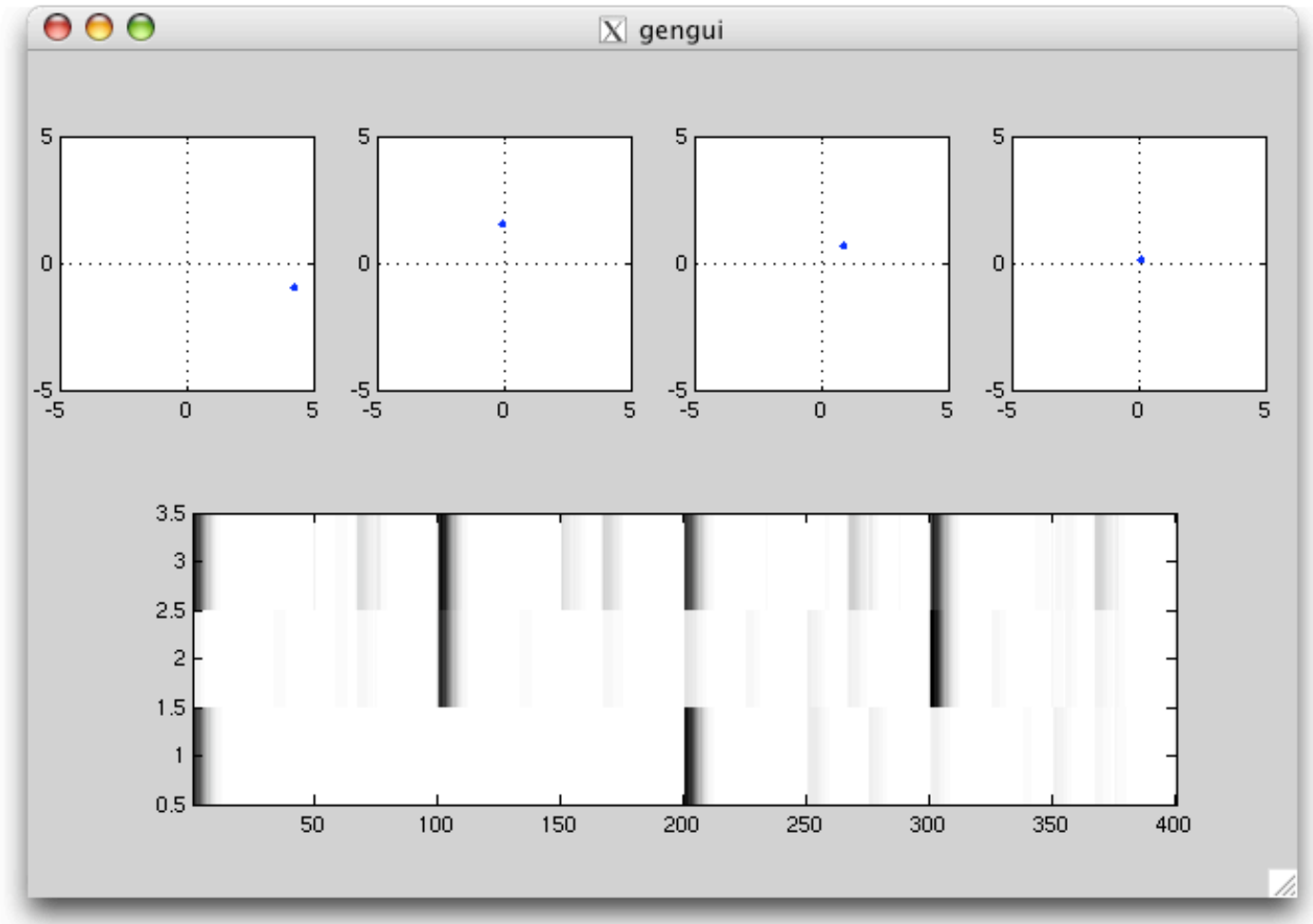
NMF Eigenrhythms



- Nonnegative: only add beat-weight

Eigenrhythm BeatBox

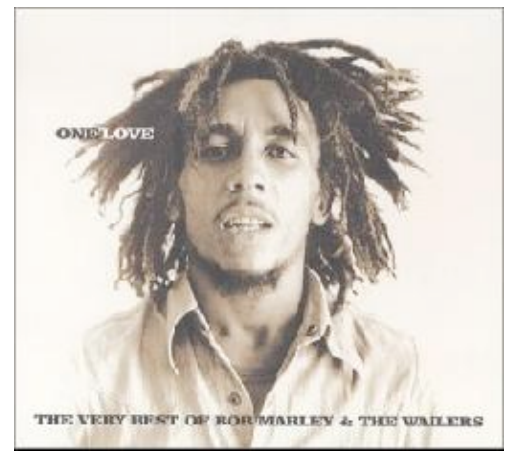
- Resynthesize rhythms from eigen-space



3. Melodic-Harmonic Fragments

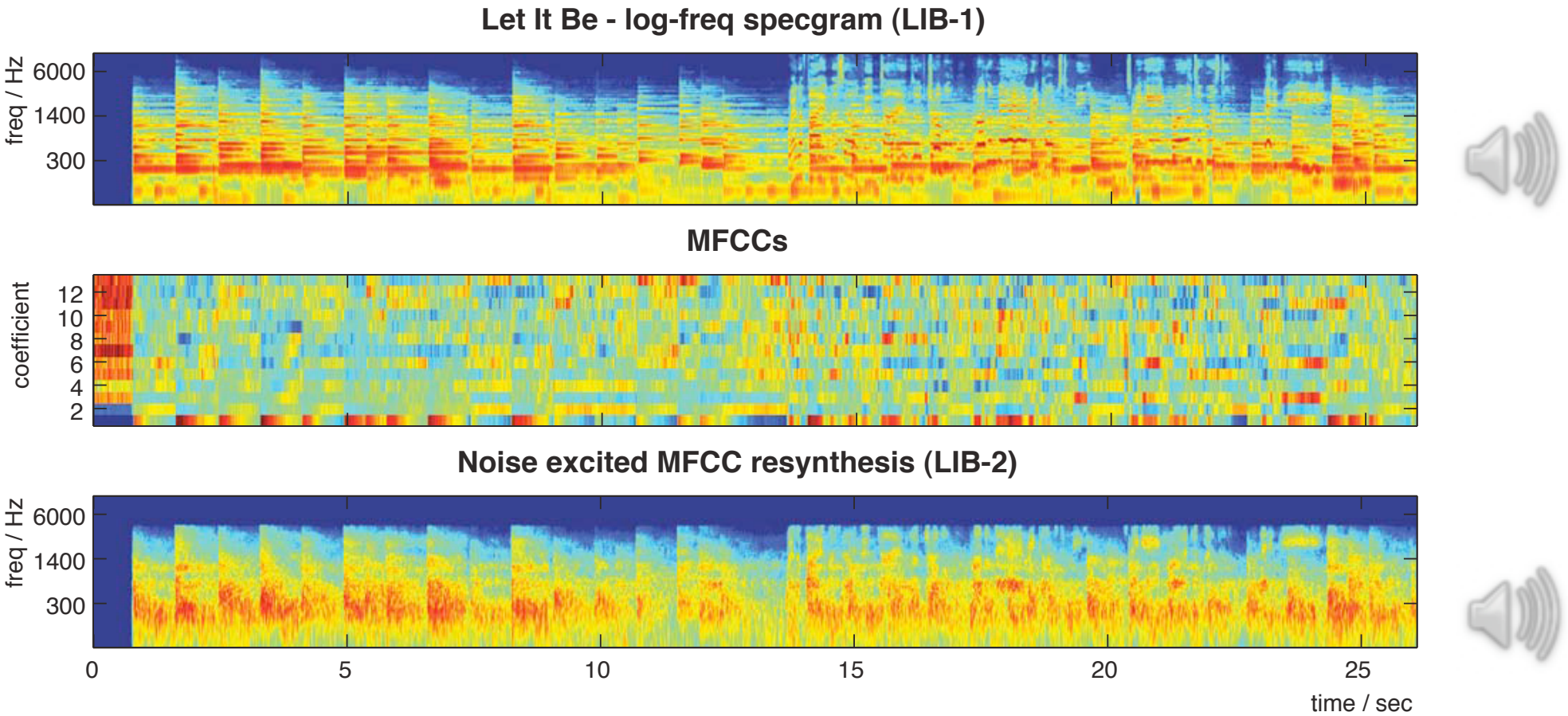
- How similar are two pieces?

- Can we find all the pop-music clichés?
  - I - V - VI - IV



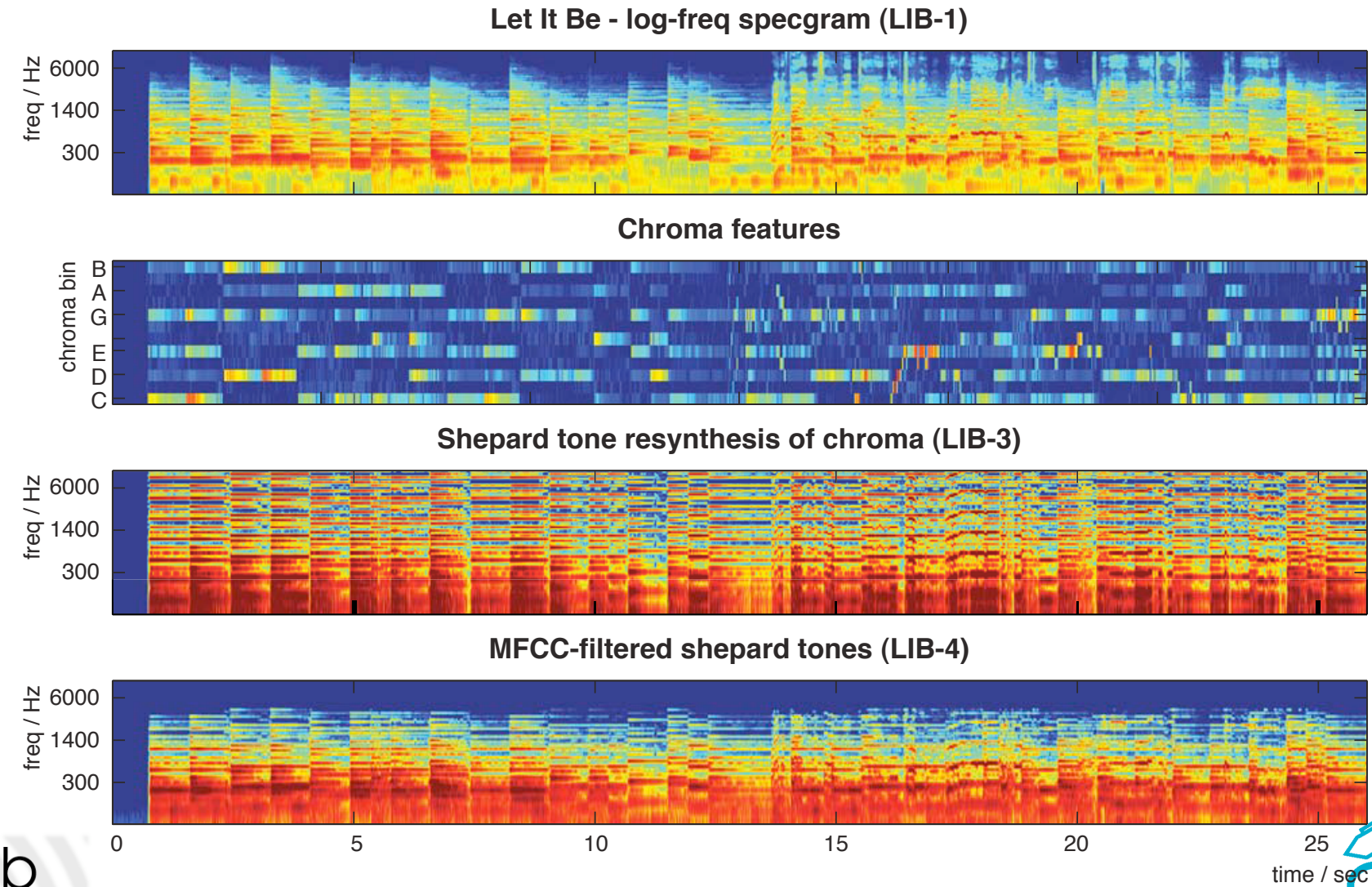
MFCC Features

- Used in speech recognition

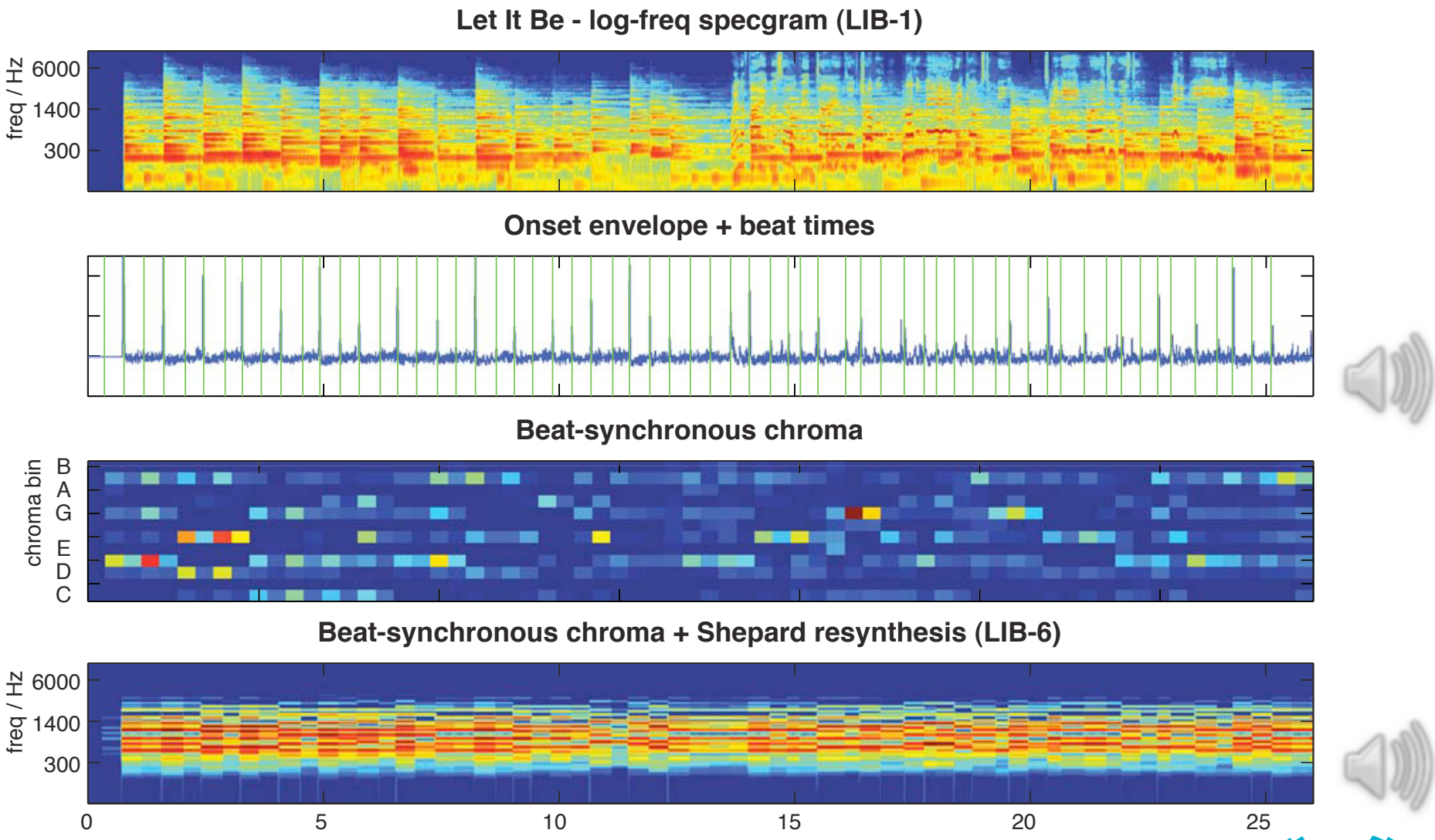


Chroma Features

- To capture "musical" content



Beat-Synchronous Chroma

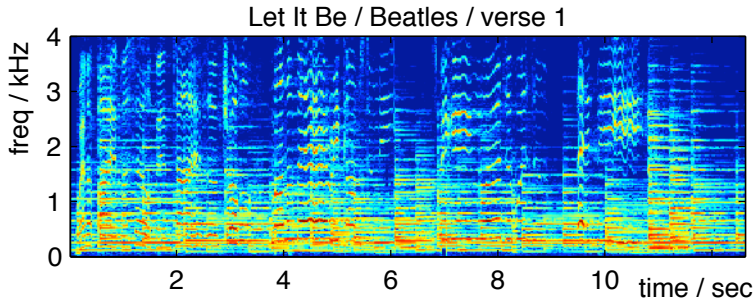


Finding Cover Songs

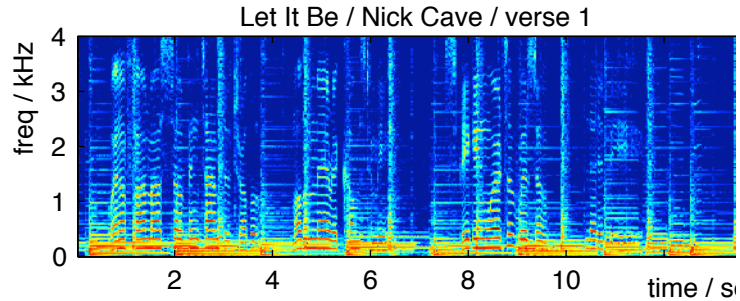
Ellis & Poliner '07

- Little similarity in surface audio...

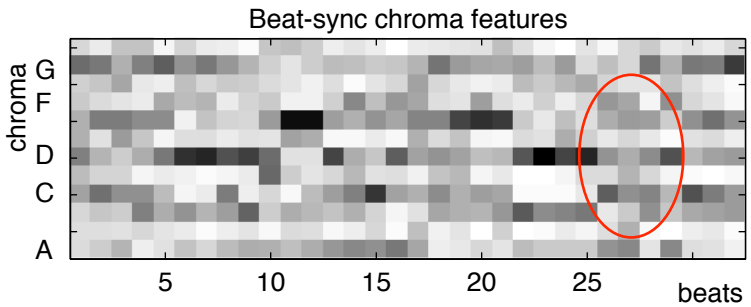
Let It Be - The Beatles

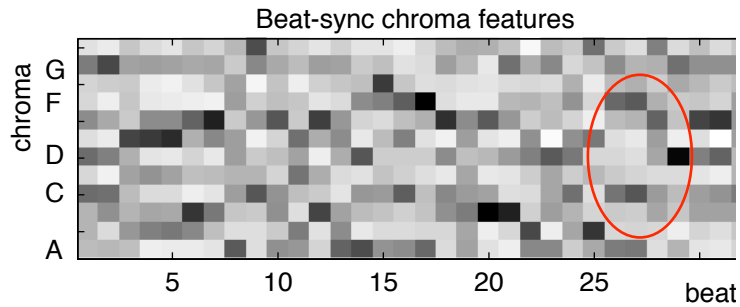


Let It Be - Nick Cave



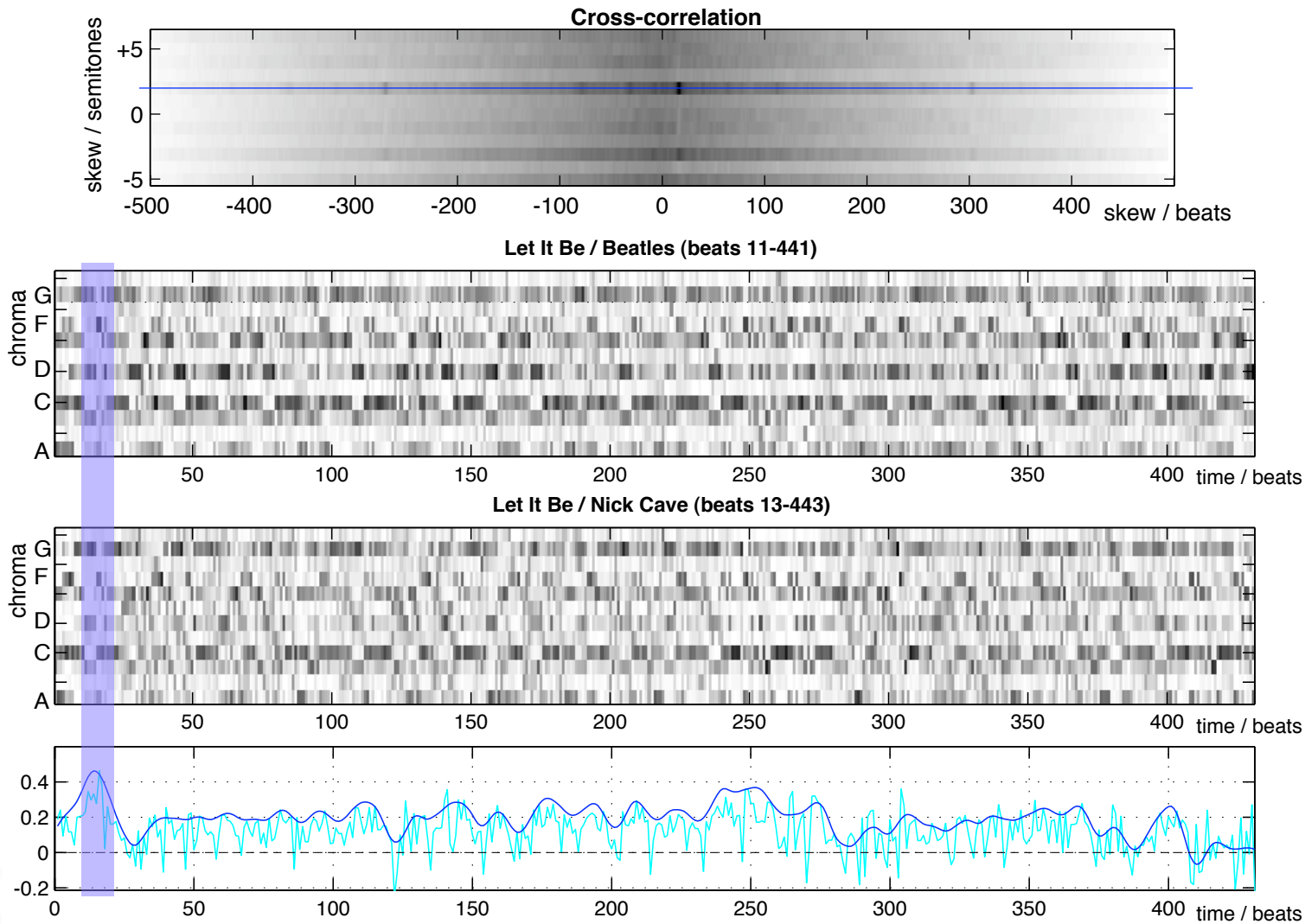
- .. but appears in beat-chroma





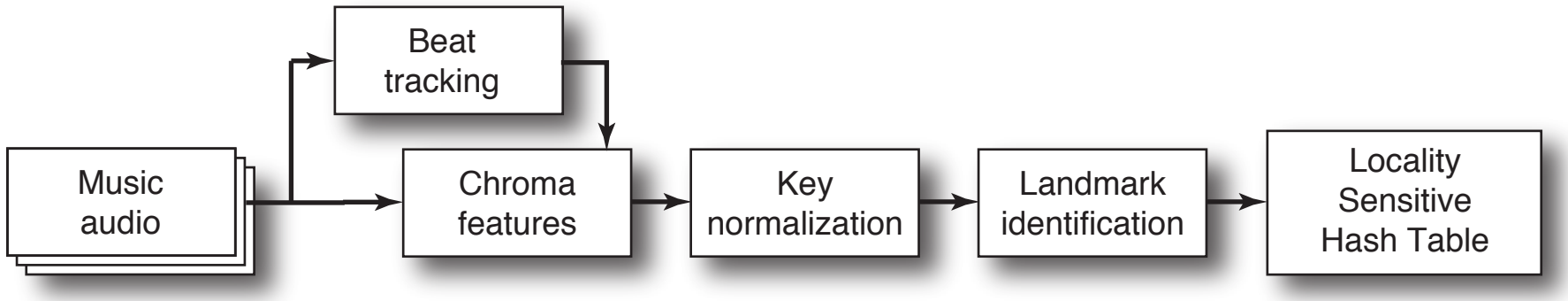
Finding Cover Songs

- Match via global cross-correlation

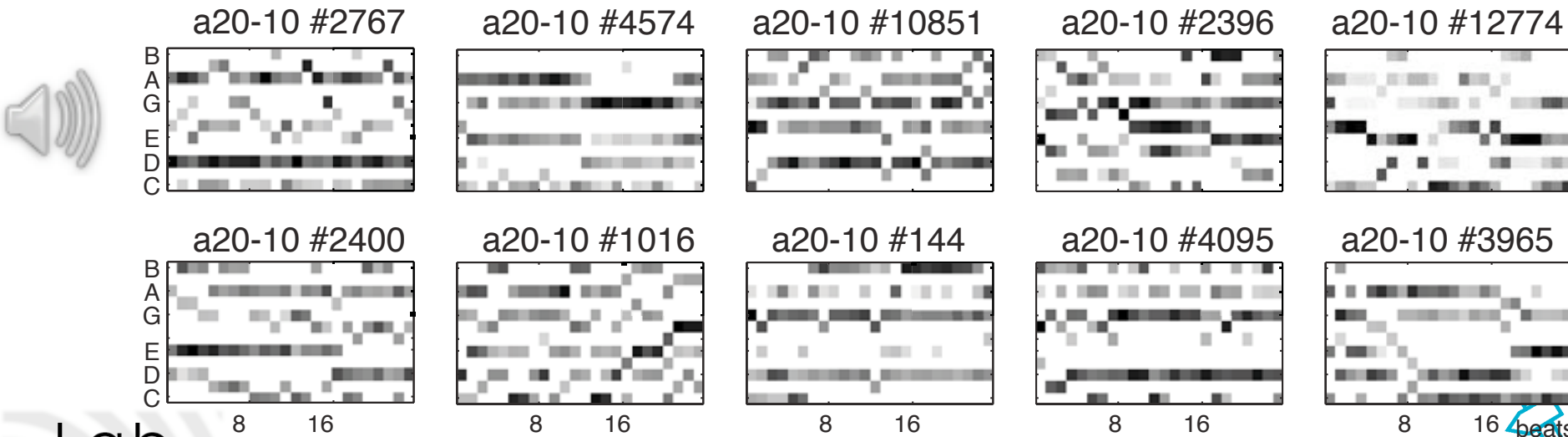


Finding Common Fragments

- Data mining in beat-chroma database

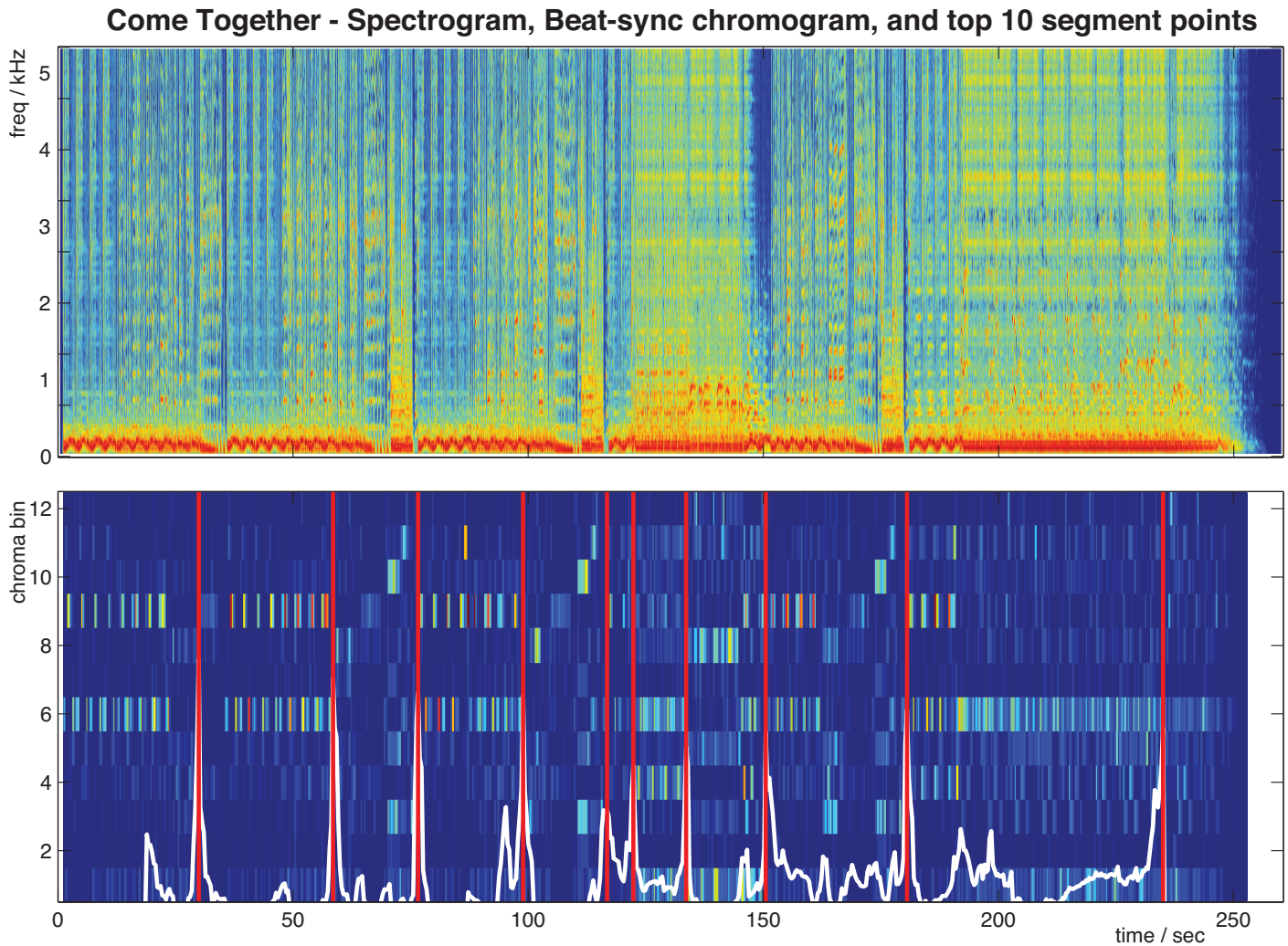


- .. a large set of excerpts (patches)



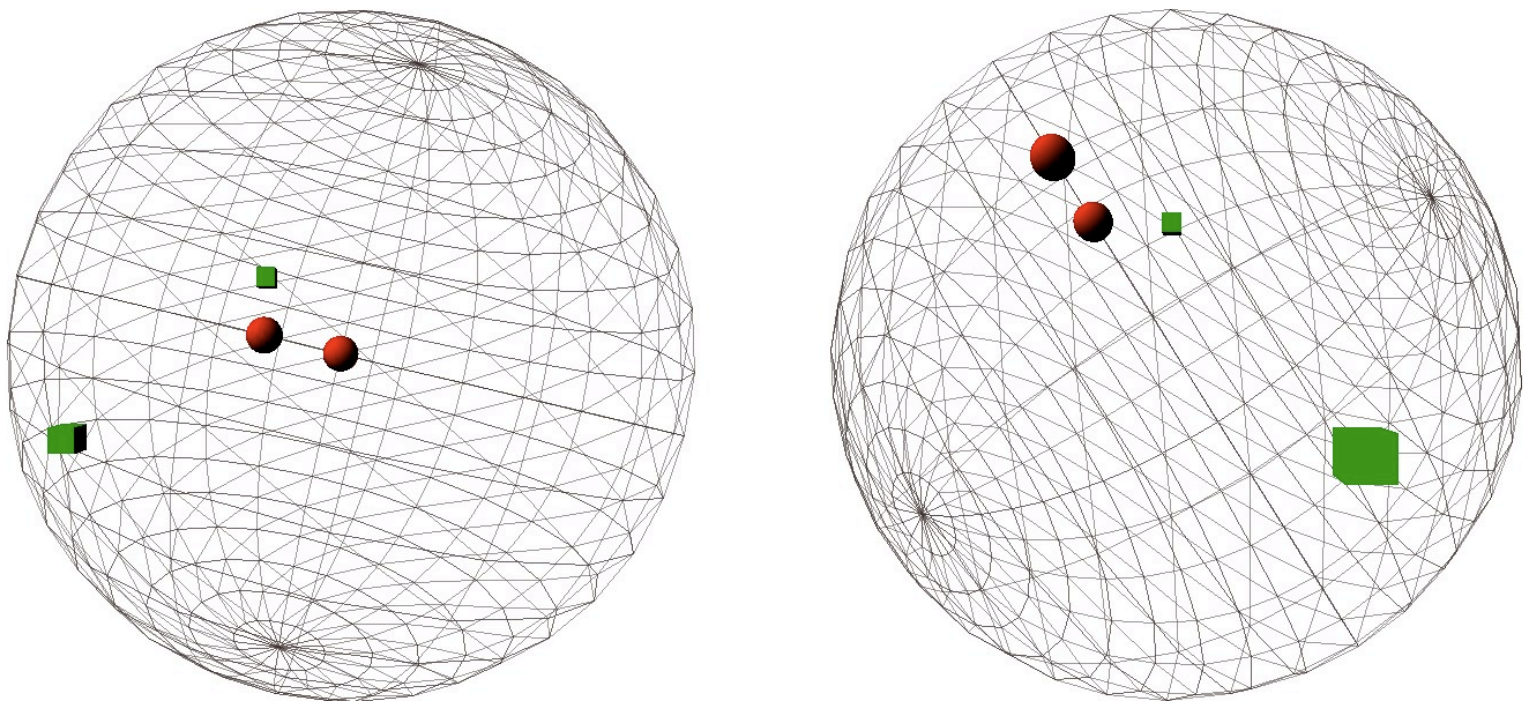
Landmarks

- Extract patches from starts of phrases



Locality Sensitive Hash

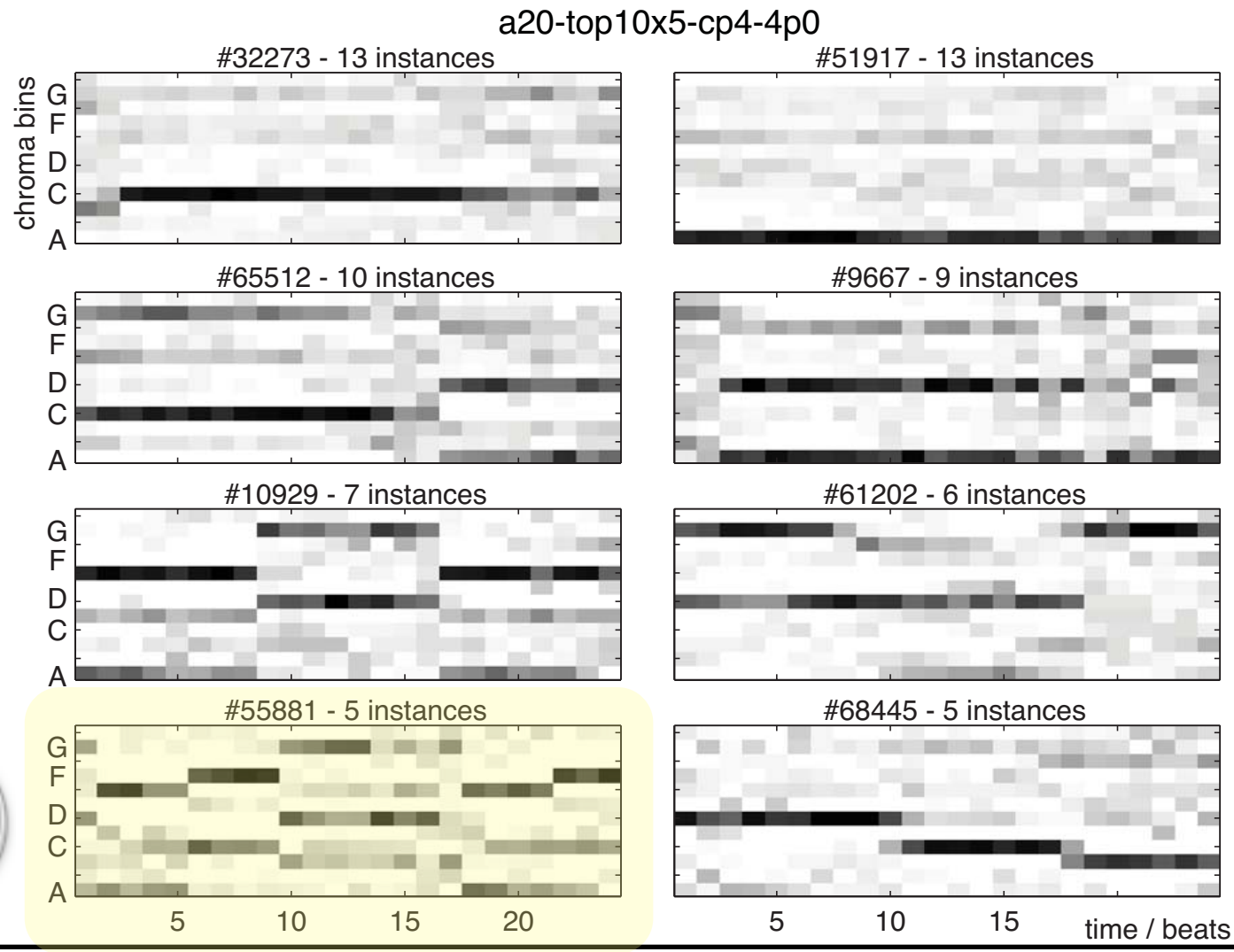
- Nearby items go into same hash bucket via multiple random projections



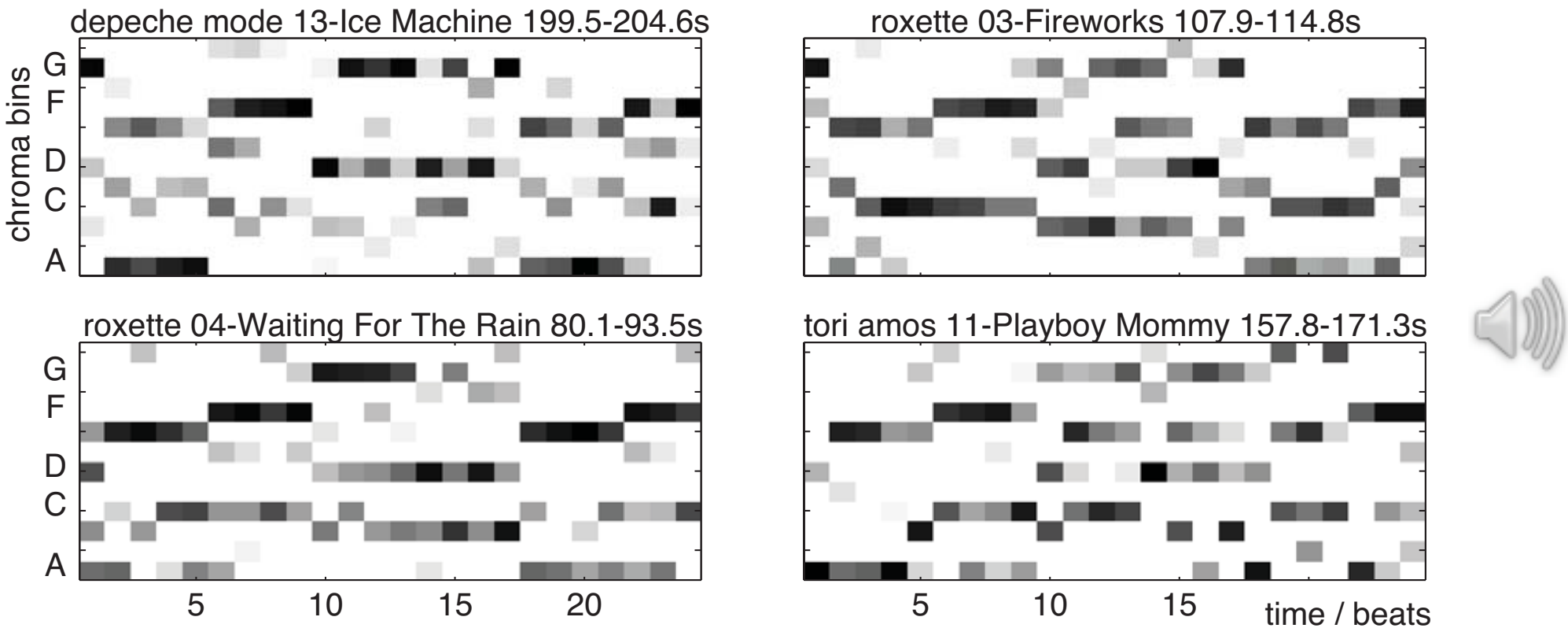
from Slaney & Casey '08

Common Fragments

- Cluster beat-synchronous chroma patches



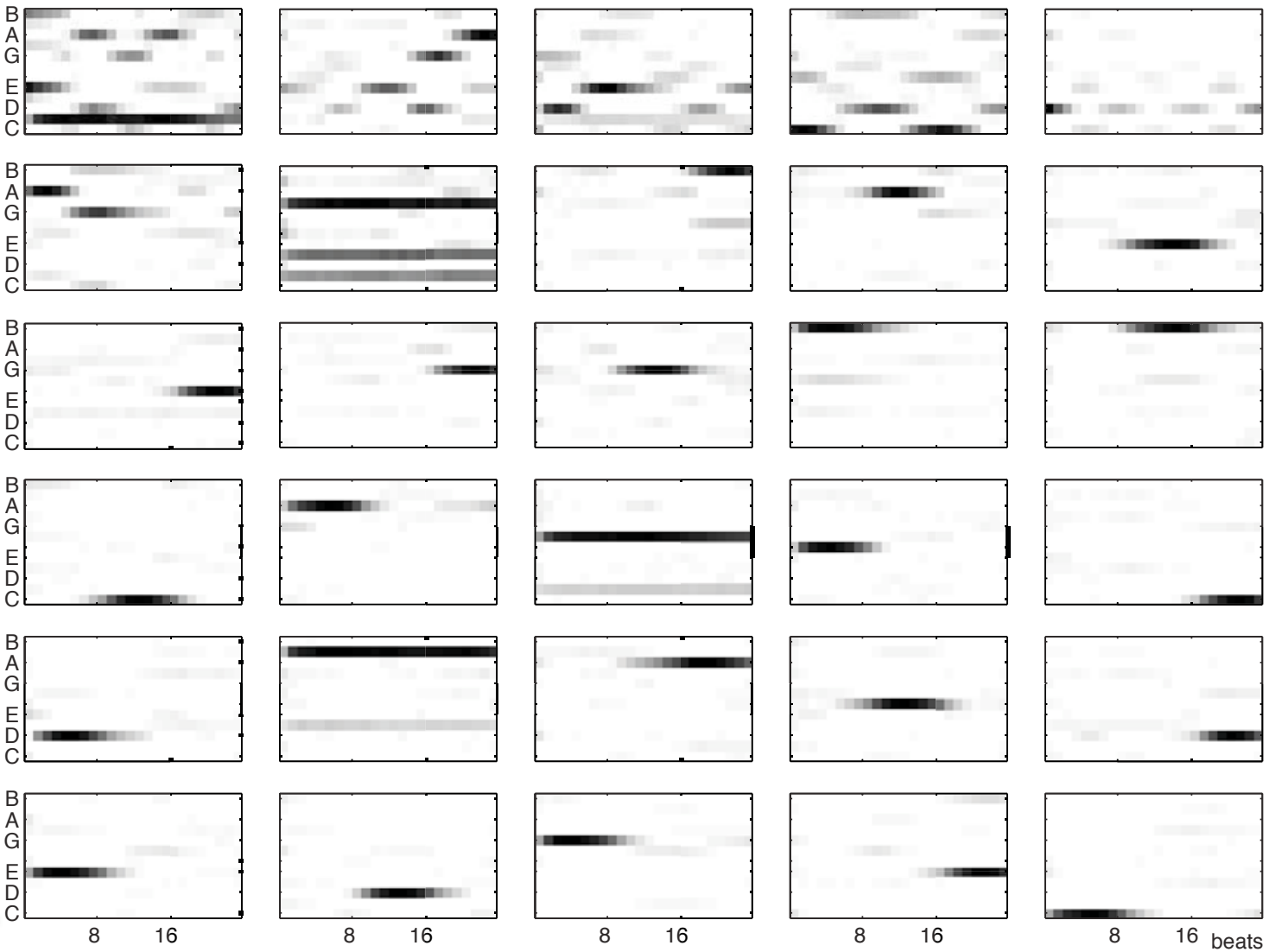
Clustered Fragments



- ... for a dictionary of common themes?

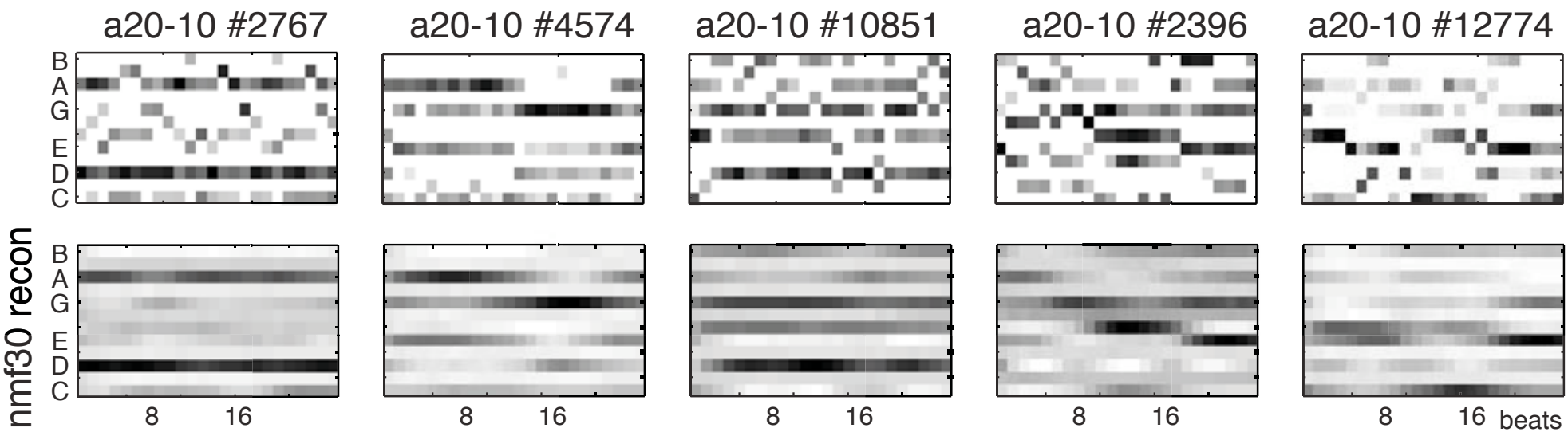
NMF Decomposition

Beat-chroma fragments: 30 Basis NMF decomposition



NMF Decomposition

- Originals and 30-basis NMF reconstructions

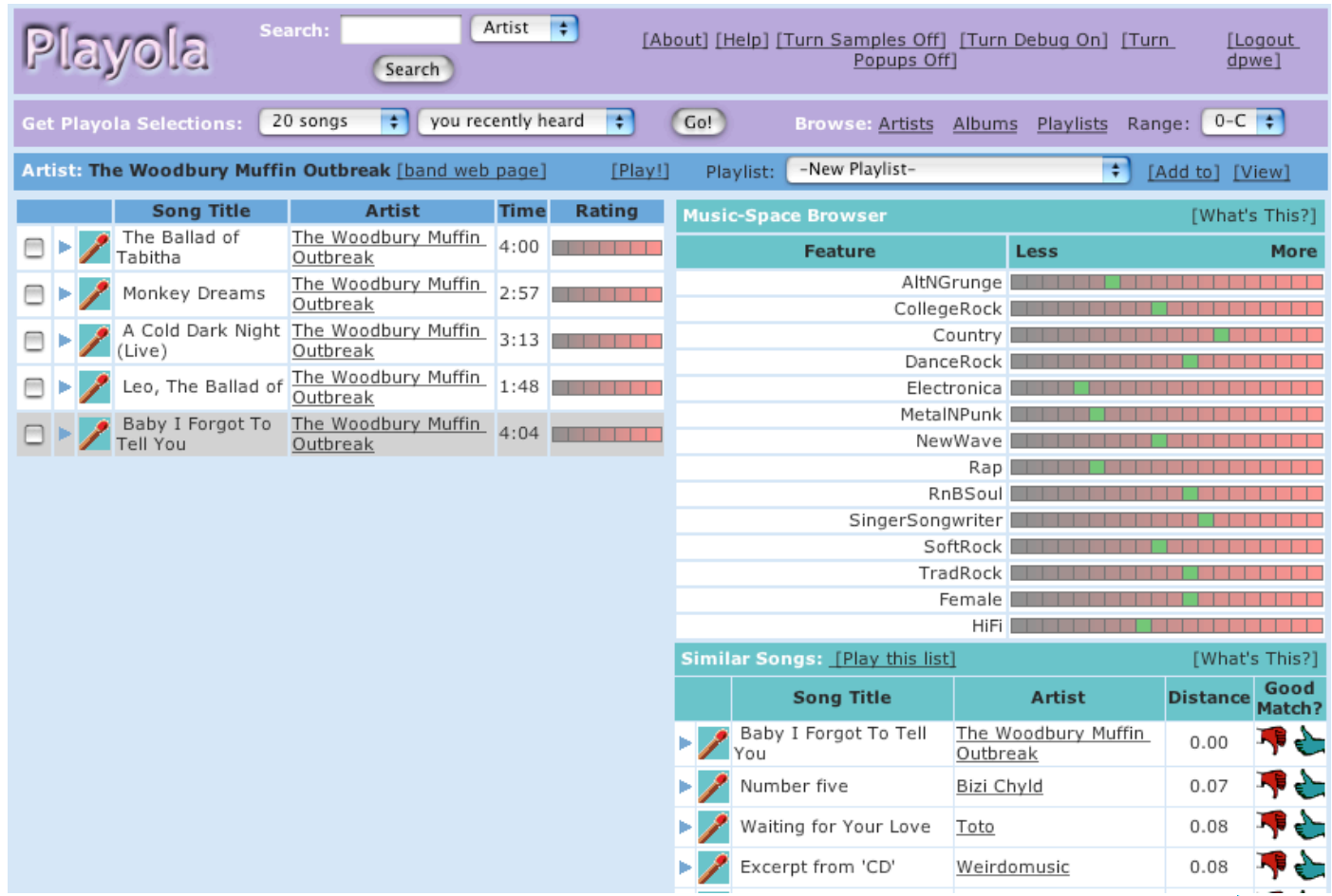


- Conclusion?

4. Example Applications: Music Discovery

Berenzweig & Ellis '03

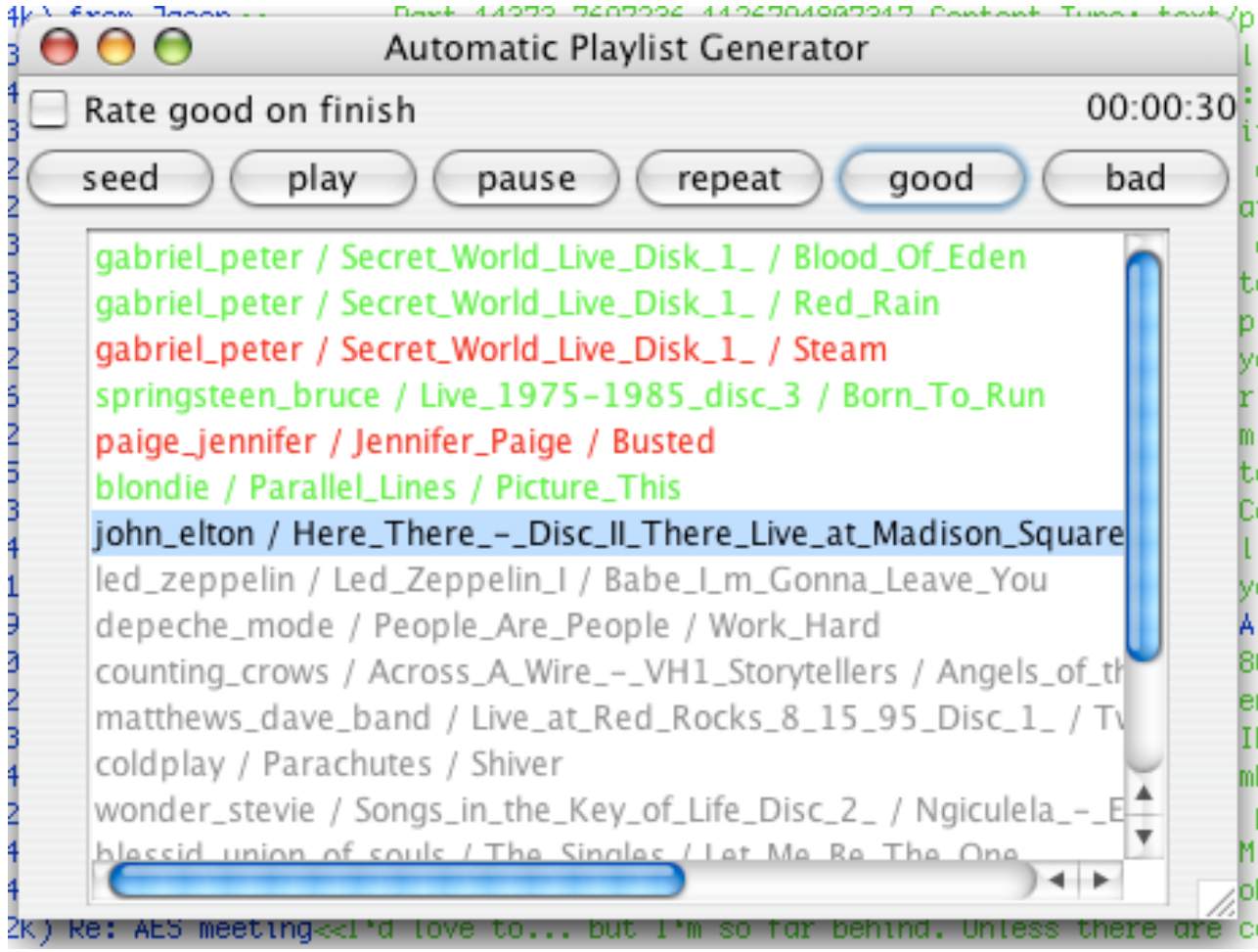
- Connecting listeners to musicians



Playlist Generation

Mandel, Poliner, Ellis '06

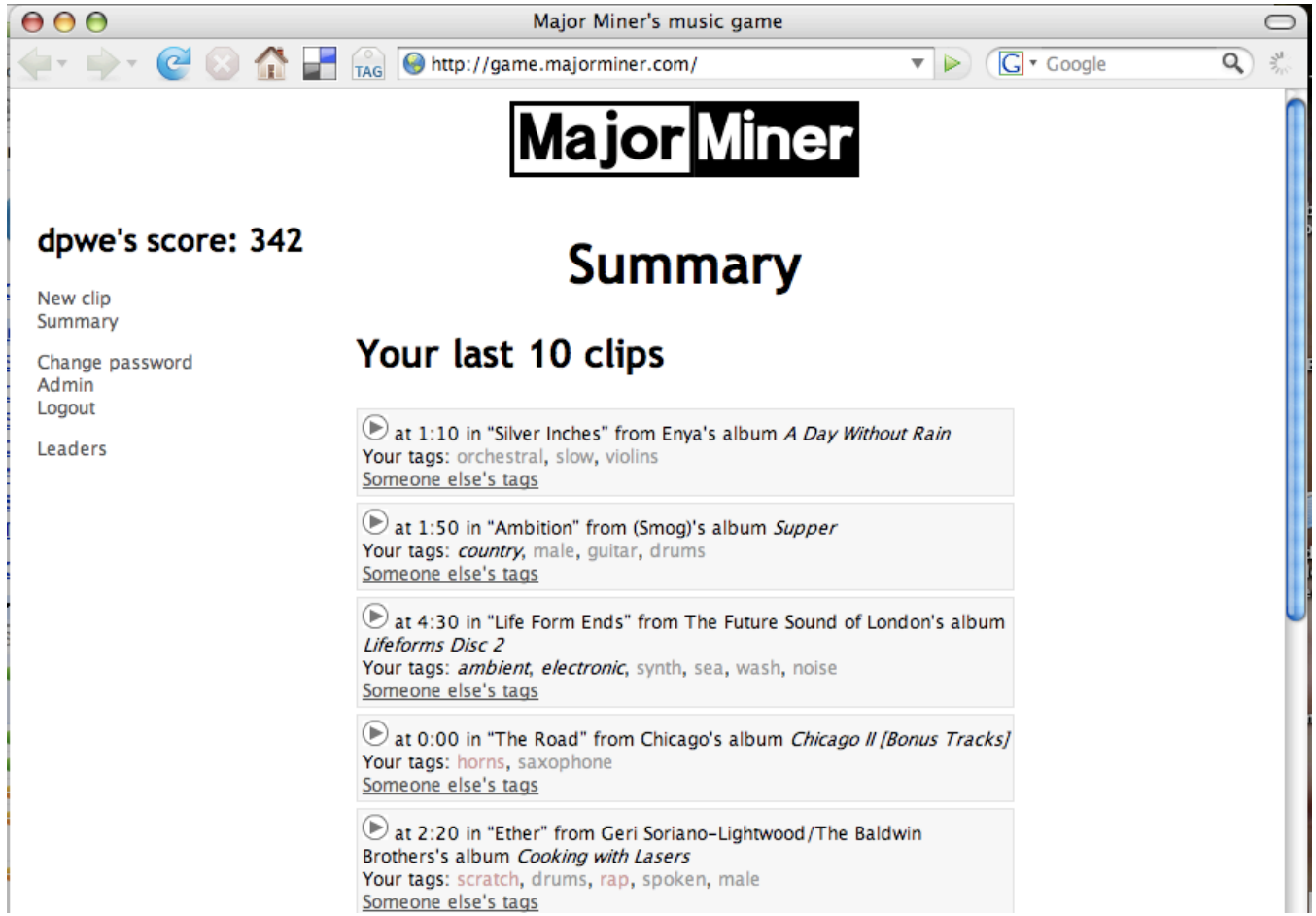
- Incremental learning of listeners' preferences



MajorMiner: Music Tagging

Mandel & Ellis '07,'08

- Describe music using words



Music Transcription

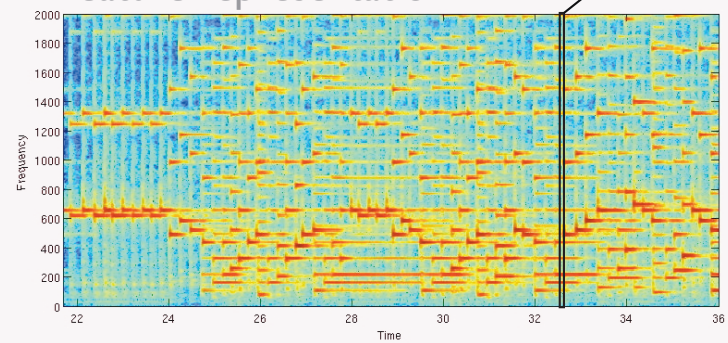
Poliner & Ellis '05,'06,'07

Training data and features:
- MIDI, multi-track recordings, playback piano, & resampled audio (less than 28 mins of train audio).
- Normalized magnitude STFT.

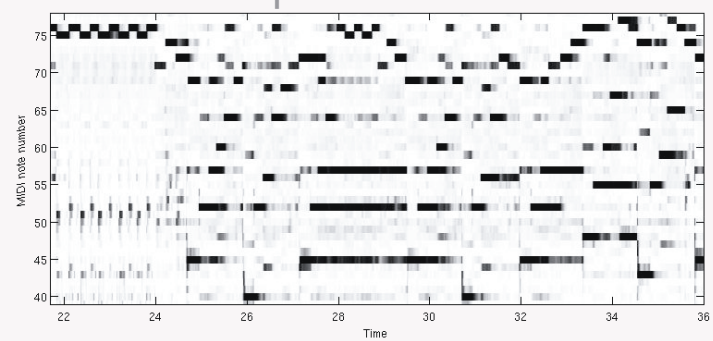
Classification:
- N-binary SVMs (one for ea. note).
- Independent frame-level classification on 10 ms grid.
- Dist. to class bndy as posterior.

Temporal Smoothing:
- Two state (on/off) independent HMM for ea. note. Parameters learned from training data.
- Find Viterbi sequence for ea. note.

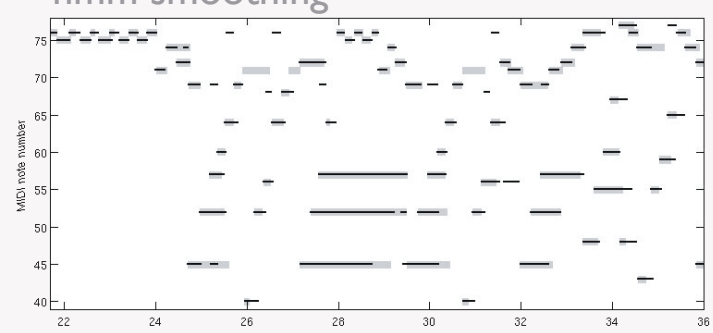
feature representation



classification posteriors



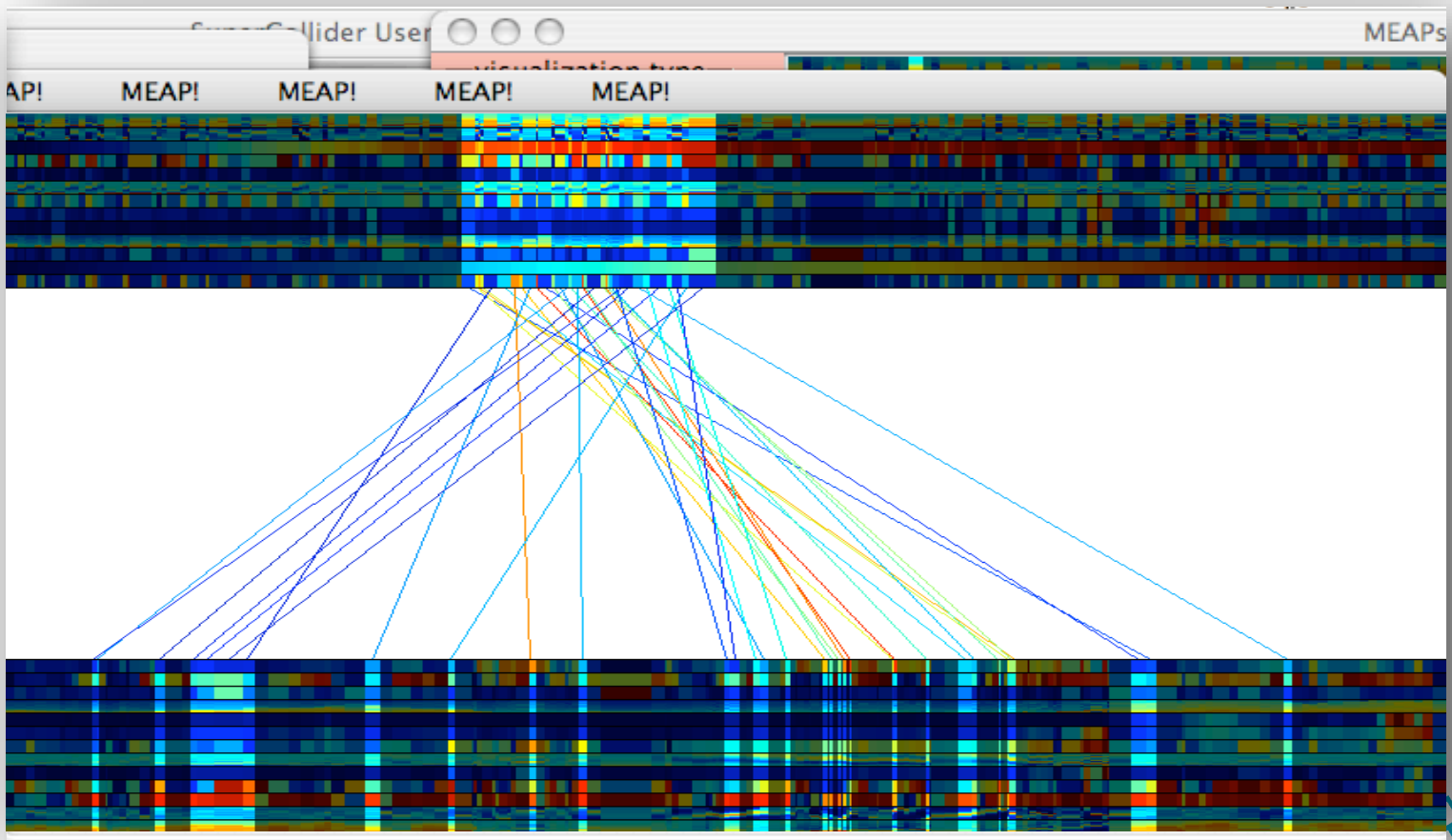
hmm smoothing



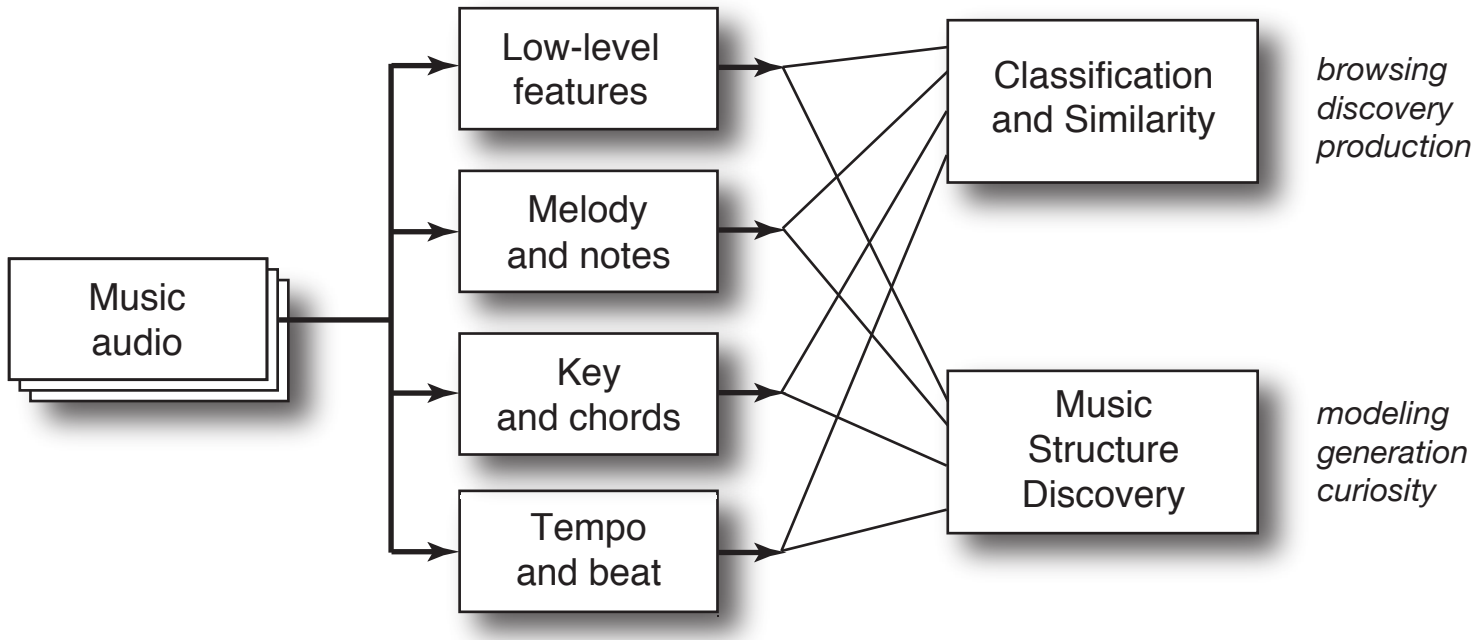
MEAPsoft

- Music Engineering Art Projects
  - collaboration between EE and Computer Music Center

with Douglas Repetto, Ron Weiss, and the rest of the MEAP team



Conclusions



- Lots of data
  + noisy transcription
  + weak clustering
  ⇒ musical insights?