SIPL SIGNAL & IMAGE PROCESSING LAB

Content-based Organization of Musical Performers using Self Organized Maps

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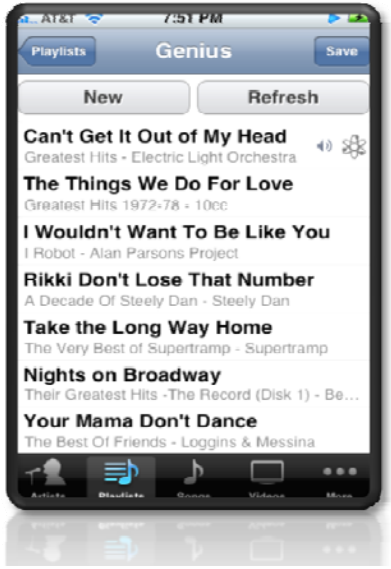
Introduction

- Most of the people can recognize artists,

  what are the features that makes it possible?
- How can we organize artists based on sound?

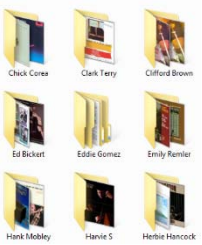
Possible Applications

- Musicology research
- Create dynamic playlists suitable with the user's musical preferences



High Level Design

Music Library



Feature Extraction

Training

Mapping and Classification

Musical map

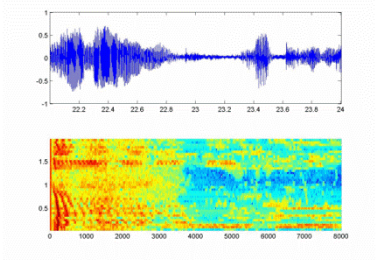
Music Genres

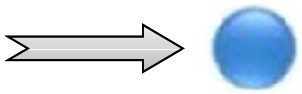
- Each song divided into 3 segments of 30 second

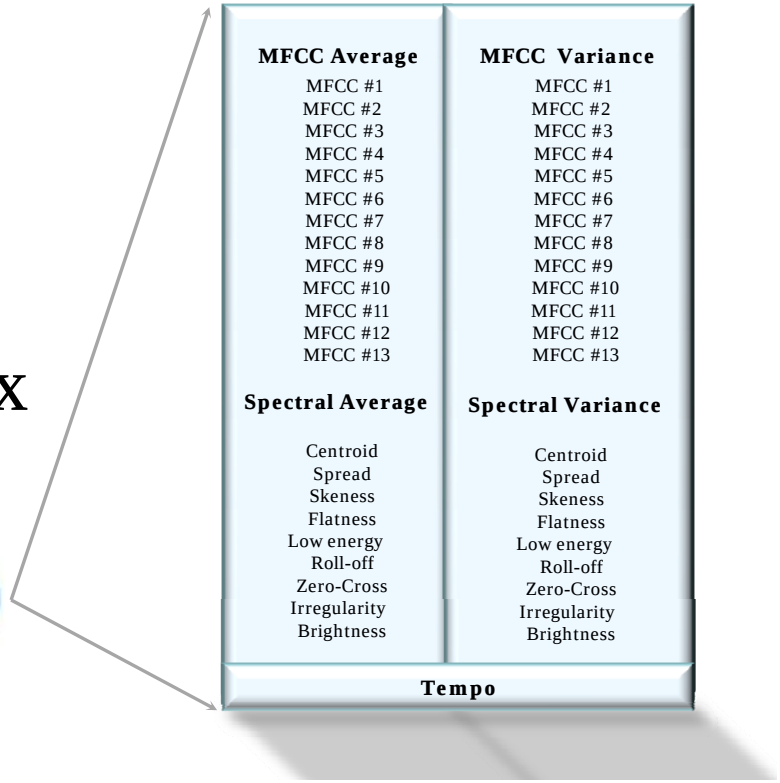
ROCK		POP	JAZZ	RAP/ HIP-HOP	CLASSIC	ELECTRONIC
Metallica	Red Hot Chili Peppers	Britney Spears	Ella Fitzgerald	OutKast	Bach	Infected Mushroom
Jimi Hendrix	The Doors	Madonna	Frank Sinatra	The Black Eyed Peas	Vivaldi	DJ Tiesto
LTE	Dream Theater	Spice Girls	Sarah Vaughan	Snoop Dogg	Beethoven	Armin Van Buuren
Queen	Symphony X	Shakira		50 Cent	Chopin	Prodigy
Coldplay	Guns N Roses			Eminem		Pendulum
Pink Floyd	Nirvana			Jamiroquai		David Guetta
Leonard Cohen	Pearl Jam					
	Aerosmith					

Feature Extraction

- Features represent Timbre, Genre and Mood
  - MFCC
  - Spectral analysis
  - Tempo
- Extracted using MIR Toolbox

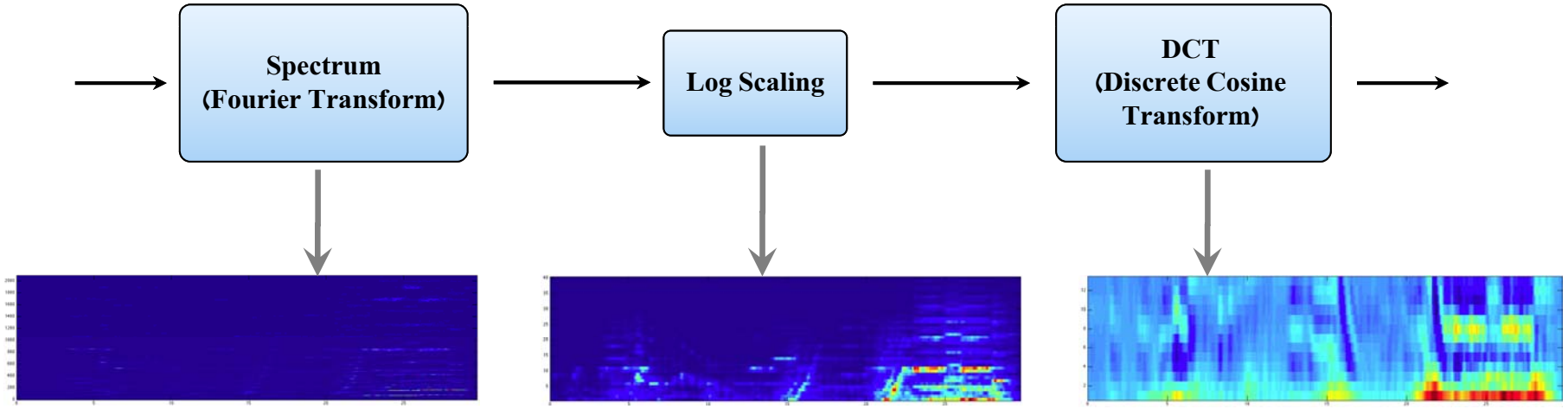






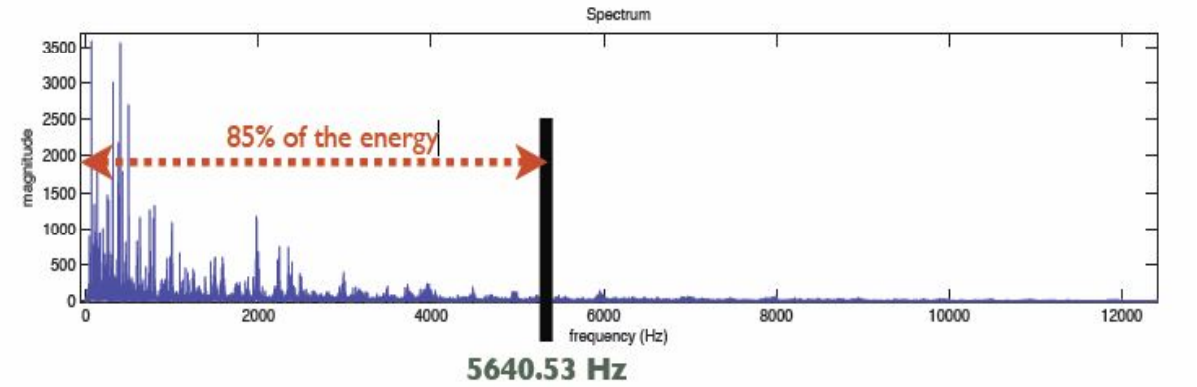
Mel-Freq Cepstral Coeff

- Common tool in MIR and speech recognition
- Approximates the human auditory system



Spectral Features

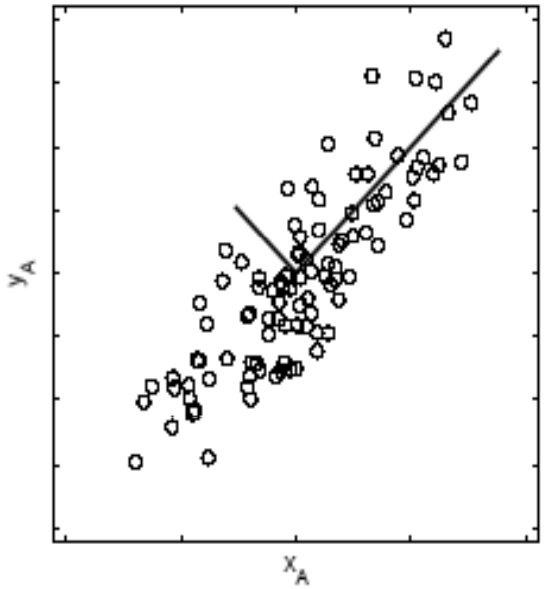
- First 3 moments of the spectrum
- Spectral Roll-off frequency



- Spectral Flatness – noisiness of the spectrum

PCA

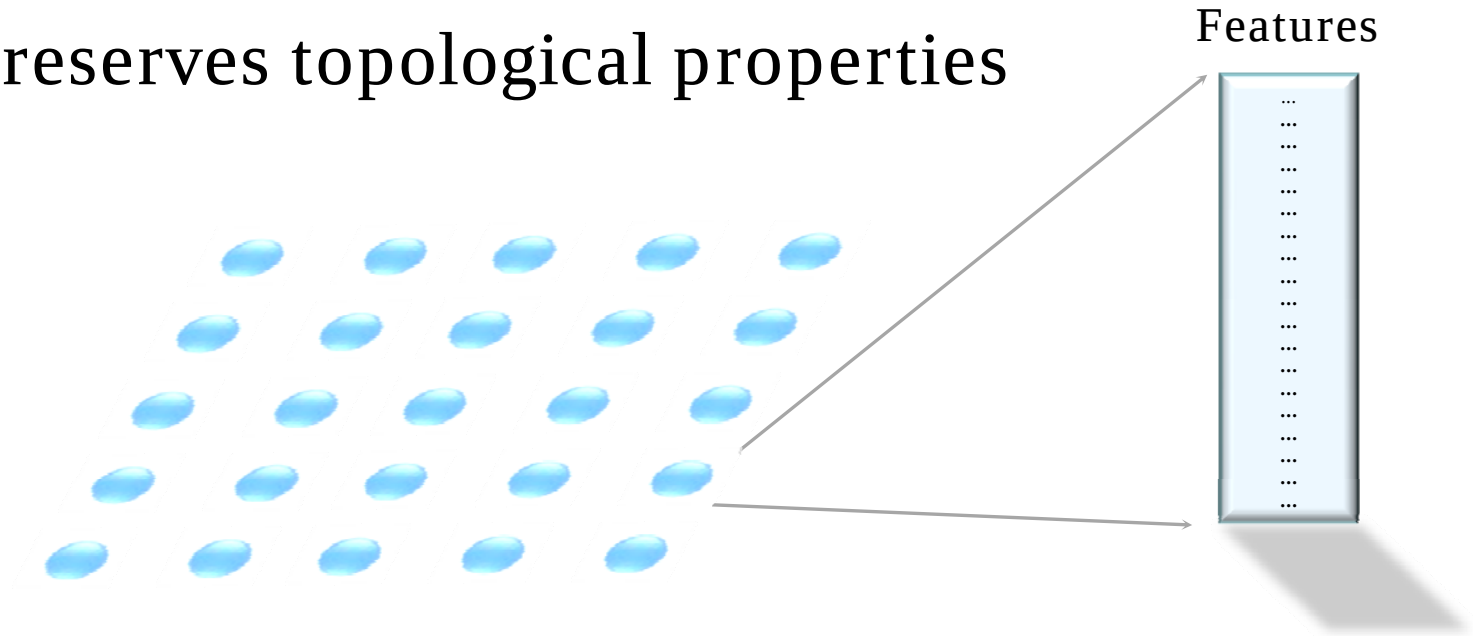
- Represent the data in an orthogonal basis in which the variance is maximized
- Better separation and computability improvement
- Finds the best separating features
  - MFCC, Flatness, 3rd Moment



High Level Design

Self Organized Map

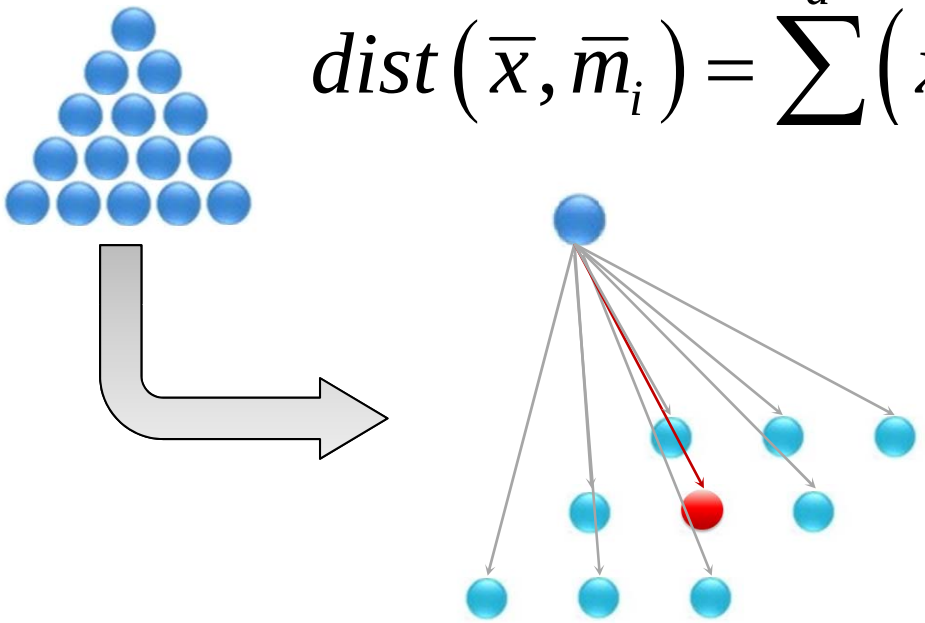
- 2-Dimensional node grid
- Unsupervised training process
- Useful for high dimensional input visualization
- Preserves topological properties



Training

- Choose a segment randomly
- Winner determination

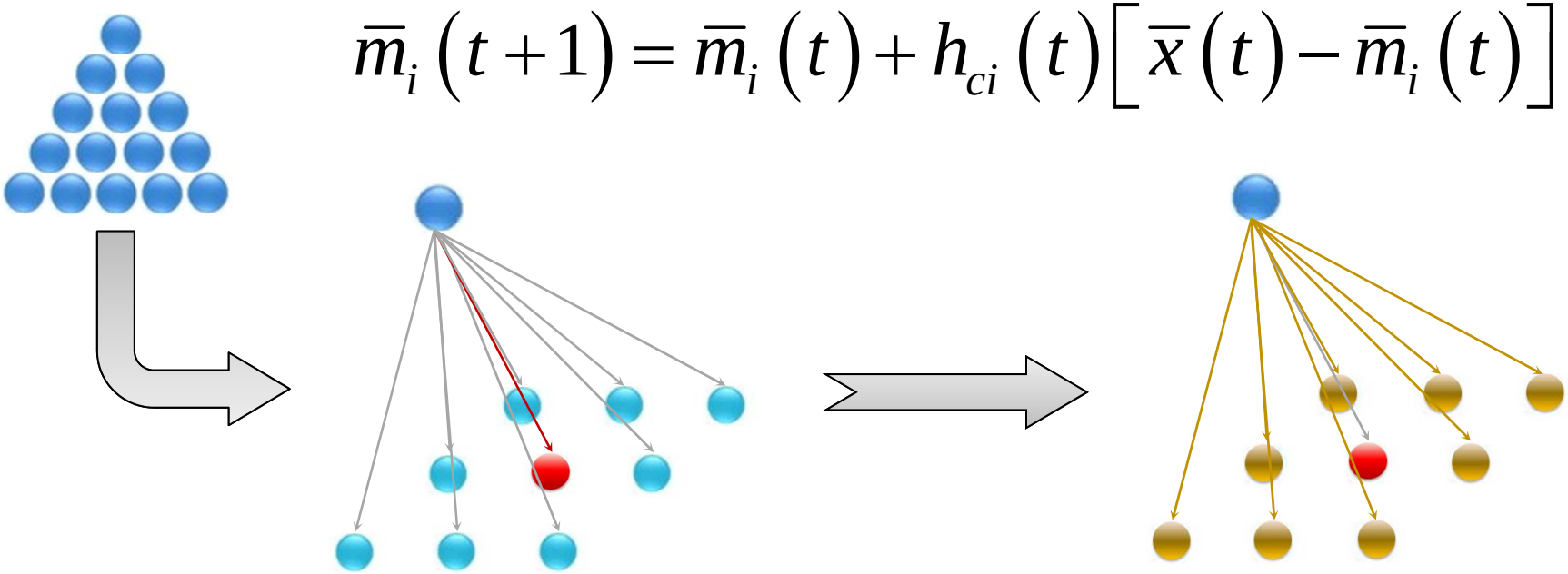
$$dist\left(\bar{x}, \bar{m}_i\right) = \sum^{d} \left(x_j - m_{ij}\right)^2 \sqrt{\lambda_j}$$



Self Organized Map

- Closest node and neighborhood adaptation

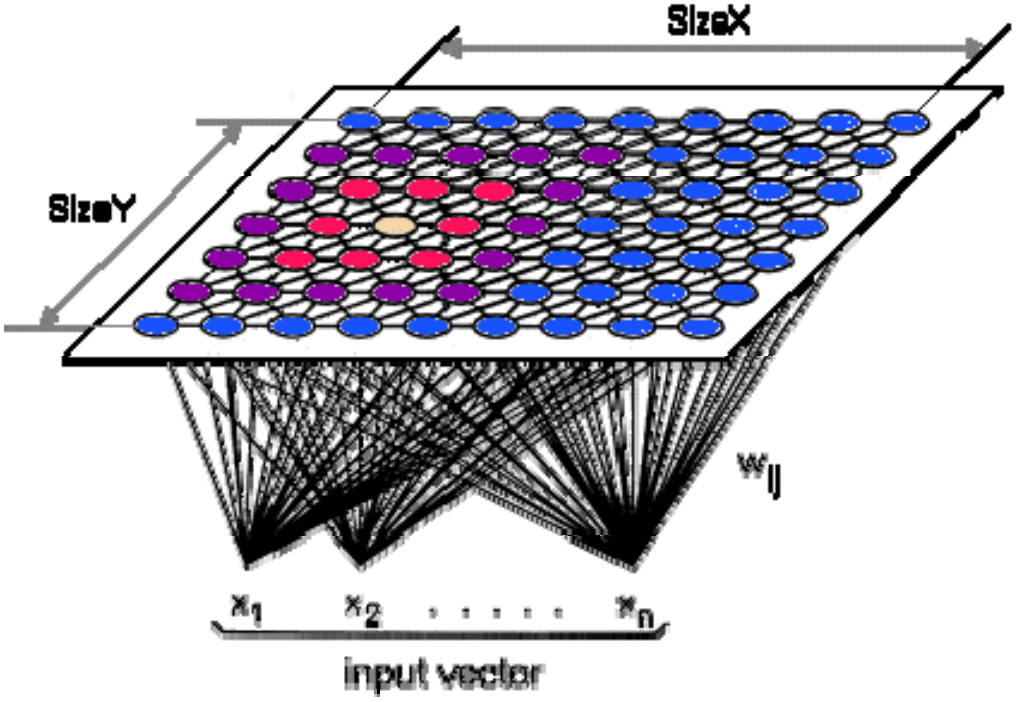
$$\bar{m}_i(t+1) = \bar{m}_i(t) + h_{ci}(t)\left[\bar{x}(t) - \bar{m}_i(t)\right]$$



Learning rate

- Starting with a large learning rate, gradually decreased to facilitate convergence

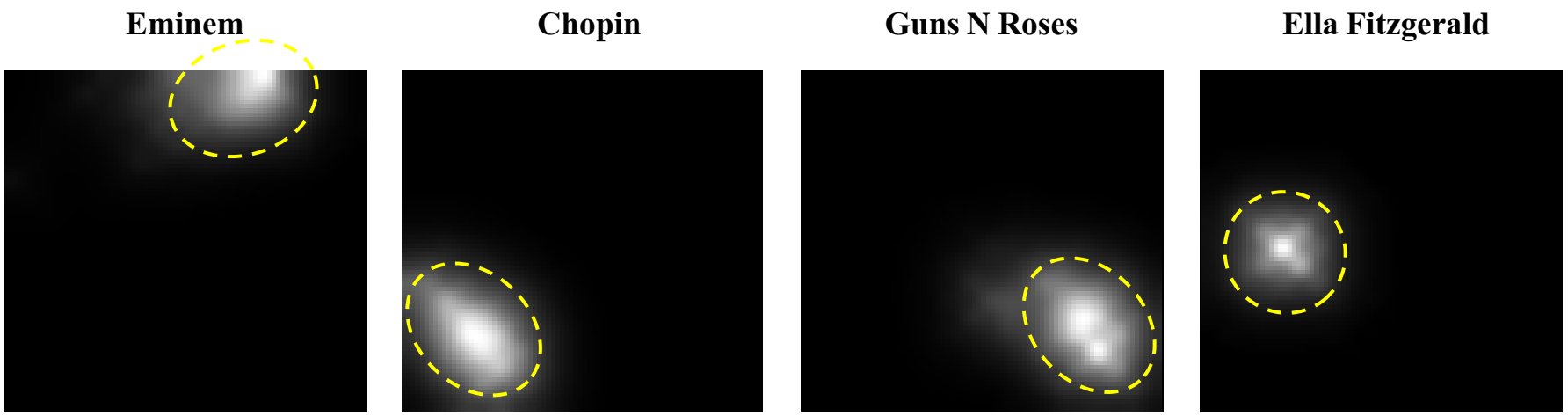
$$h_{ci} = \alpha(t)\exp\left(-\frac{|r_c - r_i|^2}{2\sigma^2(t)}\right)$$



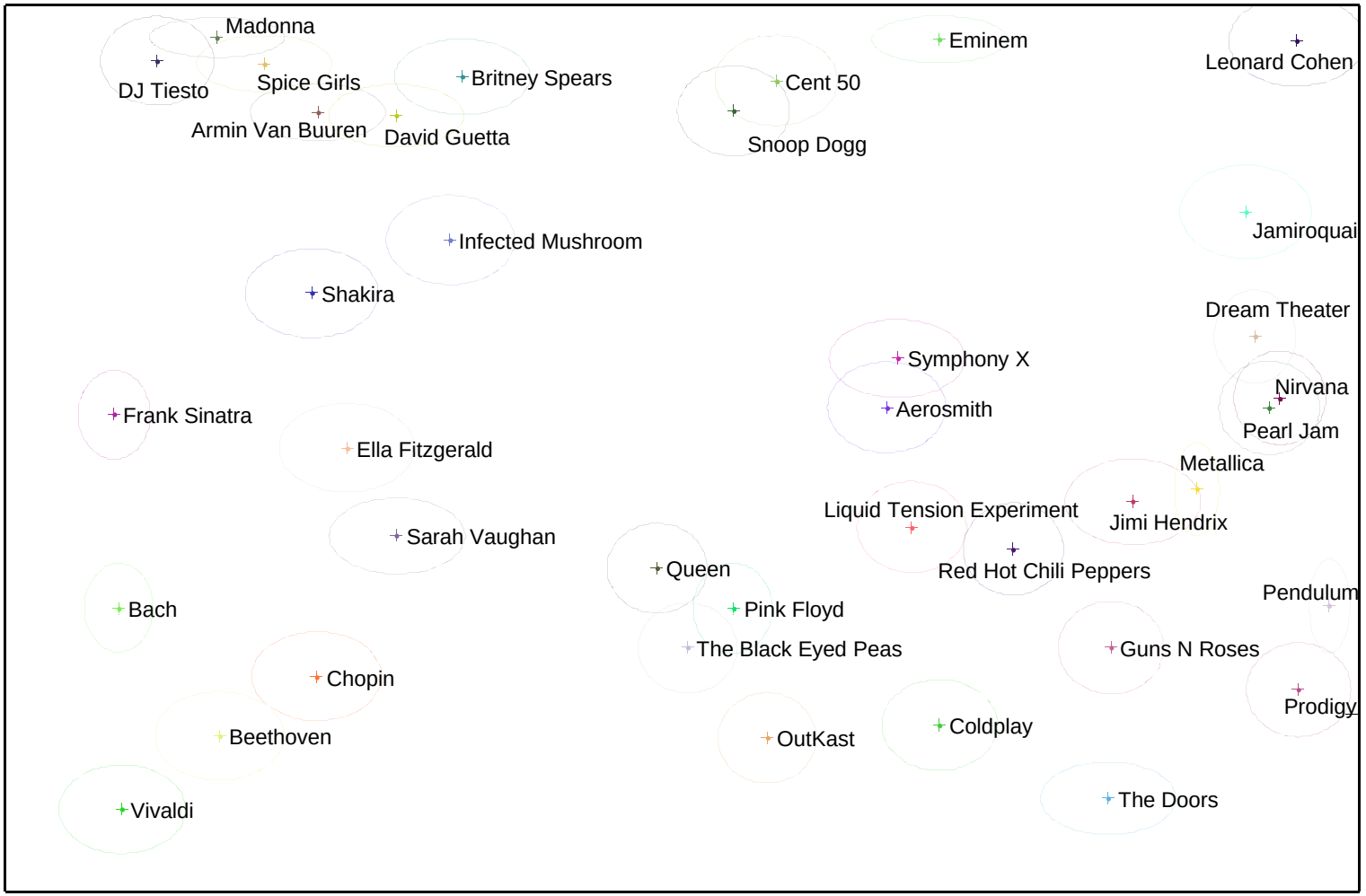
High Level Design

Mapping

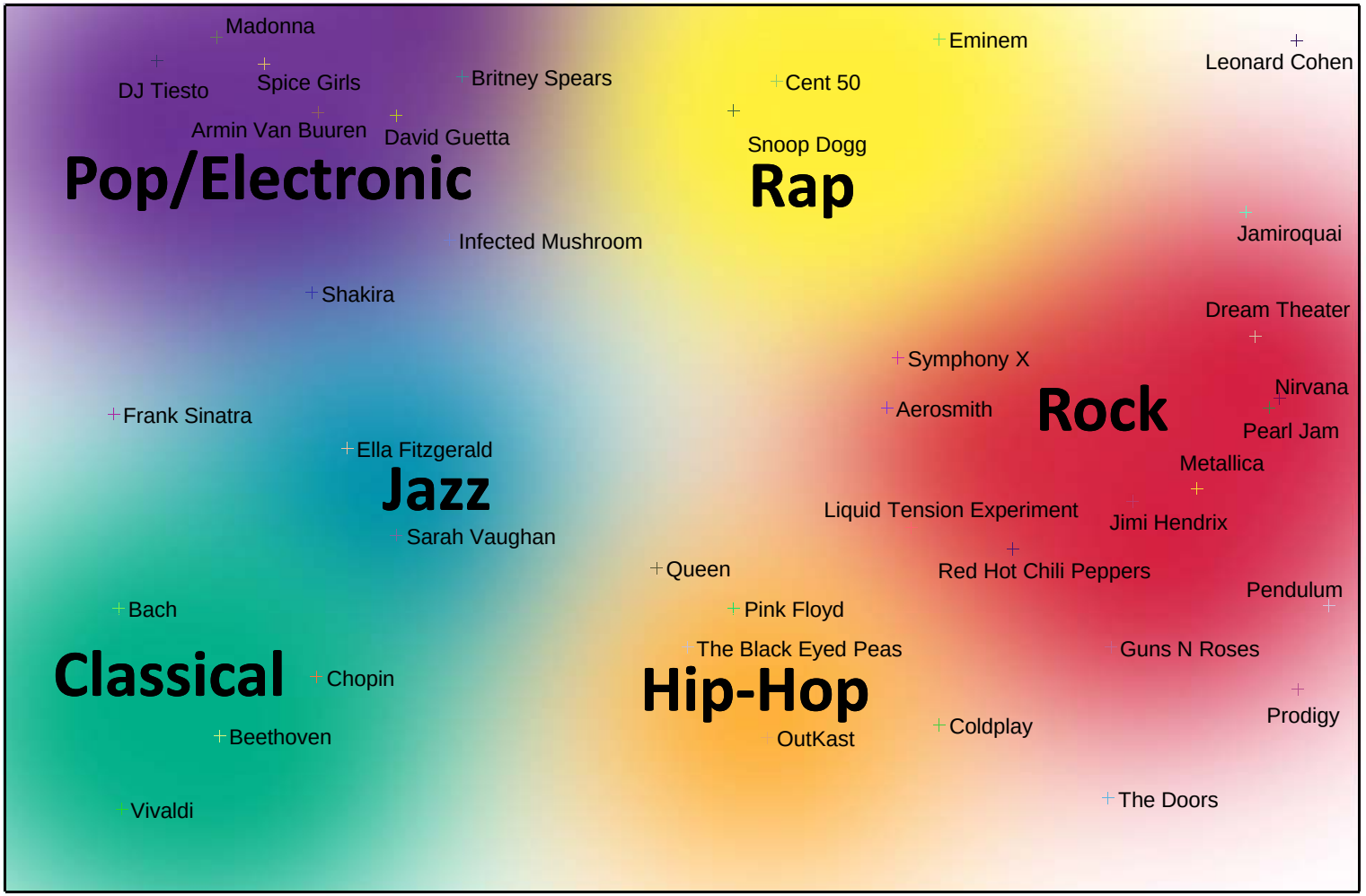
- Histogram maps for each artist



Artists Ellipse Map

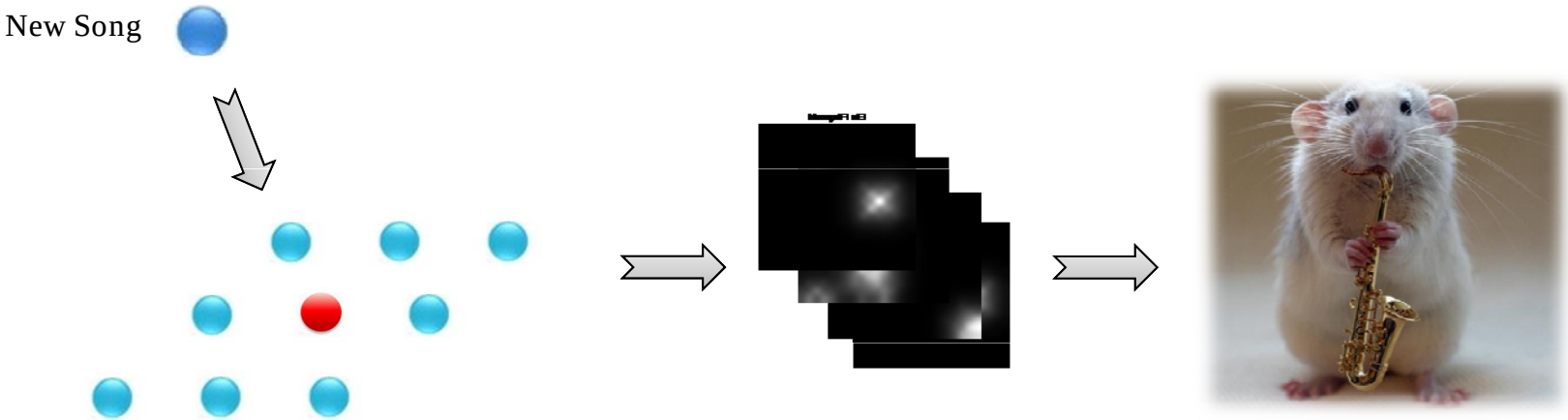


Artists Ellipse Map

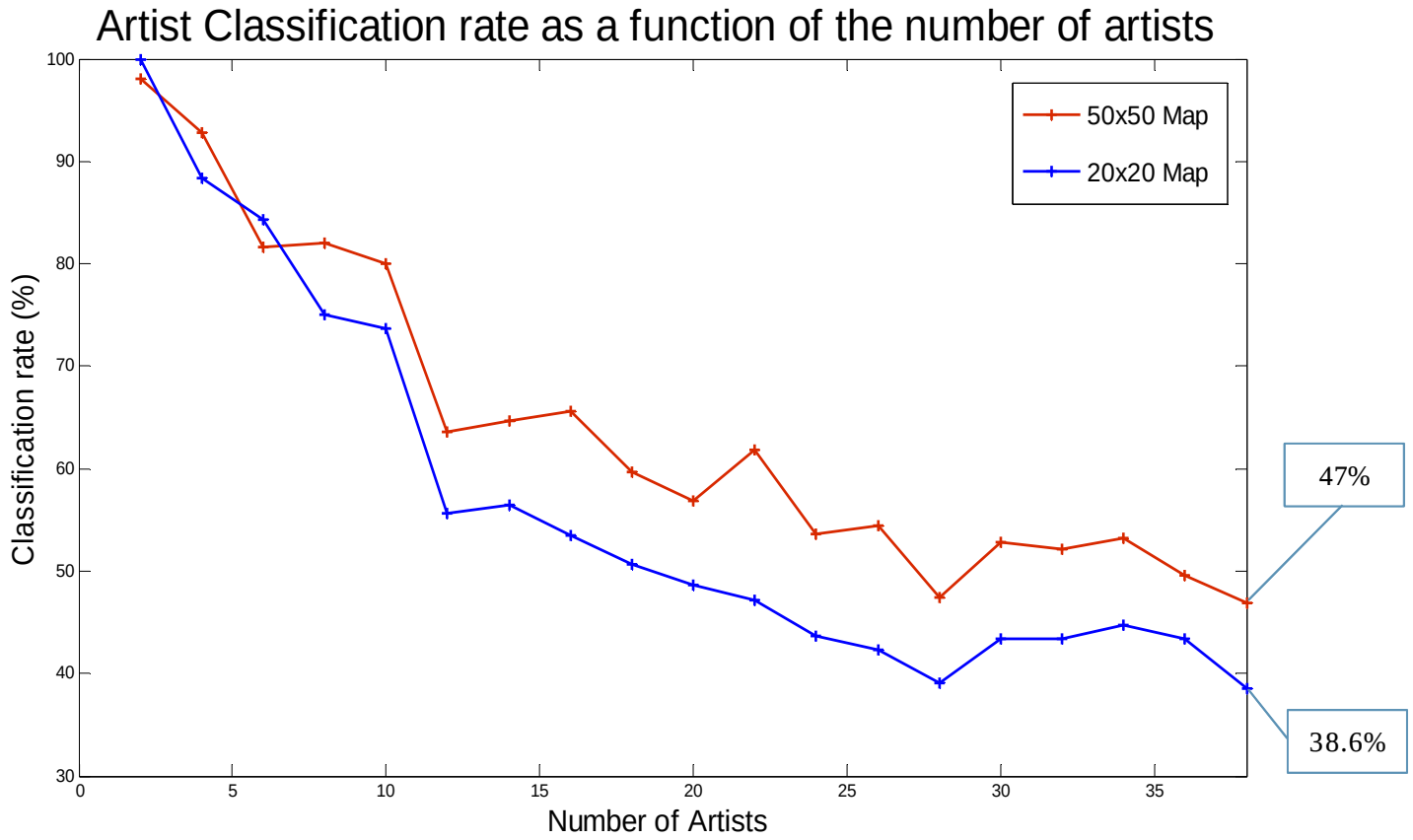


Classification

- New (untrained) song from each album
- Find best matching node in the map
- Classification based on artist's histograms



Performance Analysis



Classification

- Classifying unknown artists:

  Mozart

  Billy Holiday

  Beatles

  Kanye West

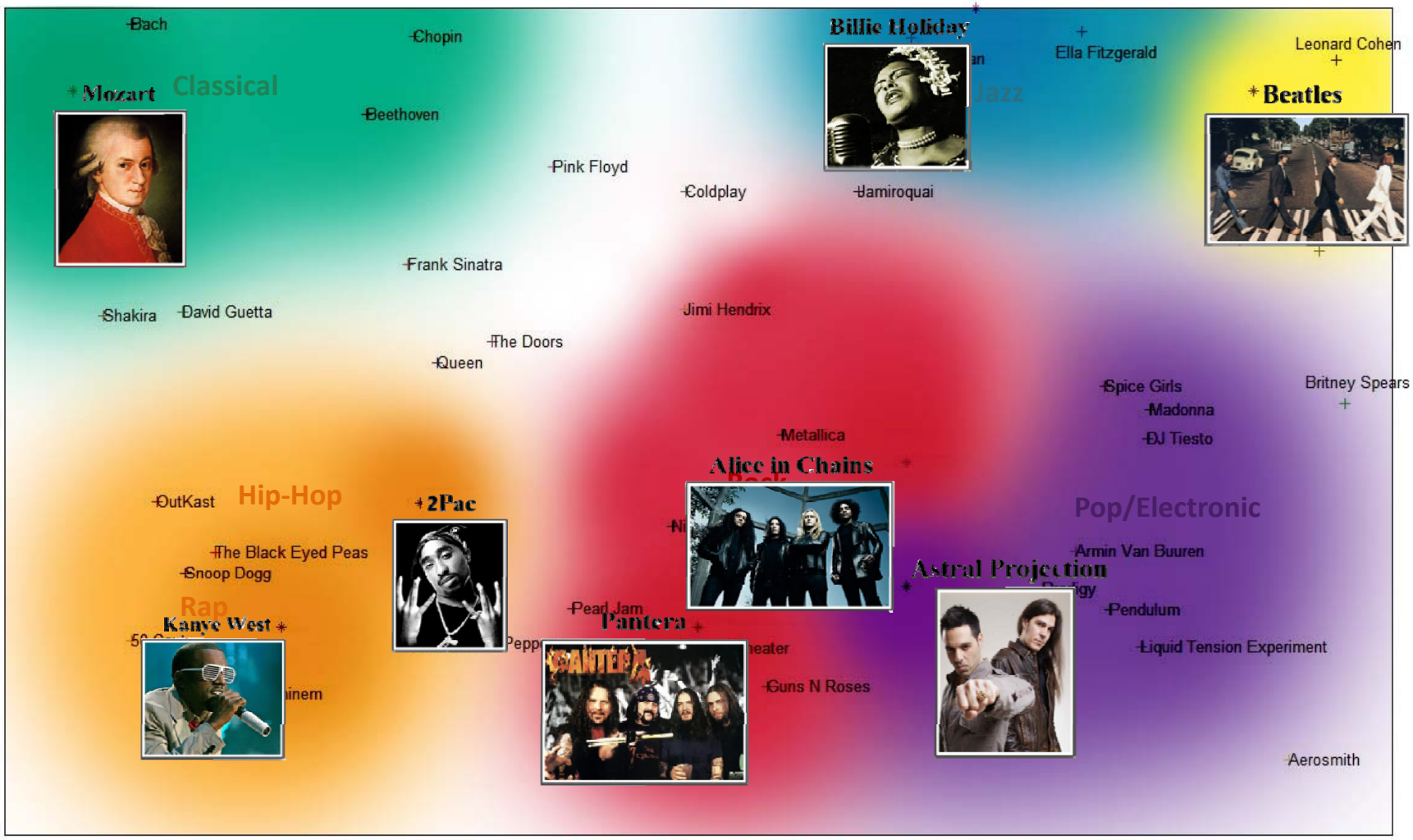
  2Pac

  Pantera

  Alice in Chains

  Astral Projection

Classifying Unknown Artists



Conclusions

- PCA + SOM for representing music similarities
- We manage to implement approach for music organization
- 50.7% artist classification rate
- 78.5% genre classification rate

Future Work

- Further study for features selection
- Automatic playlist creation
- Similar artists suggestions
- Adapting the algorithm to other fields

  i.e. painter classification


Thank You