Eigenrhythms: Drum Track Bases

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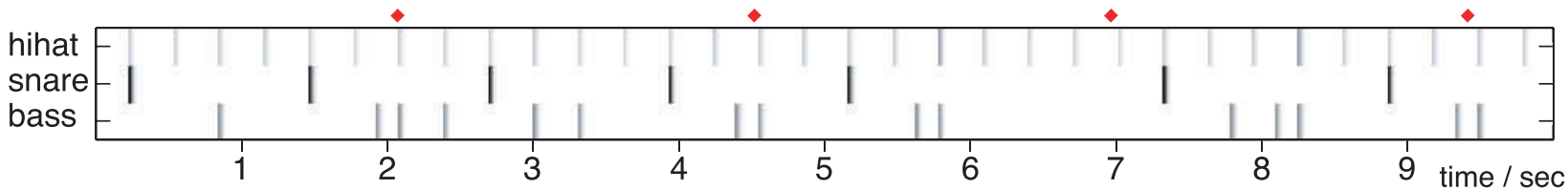
1. Eigenrhythms: Representing drum tracks
2. Basis projections
3. Aligning the data
4. Classification and Synthesis

Drum Track Structure

- To first order,
  All pop music has the same drum track:



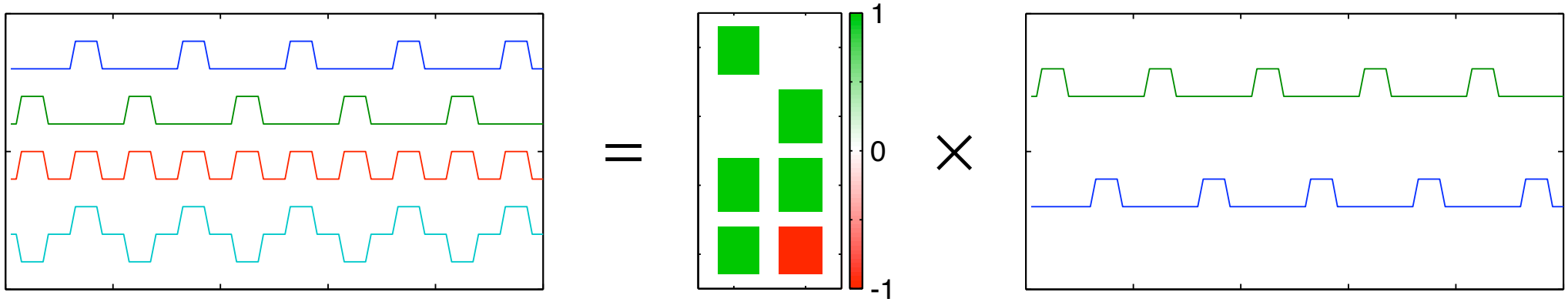
- Can we capture this from examples?
  - .. including the variations
- Can we exploit it?
  - .. for synthesis
  - .. for classification
  - .. for insight

Basis Sets

- Dataset reduced to linear combinations of a few basic patterns

weights

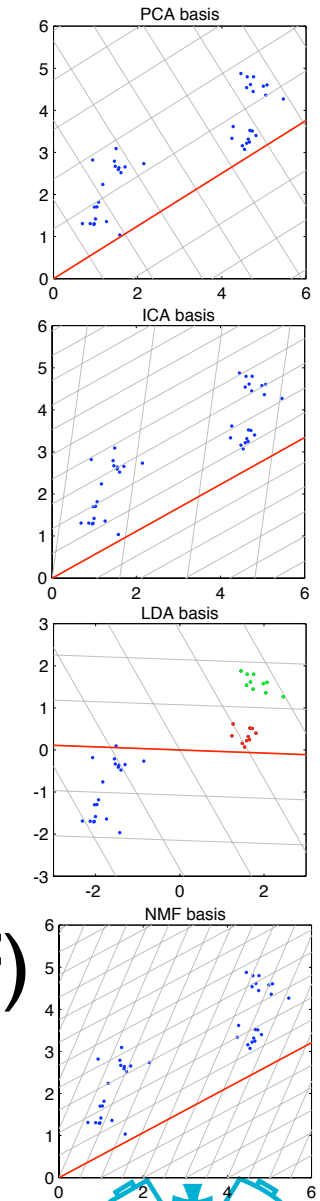
data $\mathbf{X} = \mathbf{W} \times \mathbf{H}$ *bases*



- bases $\mathbf{H}$: subspace that spans the data
- weights $\mathbf{W}$: dimension-reduced projection of data

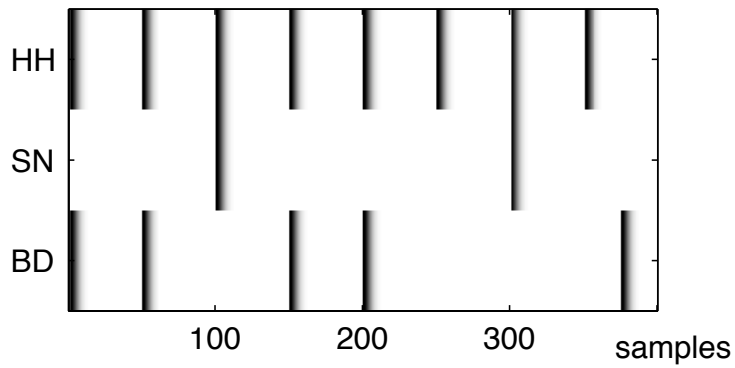
Different basis projections

- Principal Component Analysis (PCA)
  - optimizes MSE of low-D reconstruction
- Independent Component Analysis (ICA)
  - projections are independent (cf decorrelated)
- Linear Discriminant Analysis (LDA)
  - given class labels for data, find dimensions to separate them
- Nonnegative Matrix Factorization (NMF)
  - each basis function only adds bits in



Data

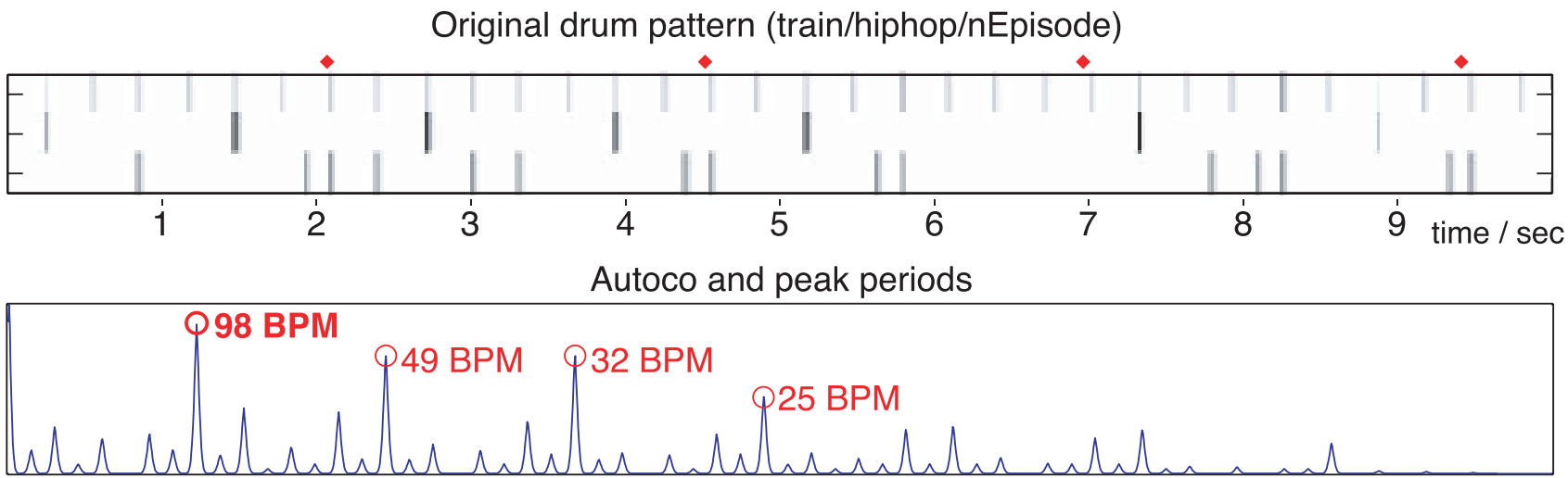
- **Drum tracks extracted from MIDI**
  - 100 examples (10 × 10 genre classes)
  - fixed mapping of instruments to 3 classes
    bass drum, snare, hi-hat
- **Pseudo-envelope representation**
  - 40ms half-Gauss window sampled at 200 Hz



- **Extract just one pattern from each MIDI**
  - looking for variety, quantity not a problem

Aligning Data: Tempo

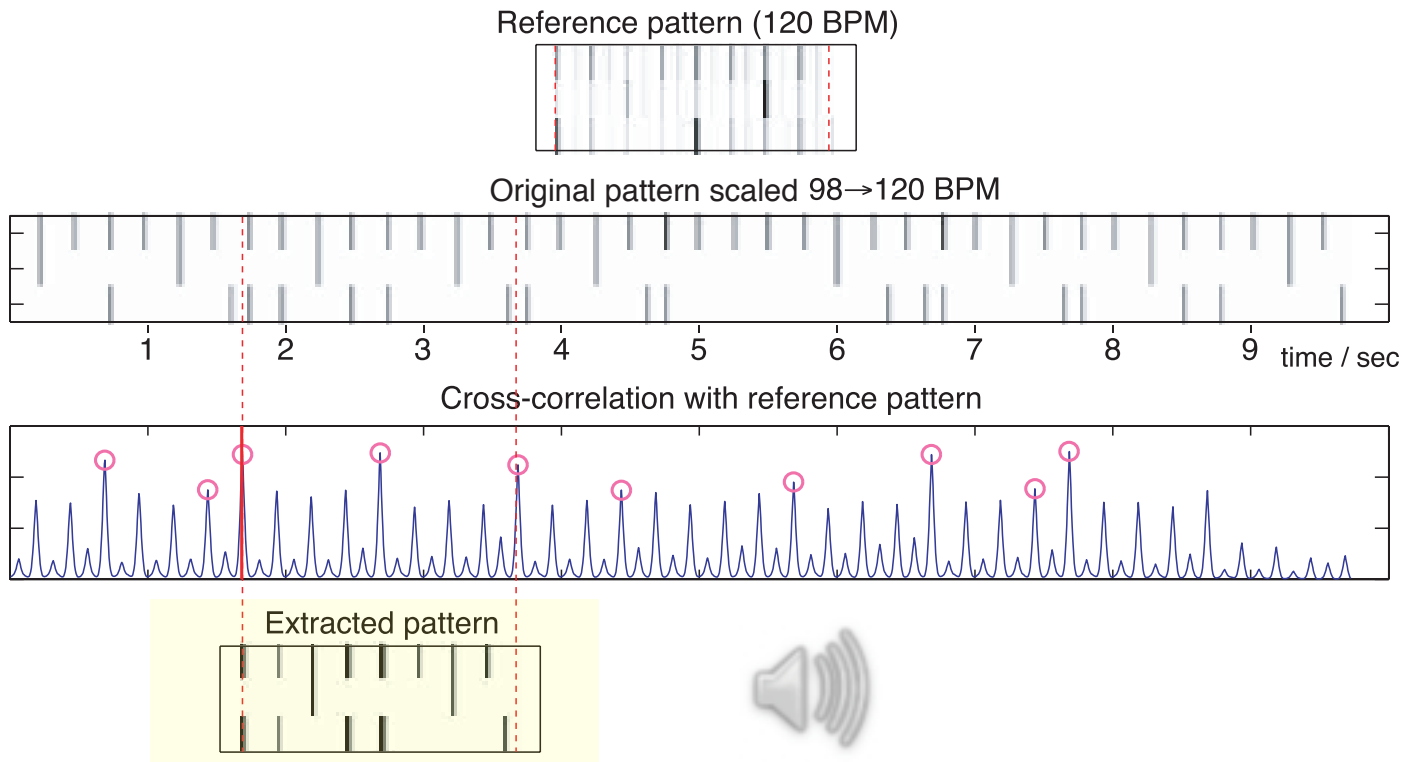
- Need to align patterns prior to PCA...
- First, normalize tempo
  - autocorrelation gives BPM candidates



Sound Examples

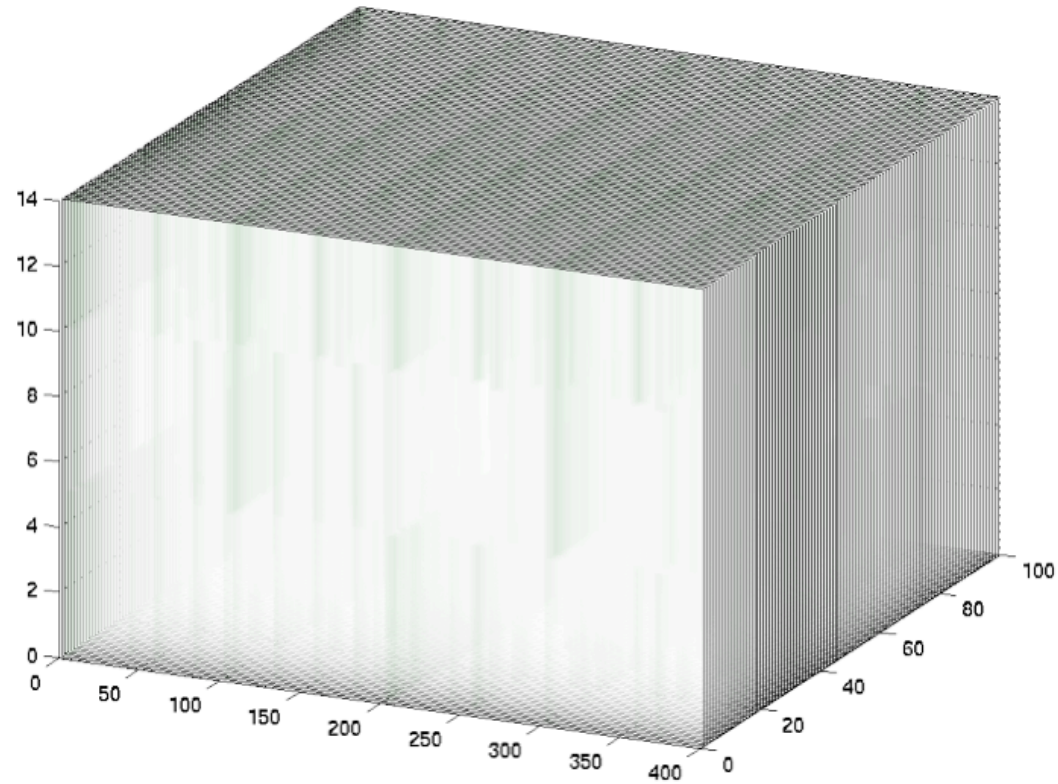
Aligning Data: Downbeat

- Downbeat from best match of tempo-normalized pattern to 'mean' template
  - try every tempo hypotheses, choose best match



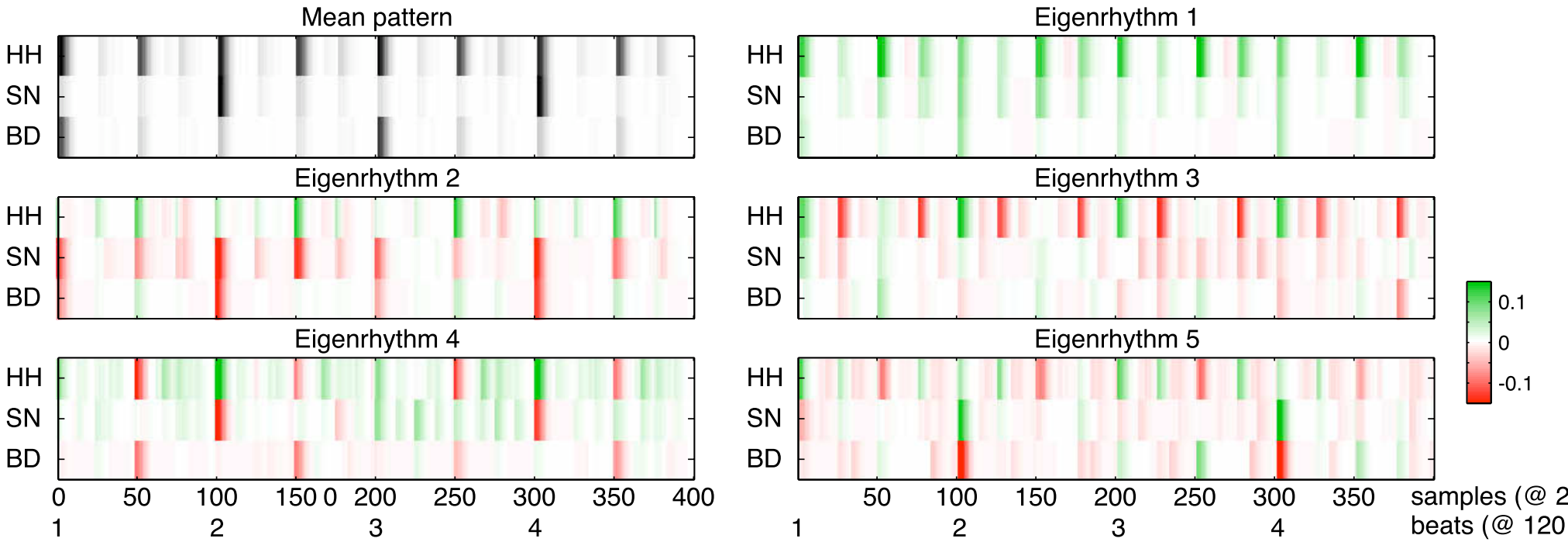
Aligned Data

- Tempo normalization + downbeat alignment
  → 100 2-bar excerpts:



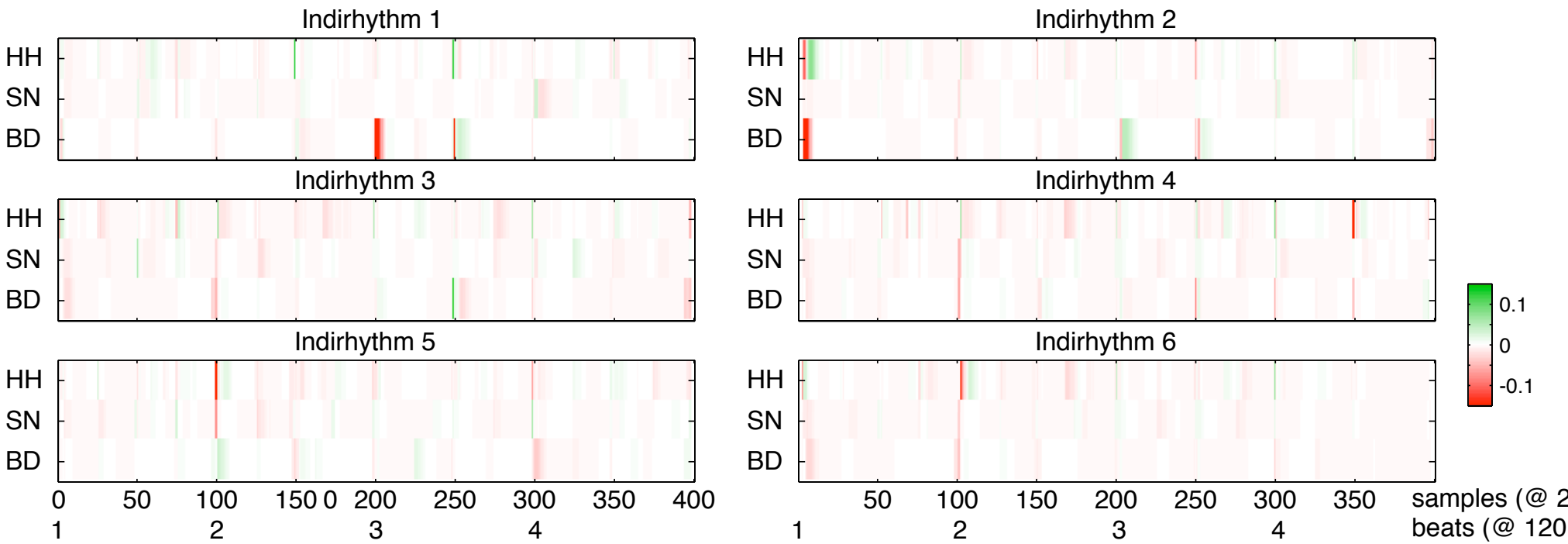
- Can now apply basis projection(s)

Eigenrhythms (PCA)



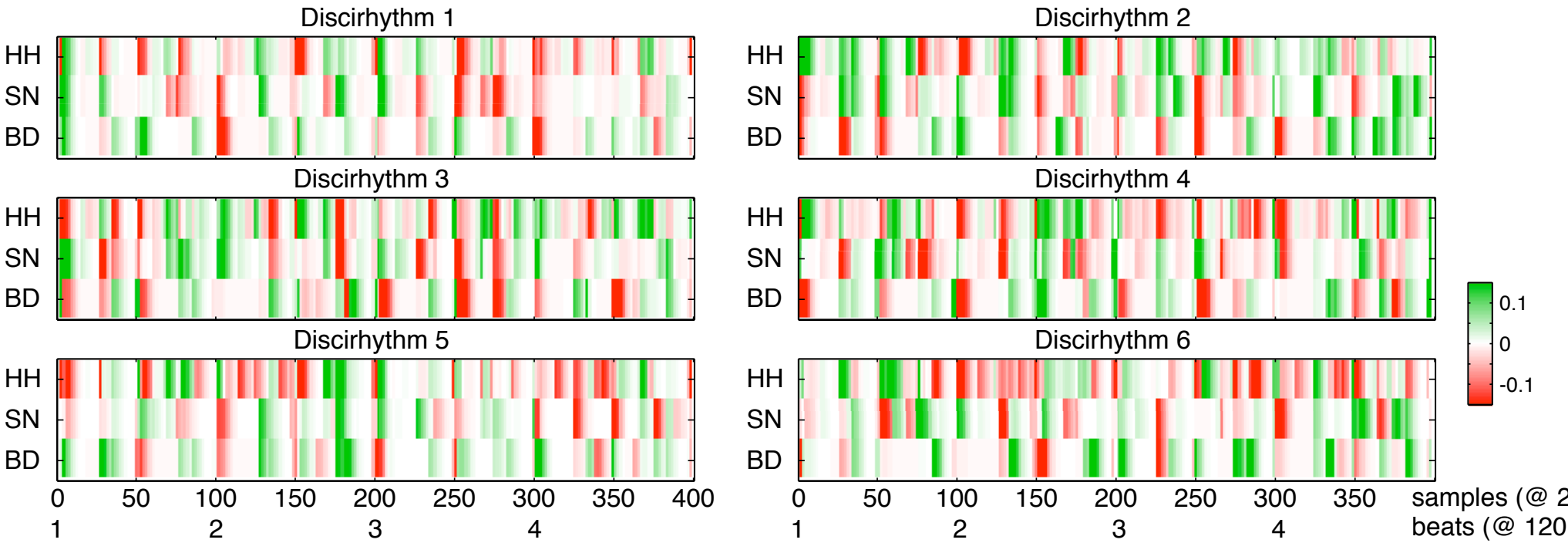
- Need 20+ Eigenvectors for good coverage of 100 training patterns (1200 dims)
- Eigenrhythms both add and subtract

Indirhythms (ICA)



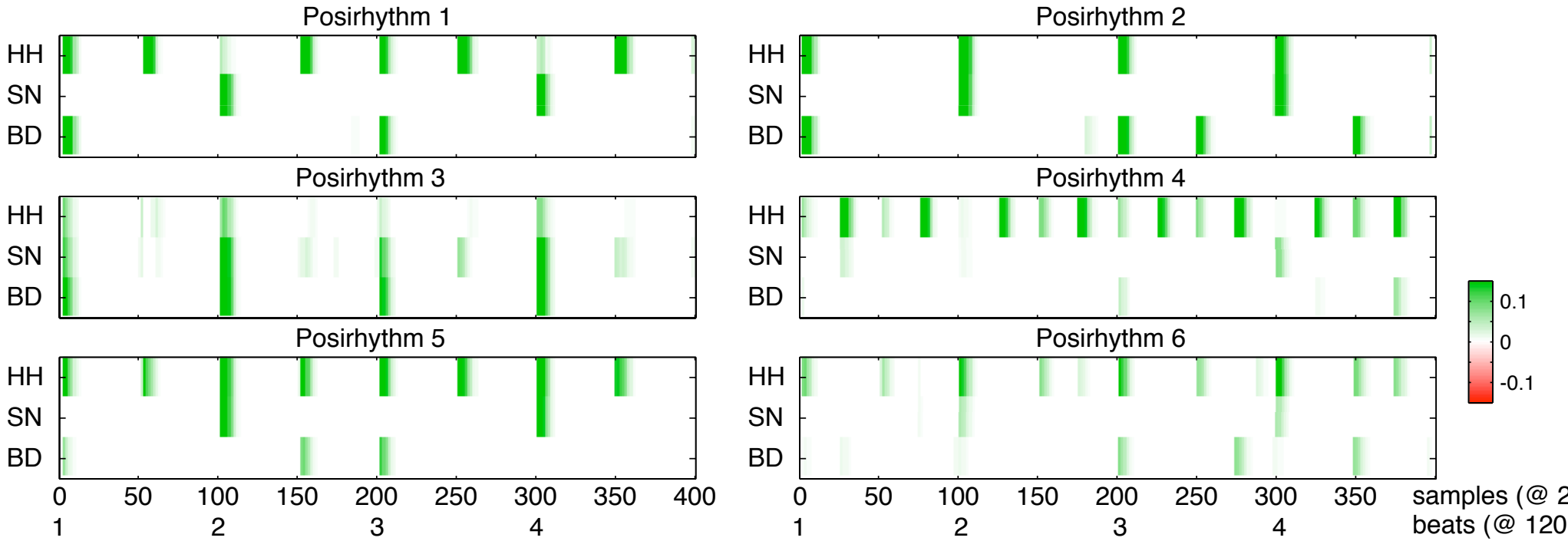
- 6 of 12 components from FastICA2_1
  - picking up fine timing shifts?

Discrirhythms (LDA)



- Trying to differentiate genre classes...

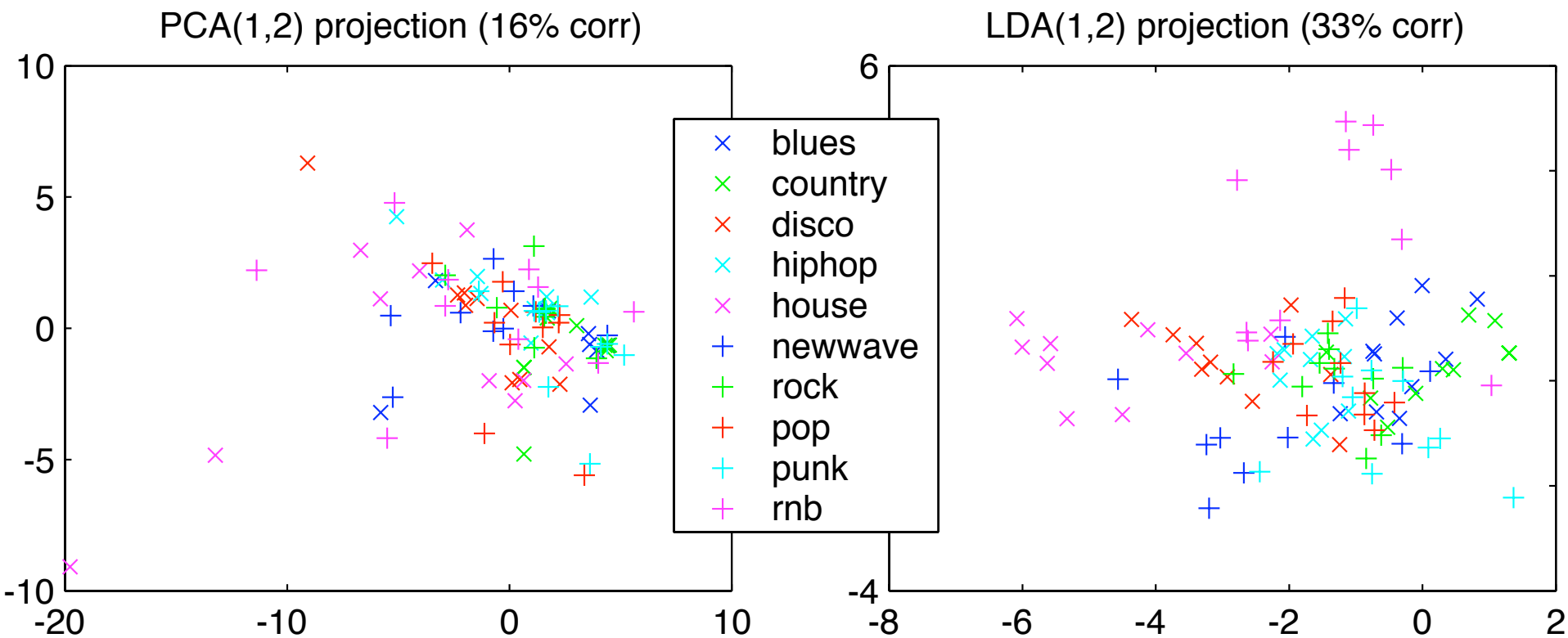
Posirhythms (NMF)



- Nonnegative: only adds beat-weight
- Capturing some structure

Eigenrhythms for Classification

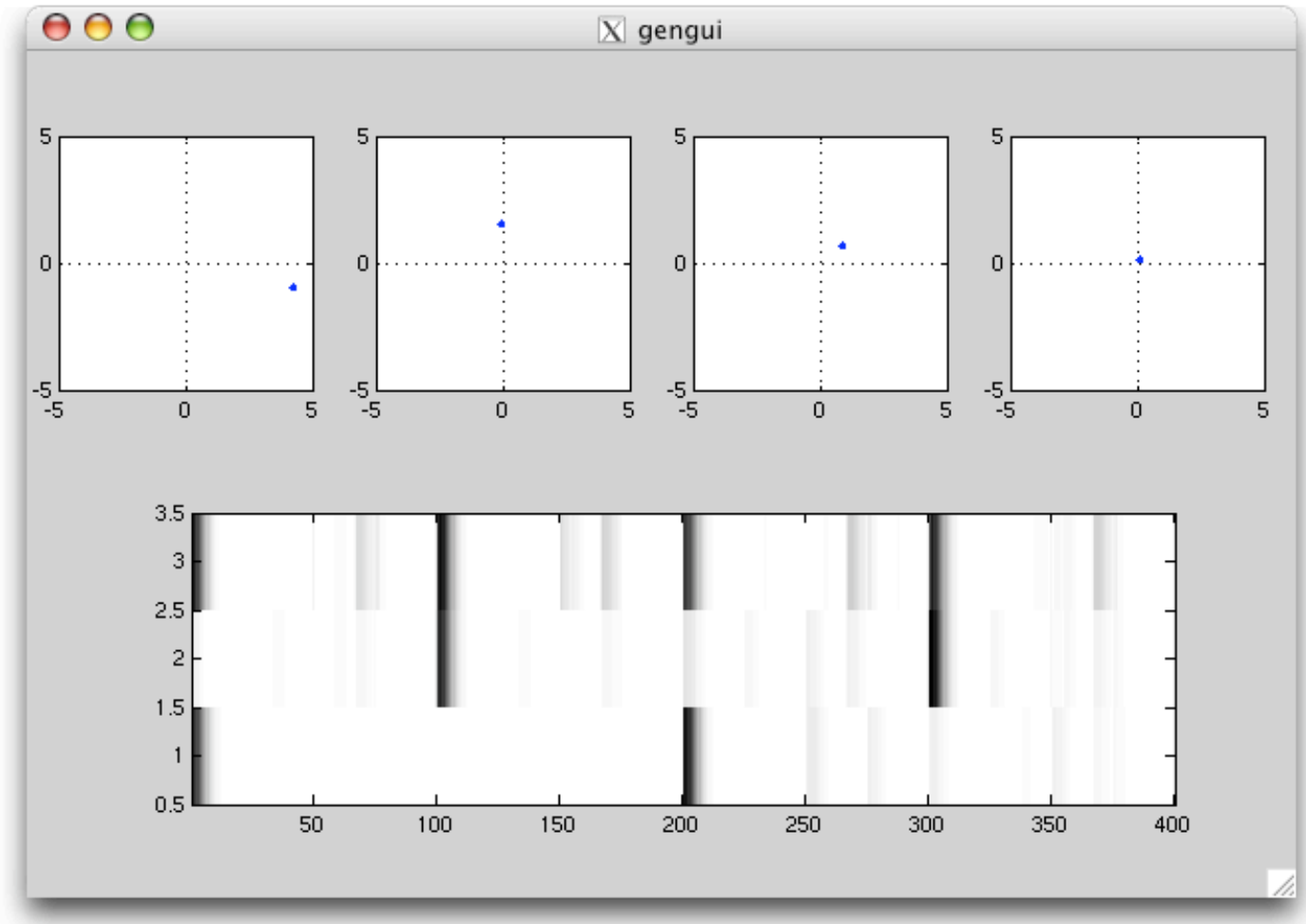
- Projections in Eigenspace / LDA space



- 10-way Genre classification (nearest nbr):
  - PCA3: 20% correct
  - LDA4: 36% correct

Eigenrhythm BeatBox

- Resynthesize rhythms from eigen-space



Conclusions & Future Work

- Basis projections
  capture subspace of drum patterns

- Not genre, but something?
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- Future work
  - use more data
  - extract drum patterns from audio
  - examine 'feel'?