Hochschule für Musik Karlsruhe

Blockvorlesung

Advanced Audio-Based Music Processing

6. Corpus Analysis

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Dissertation: Tonality-Based Style Analysis

Christof Weiß
Computational Methods for Tonality-Based Style Analysis of Classical Music Audio Recordings
PhD thesis, Ilmenau University of Technology, 2017
https://www.db-thueringen.de/receive/dbt_mods_00032890

Chapter 7: Clustering and Analysis of Musical Styles

Corpus Analysis

Motivation

- Harmony analysis: individual pieces
- **Musical corpora**:
  - Closed set of pieces of a genre
  - Comprehensive set of pieces by a composer / artist
  - Representative set for a certain musical style
- **Corpus analysis**:
  - Analysis of individual pieces
  - **Aggregate** piece-wise results
  - **Visualize** results to see trends **on the large scale**

Corpus Analysis

Overview

Three example studies:

- Chord transitions in Western classical music
- Tonal complexity in Western classical music
- Tonal complexity in jazz solos

Corpus Analysis

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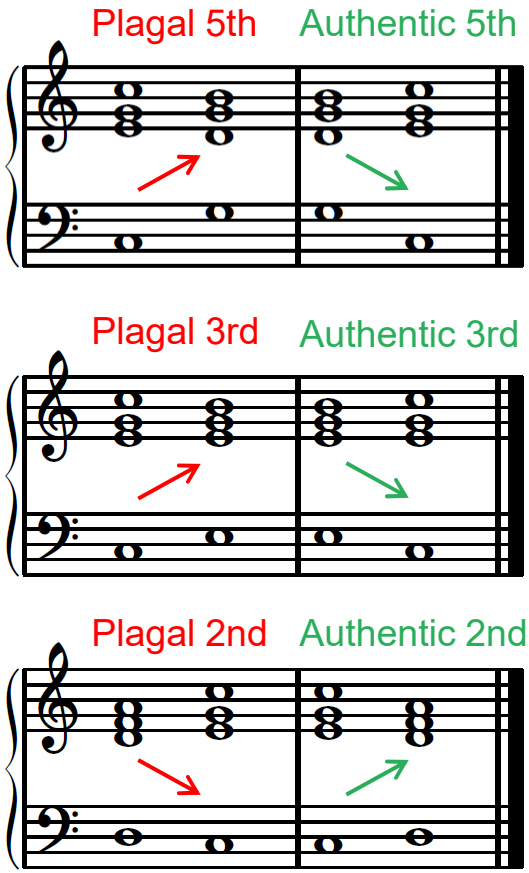
- Tonal complexity in Western classical music
- Tonal complexity in jazz solos

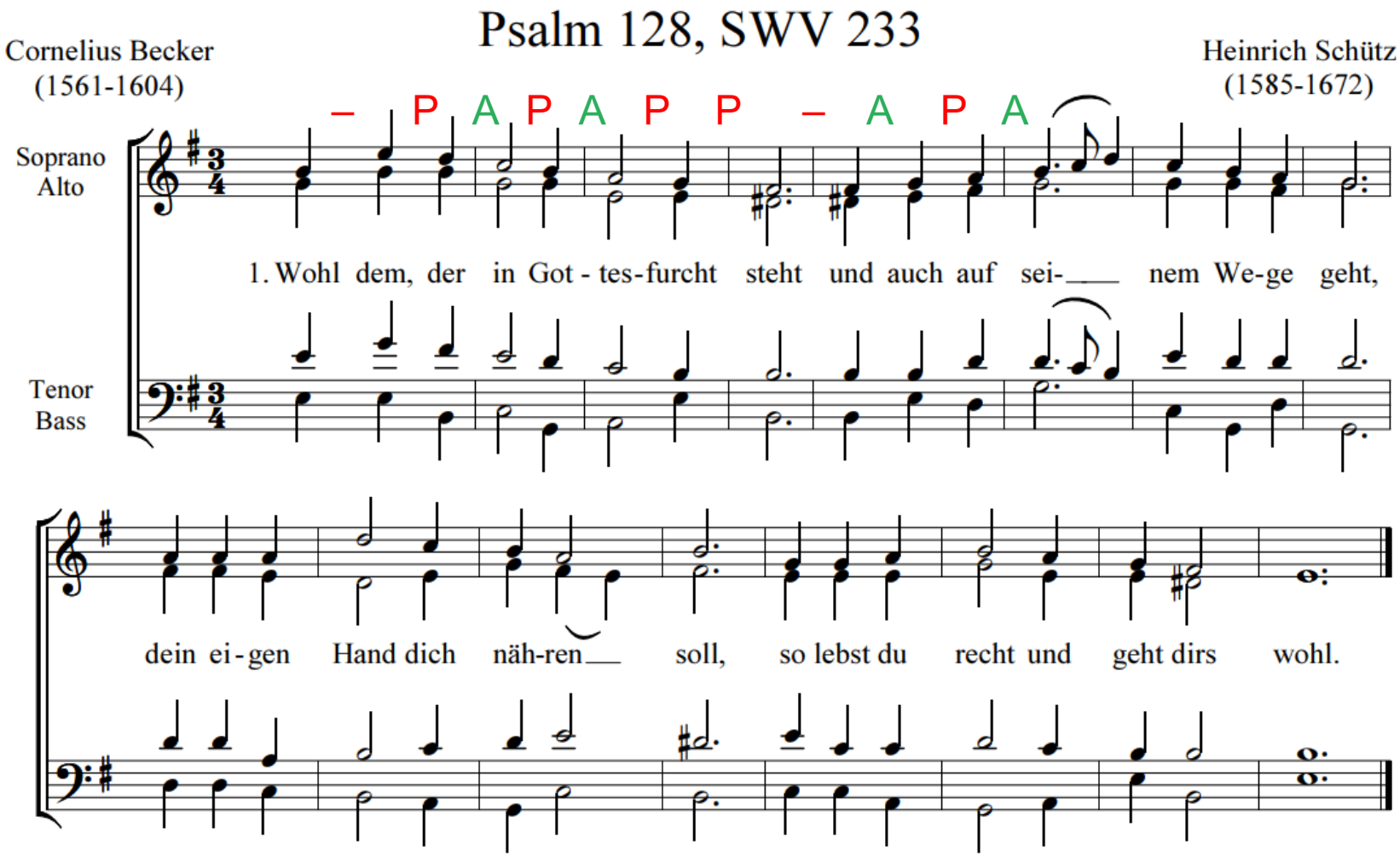
Chord transitions: Plagal vs. Authentic

- Authentic progressions: „falling“, „moving forward“, „directional“
- Plagal progressions: „opening“, „archaic“ („A-men“), colorful



Interval	Δ	Complem.	Δ	Quality
P1	0	P8 ↘	-12	None
m2 ↗	+1	M7 ↘	-11	Authentic
M2 ↗	+2	m7 ↘	-10	Authentic
m3 ↗	+3	M6 ↘	-9	Plagal
M3 ↗	+4	m6 ↘	-8	Plagal
P4 ↗	+5	P5 ↘	-7	Authentic
+4 ↗	+6	°5 ↘	-6	None
P5 ↗	+7	P4 ↘	-5	Plagal
m6 ↗	+8	M3 ↘	-4	Authentic
M6 ↗	+9	m3 ↘	-3	Authentic
m7 ↗	+10	M2 ↘	-2	Plagal
M7 ↗	+11	m2 ↘	-1	Plagal
P8 ↗	+12	P1	0	None

Chord transitions: Plagal vs. Authentic

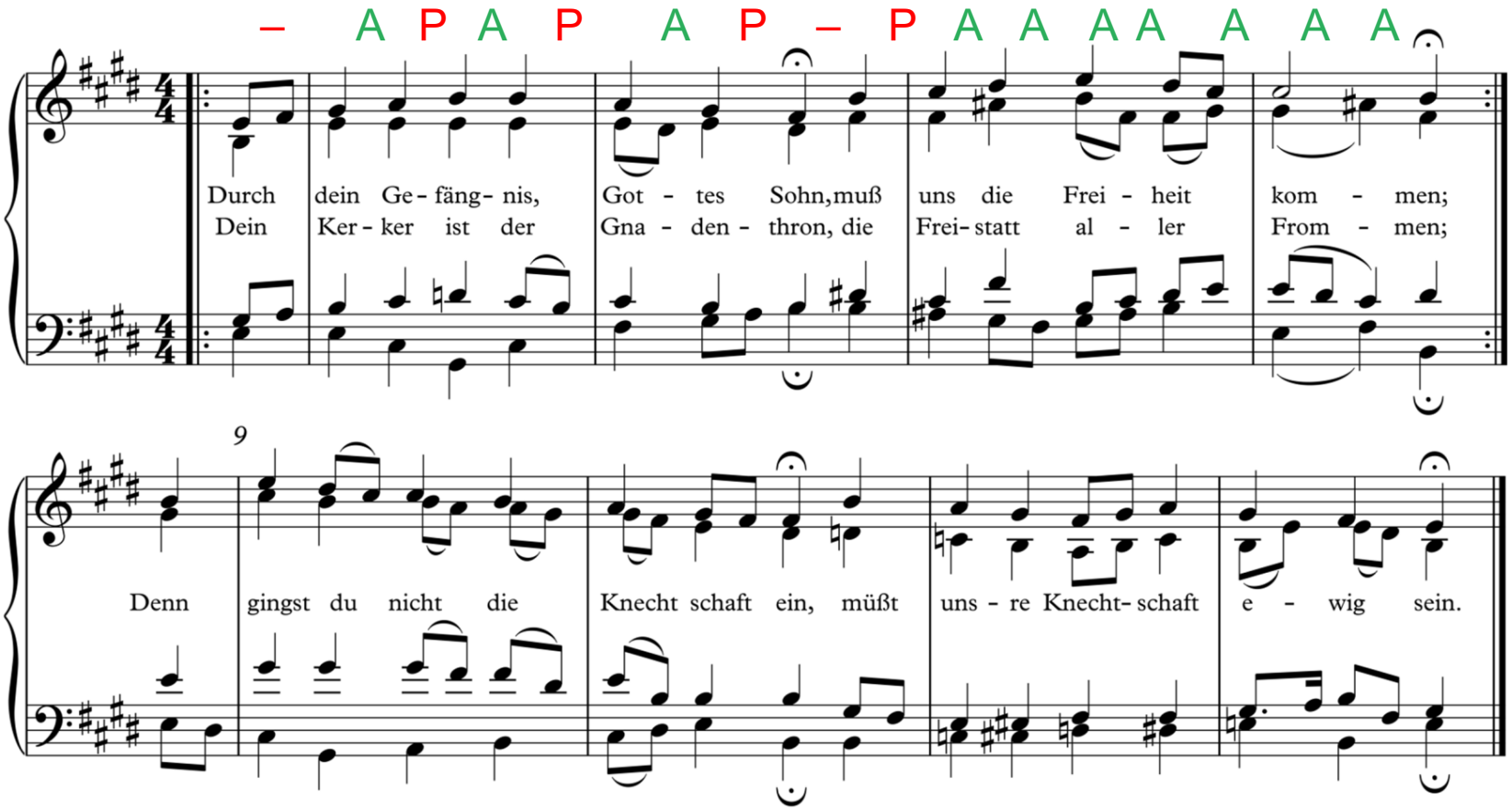


∑ P: 14 A: 13

Chord transitions: Plagal vs. Authentic

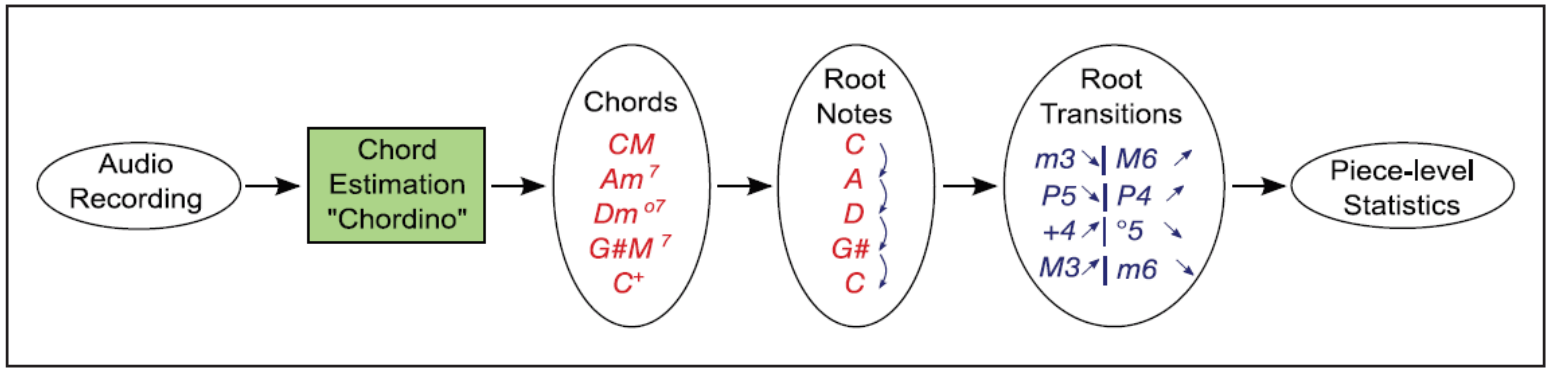
"Durch Dein Gefängnis" (Johannespassion)

J. S. Bach



∑ P: 9 A: 20

Chord transitions: Plagal vs. Authentic



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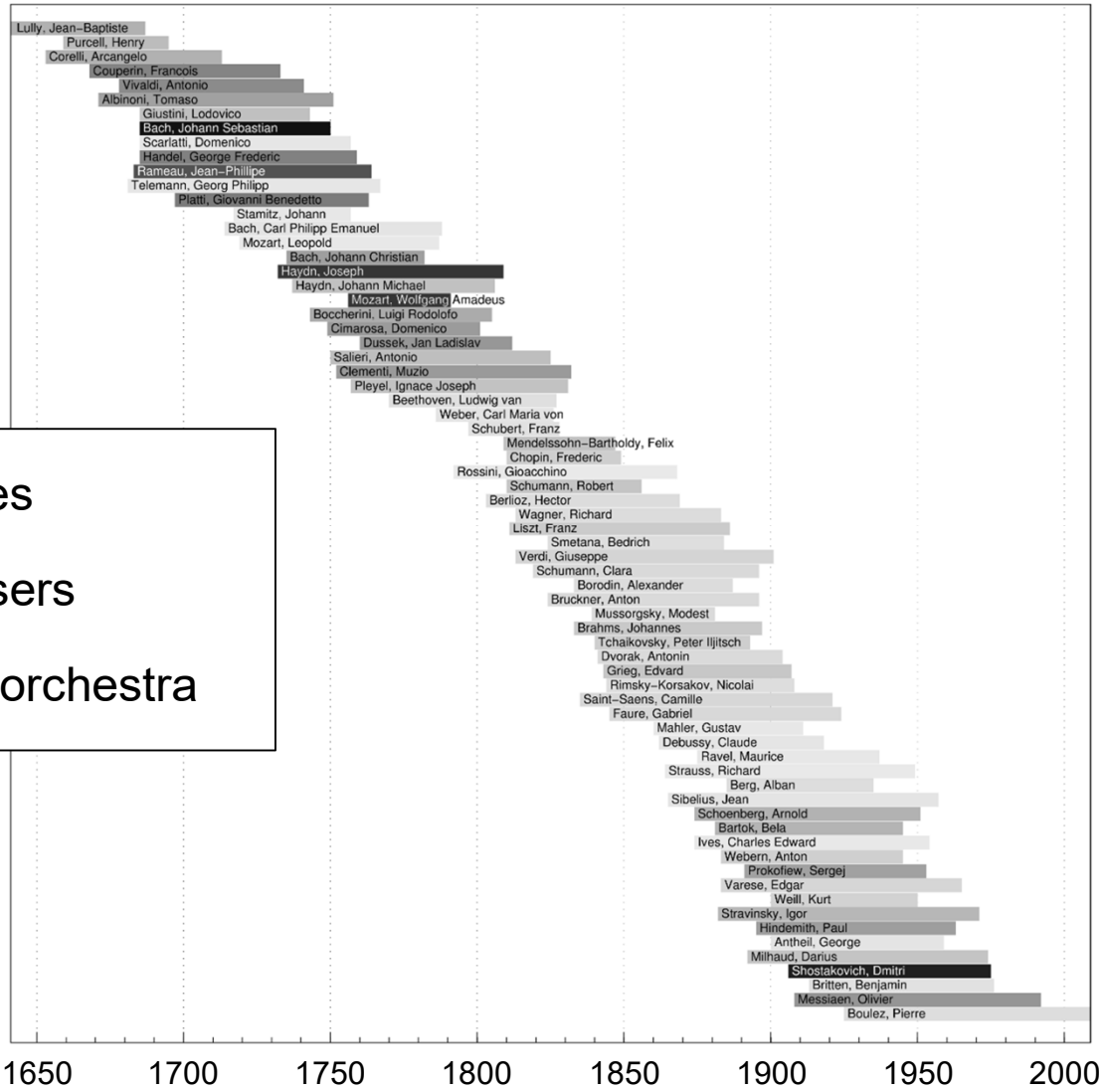
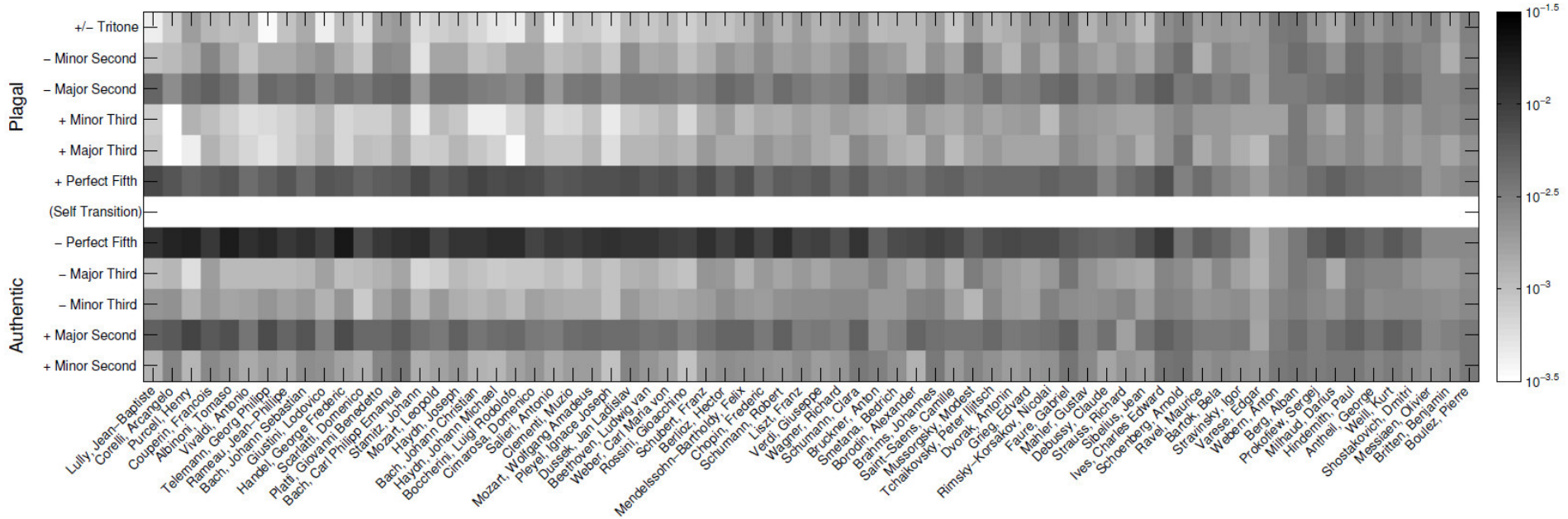
Chord transitions: Plagal vs. Authentic

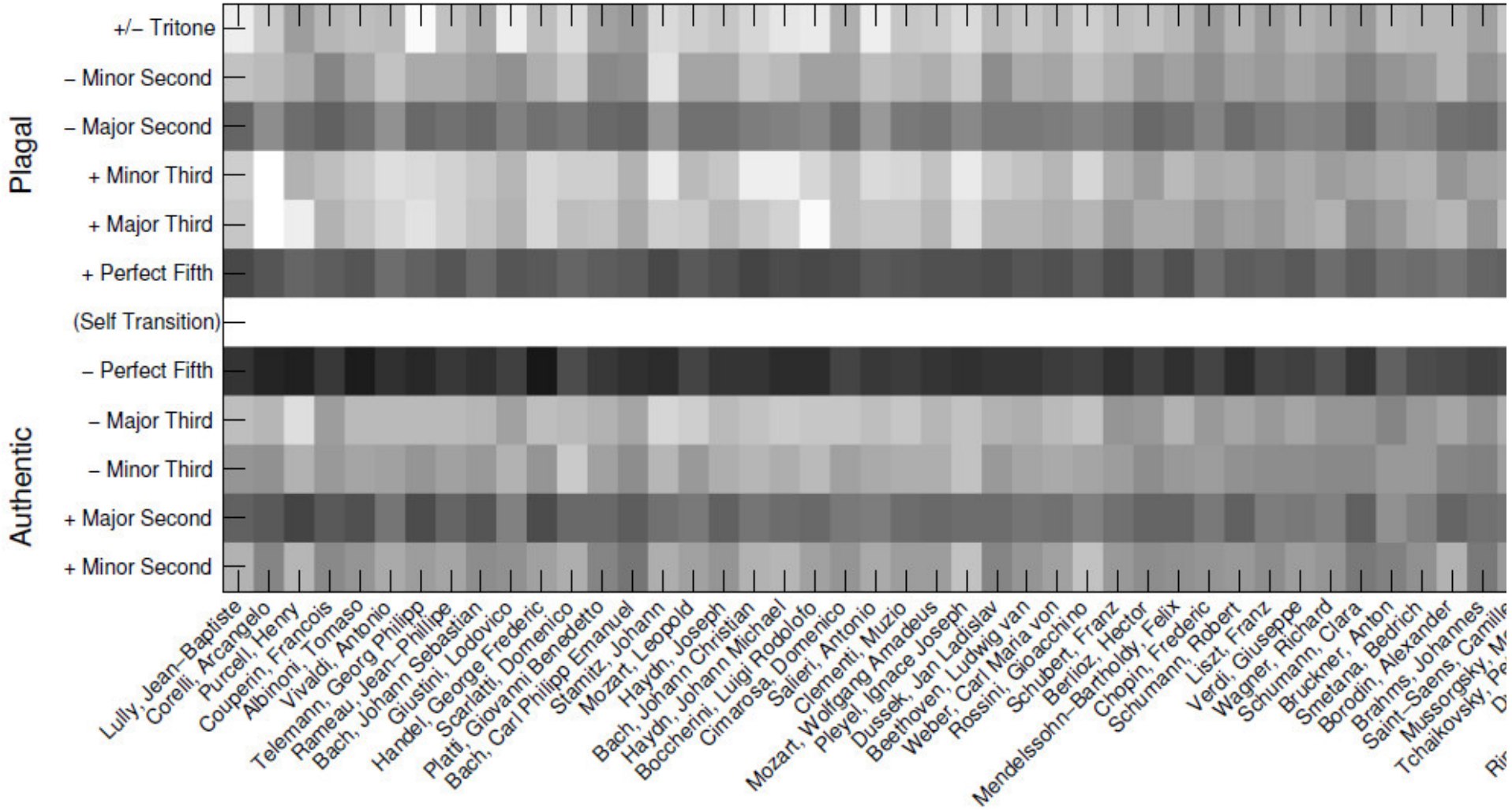


- 2000 pieces
- 70 composers
- piano and orchestra

Chord transitions: Plagal vs. Authentic



Chord transitions: Plagal vs. Authentic



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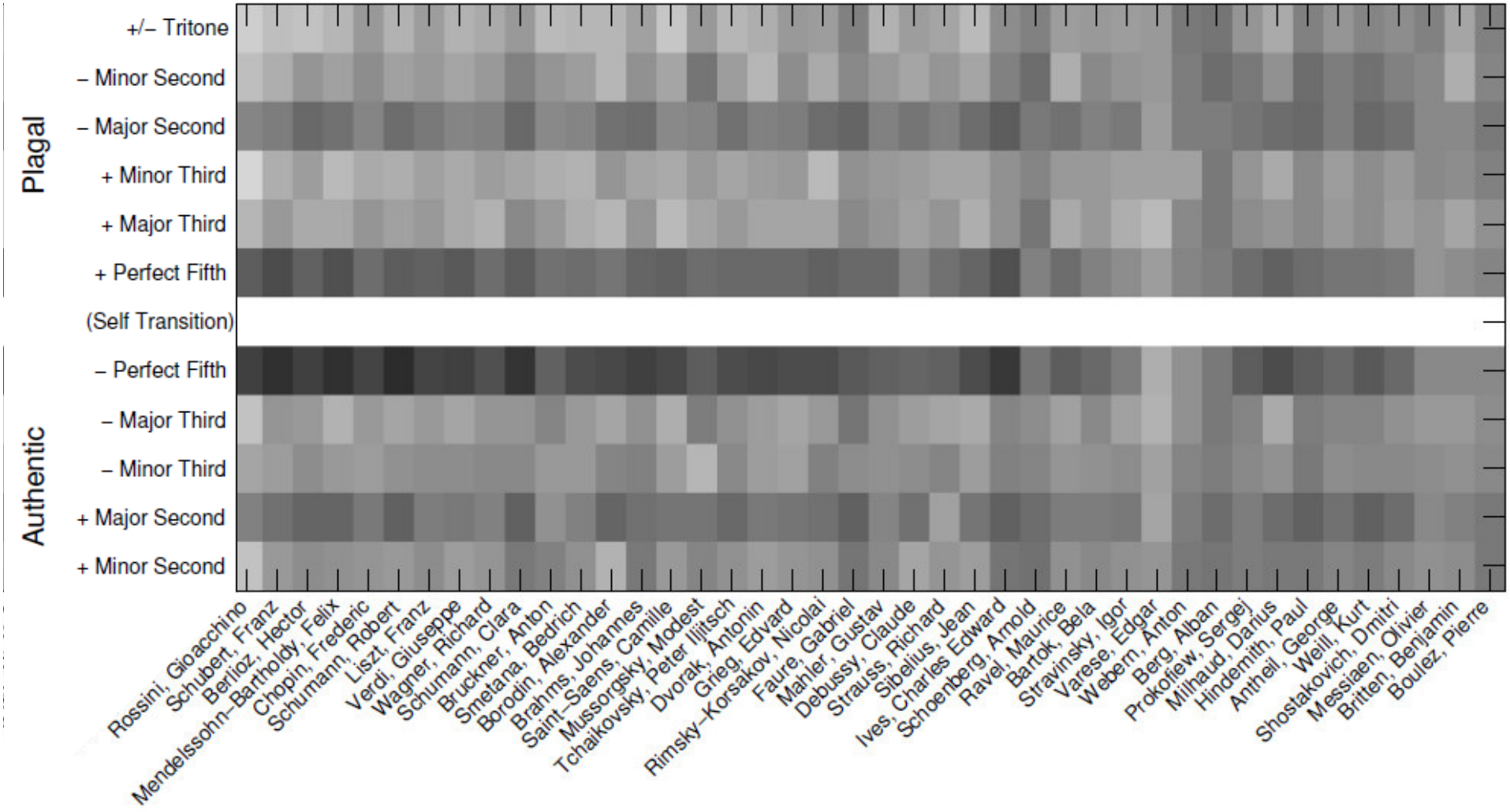
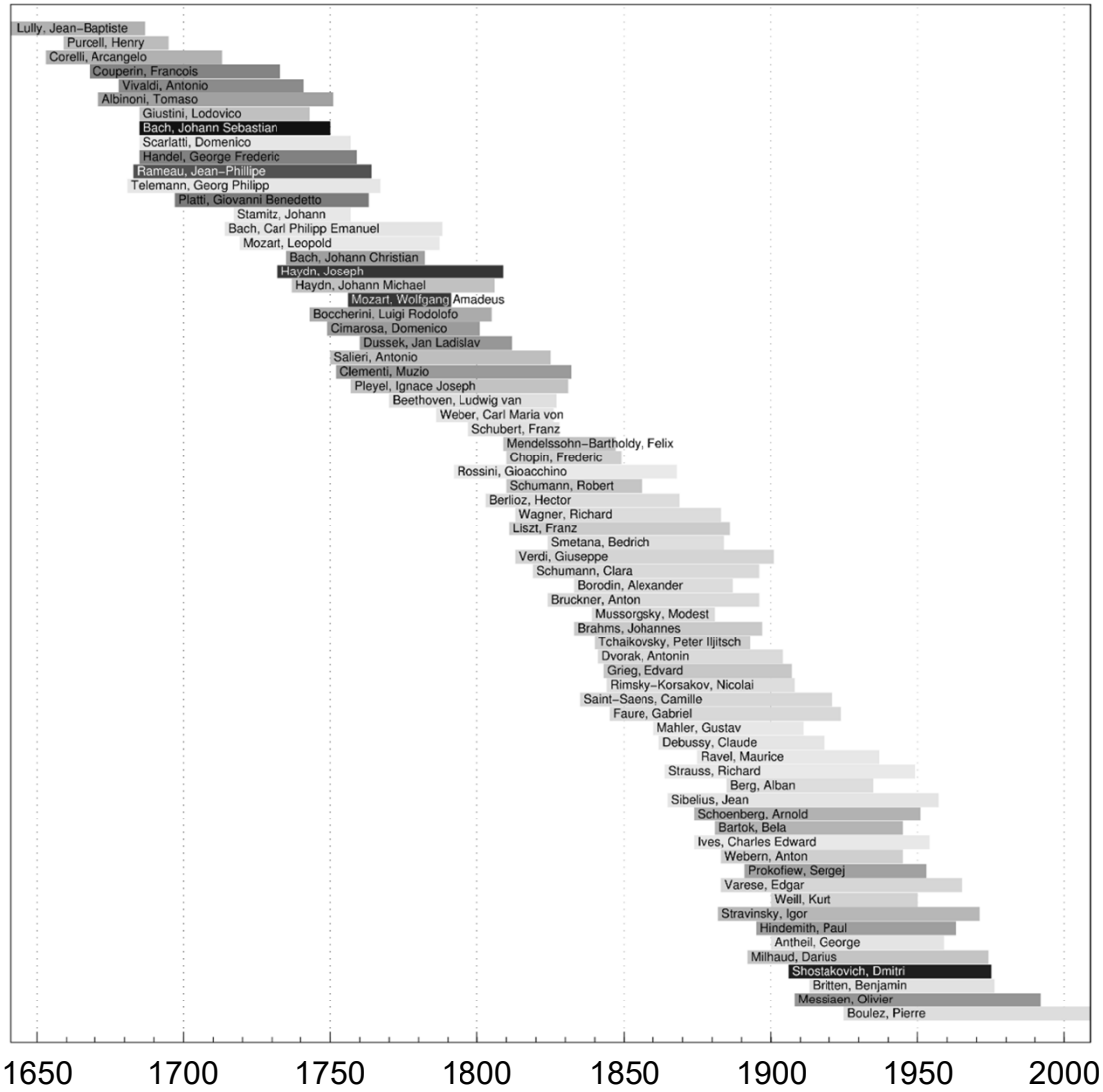
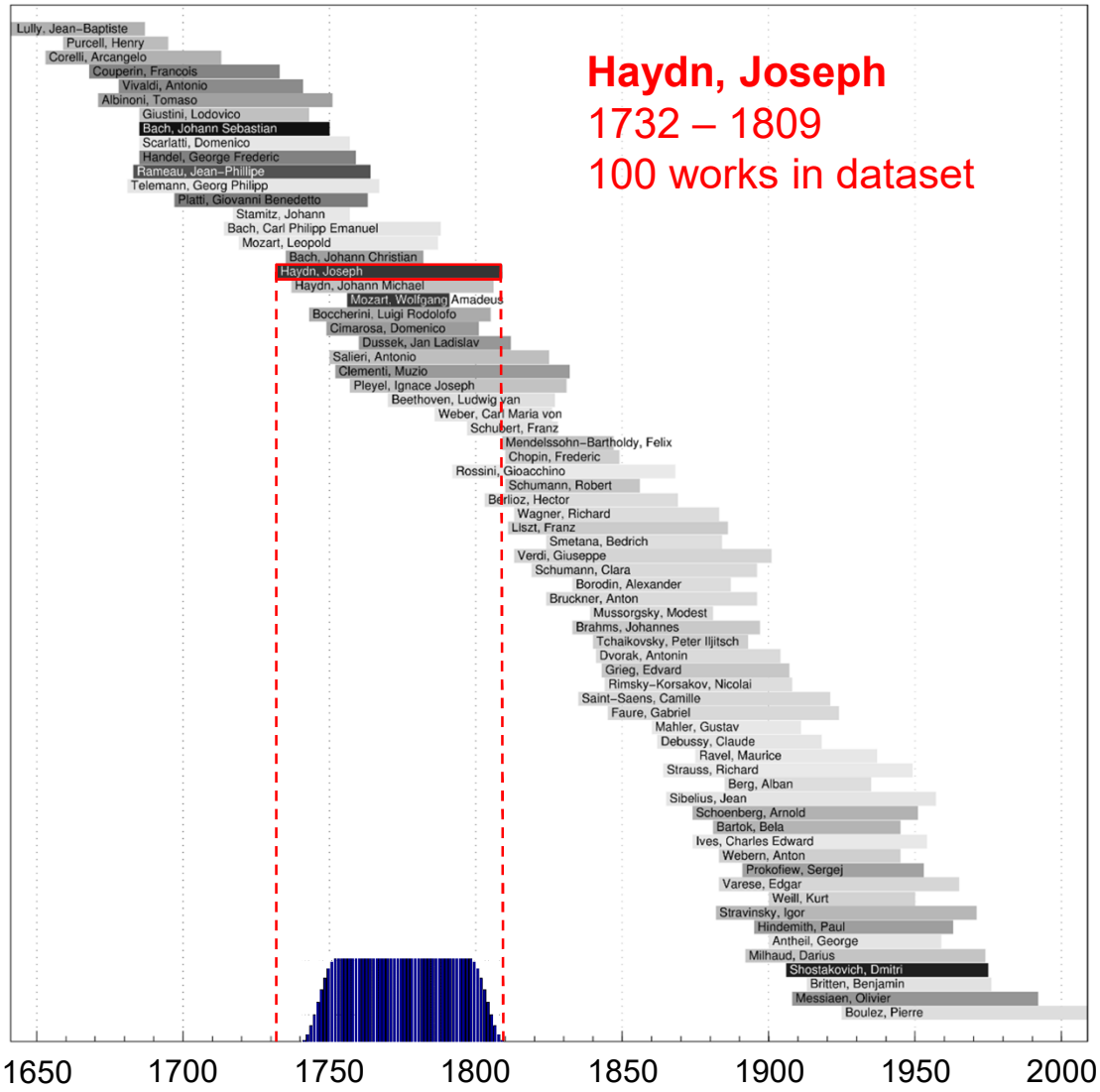
Chord transitions: Plagal vs. Authentic



Chord transitions: Plagal vs. Authentic



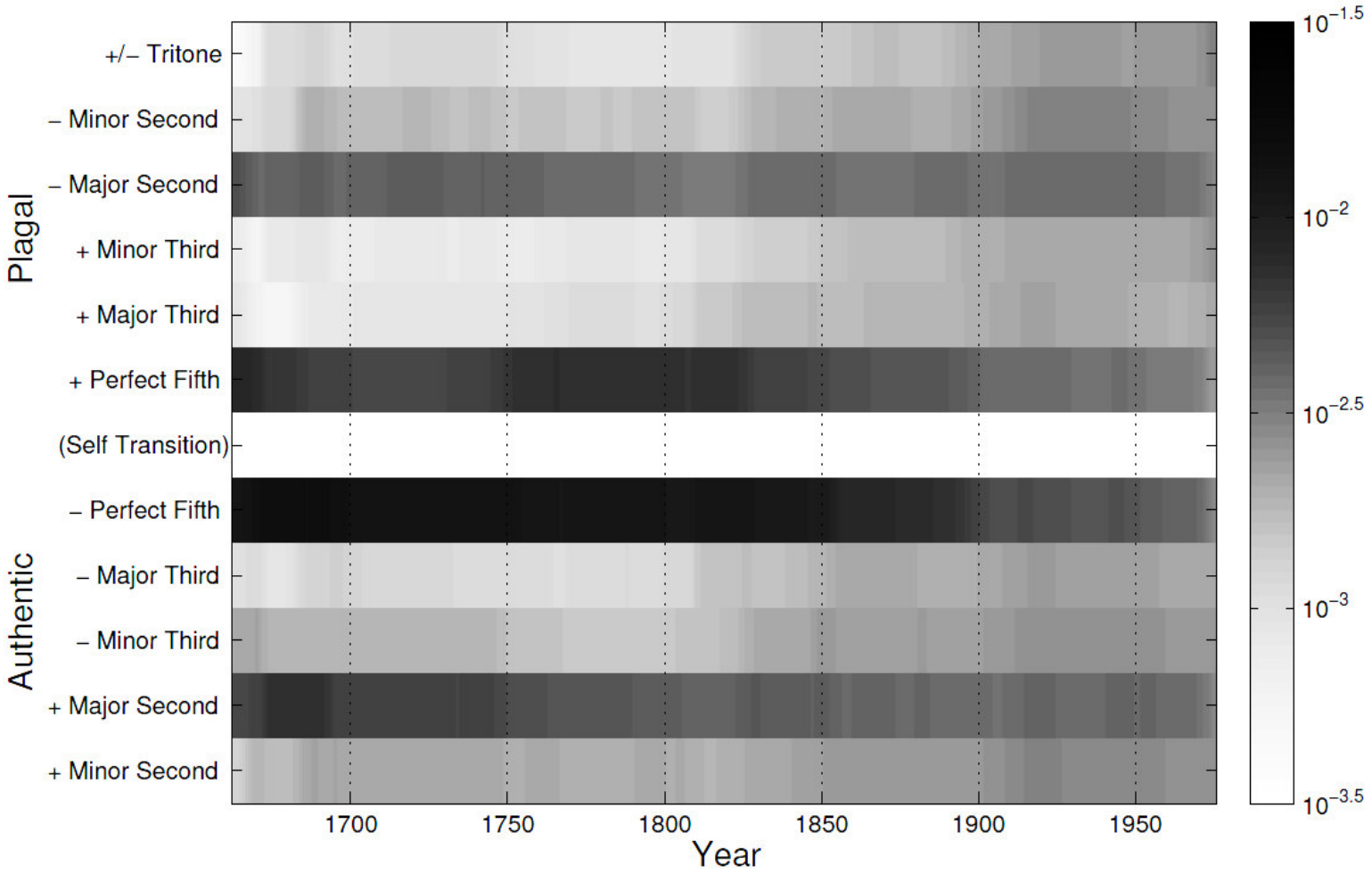
Chord transitions: Plagal vs. Authentic



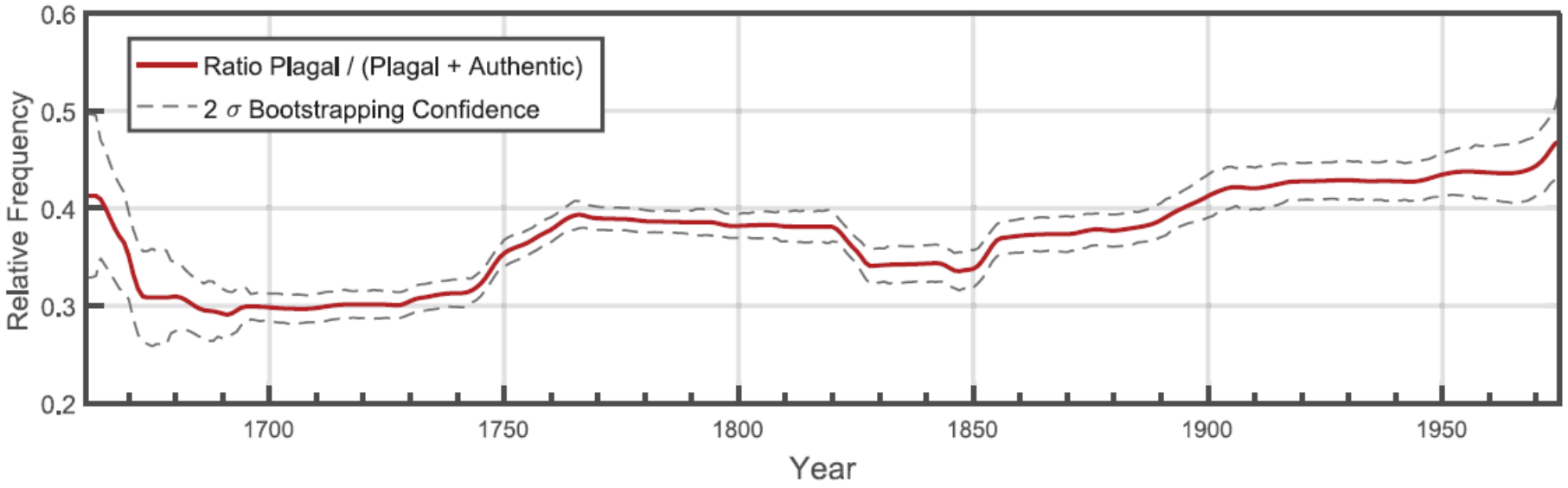
Haydn, Joseph
1732 – 1809
100 works in dataset

Tukey window

Chord transitions: Plagal vs. Authentic



Chord transitions: Plagal vs. Authentic



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Corpus Analysis

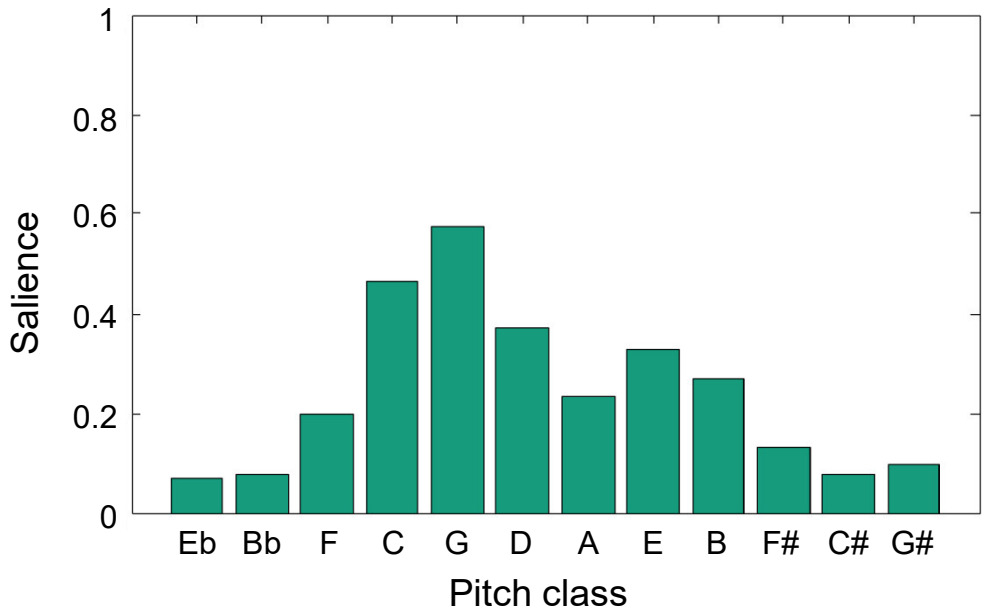
Overview

Three example studies:

- Chord transitions in Western classical music
- Tonal complexity in Western classical music
- Tonal complexity in jazz solos

Tonal Complexity

- Global chroma statistics (audio)
- **1783** – W. A. Mozart, „Linz“ symphony KV 425, 1. Adagio / Allegro



Circle of fifths →

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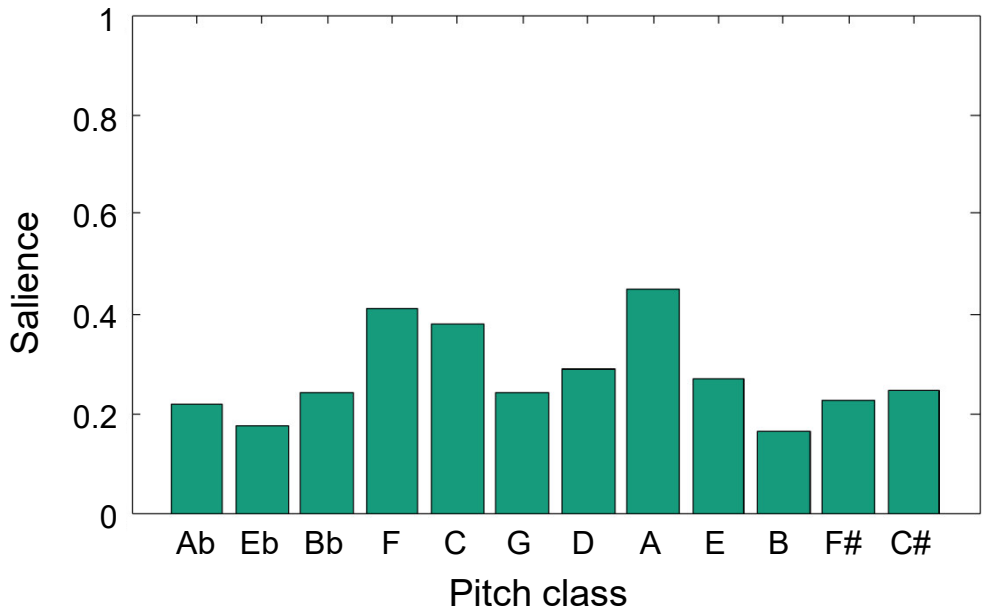
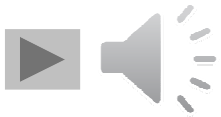
Tonal Complexity

- Global chroma statistics (audio)
- **1883** – J. Brahms, Symphony No. 3, 1. Allegro con brio (F major)





Circle of fifths →

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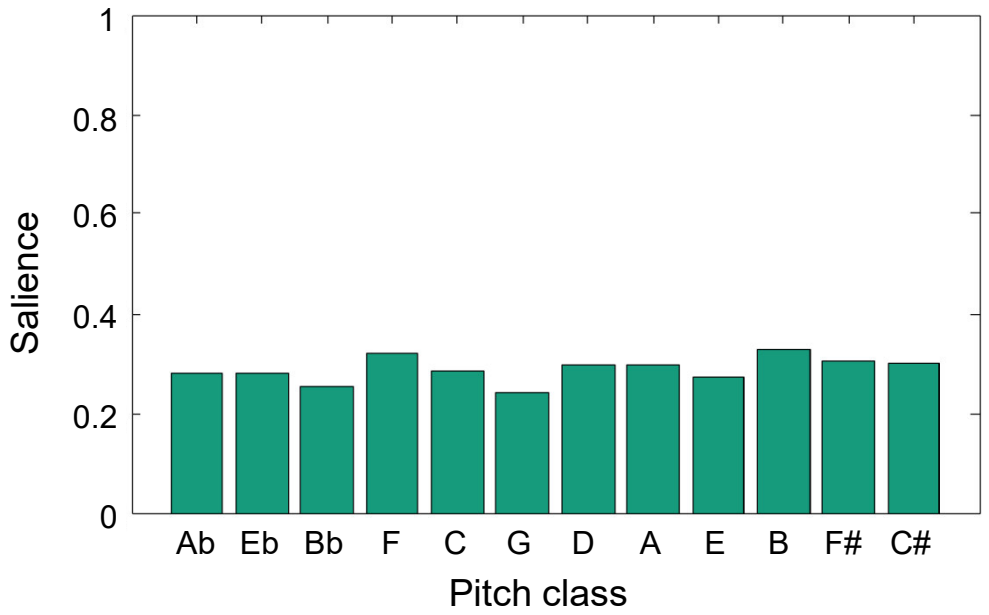
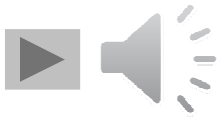
Tonal Complexity

- Global chroma statistics (audio)
- **1940** – A. Webern, Variations for Orchestra op. 30





Circle of fifths →

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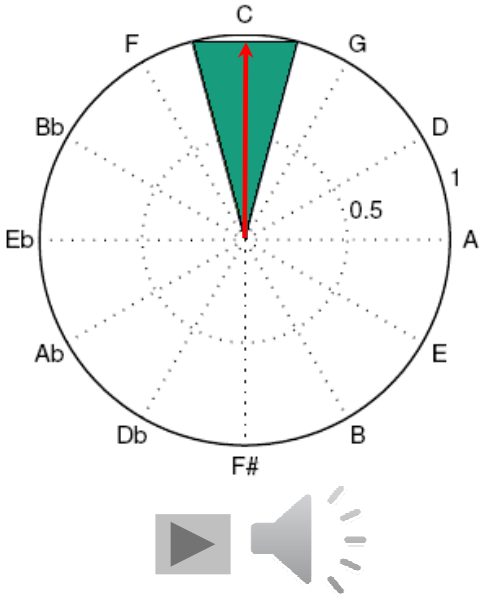
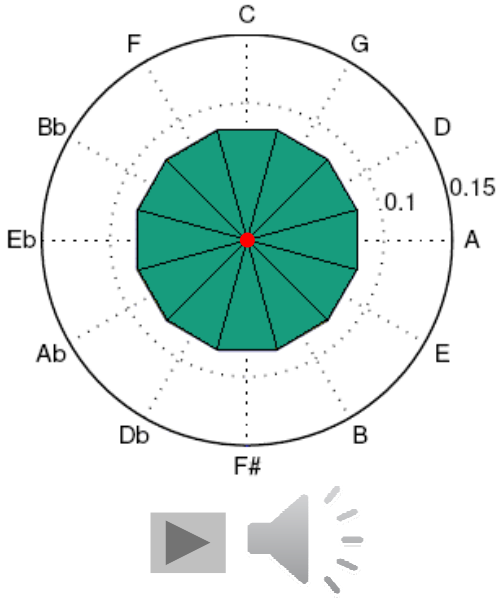
Tonal Complexity

- Realization of complexity measure Γ
- Distribution over *Circle of Fifths*

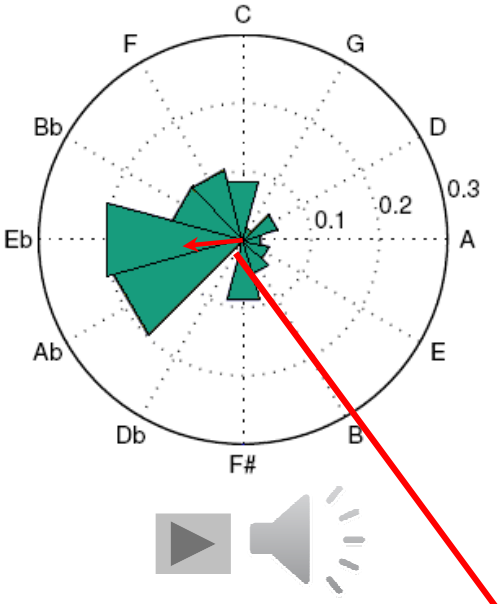
$Complexity = 0$



$Complexity = 1$



$Complexity = 0.6$



$Complexity = 1 - Length$

- Relating to different time scales!

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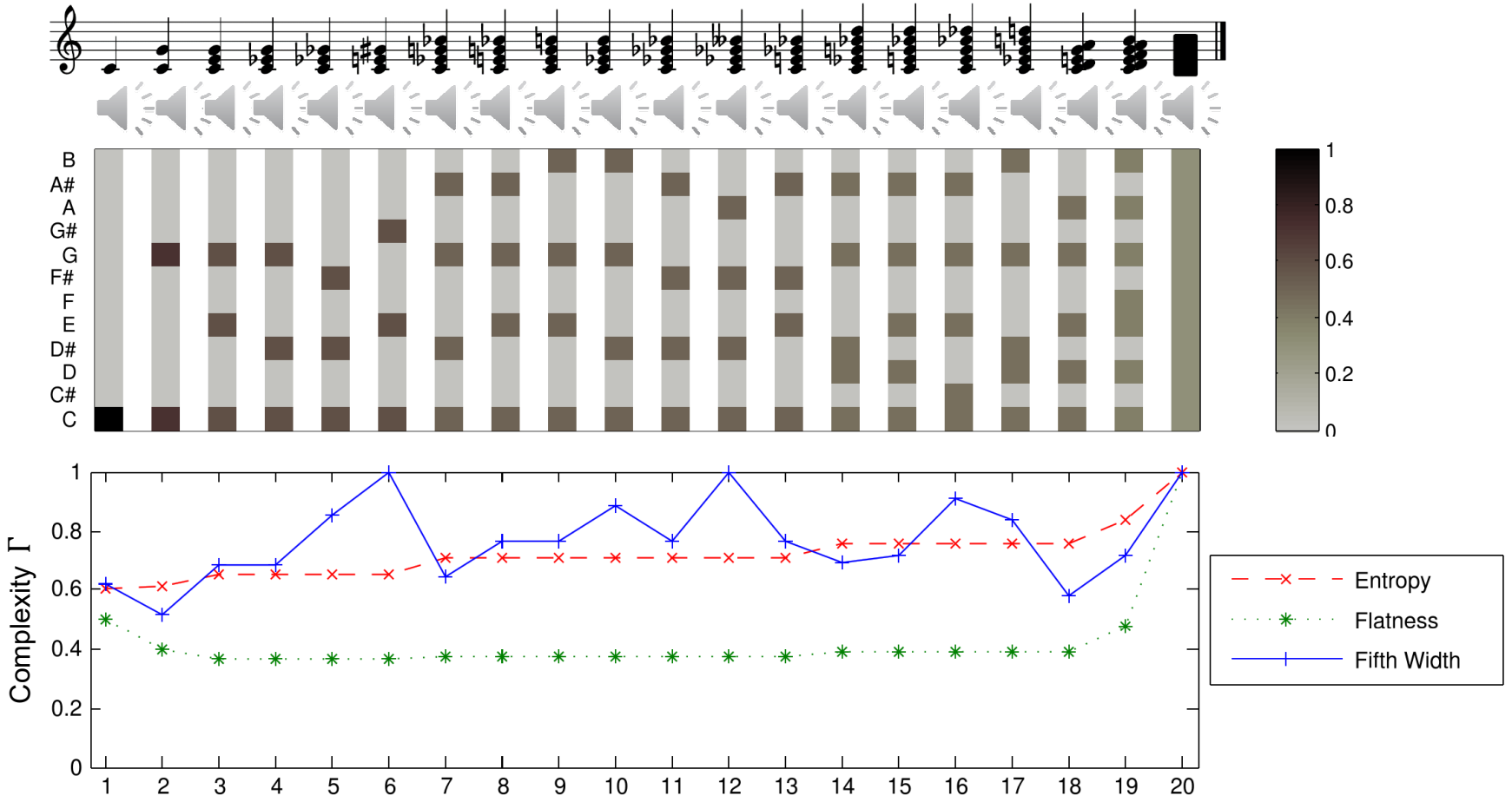
Tonal Complexity – Chords



[5] Weiss / Müller, *Quantifying and Visualizing Tonal Complexity*, Proc. Conference on Interdisciplinary Musicology 2014

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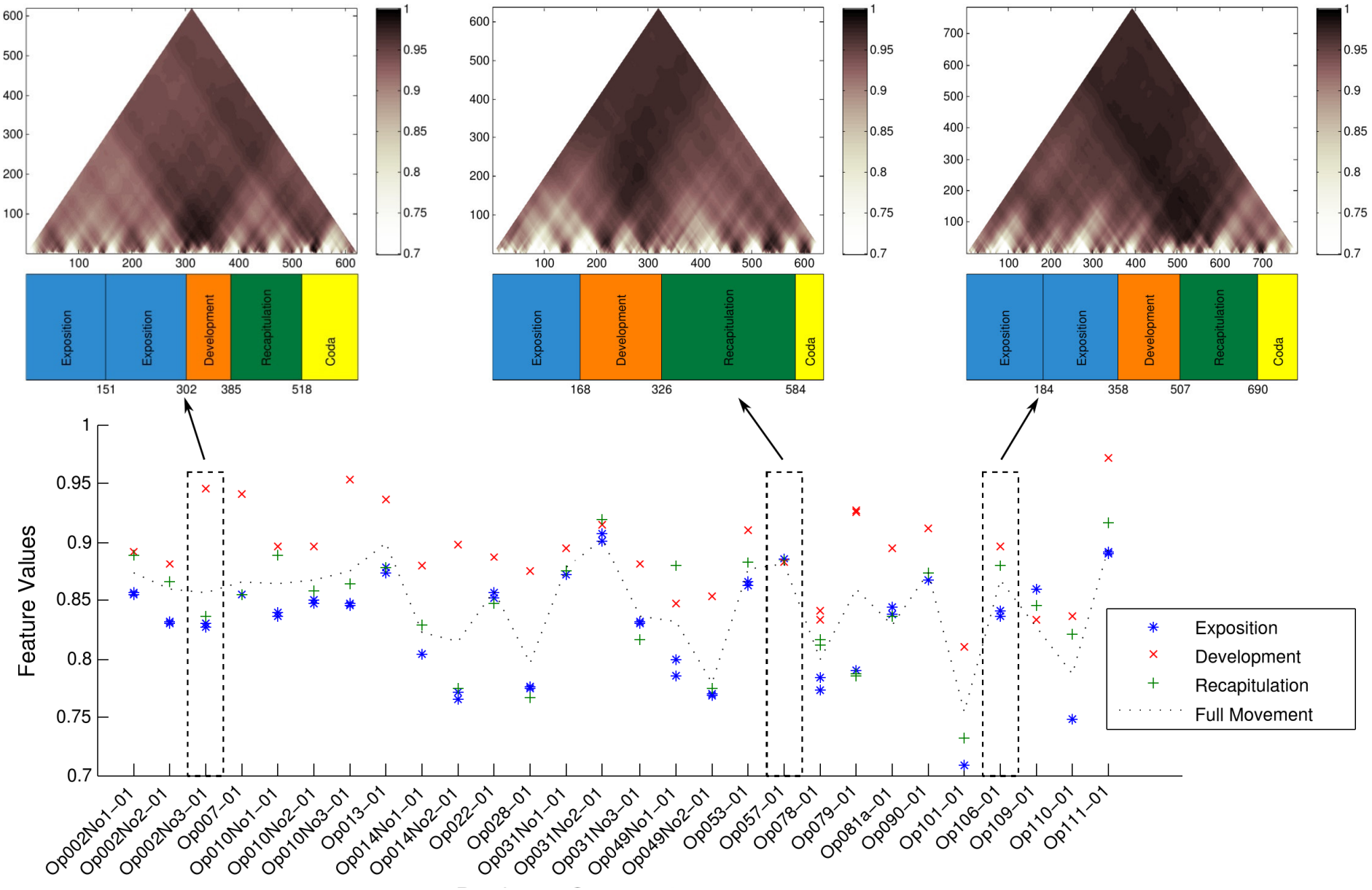
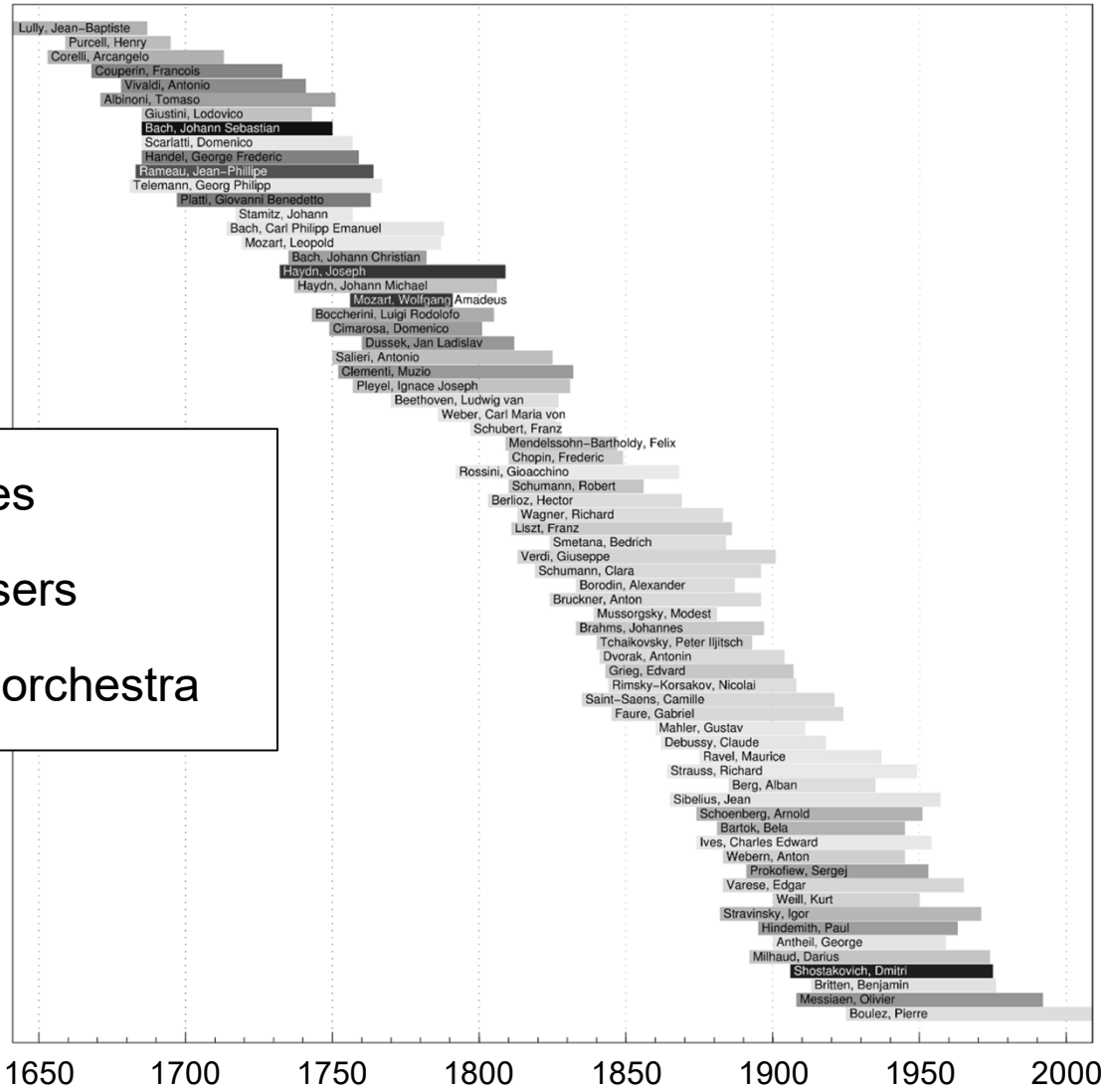
Tonal Complexity – Beethoven's Sonatas

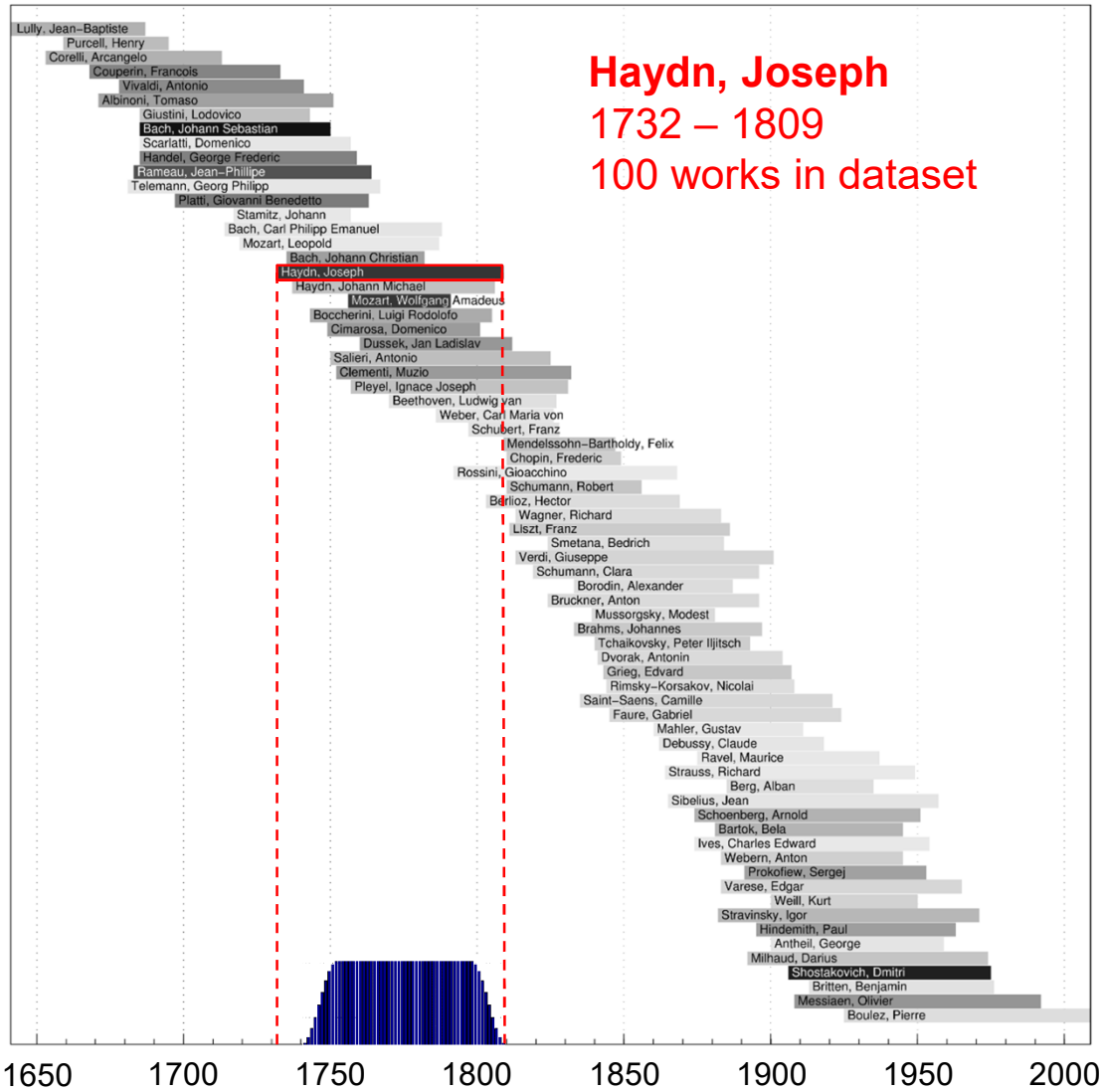


Analyzing Composer Styles

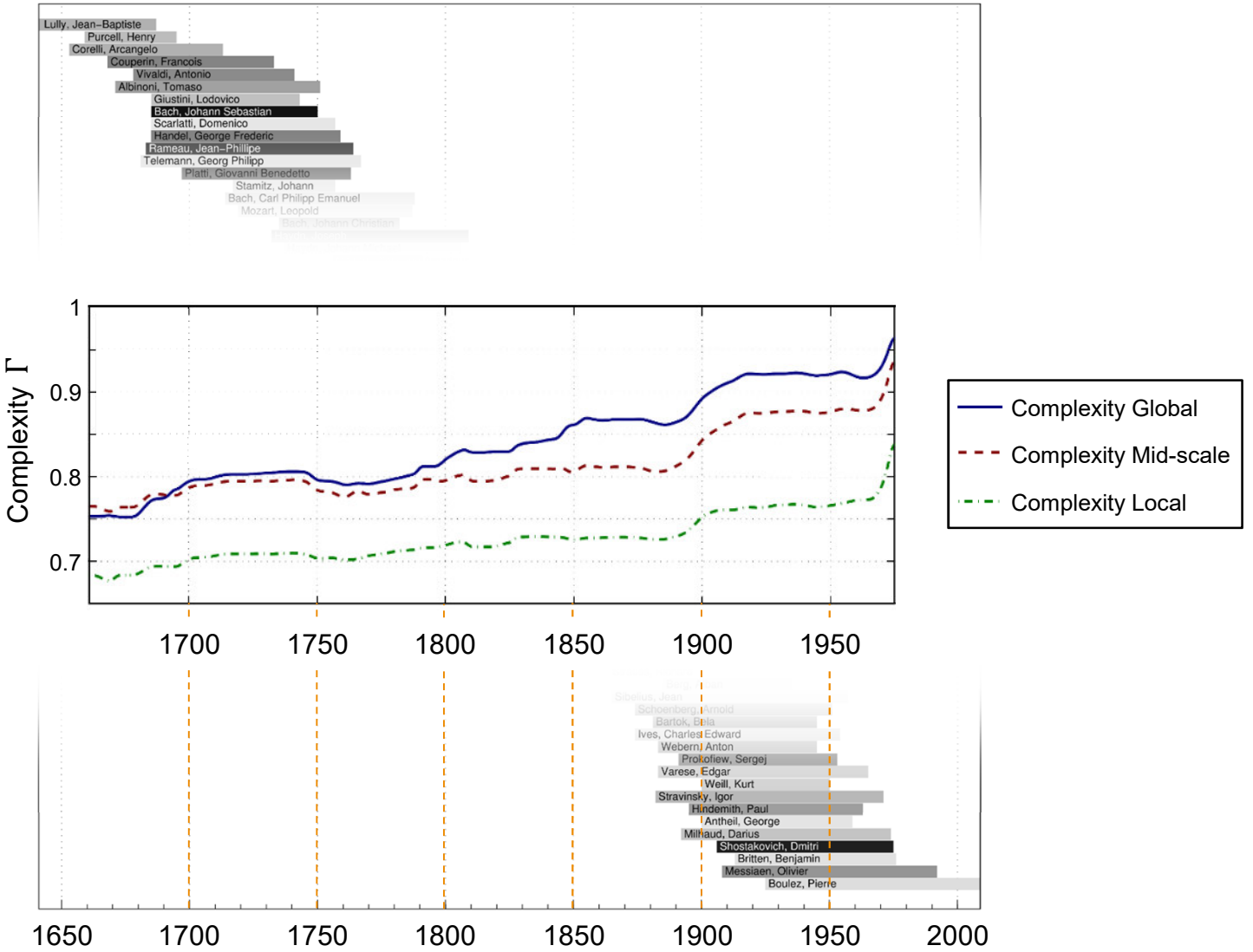
- 2000 pieces
- 70 composers
- piano and orchestra



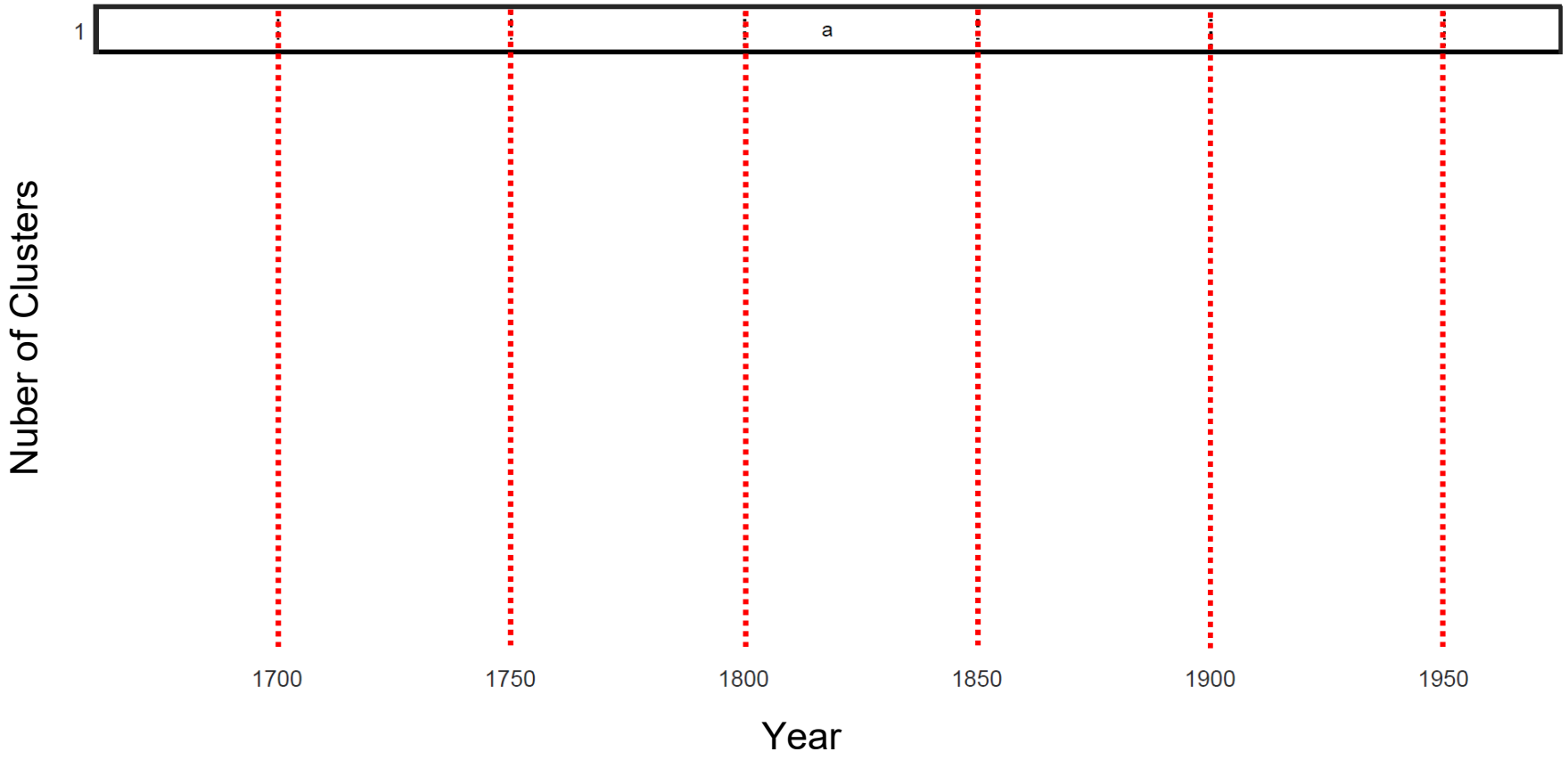
Analyzing Composer Styles



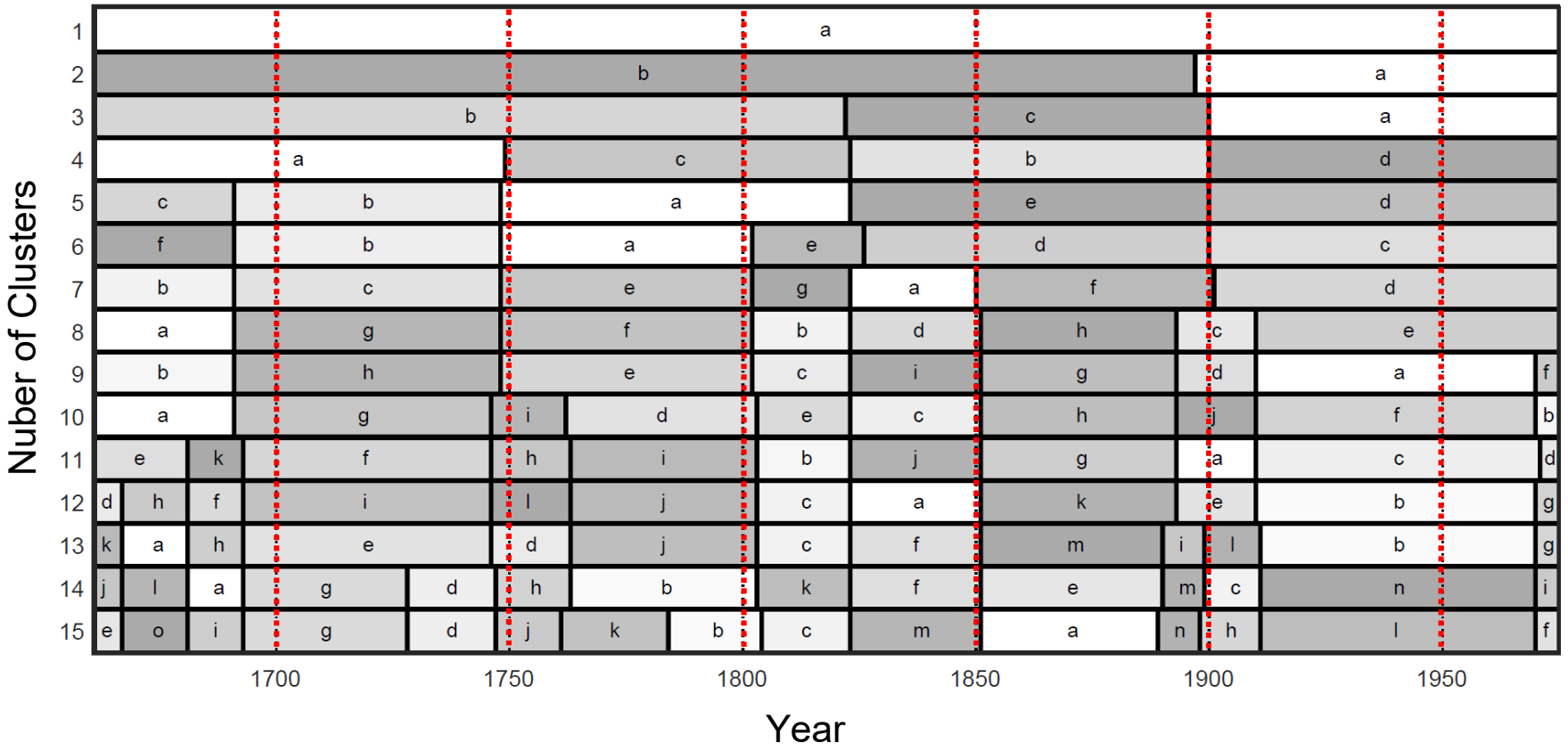
Analyzing Composer Styles



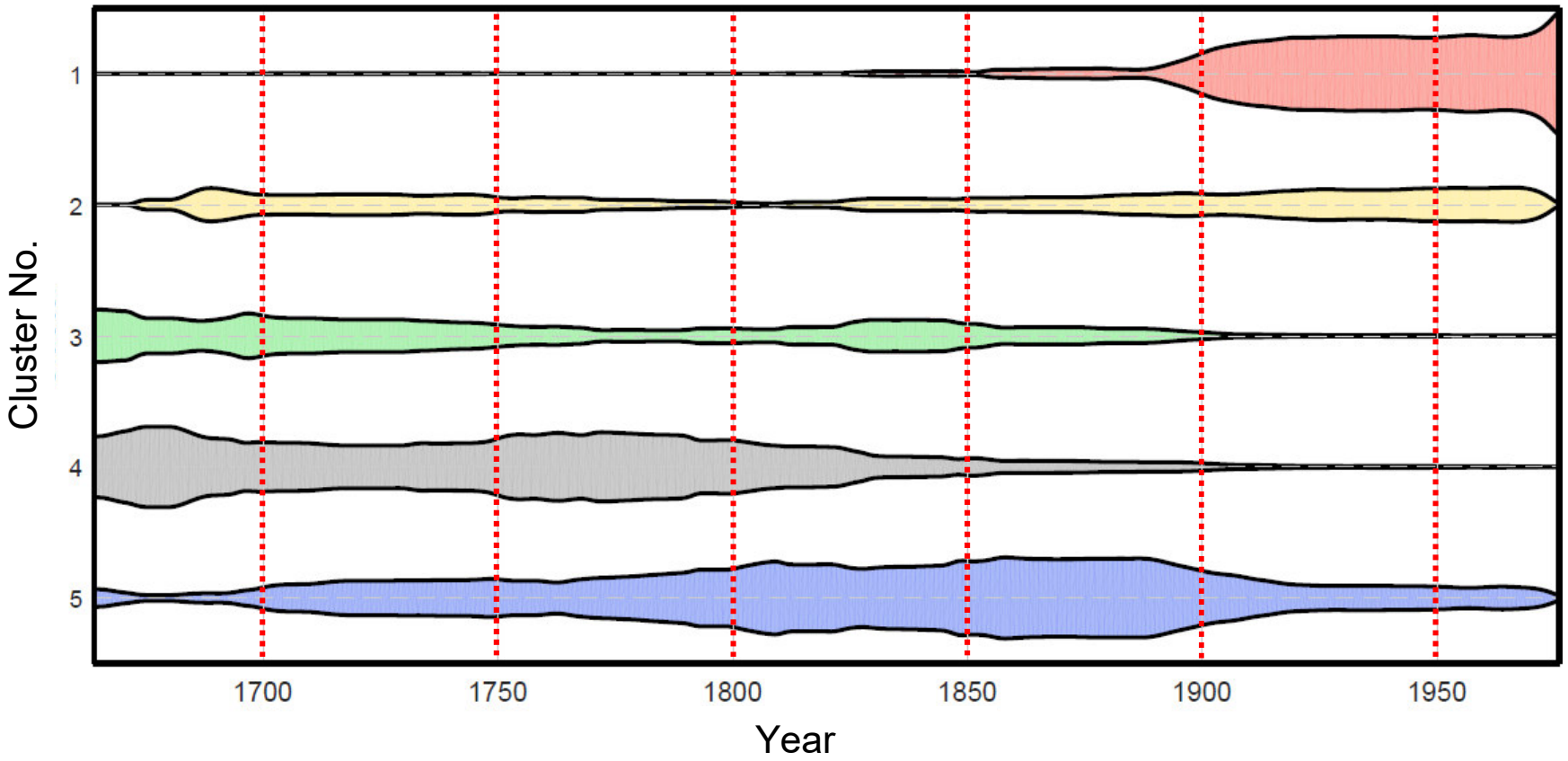
Clustering Composition Years



Clustering Composition Years



Clustering Individual Pieces



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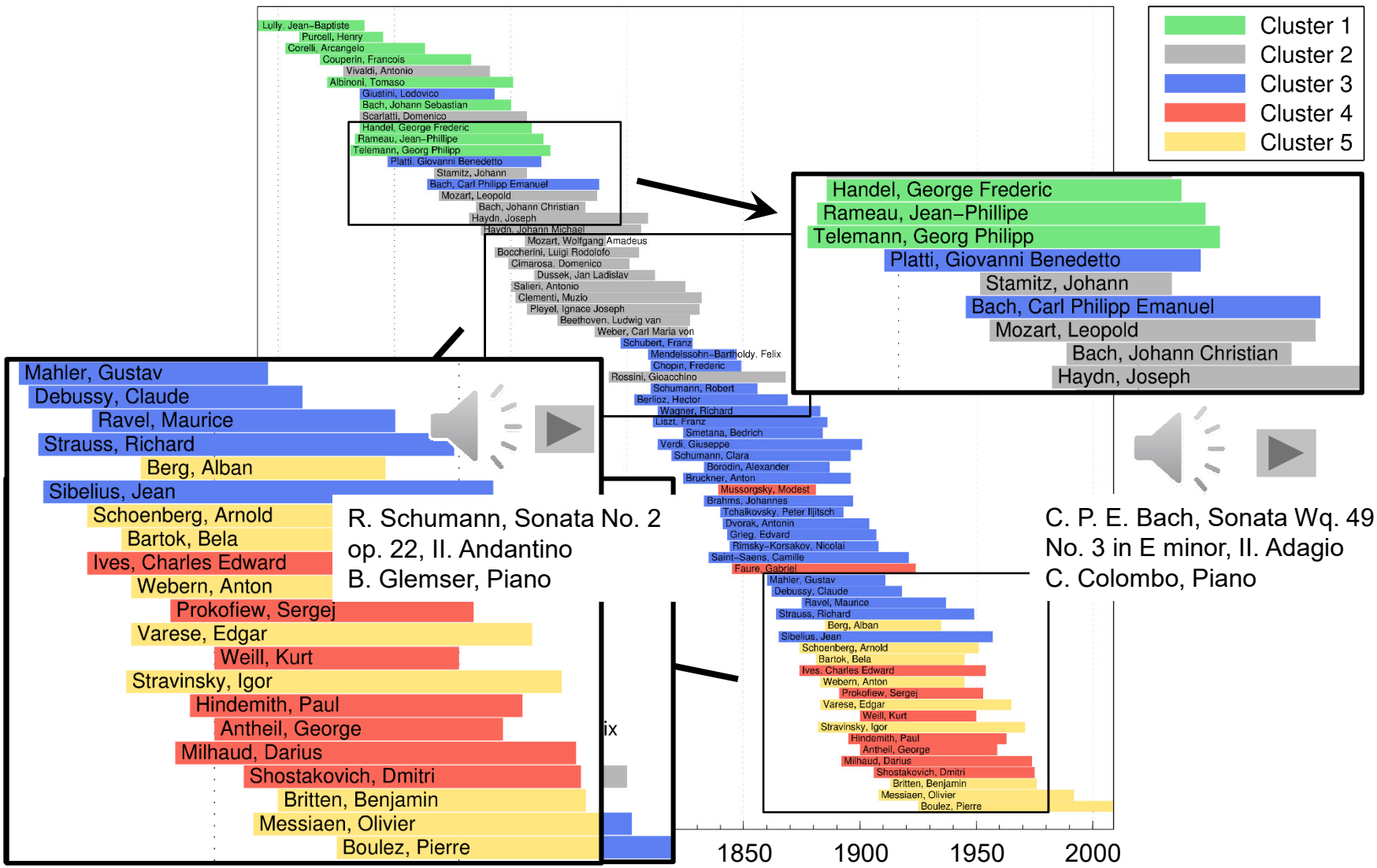
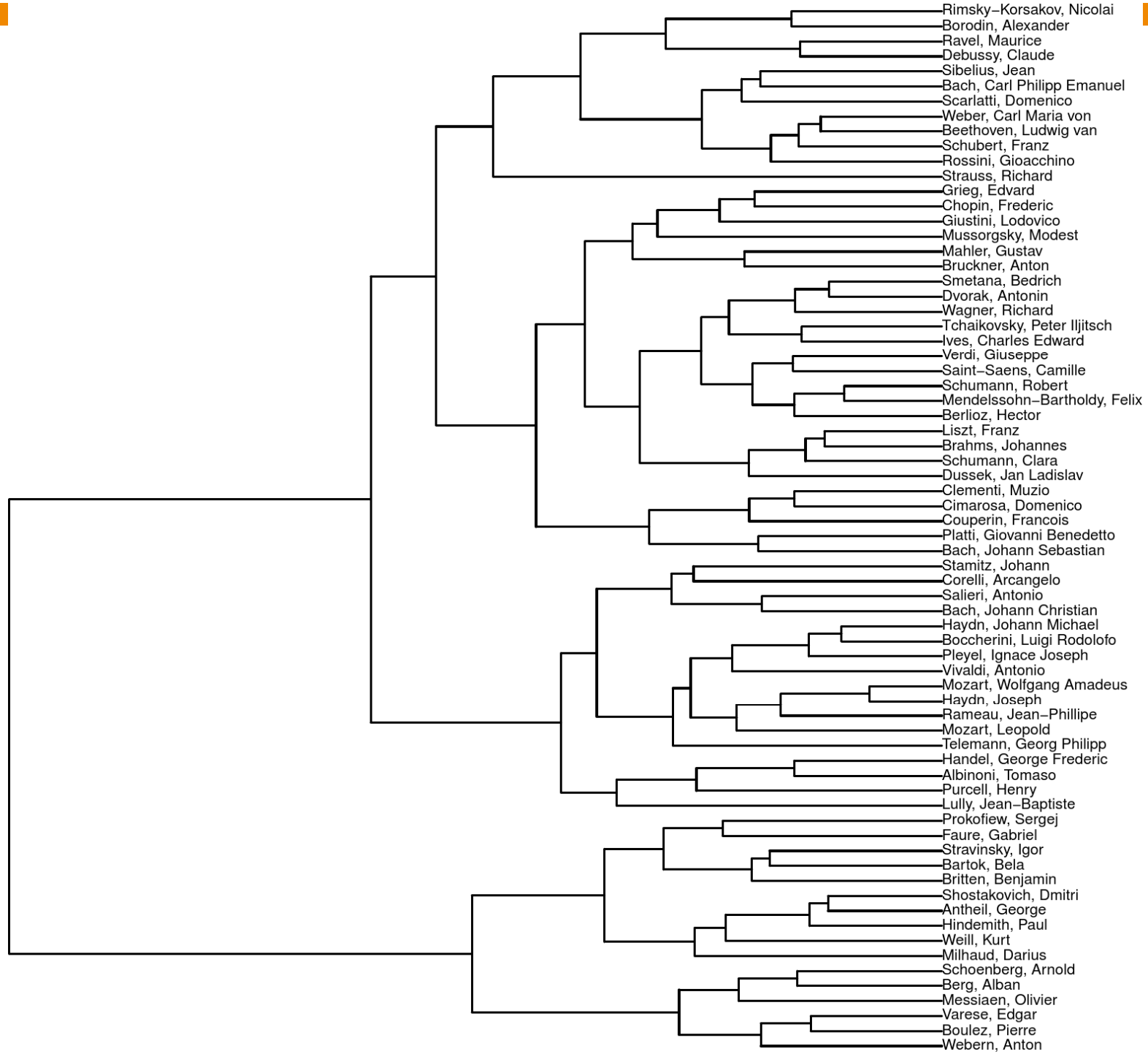
Clustering Composers



R. Schumann, Sonata No. 2
op. 22, II. Andantino
B. Glemser, Piano

C. P. E. Bach, Sonata Wq. 49
No. 3 in E minor, II. Adagio
C. Colombo, Piano


Rimsky–Korsakov, Nicolai
Borodin, Alexander
Ravel, Maurice
Debussy, Claude
Sibelius, Jean
Bach, Carl Philipp Emanuel
Scarlatti, Domenico
Weber, Carl Maria von
Beethoven, Ludwig van
Schubert, Franz
Rossini, Gioacchino
Strauss, Richard
Grieg, Edvard
Chopin, Frederic
Giustini, Lodovico
Mussorgsky, Modest
Mahler, Gustav
Bruckner, Anton
Smetana, Bedrich
Dvorak, Antonin
Wagner, Richard
Tchaikovsky, Peter Iljitsch
Ives, Charles Edward
Verdi, Giuseppe
Saint–Saens, Camille
Schumann, Robert
Mendelssohn–Bartholdy, Felix
Berlioz, Hector
Liszt, Franz
Brahms, Johannes
Schumann, Clara
Dussek, Jan Ladislav
Clementi, Muzio
Cimarosa, Domenico
Couperin, Francois
Platti, Giovanni Benedetto
Bach, Johann Sebastian
Stamitz, Johann
Corelli, Arcangelo
Salieri, Antonio
Bach, Johann Christian
Haydn, Johann Michael
Boccherini, Luigi Rodolofo
Pleyel, Ignace Joseph
Vivaldi, Antonio
Mozart, Wolfgang Amadeus
Haydn, Joseph
Rameau, Jean–Phillipe
Mozart, Leopold
Telemann, Georg Philipp
Handel, George Frederic
Albinoni, Tomaso
Purcell, Henry
Lully, Jean–Baptiste
Prokofiew, Sergej
Faure, Gabriel
Stravinsky, Igor
Bartok, Bela
Britten, Benjamin
Shostakovich, Dmitri
Antheil, George
Hindemith, Paul
Weill, Kurt
Milhaud, Darius
Schoenberg, Arnold
Berg, Alban
Messiaen, Olivier
Varese, Edgar
Boulez, Pierre
Webern, Anton

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Corpus Analysis

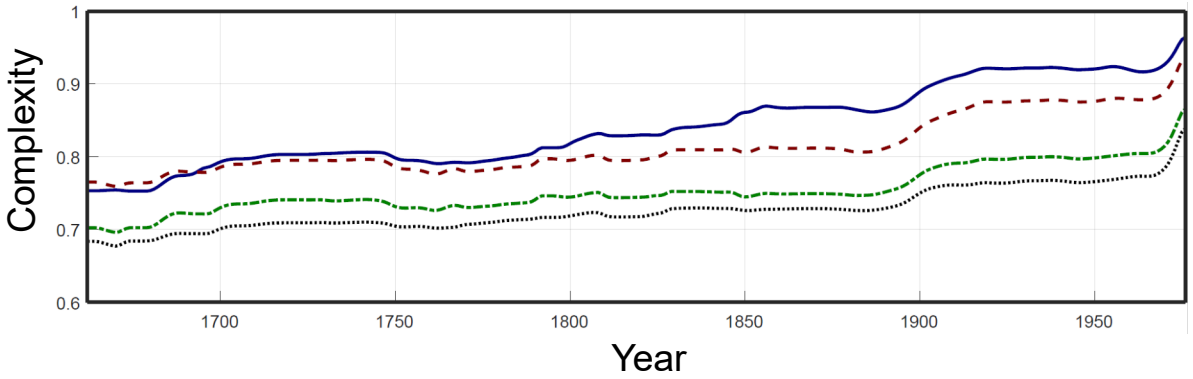
Overview

Three example studies:

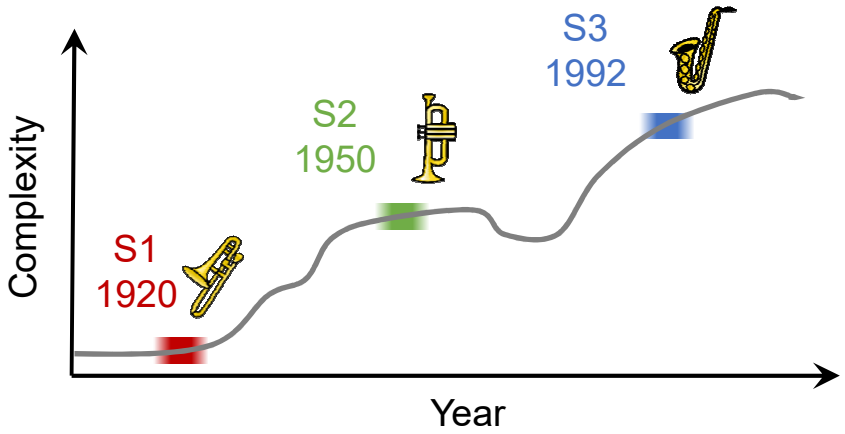
- Chord transitions in Western classical music
- Tonal complexity in Western classical music
- Tonal complexity in jazz solos

Tonal Complexity: Jazz Solos

- Motivation: Corpus study on Western classical music
- „Evolution curves“ – tonal complexity over 300 years:



- What about jazz?



- Example: John Coltrane, Solo in *Giant Steps*

Music Scenario: Weimar Jazz Database (WJD)

- Jazz corpus comprising 456 jazz soli
- Used for our study:
  - High quality symbolic transcriptions of **solo melody**
  - Audio recordings of solo parts
- Corpus analysis :
  - Evolution of tonal complexity?

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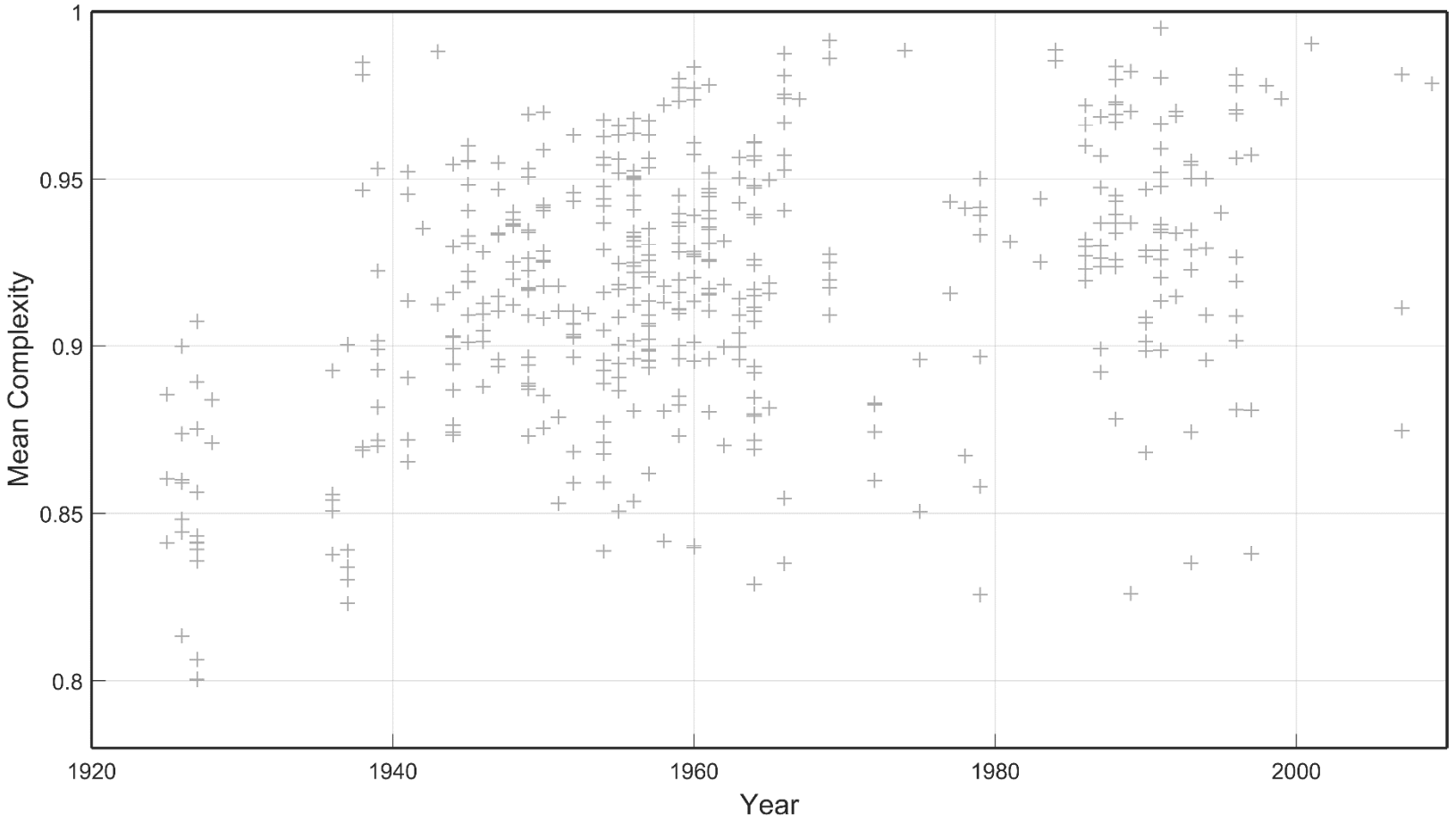
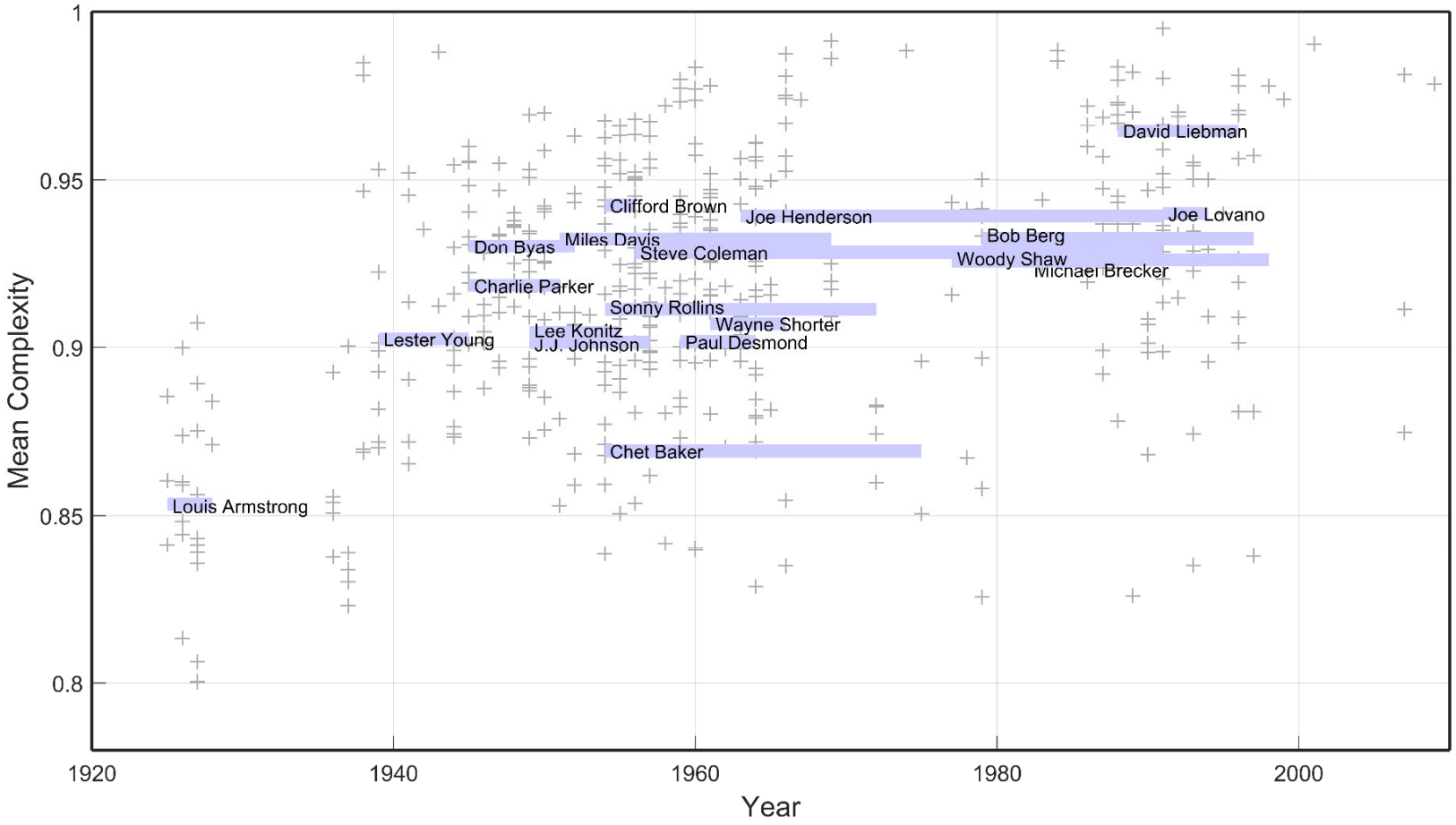
Tonal Complexity: Jazz Solos

- Compute tonal complexity from audio recordings
- **Individual solos** over recording year



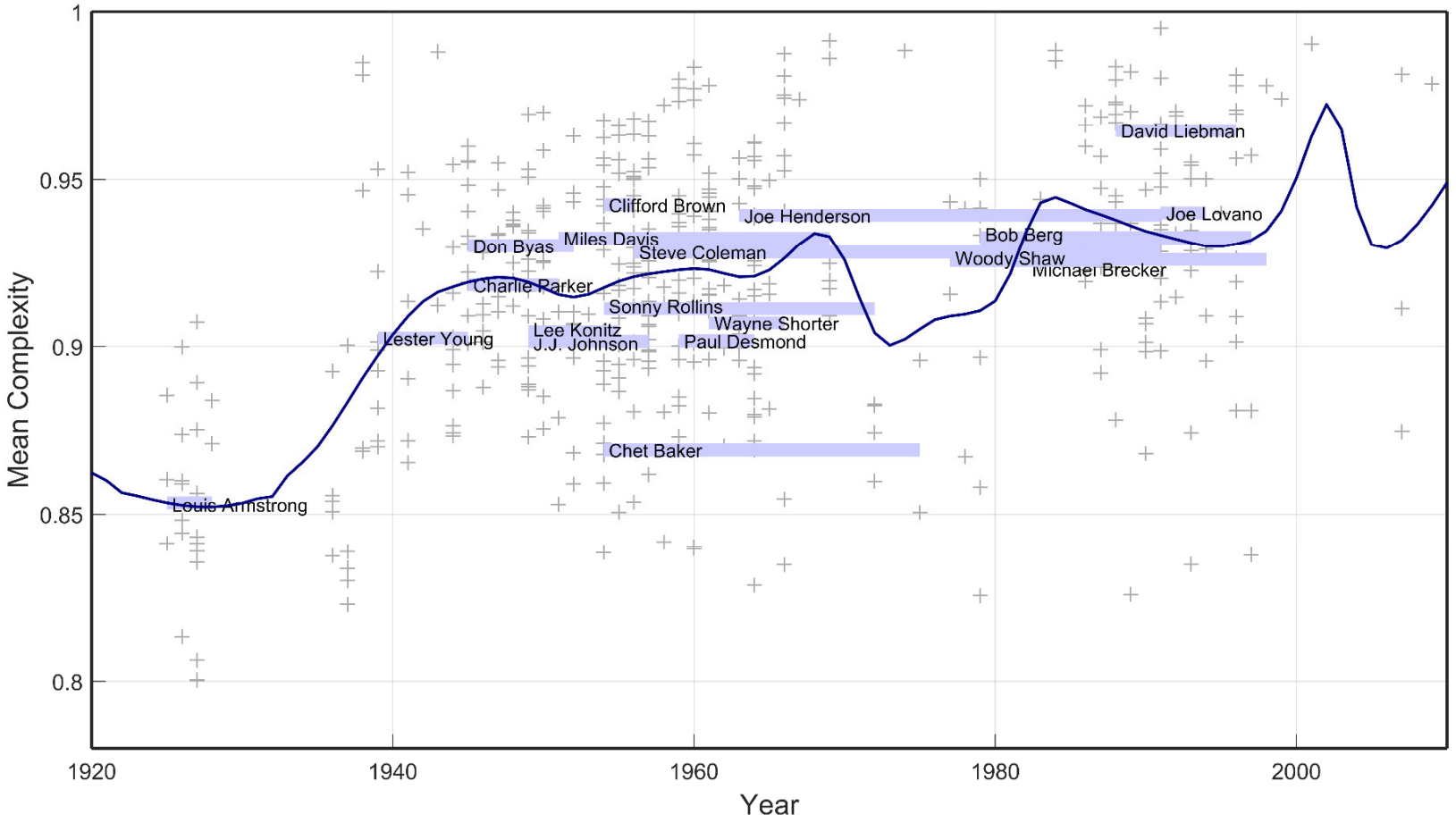
Tonal Complexity: Jazz Solos

- Compute tonal complexity from audio recordings
- Add **mean complexity** for 20 most frequent soloists



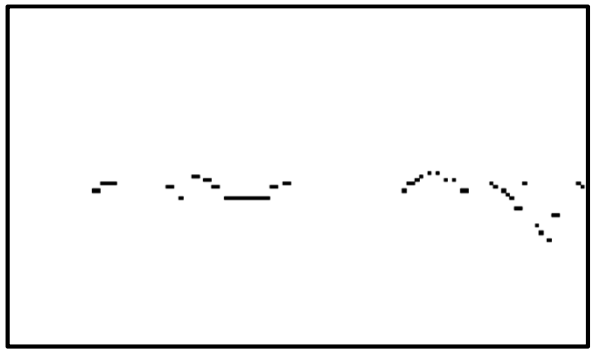
Tonal Complexity: Jazz Solos

- Compute tonal complexity from audio recordings
- Add **evolution curve** for all solos



Music Scenario: Weimar Jazz Database (WJD)

- Jazz corpus comprising 456 jazz soli
  - High quality symbolic transcriptions of **solo melody**
  - Audio recordings of solo parts
- Influence of music representation?



	Solo F0	Overtones	Percussive part	Accompaniment
a) Symbolic transcription	✓	✗	✗	✗

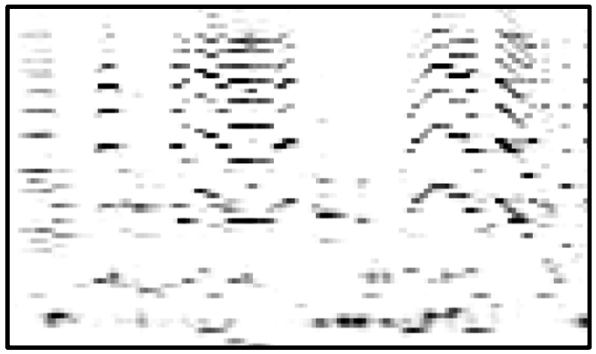
Music Scenario: Weimar Jazz Database (WJD)

- Jazz corpus comprising 456 jazz soli
  - High quality symbolic transcriptions of **solo melody**
  - Audio recordings of solo parts
- Influence of music representation?

	Solo F0	Overtones	Percussive part	Accompaniment	
a) Symbolic transcription	✓	✗	✗	✗	🔈
b) Audio source separated melody	✓	✓	✓	✗	🔈🔈

Music Scenario: Weimar Jazz Database (WJD)

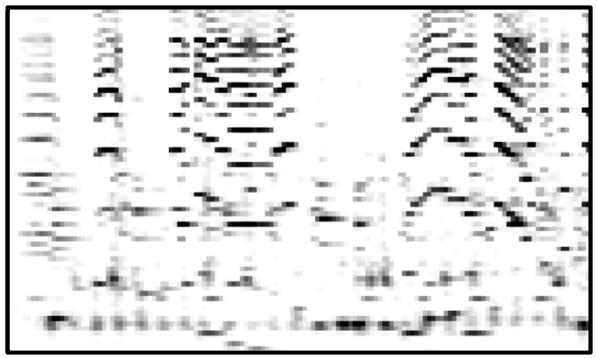
- Jazz corpus comprising 456 jazz soli
  - High quality symbolic transcriptions of **solo melody**
  - Audio recordings of solo parts
- Influence of music representation?



	Solo F0	Overtones	Percussive part	Accompaniment	
a) Symbolic transcription	✓	✗	✗	✗	🔈
b) Audio source separated melody	✓	✓	✓	✗	🔈🔈
c) Audio harmonic component	✓	✓	✗	✓	🔈

Music Scenario: Weimar Jazz Database (WJD)

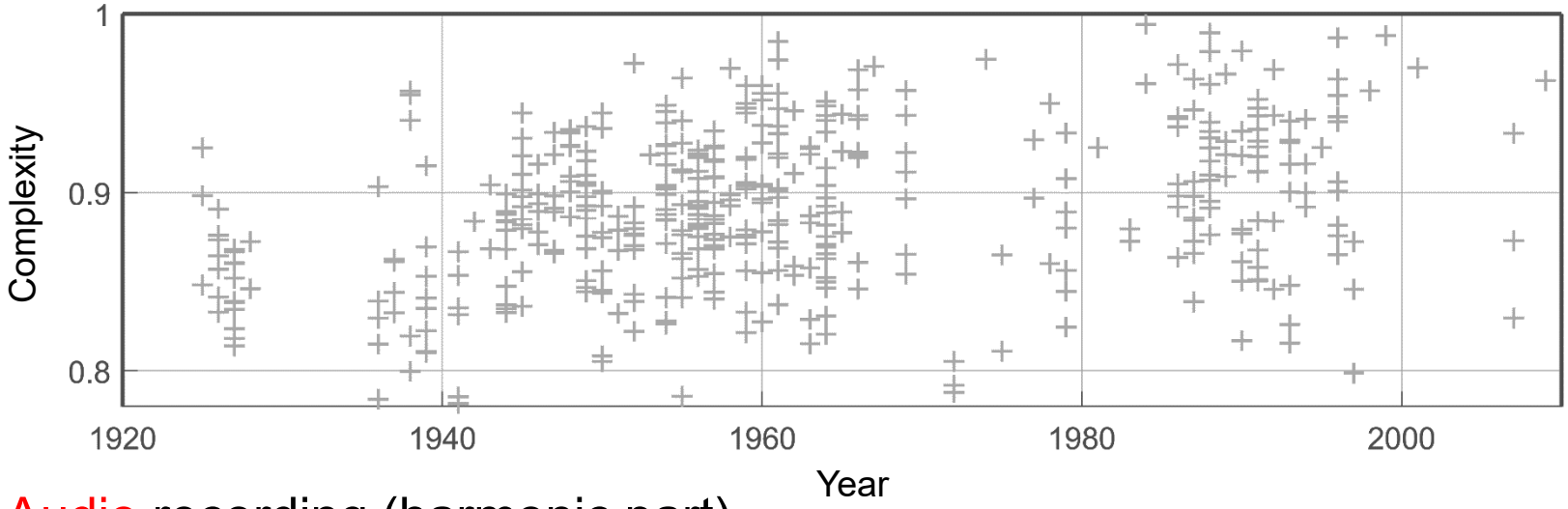
- Jazz corpus comprising 456 jazz soli
  - High quality symbolic transcriptions of **solo melody**
  - Audio recordings of solo parts
- Influence of music representation?



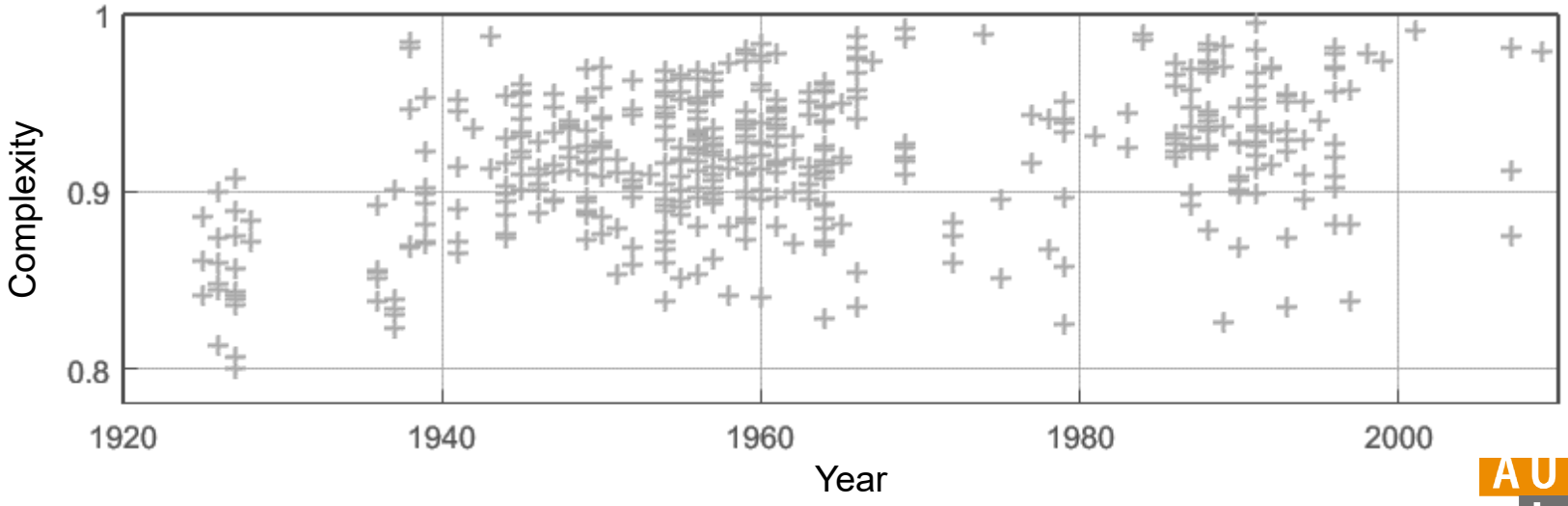
	Solo F0	Overtones	Percussive part	Accompaniment	
a) Symbolic transcription	✓	✗	✗	✗	
b) Audio source separated melody	✓	✓	✓	✗	
c) Audio harmonic component	✓	✓	✗	✓	
d) Audio full mix	✓	✓	✓	✓	

Tonal Complexity: Jazz Solos

- Symbolic transcription

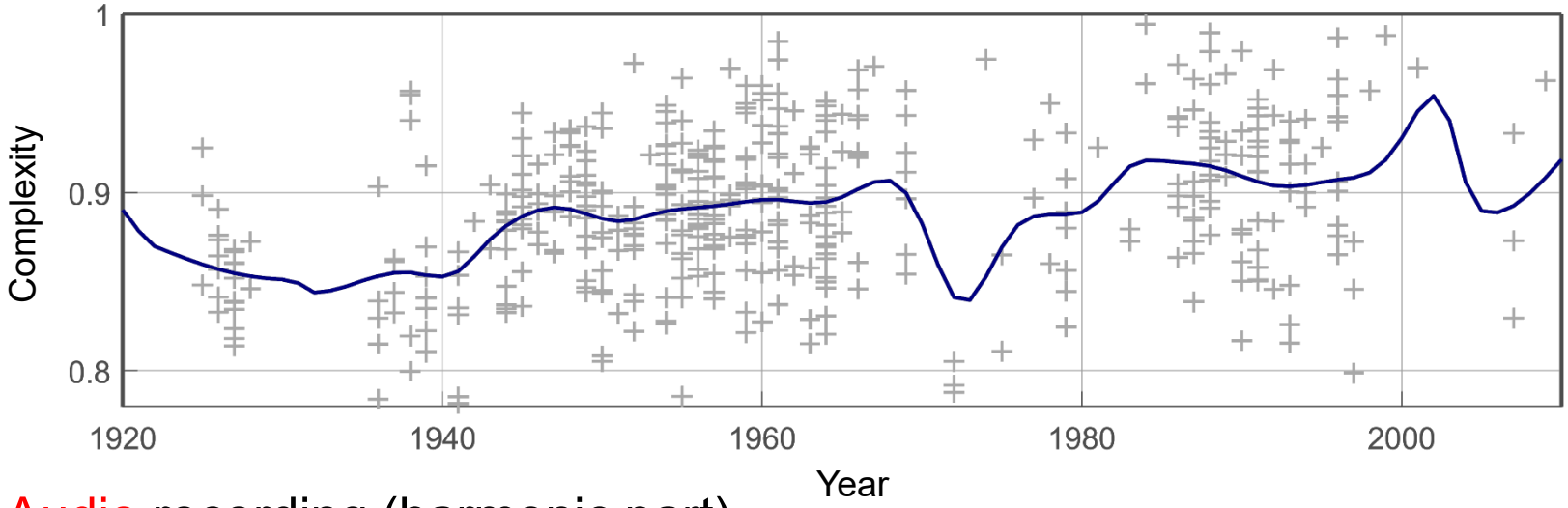


- Audio recording (harmonic part)

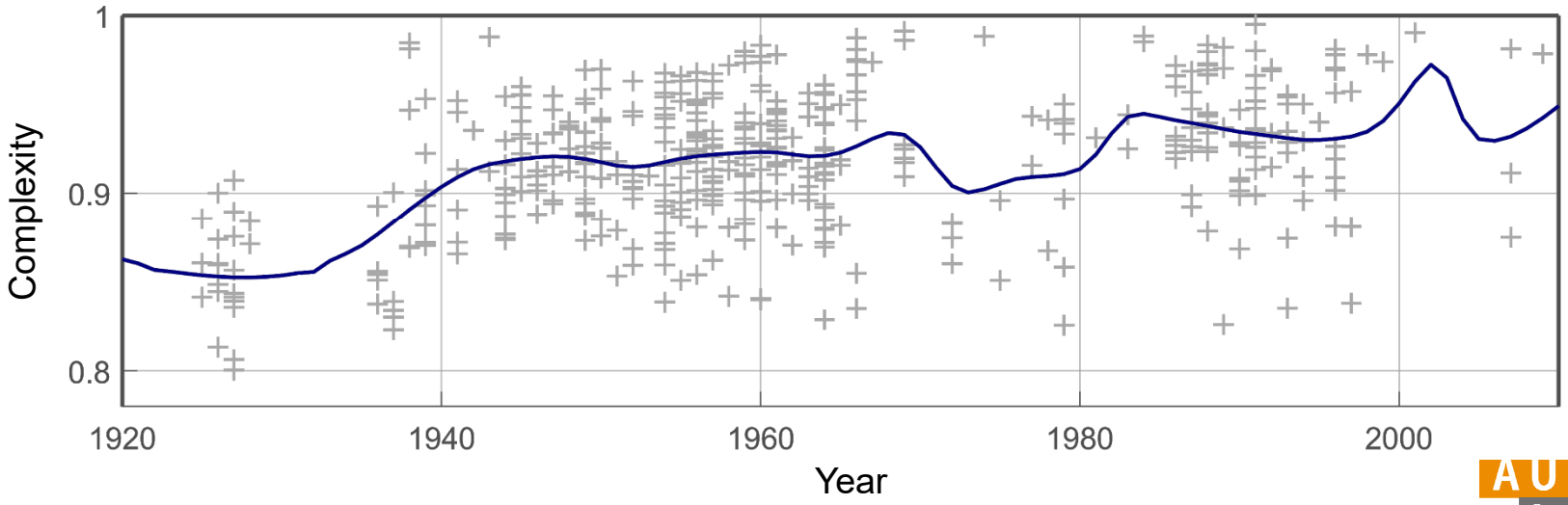


Tonal Complexity: Jazz Solos

- Symbolic transcription

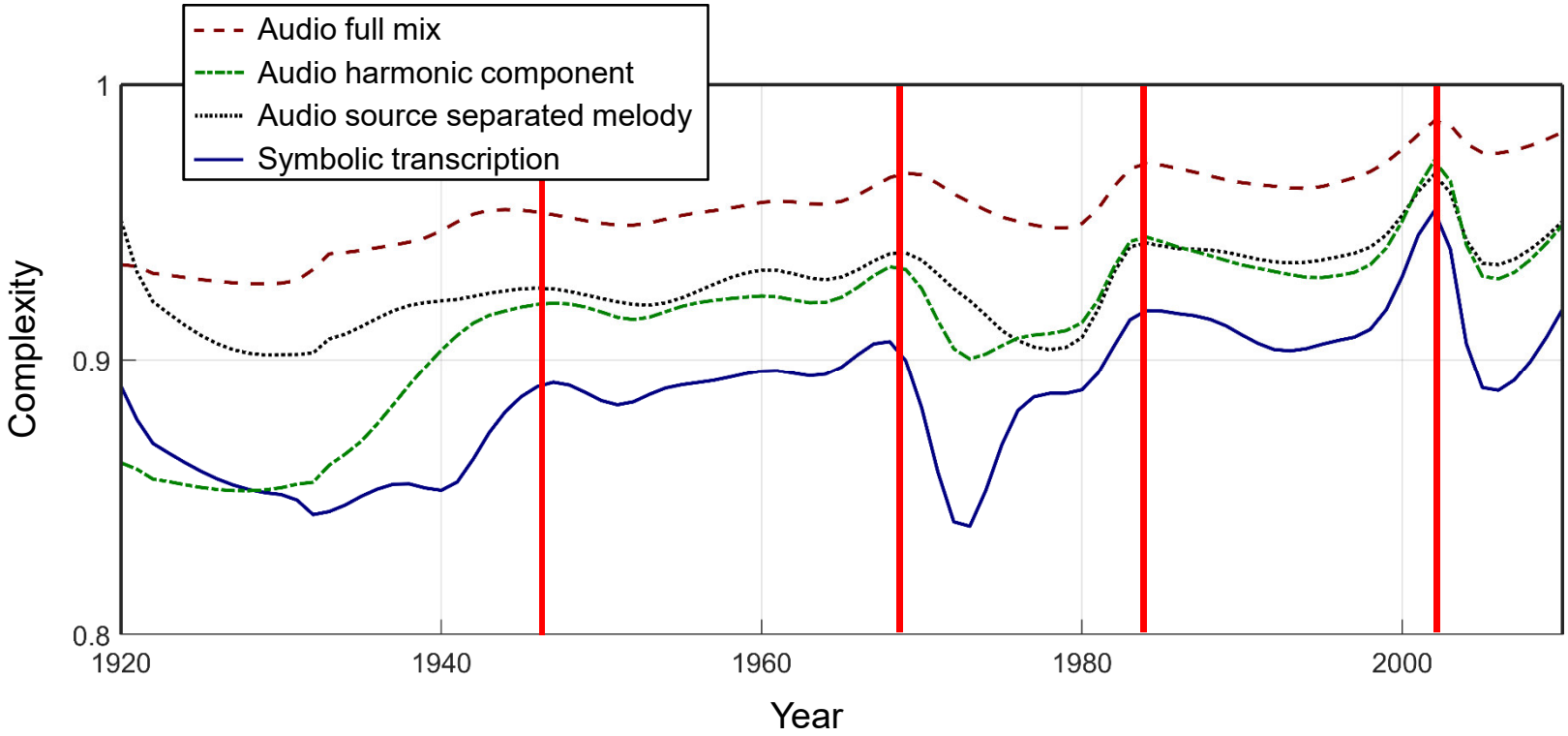


- Audio recording (harmonic part)



Corpus Analysis: Music Representations

- Compare all four representation types:



→ Evolution curves have different ranges, but same general trends

→ Corpus analysis can also be performed on audio recordings

AUDIO LABS