AUDIO LABS

2nd International Jazzomat Research Workshop
Perspectives for Computational Jazz Studies

Using Domain Knowledge for Automatic Structure Analysis of Jazz Recordings

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Fraunhofer IIS

Thanks to the Band!

Meinard Müller

Christian Dittmar

Jonathan Driedger

Patricio López-Serrano

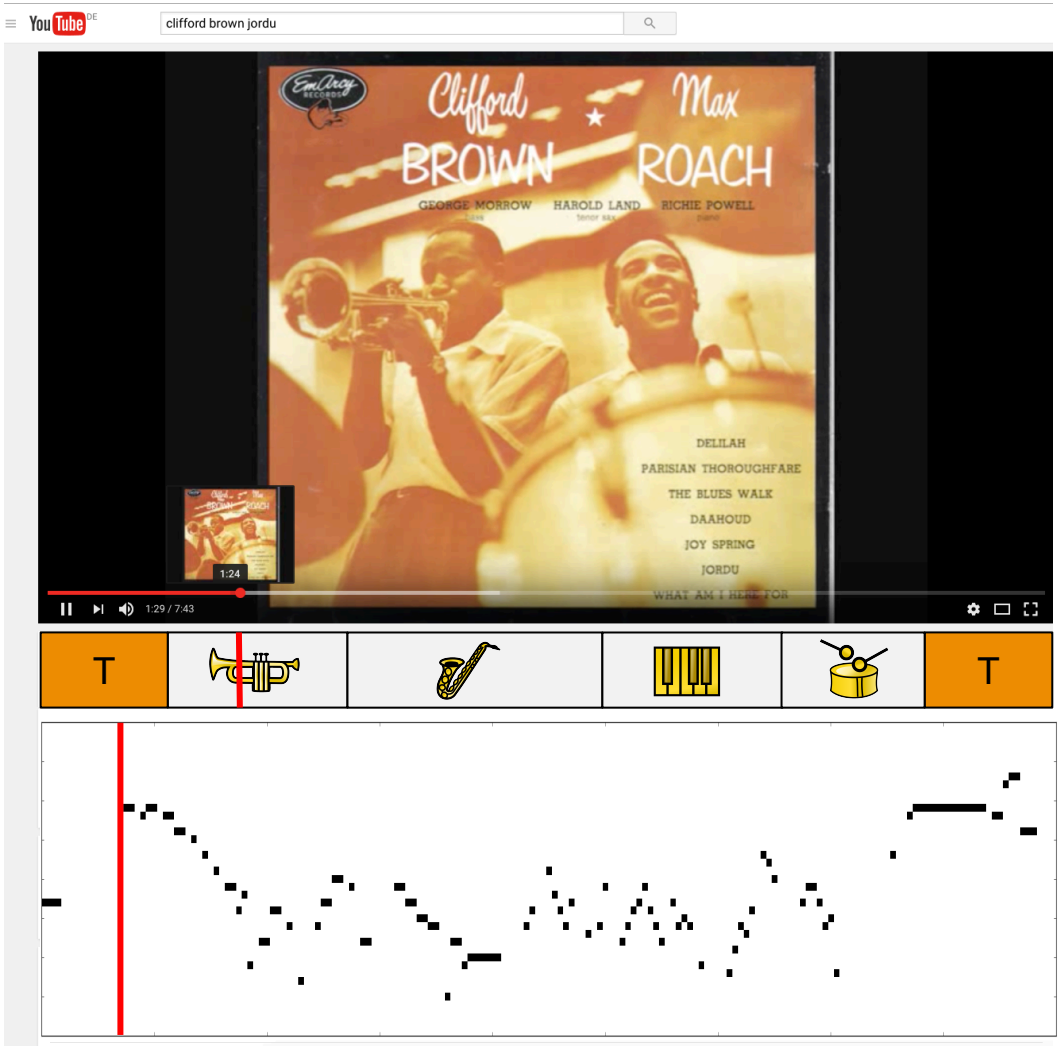
Thomas Prätzlich

Christof Weiß

Frank Zalkow

Jakob Abeßer

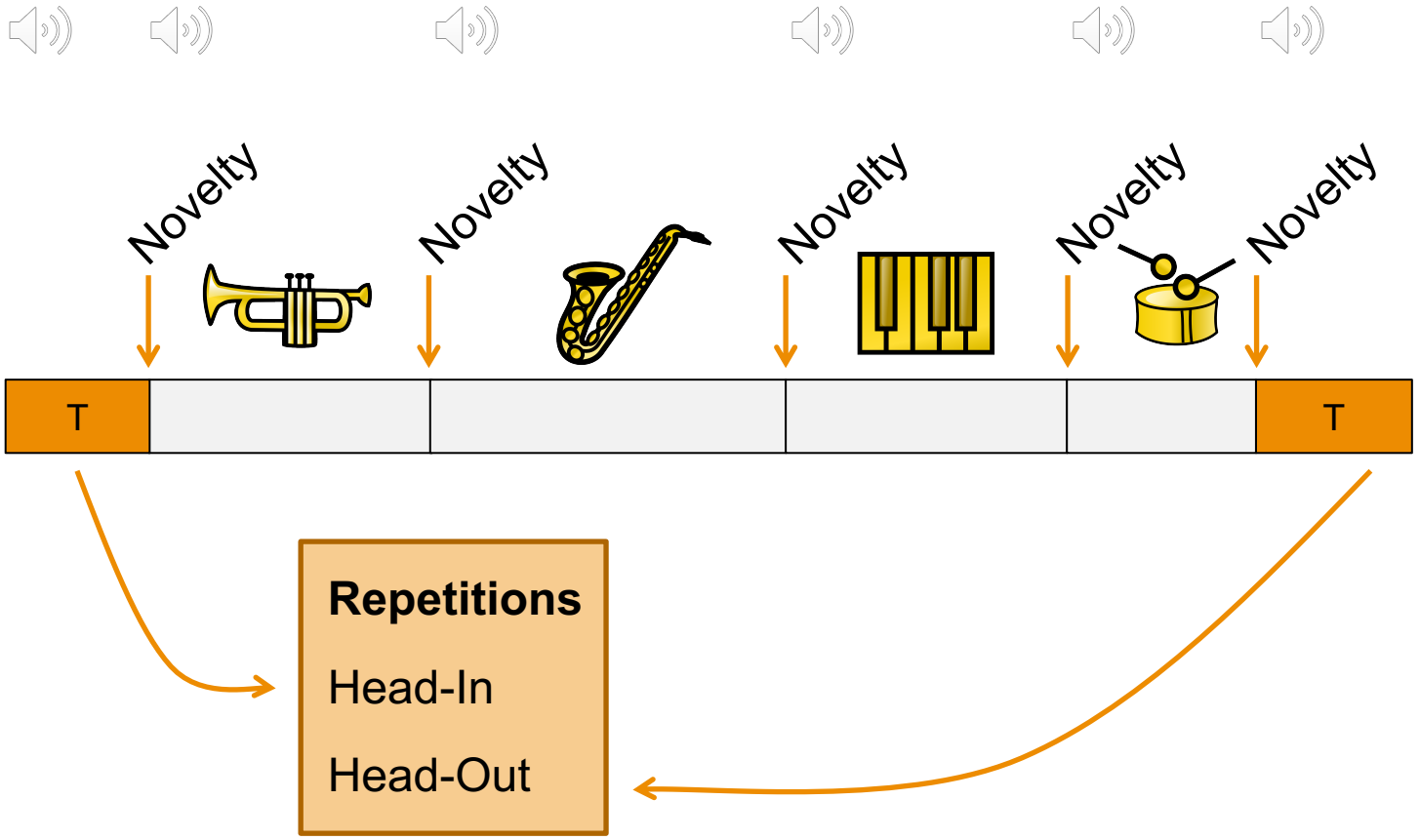
Motivation


clifford brown jordu
Clifford BROWN
Max ROACH
GEORGE MORROW
HAROLD LAND
RICHIE POWELL
DELILAH
PARISIAN THOROUGHFARE
THE BLUES WALK
DAAHOUD
JOY SPRING
JORDU
1:24
1:29 / 7:43
T
T

Outline

- Introduction
- Definition of Structure
- Principles of Automatic Structure Analysis
- Structure Annotations in the WJD
- Preliminary Results

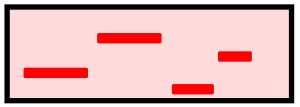
Basic Structure



Instrument Comics by H. Grohganz: https://mir.sechsachtel.de/orchpics/

Solo-Centric Annotations

Transcription



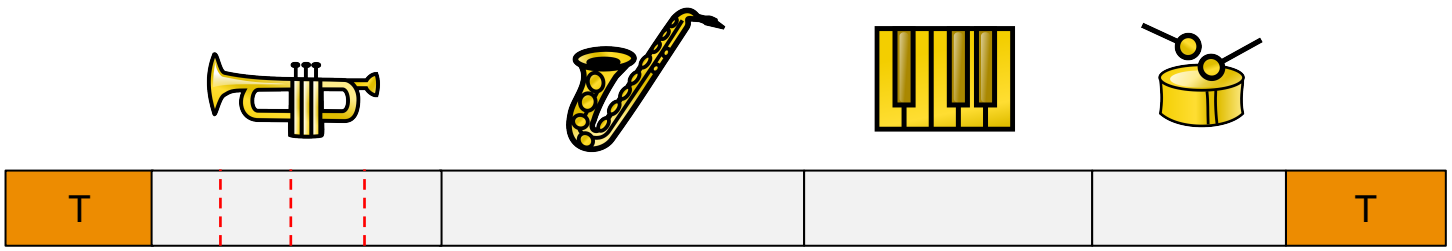
Beats

| E^7 A^7 | D^7 G^7 | …

Chords

…

Song-Centric Annotations

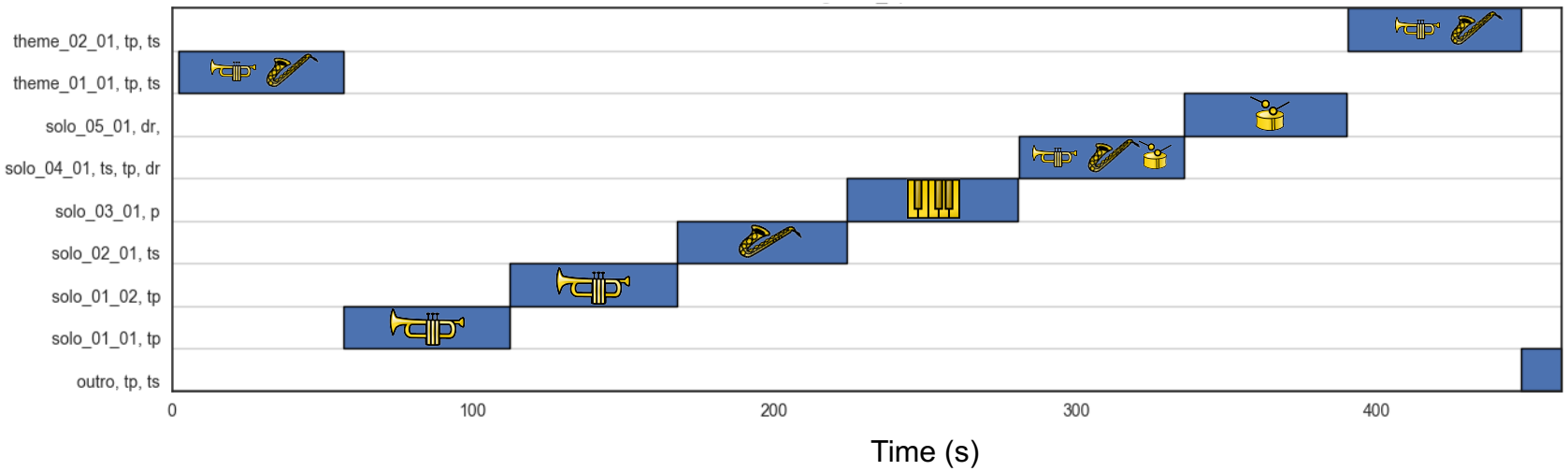


Payback Time

New annotations from the groups in Erlangen/Weimar!

Annotation Example from the Weimar Jazz DB

Clifford Brown - Jordu



Song-Centric Annotations:

- Chorus boundaries
- Solo choruses
- Theme repetitions

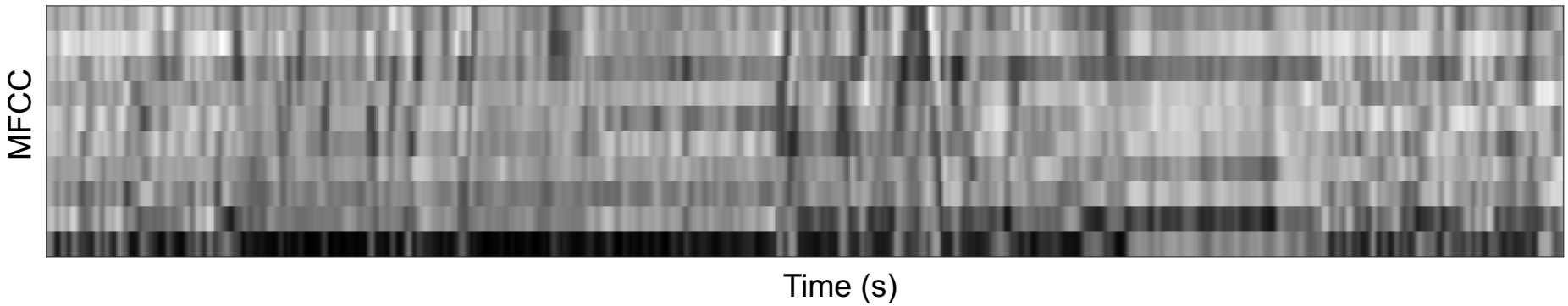
Thank you,
Moritz Berendes!

Automatic Structure Analysis (MIR)

- Active research direction since ~20 years.
- Main principles:
  - **Repetition**-based Structure Analysis
  - **Homogeneity**-based Structure Analysis
  - **Novelty**-based Structure Analysis

Self-Similarity Matrix

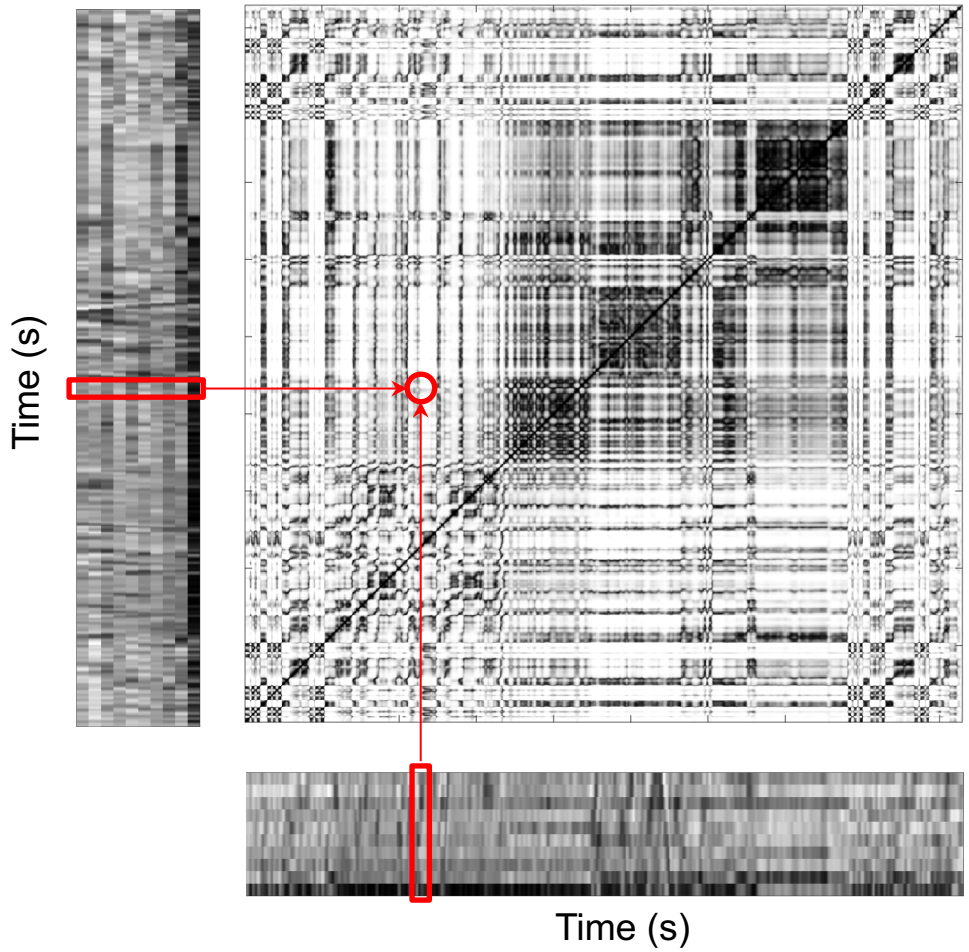
1. Step: Extract Audio Features



- Mel Frequency Cepstral Coefficients (MFCC) correlate to the timbre.

Self-Similarity Matrix

2. Step: Calculate Pairwise Similarity



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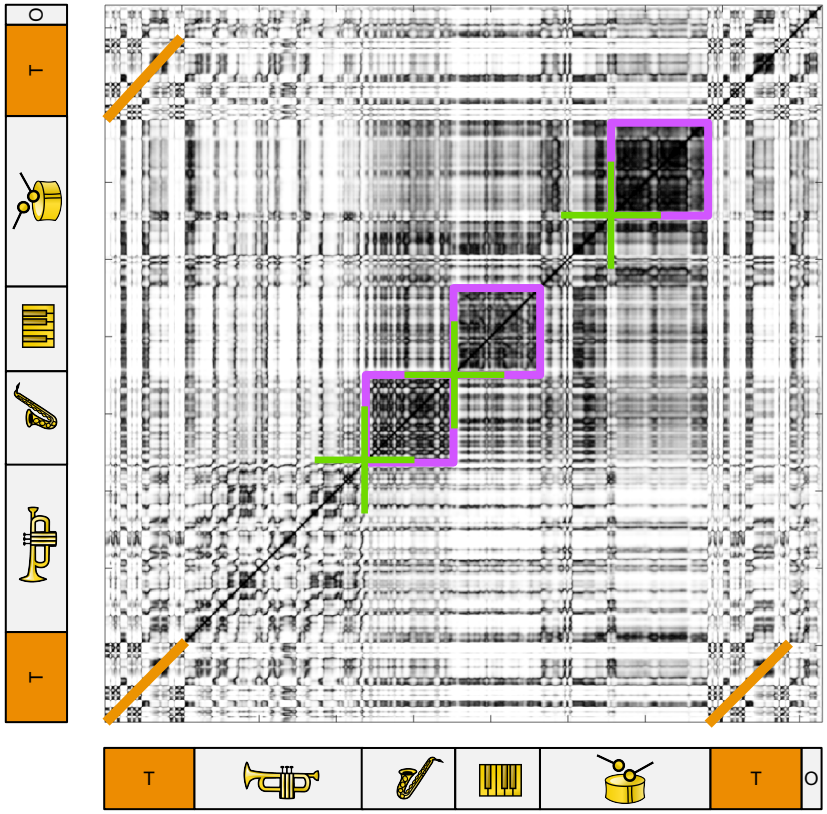
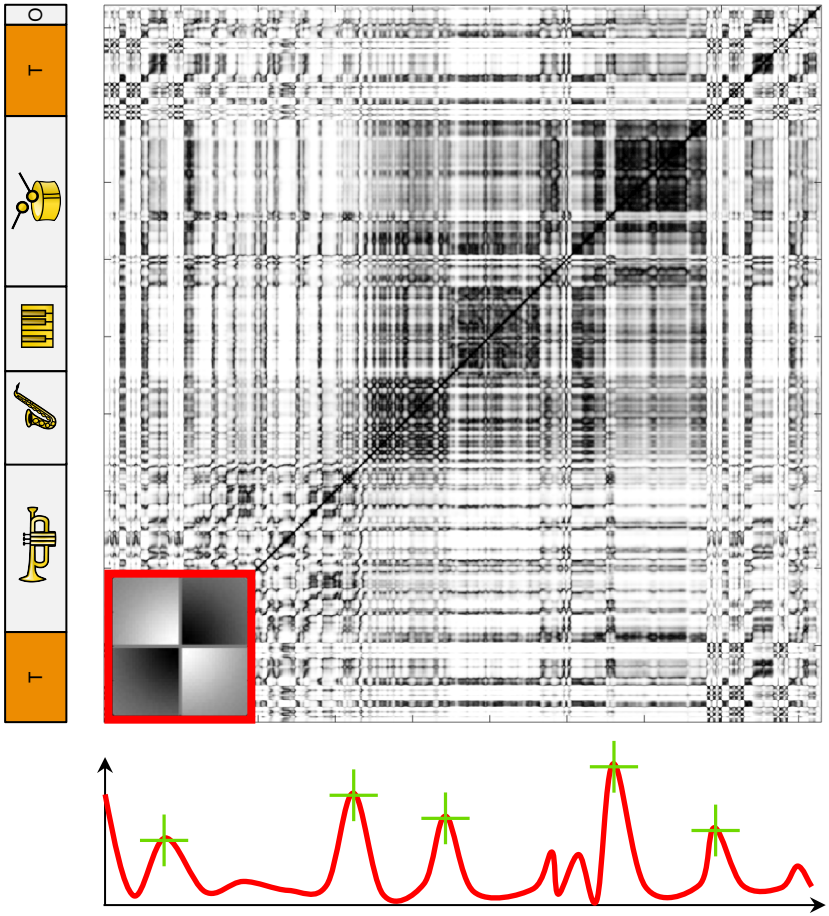
Self-Similarity Matrix
Analysis

- Repetitions:
  Path-like structures
- Homogeneity:
  Block-like structures
- Novelty:
  Corners



Self-Similarity Matrix
Novelty Detection

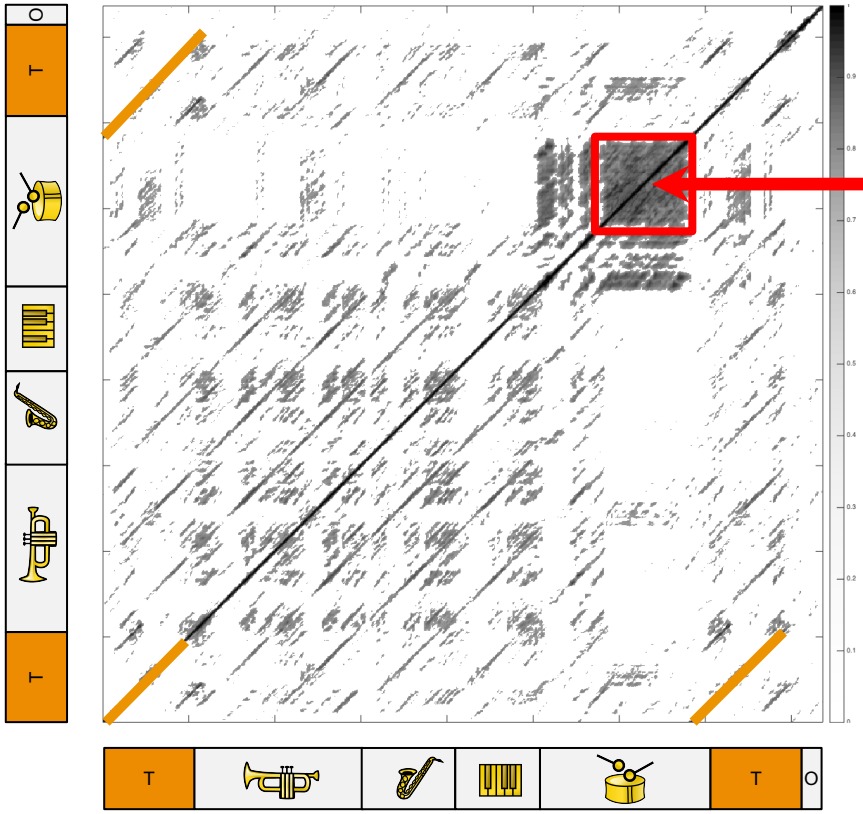


Idea (Foote):

Use checkerboard-like kernel function to detect corner points on main diagonal of SSM.

Self-Similarity Matrix
Chroma Features

- Chroma instead of MFCC
- Repetitions result in path-like structures
- Head-In and Head-Out

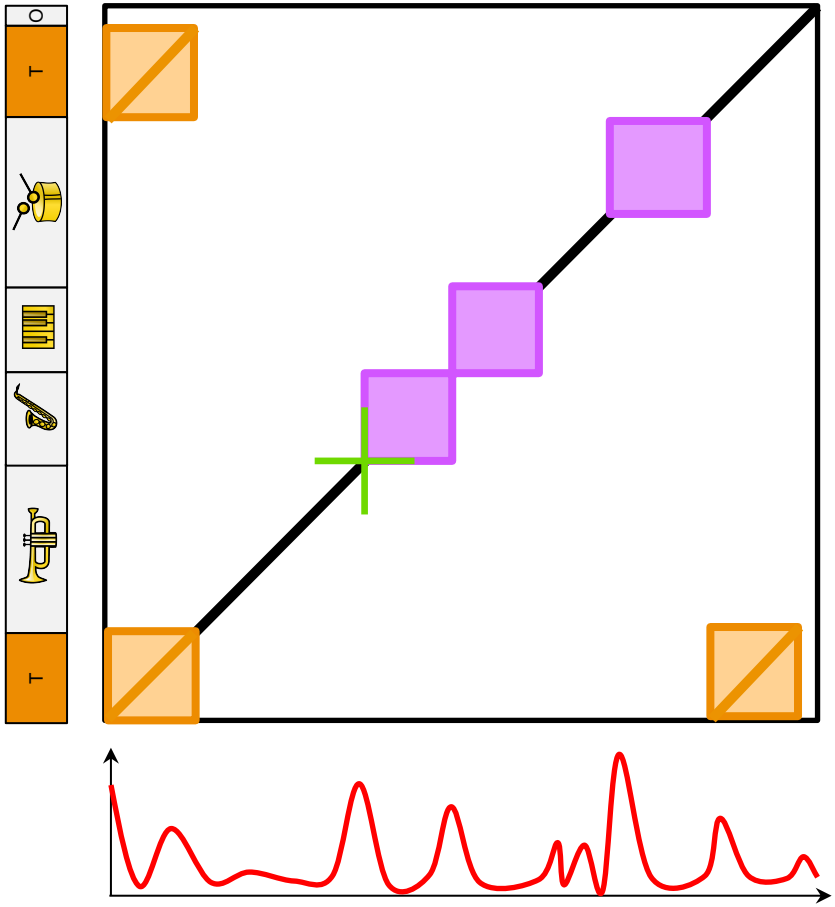


Drum Solo

Self-Similarity Matrix
Recap

- Repetitions:
  Path-like structures
- Homogeneity:
  Block-like structures
- Novelty:
  Corners

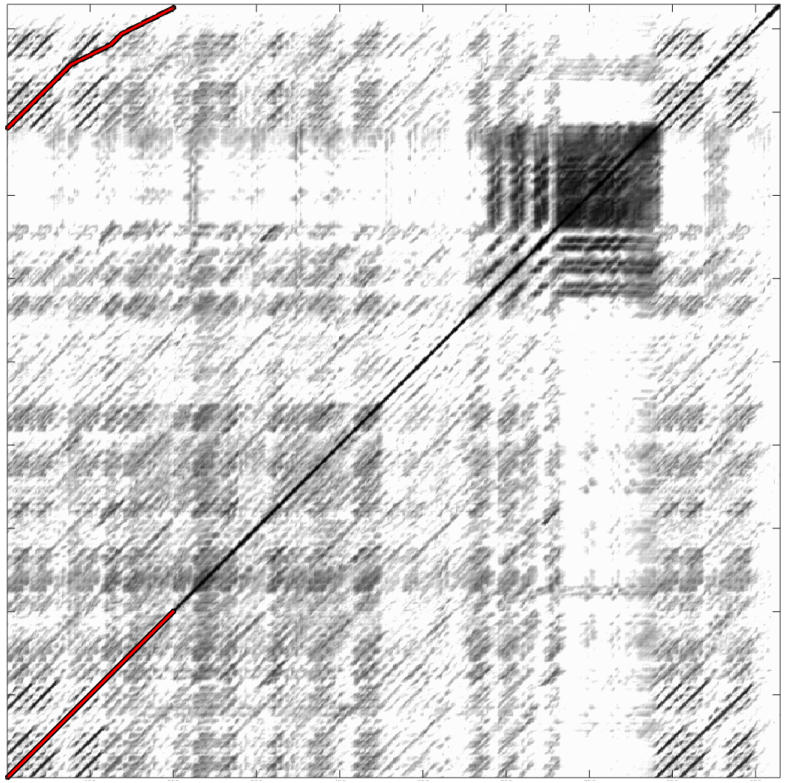
- Features are important!



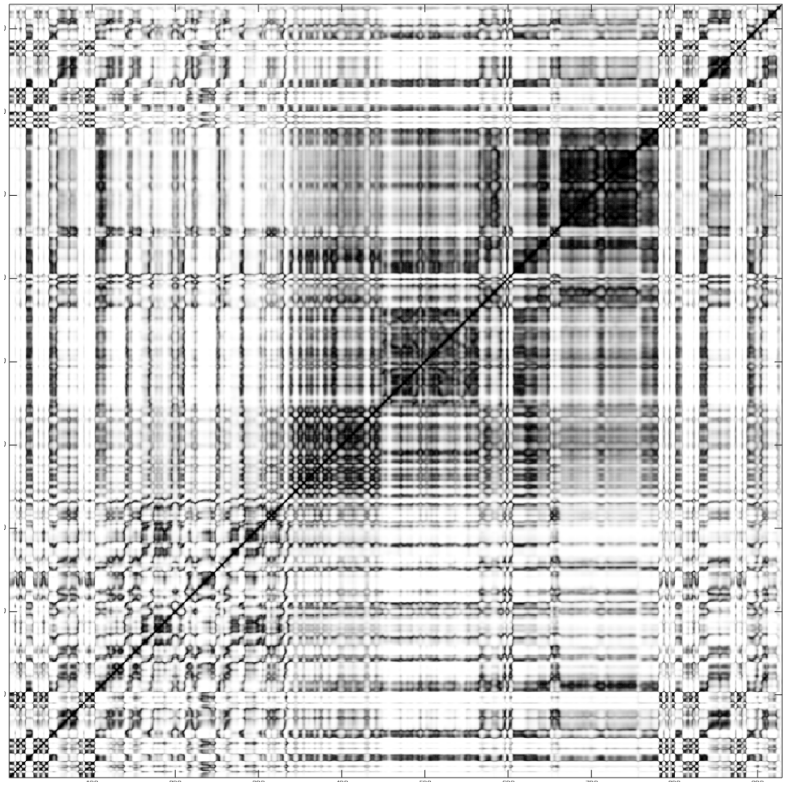
Preliminary Results

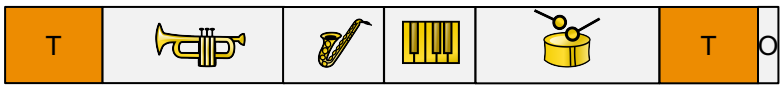
Clifford Brown – Jordu

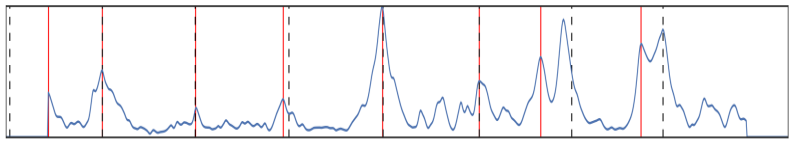
Chroma



MFCC



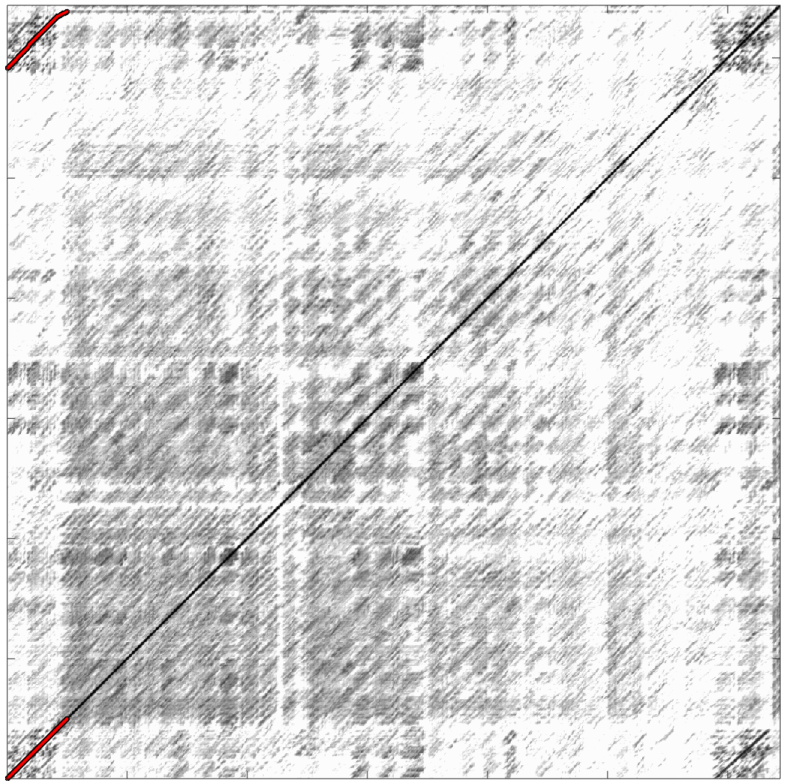




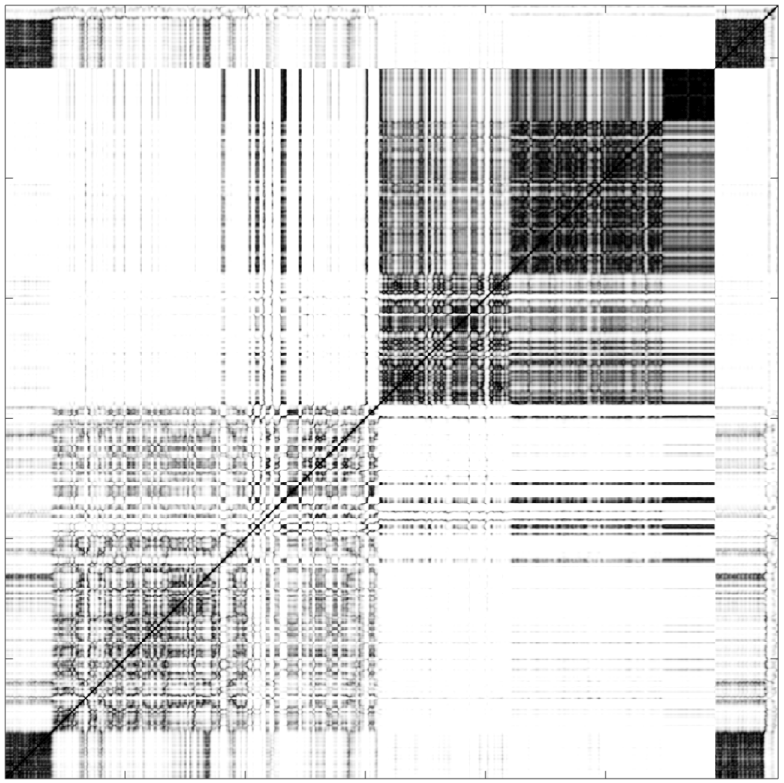
Preliminary Results

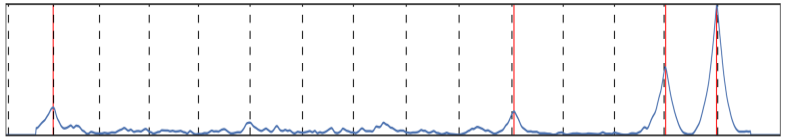
John Coltrane – Blue Trane

Chroma



MFCC





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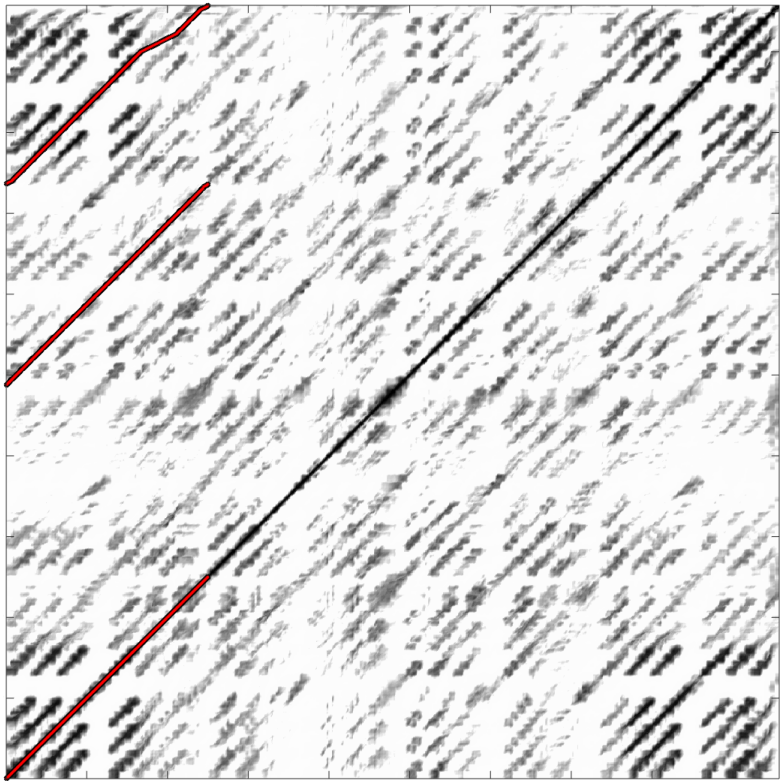
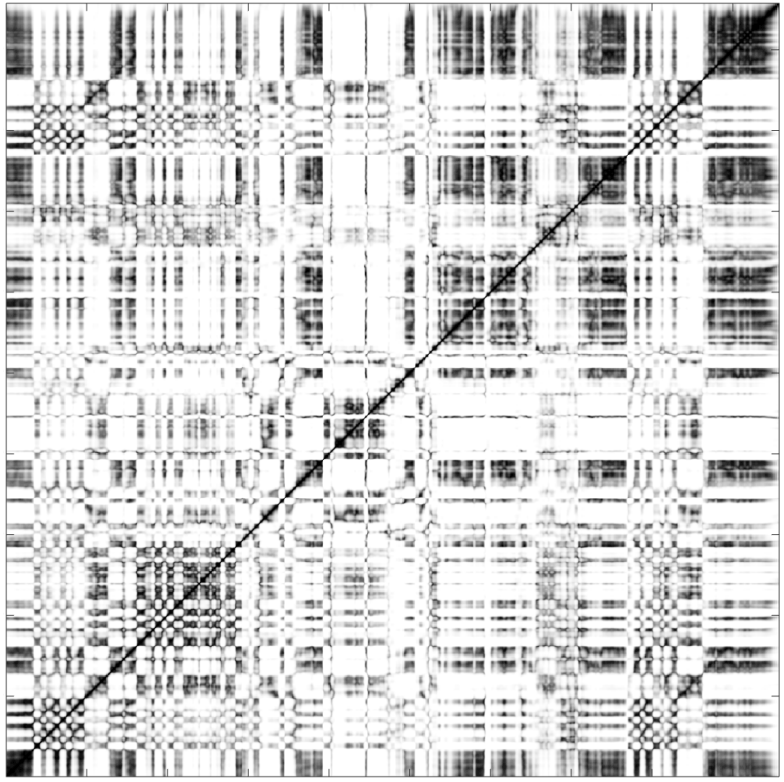
Preliminary Results

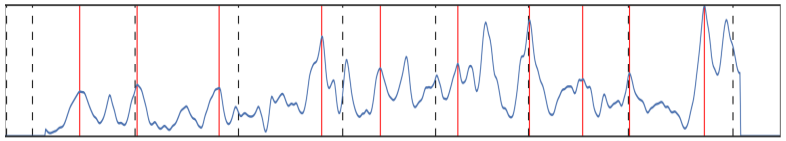
Herbie Hancock – Maiden Voyage

Chroma



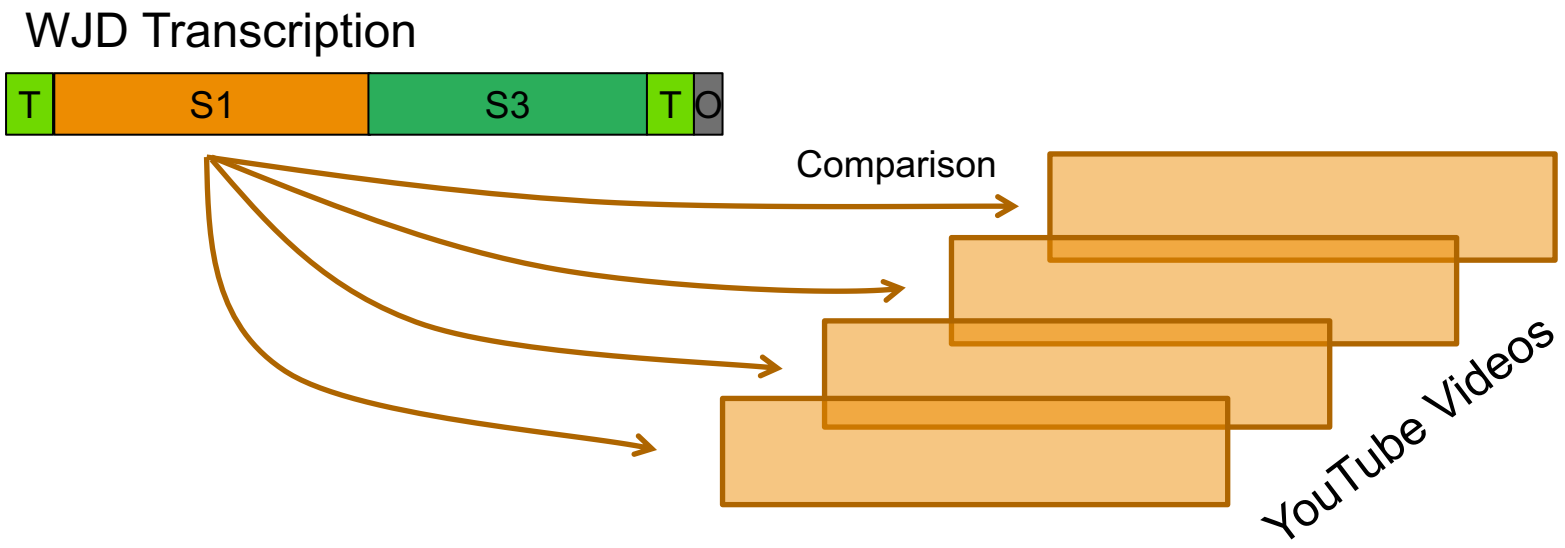
MFCC



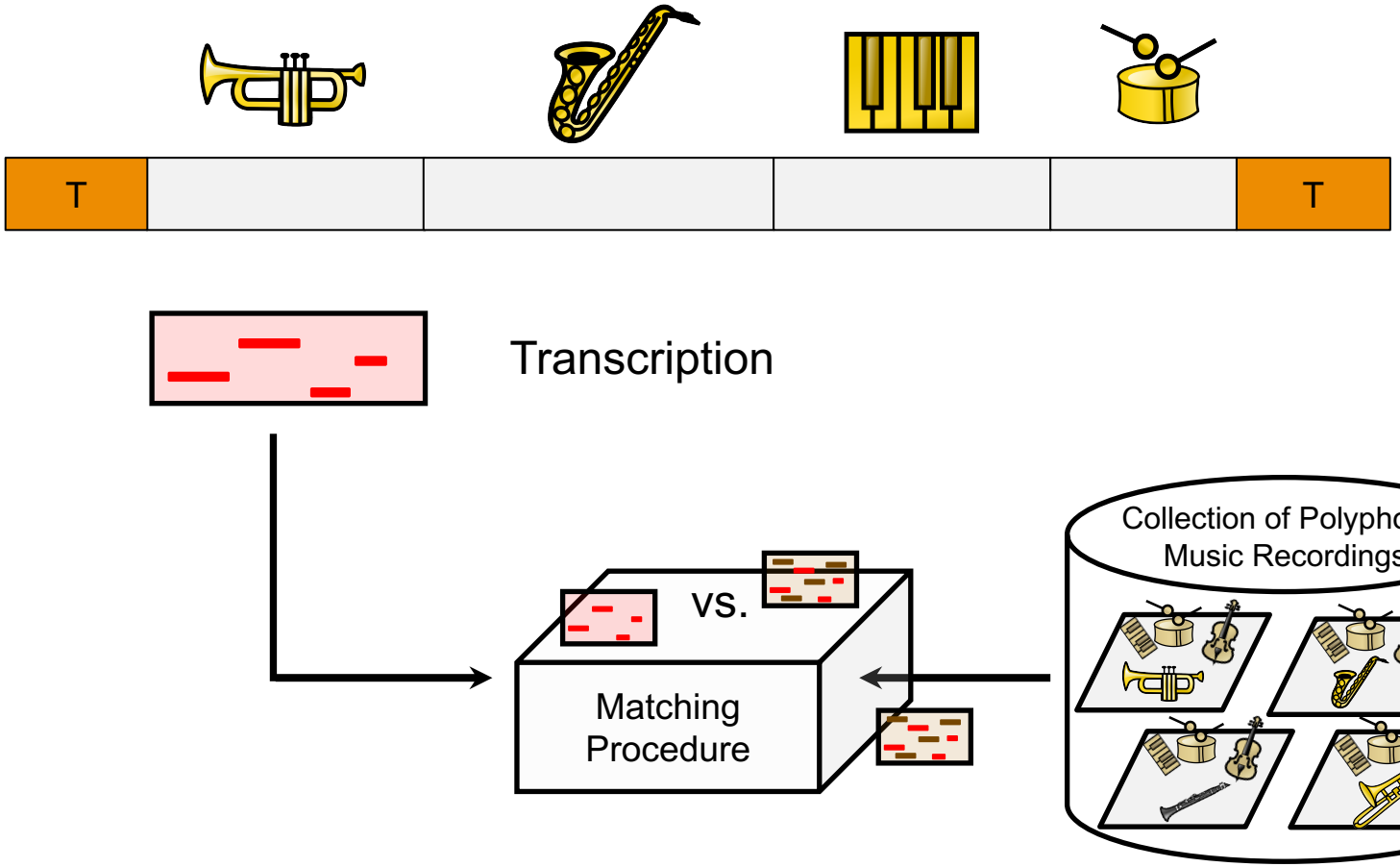


Retrieval Approach

- Motivation: Lots of Recordings are available on YouTube.
- Use Solo Transcriptions for Version Identification
- Possible Sources: YouTube, Soundcloud, etc.

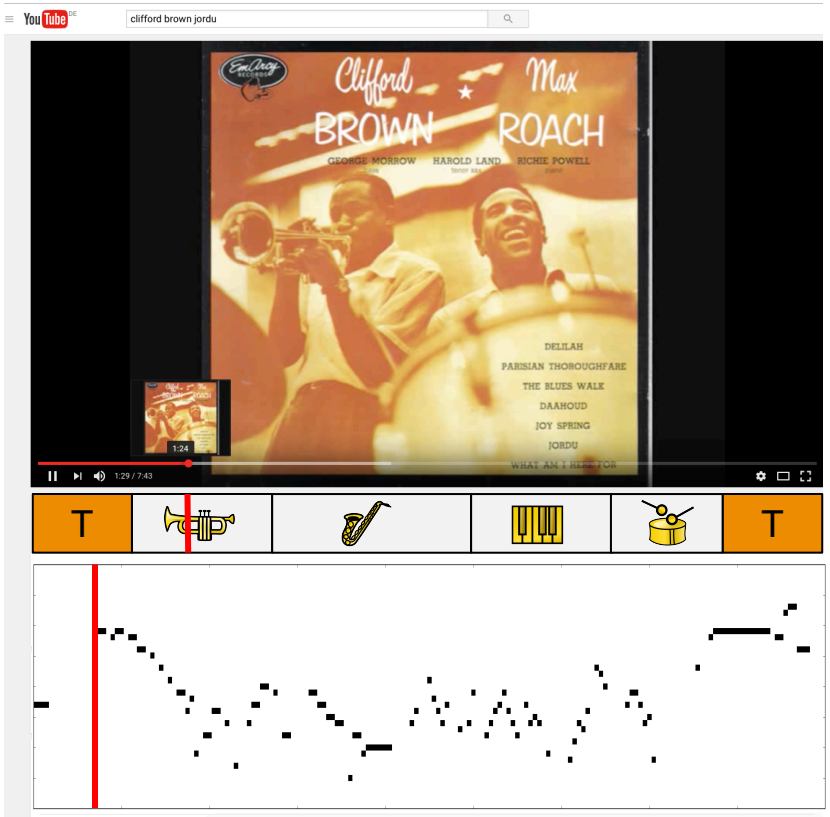


There's more than one way to bake a cake…
Retrieval Approach



Conclusions

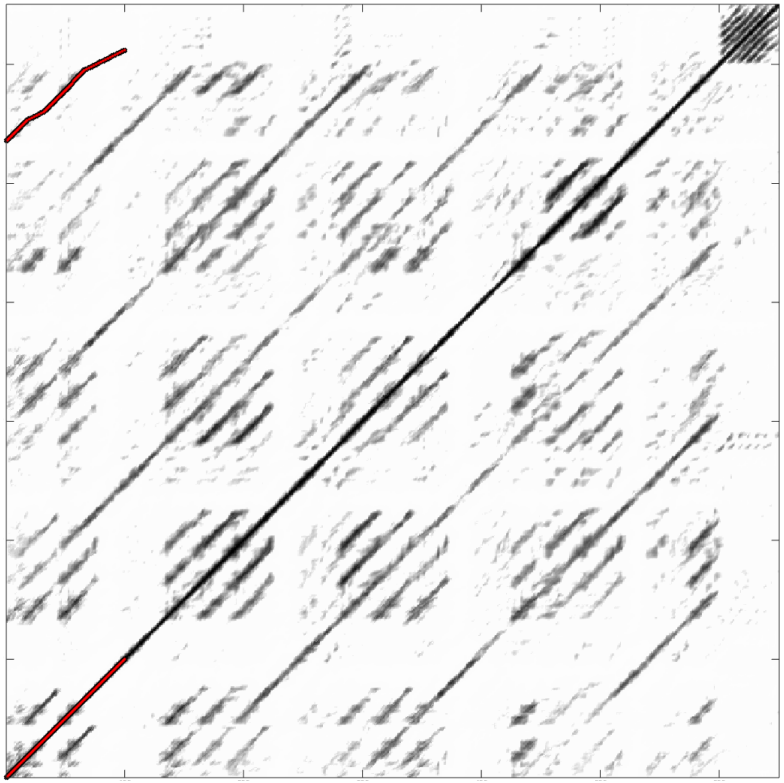
- WJD contains very cool annotations!
- Additional song-centered annotations
- Enrich listening experience
- Annotations will be made available soon!



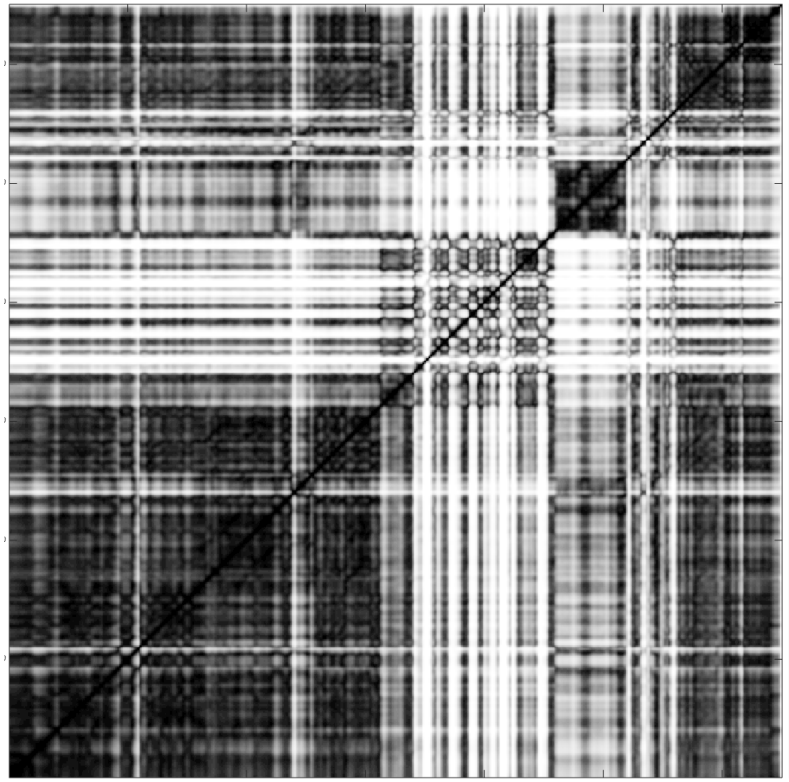
Preliminary Results

Stan Getz – The Girl from Ipanema

Chroma



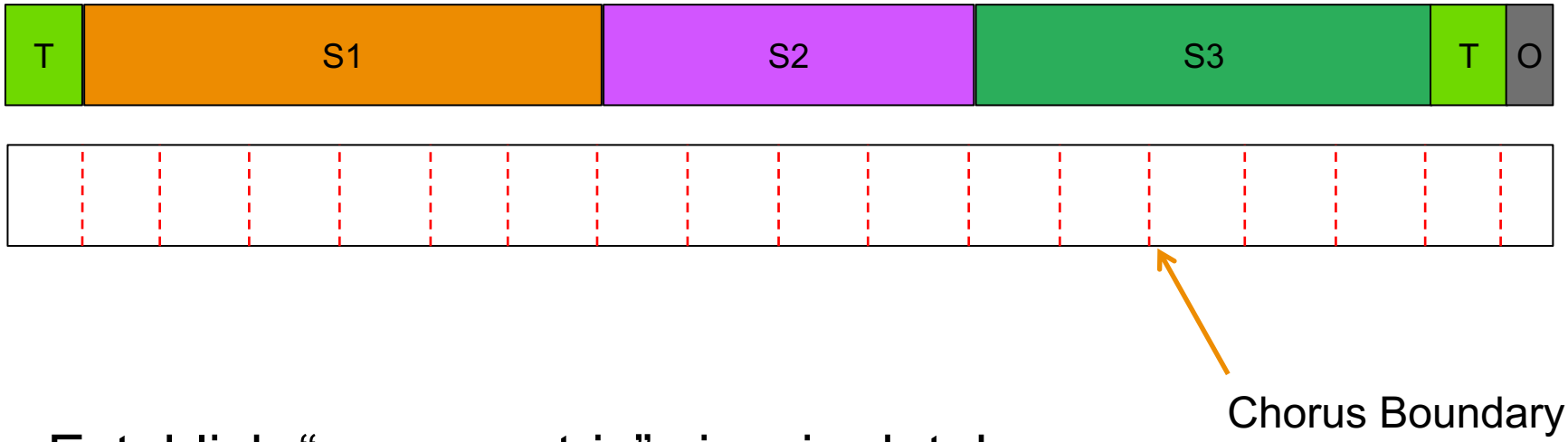
MFCC



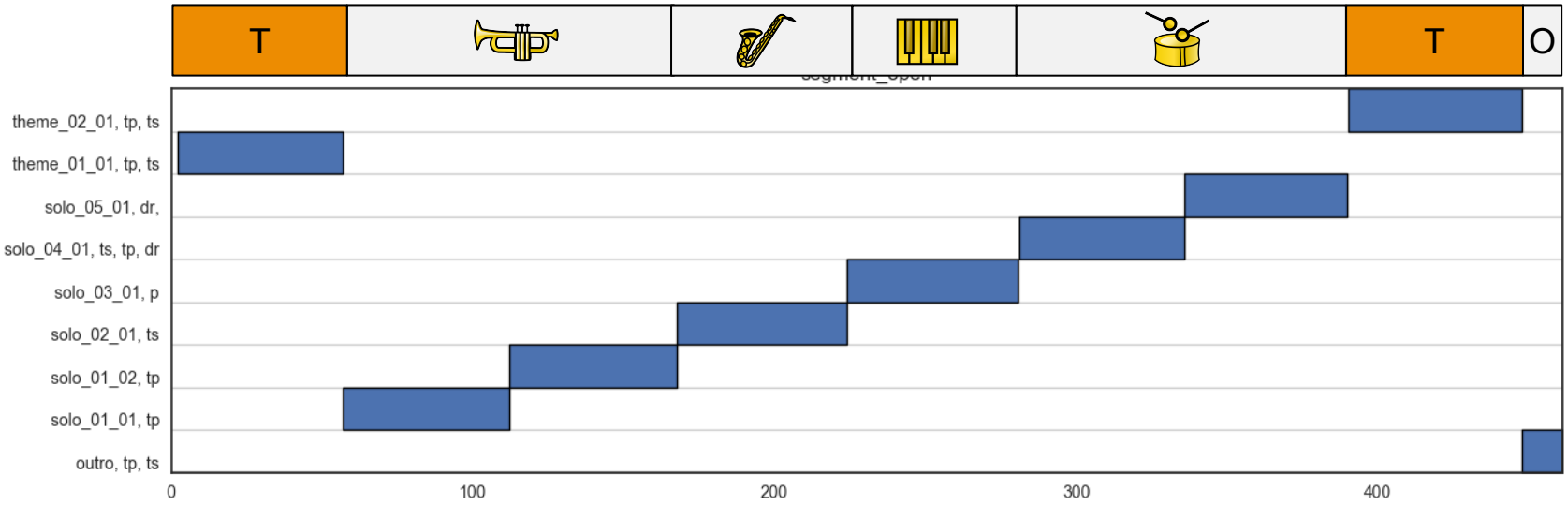
Implementation Details

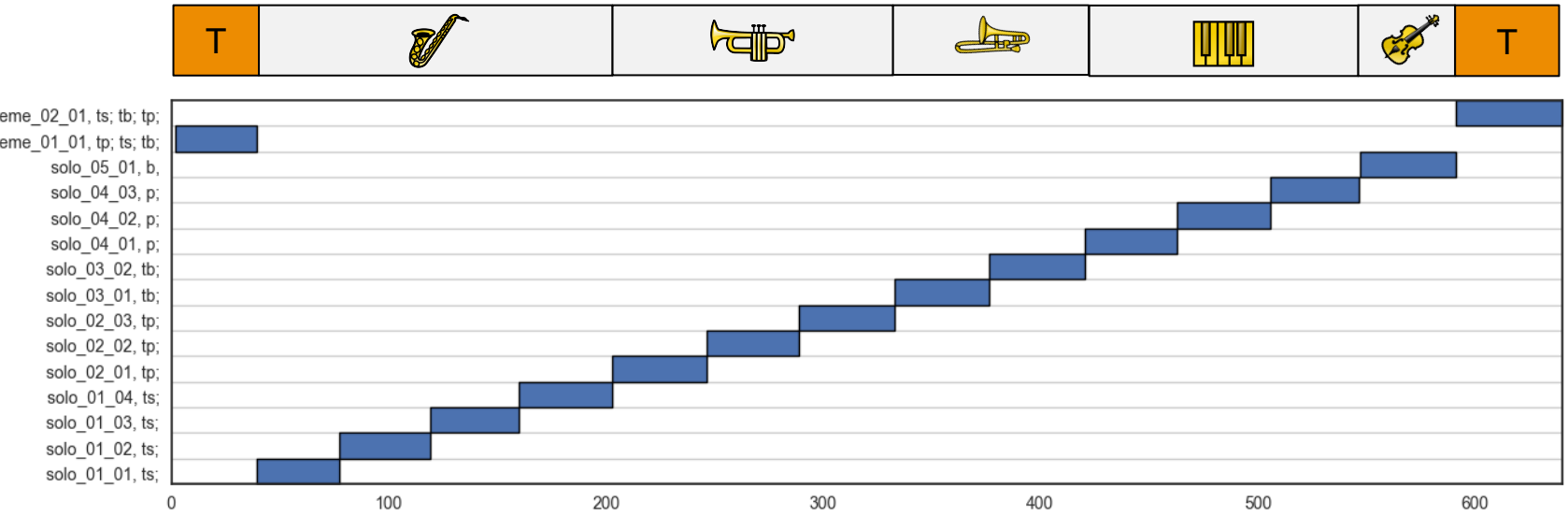
- Chroma:
  - CENS-21-5 (2 Hz feature rate)
- SSM:
  - Forward-backward smoothing
  - Tempo compensation (0.7 – 1.3, 5 steps)
- MFCC:
  - 10 coefficients (3 – 13)
  - 41 frames smoothing, 5 downsampling (2 Hz feature rate)
- Foote:
  - Kernel size: 100 frames (30 s)

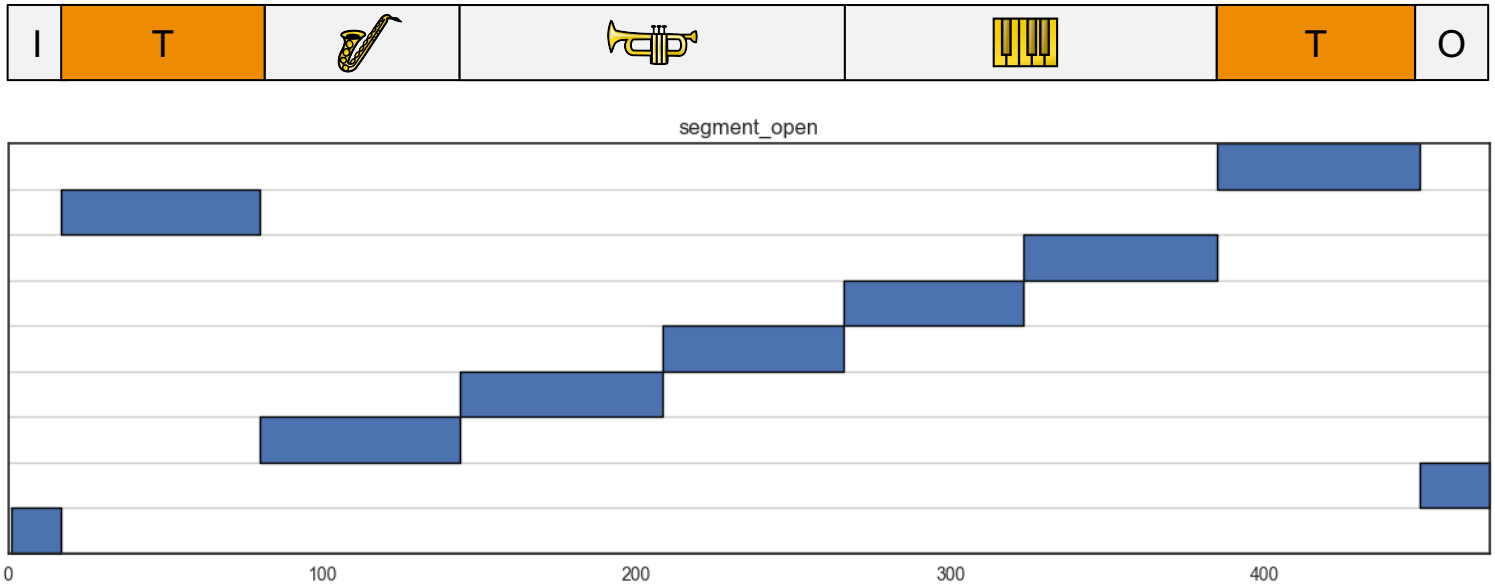
WJD – Modifications



- Establish “song-centric” view in database
- Use time axis as absolute reference
- Annotate chorus boundaries
- Annotate missing solo boundaries

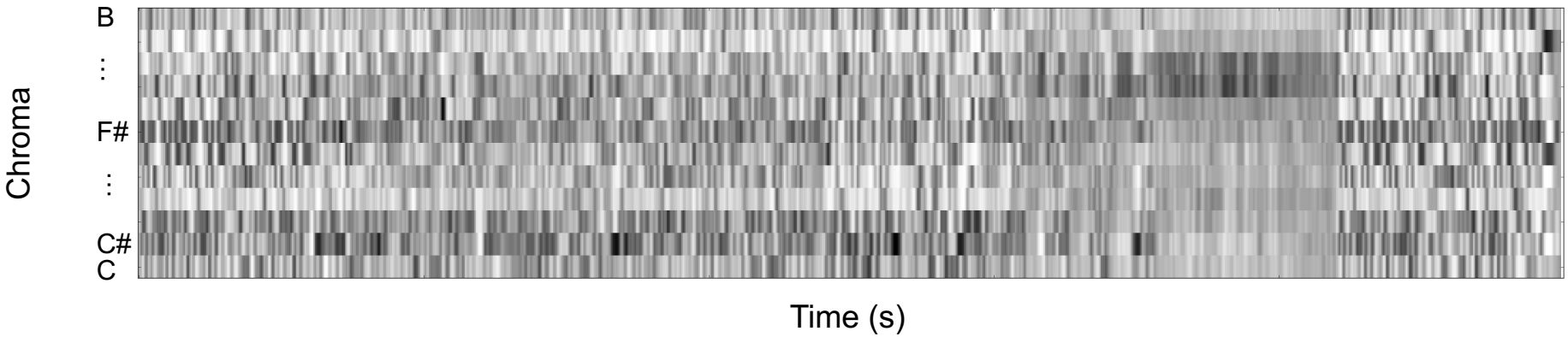

T
T
O
theme_02_01, tp, ts
theme_01_01, tp, ts
solo_05_01, dr,
solo_04_01, ts, tp, dr
solo_03_01, p
solo_02_01, ts
solo_01_02, tp
solo_01_01, tp
outro, tp, ts
0
100
200
300
400


T
T
eme_02_01, ts; tb; tp;
eme_01_01, tp; ts; tb;
solo_05_01, b,
solo_04_03, p;
solo_04_02, p;
solo_04_01, p;
solo_03_02, tb;
solo_03_01, tb;
solo_02_03, tp;
solo_02_02, tp;
solo_02_01, tp;
solo_01_04, ts;
solo_01_03, ts;
solo_01_02, ts;
solo_01_01, ts;
0
100
200
300
400
500
600


I
T
T
O
segment_open
eme_02_01, tp, ts
eme_01_01, tp,ts
solo_03_02, p
solo_03_01, p
solo_02_02, tp
solo_02_01, tp
solo_01_02, ts
outro, tp
intro, p
0
100
200
300
400

Self-Similarity Matrix

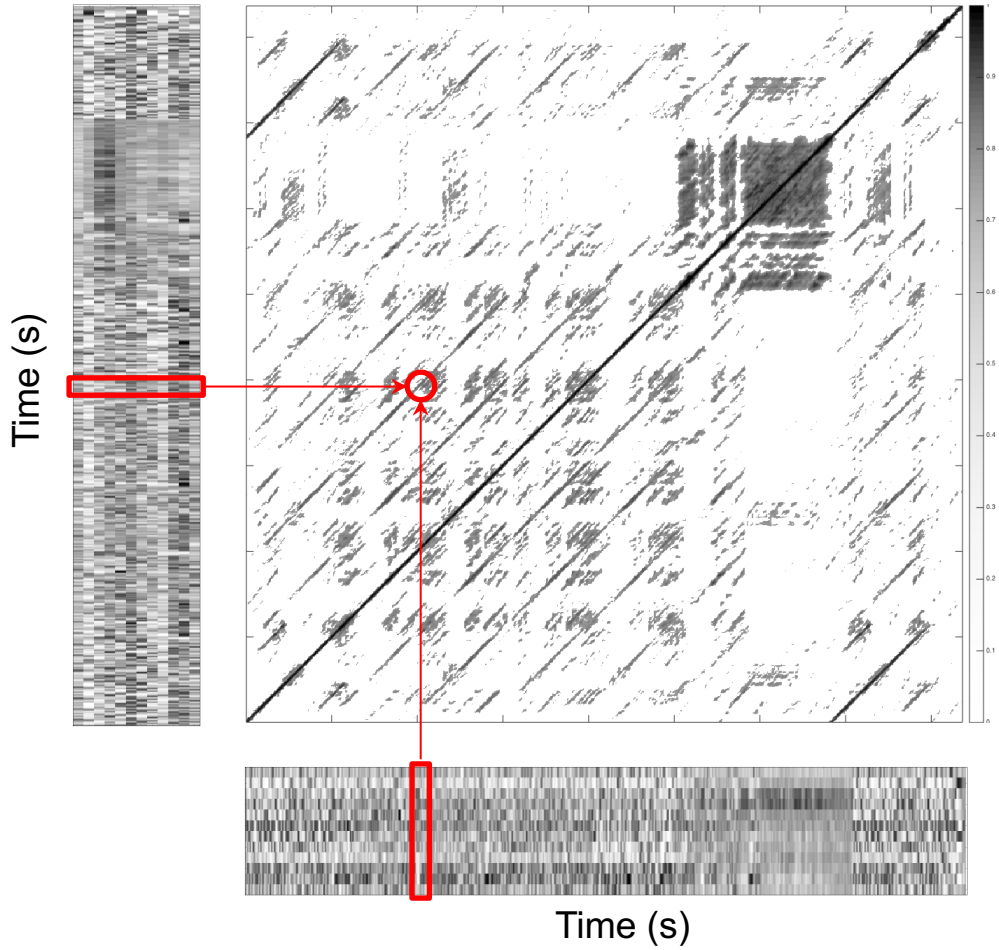
1. Step: Extract Audio Features

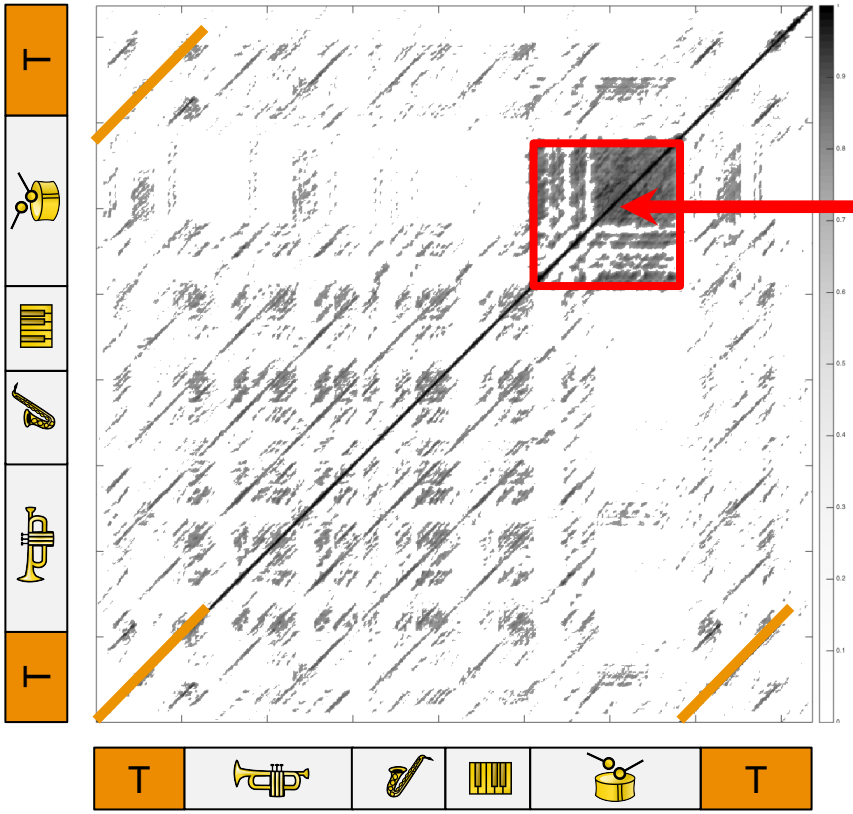


- Chroma Feature correlate to the harmonic and melodic progressions.

Self-Similarity Matrix

2. Step: Calculate Pairwise Similarity



Self-Similarity Matrix
Analysis

- Repetitions result in path-like structures
- Head-In and Head-Out