Case Studies for Systematic Music Analysis

Atte Tenkanen

Pärnu Contemporary Music Days 2020

25.1.2020

About the author

Atte Tenkanen (1965-)

- Church musician in Lohja, Finland 2019-
- Master of music, church music, Sibelius Academy, 1992

  Atte Tenkanen: *Urkuimprovisaation aspekteja: urkuimprovisaatio käytännön työssä: improvisaatio ja koulutuksen tukiaineet* (1992)

- Doctor of philosophy, University of Turku, Finland, 2010
- Doctoral thesis *Comparison Structure Analysis* [1]

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5. Tonality analysis with ***Vector Sequence Model*** *(VSM)*

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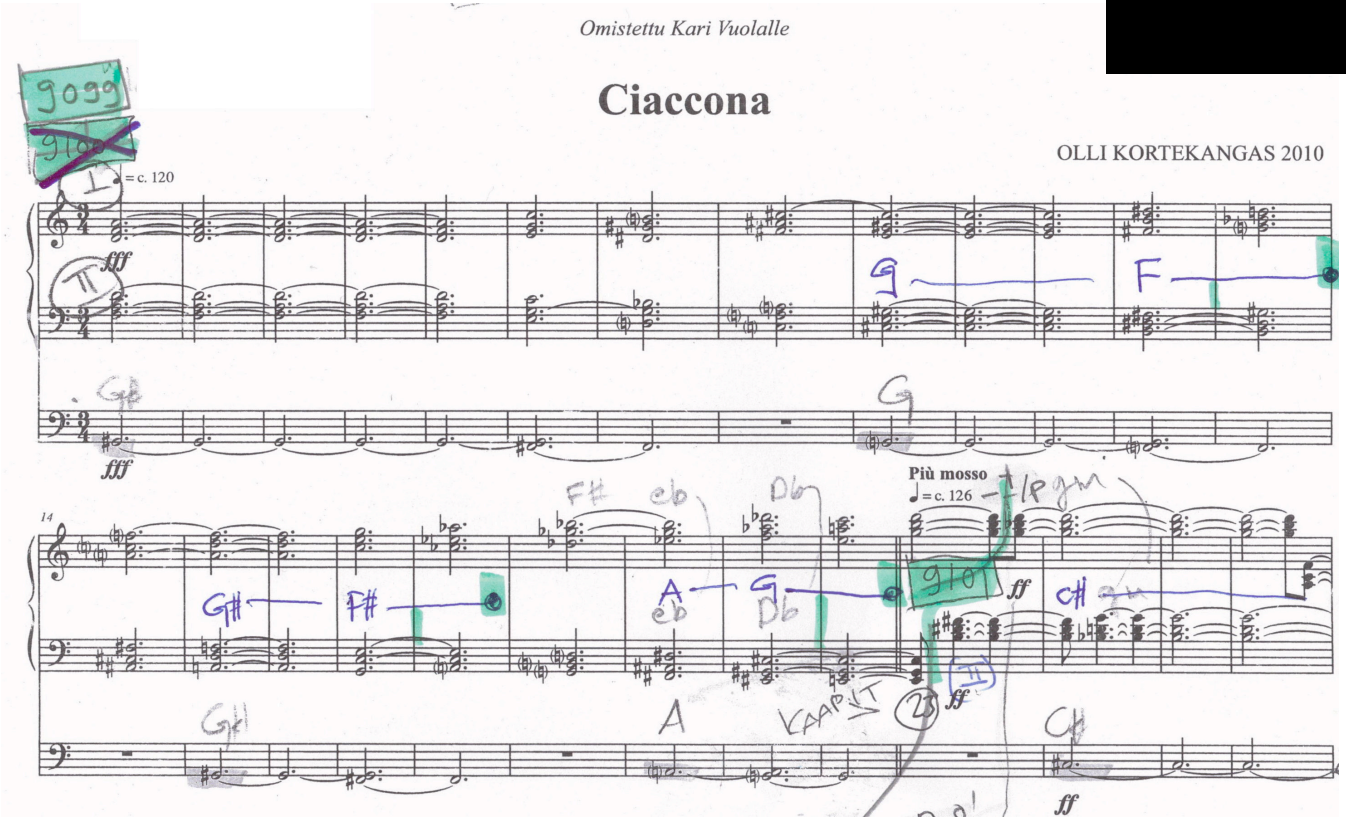
- Data is too big or too complex for manual analysis.
- To find **new ways to analyse** and **visualise** results (CSA, VSM).

An example of ad hoc -methods: Olli Kortekangas (1955-) *Ciaccona* for organ

- Based on major and minor triads, in both hands, and quite regular pedal part.

- Symmetric: fff ———> pp ———> fff



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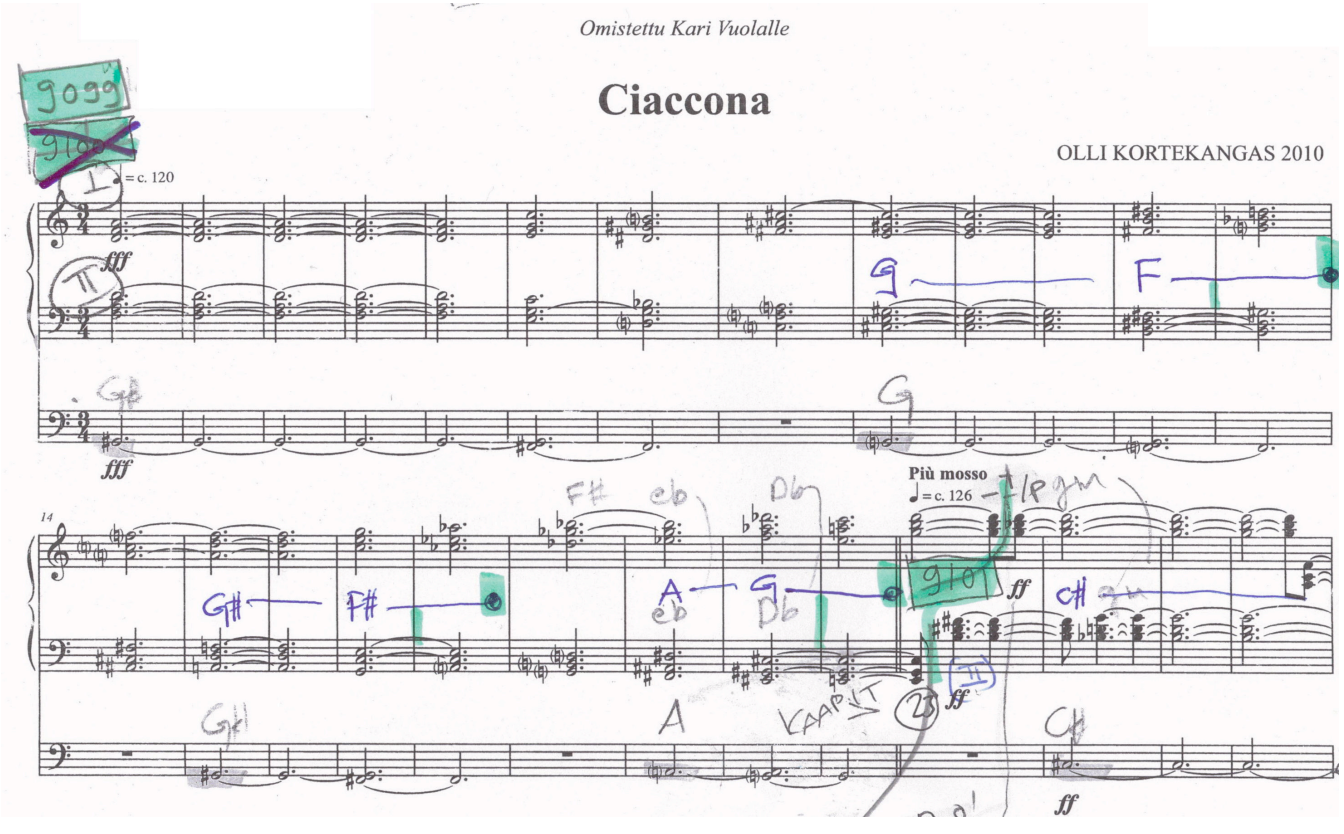

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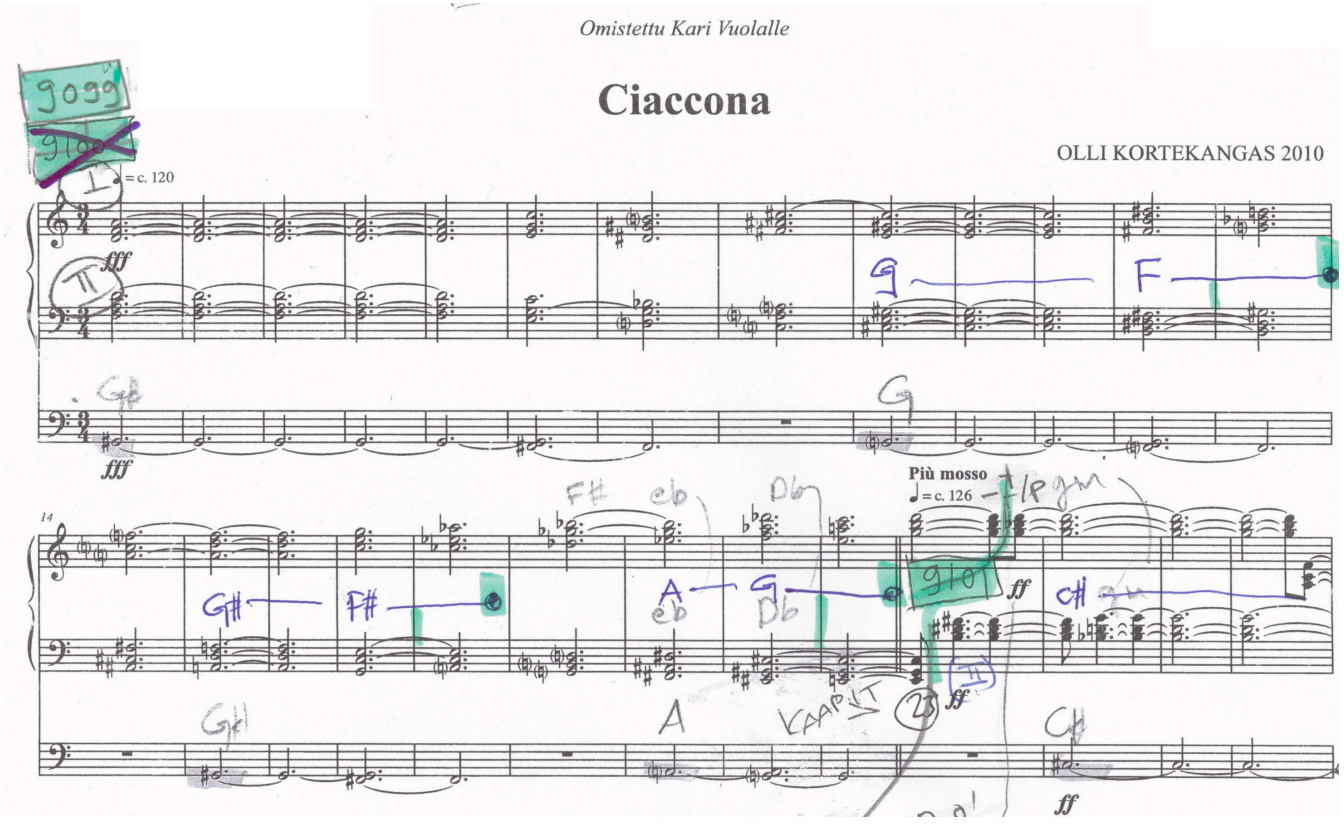

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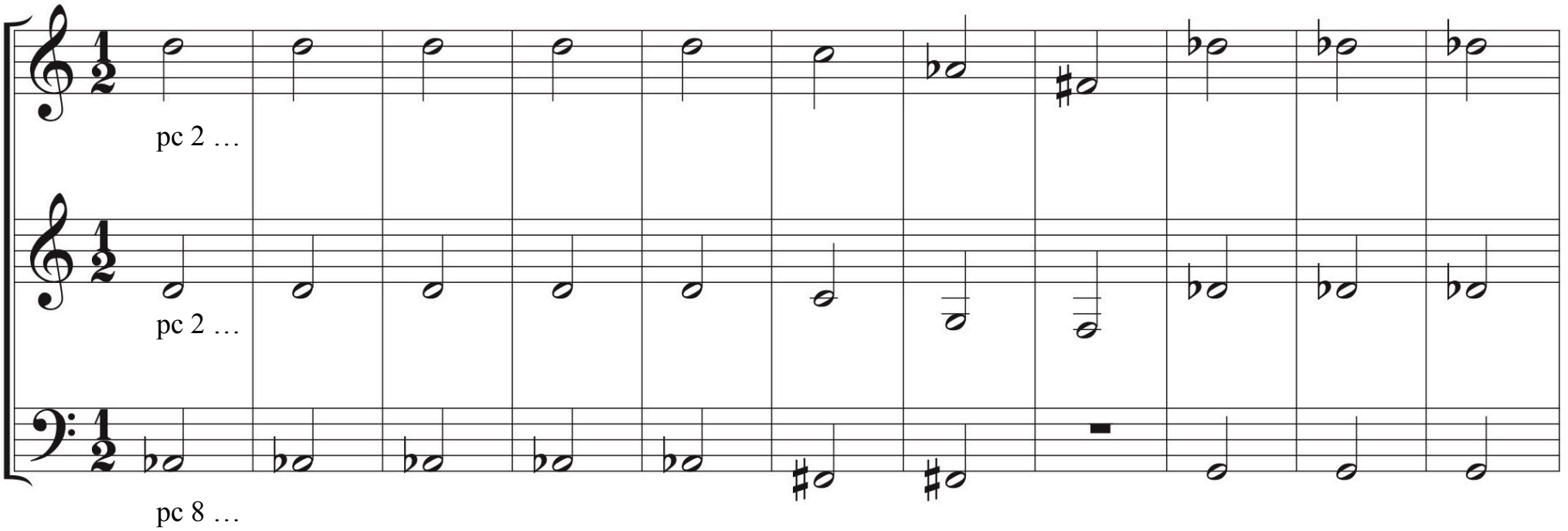

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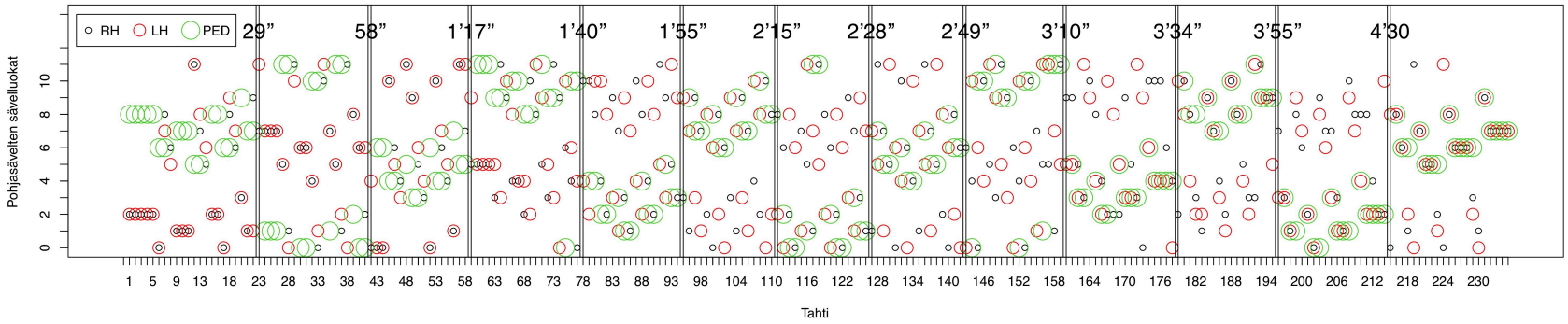

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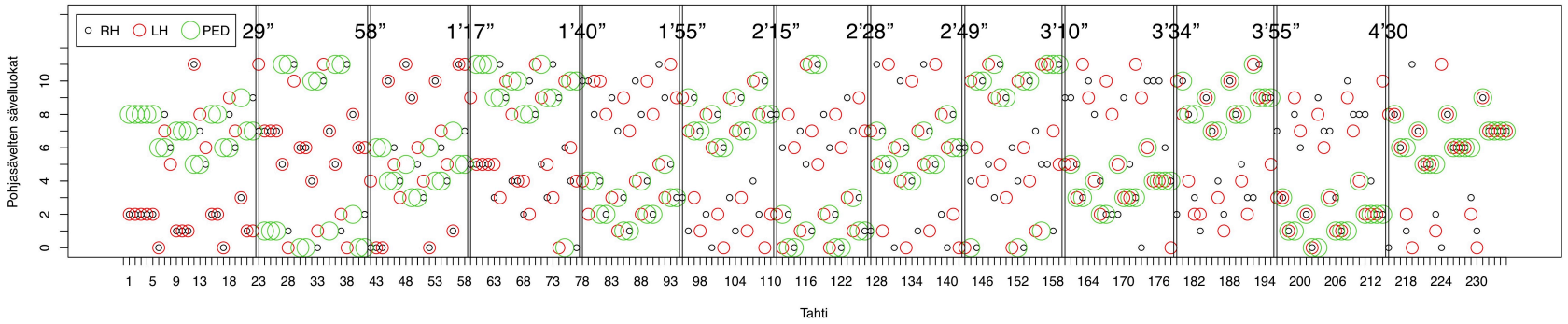

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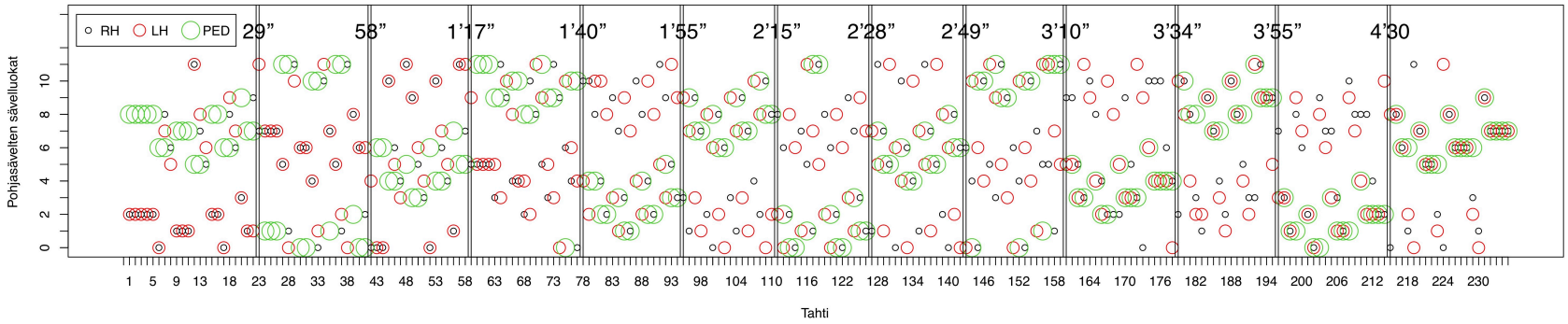

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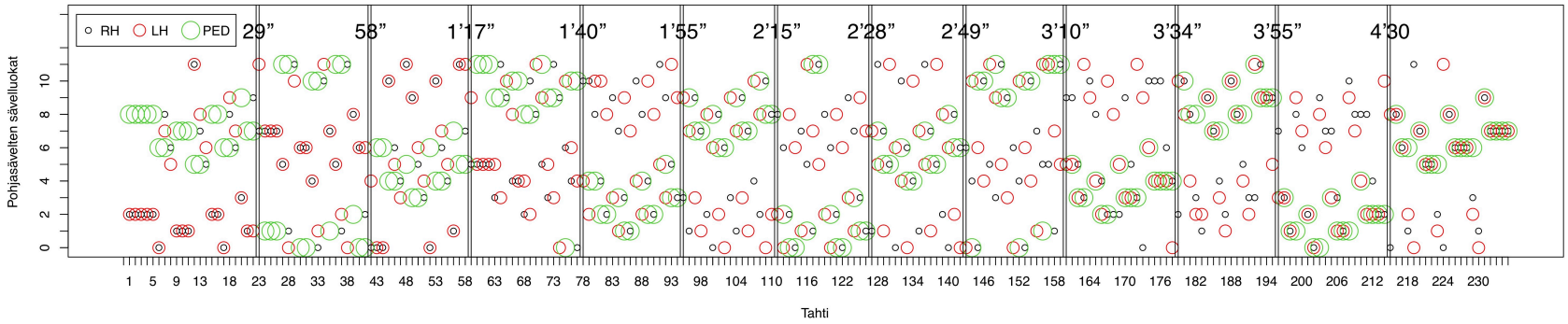

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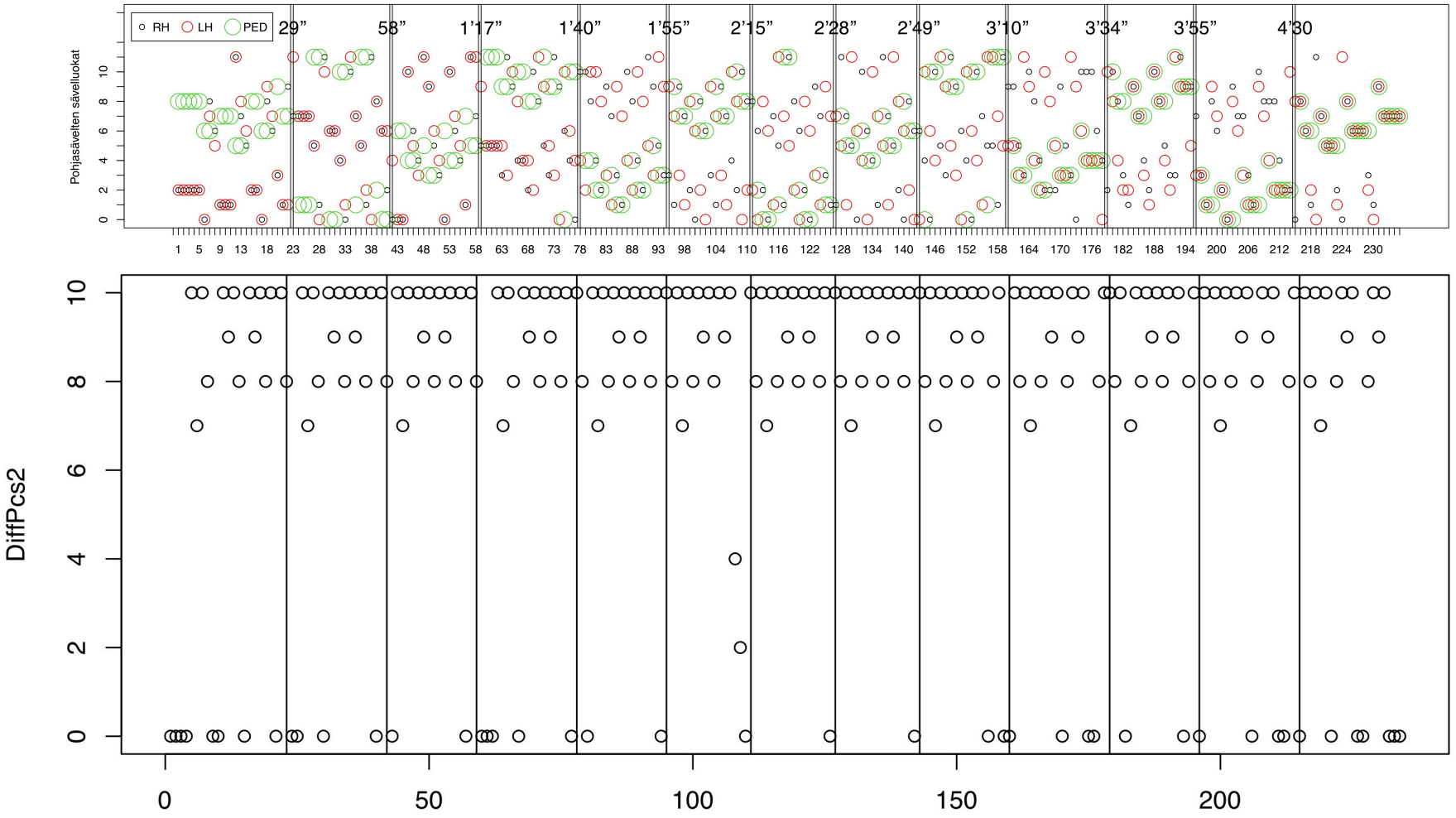
- An ”algorithmic” composition which follows a certain rule.
- A ”caleidoscopic" piece.

An example of ad hoc -methods: Olli Kortekangas (1955-) *Ciaccona* for organ

There is something odd in bars 108-110?



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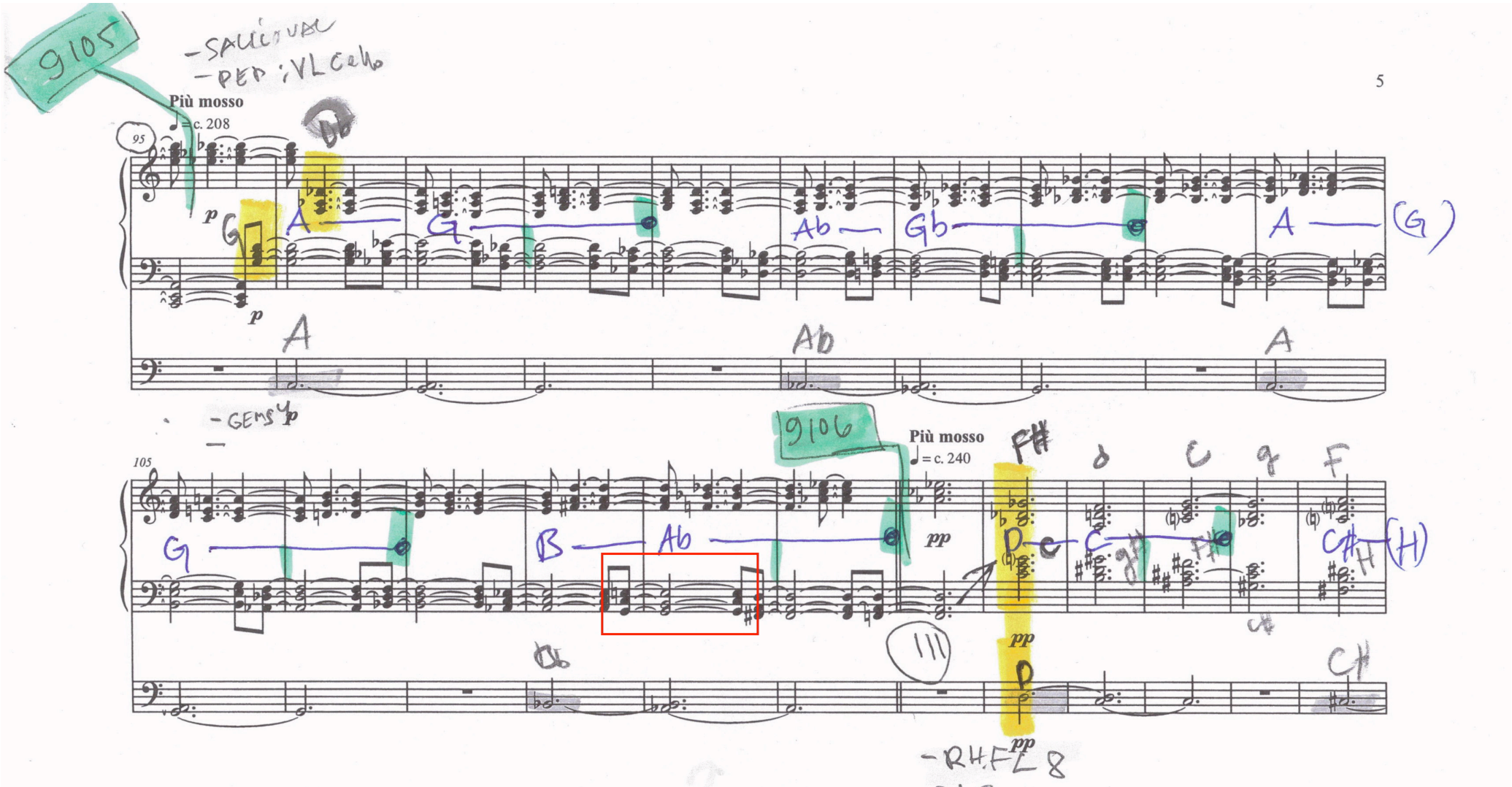
Bar 109: There are tied slurs between c-b-c in RH. Typo!



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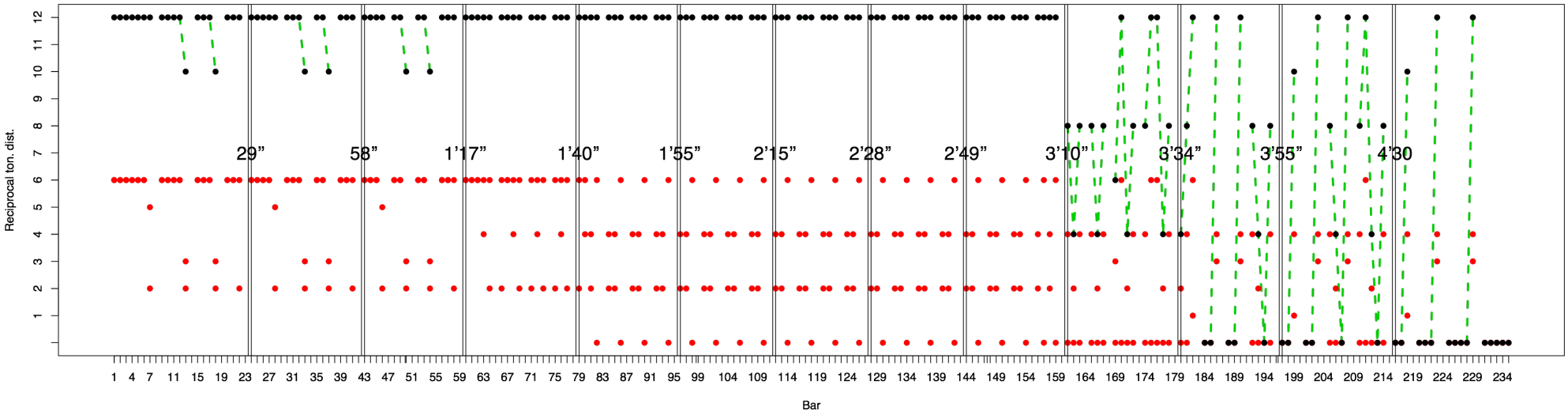
Then I calculated mutual tonal distances between parts:

- Black points represents the sum of "tonal distances".



An example of ad hoc -methods: Olli Kortekangas (1955-) *Ciaccona* for organ

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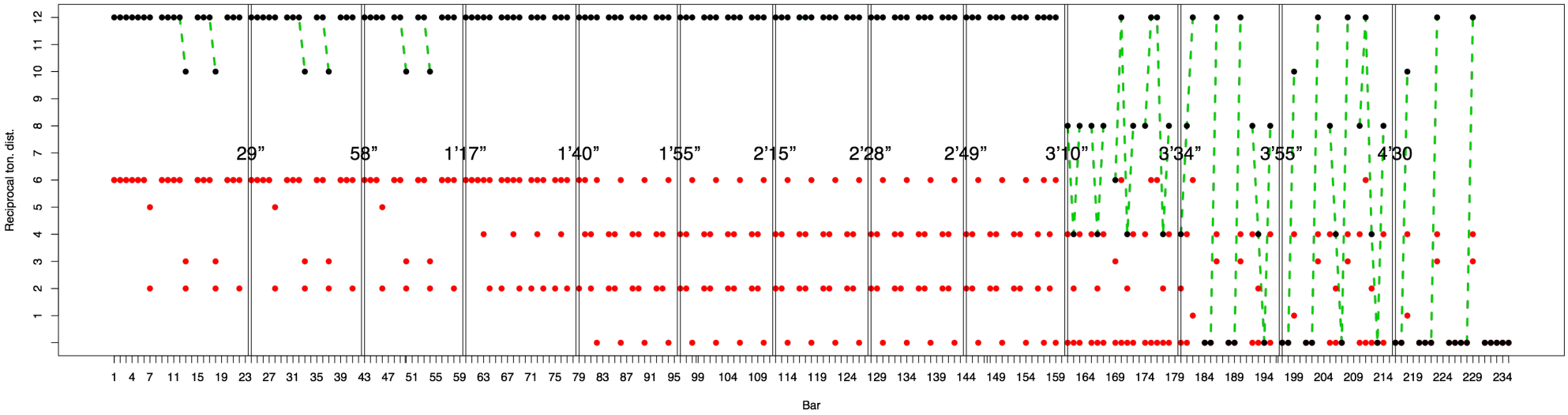
- Black points represents the sum of ”tonal distances".
- I was very impressed since this effect is audible.



Surveying compositional process order through melodic-motivic similarities

- As a composer I am interested in **compositional process order**. [2]

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- To consider what the composer might have written first, and what has been subsidiary in the compositional process, benefits composition students especially, since such observations reveal something **about constructing the musical form**.

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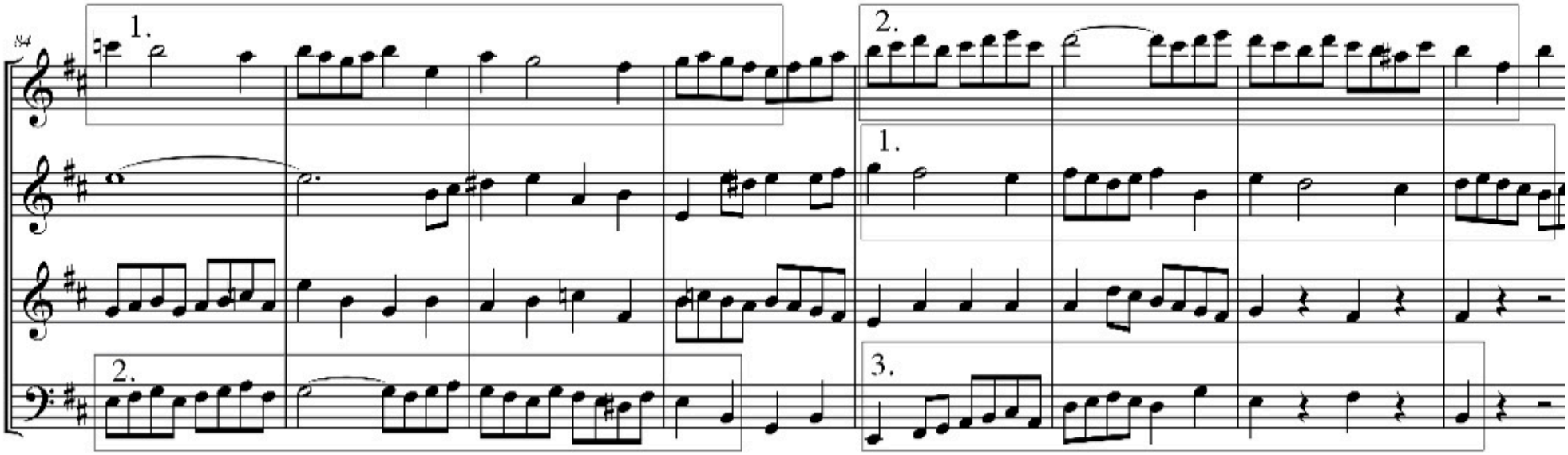
- To consider what the composer might have written first, and what has been subsidiary in the compositional process, benefits composition students especially, since such observations reveal something **about constructing the musical form**.
- The question is especially relevant in polyphonic music.

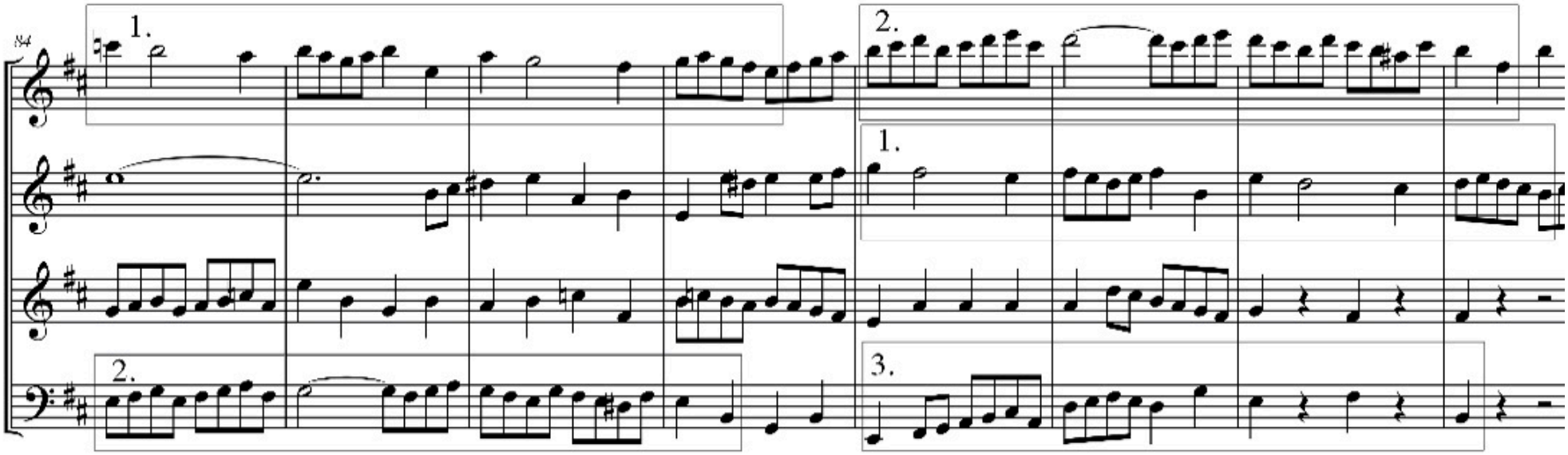
Surveying compositional process order through melodic-motivic similarities

- The compositional process includes several phases. In classical fugal pieces, for example, the main theme (1), with its variants and fixed countersubjects (2), has most probably been written before the 'freer parts' that occur at the same time. Ex.: J.S. Bach’s Orchestral Suite No. 2 in B minor BWV 1067, first movement, bars 84–90.



Surveying compositional process order through melodic-motivic similarities

- Only one simple hypothesis: ***those melodic-motivic patterns that occur more than once are seen as more important and might have been written before those that occur only once in the piece.***



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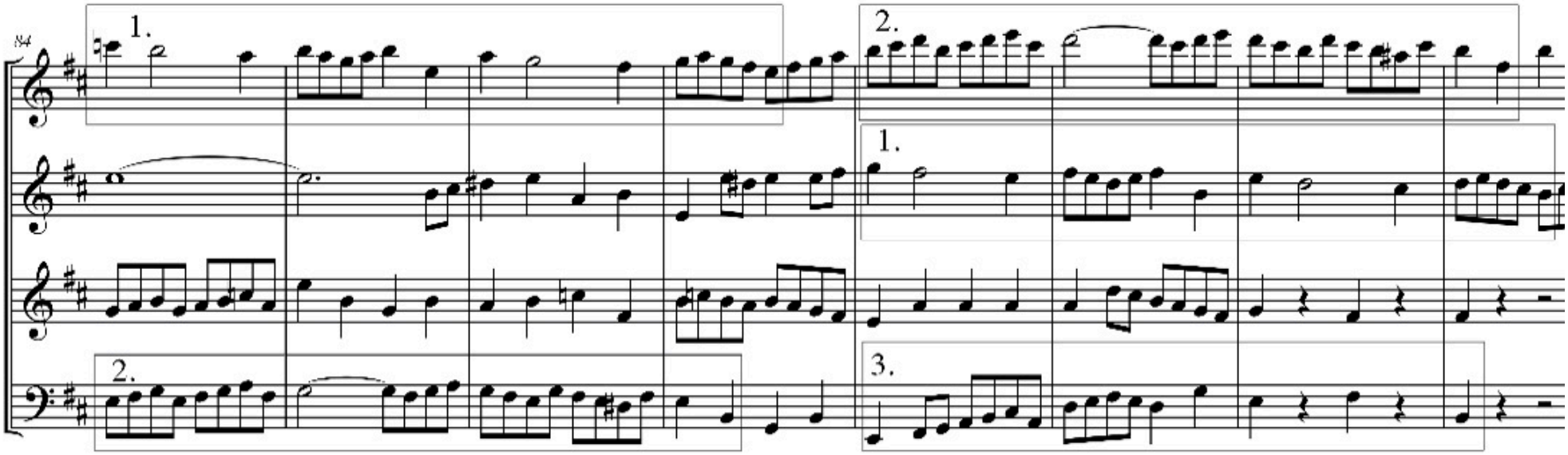
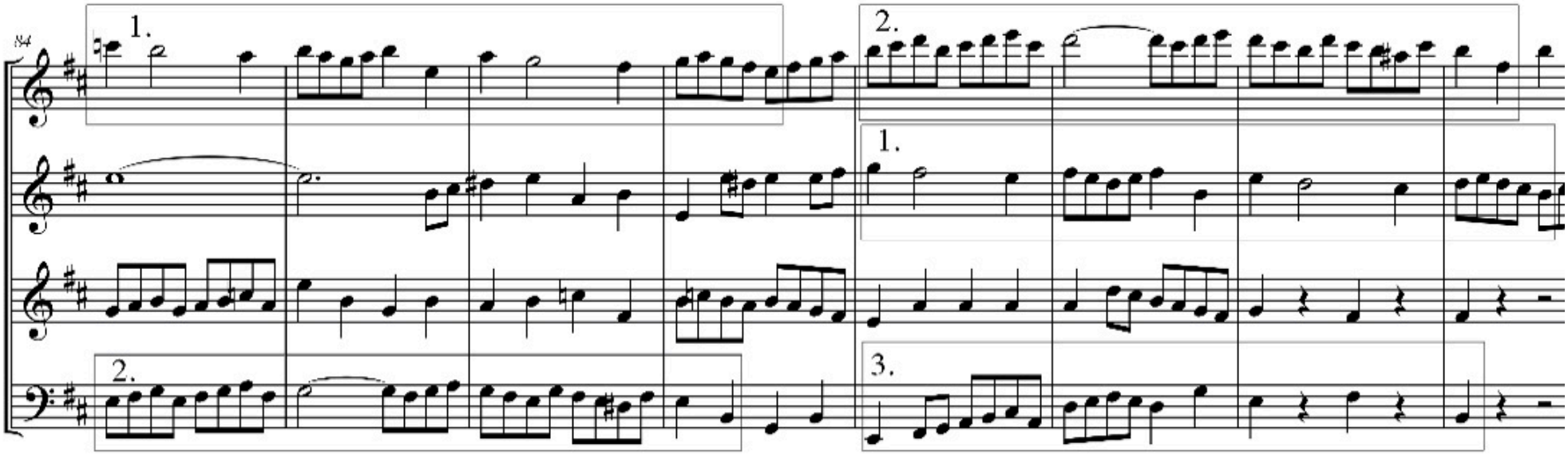
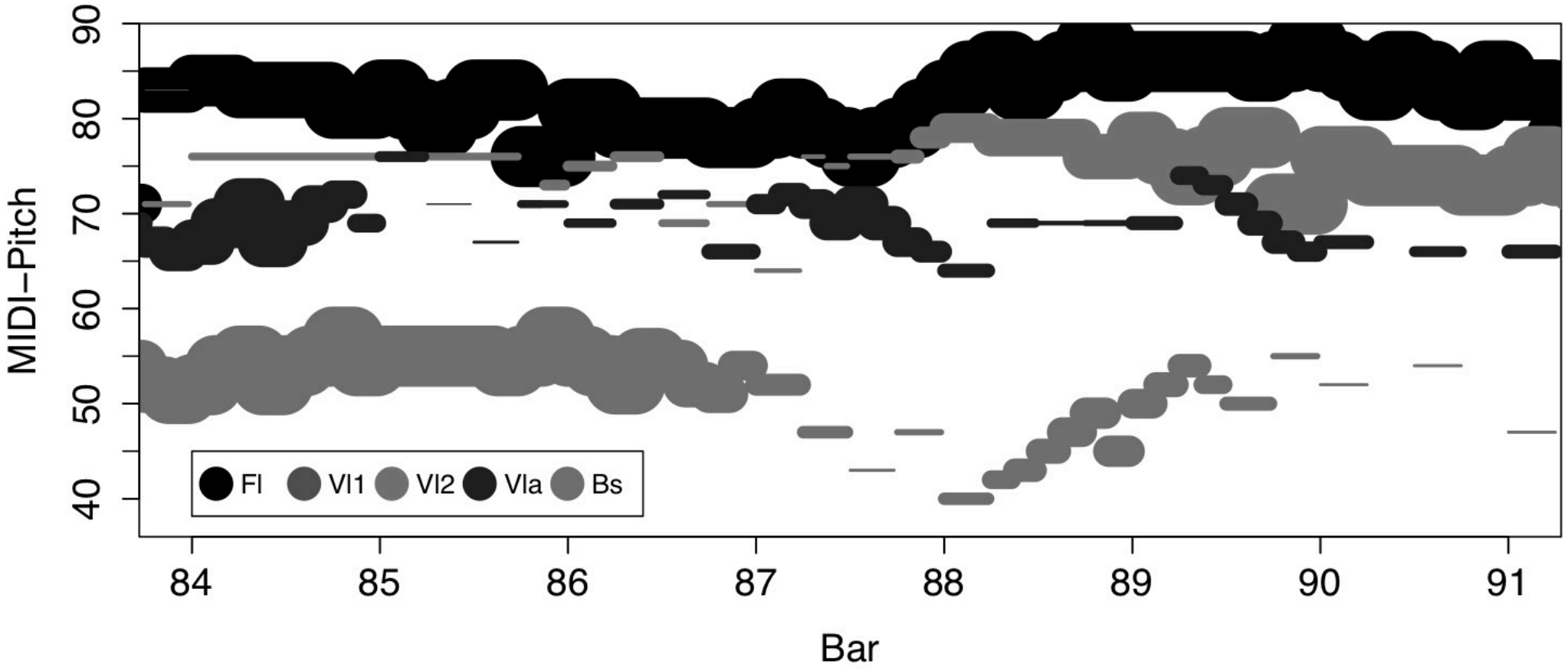
- The algorithm searches for similar melodic structures through all parts of the piece.

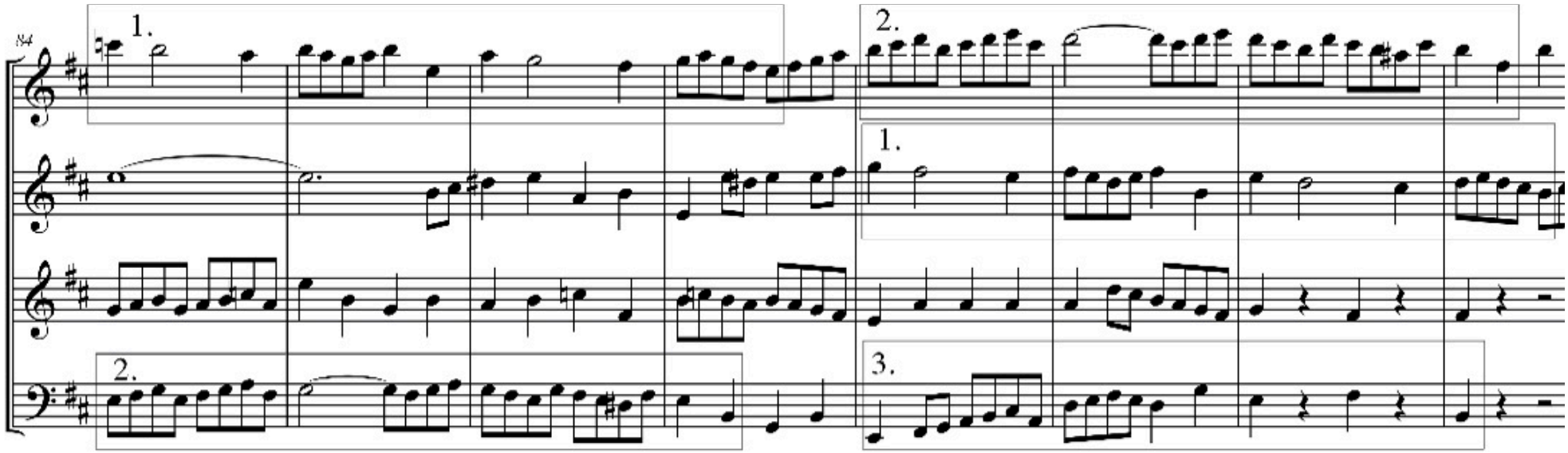


Surveying compositional process order through melodic-motivic similarities

- The piece is presented as piano-roll score but in a way that each note is bolded according to how many times it belongs to melodic segments that occur at least twice.

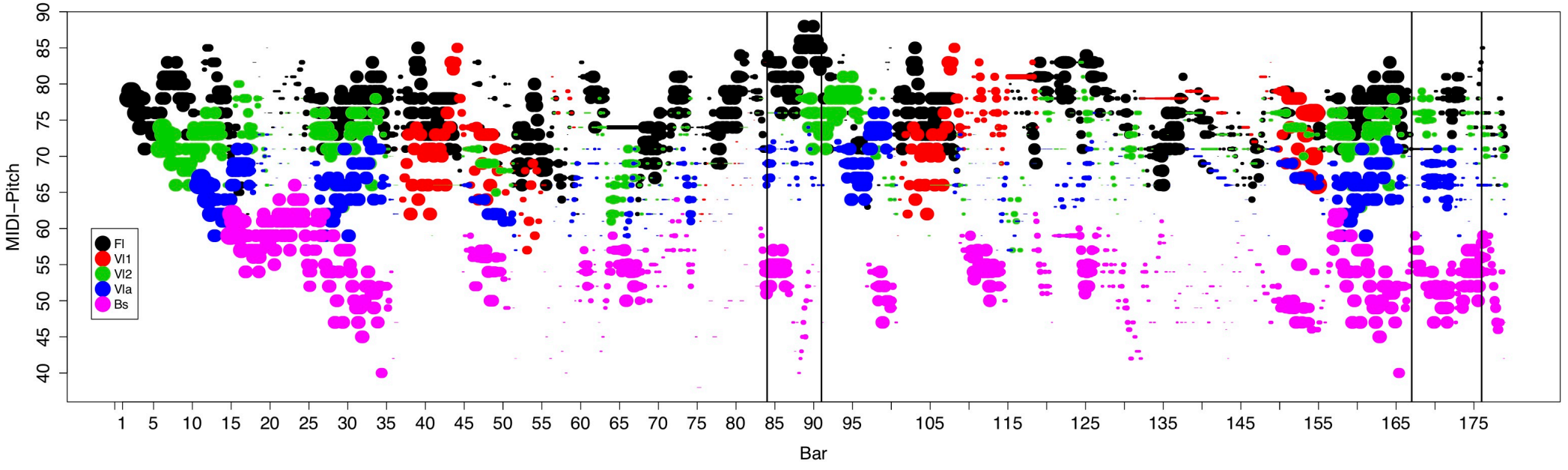



MIDI–Pitch
90
80
70
60
50
40
Fl
Vl1
Vl2
Vla
Bs
84
85
86
87
88
89
90
91
Bar


1.
2.
1.
2.
3.

Surveying compositional process order through melodic-motivic similarities

- Some observations on the whole fugue:



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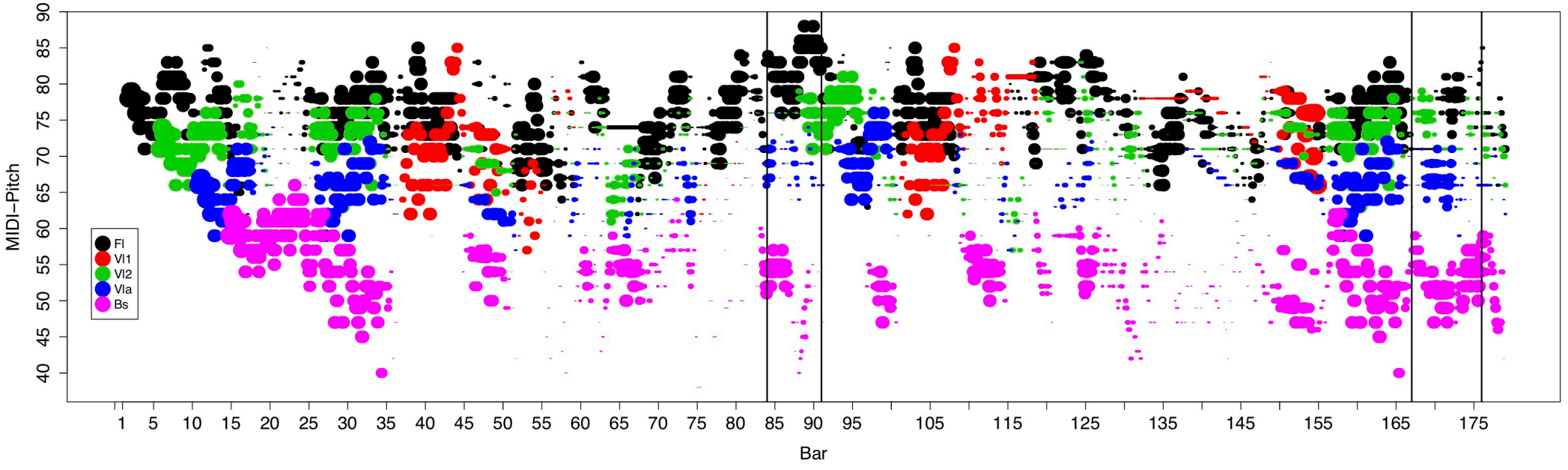
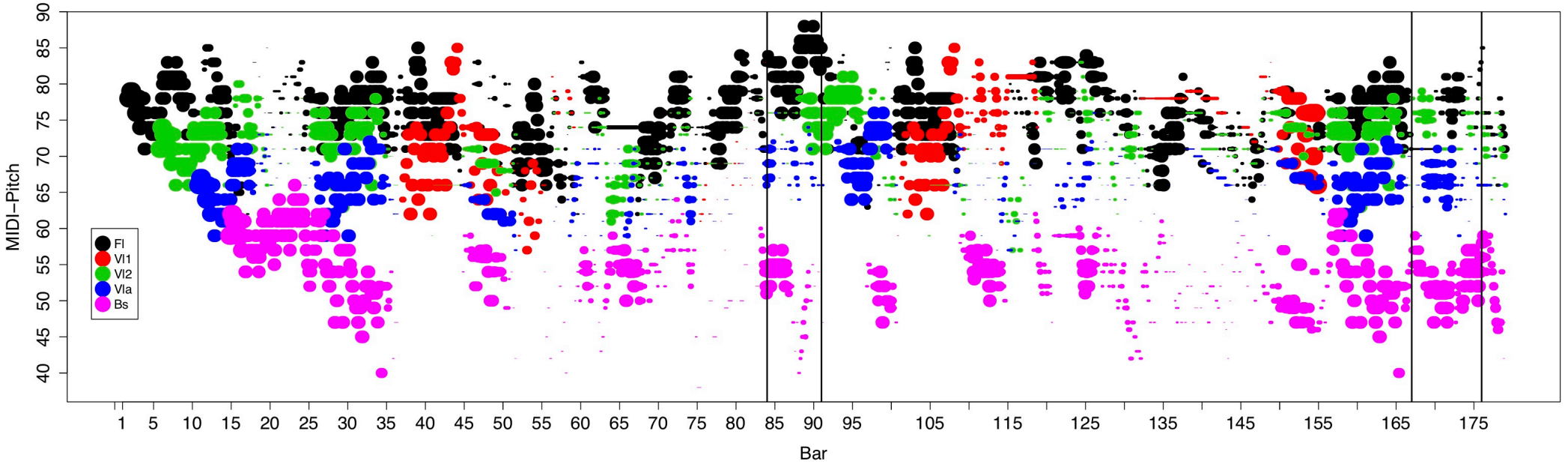
  - Totally free sections are almost absent.



Surveying compositional process order through melodic-motivic similarities

- Some observations on the whole fugue:
  - Totally free sections are almost absent.
  - The bass part is most probably written first in bars 18-- 23, 105--110 and 167–176.



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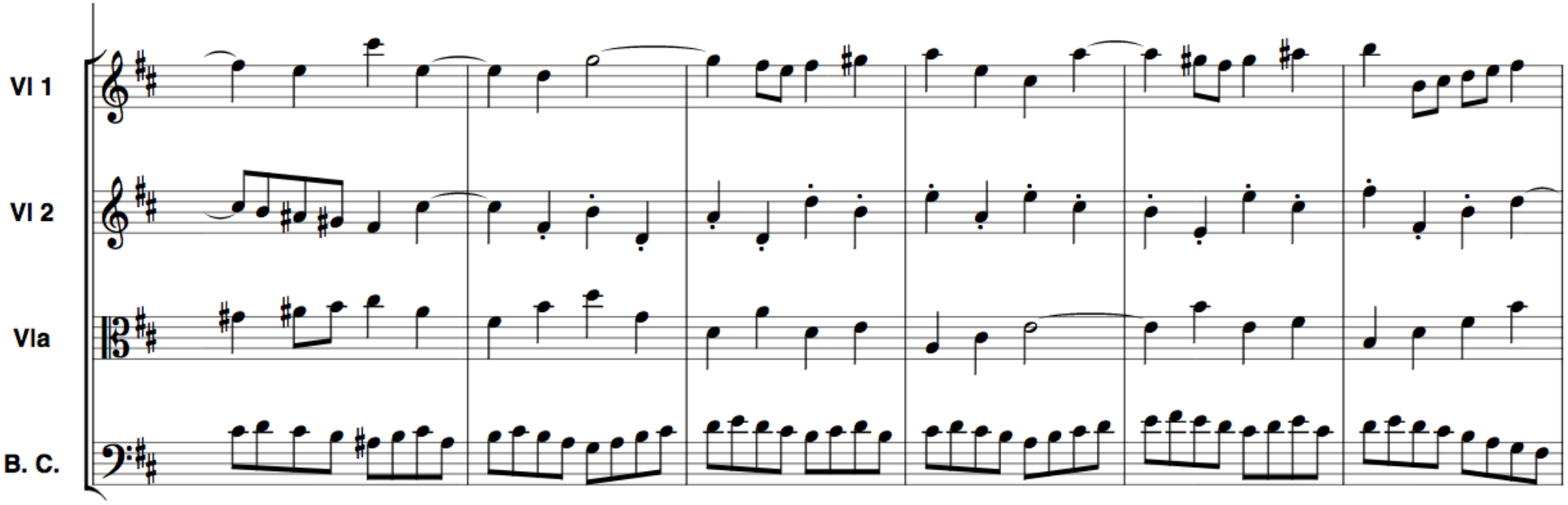
- The bass part in bars 18-- 23.



Surveying compositional process order through melodic-motivic similarities

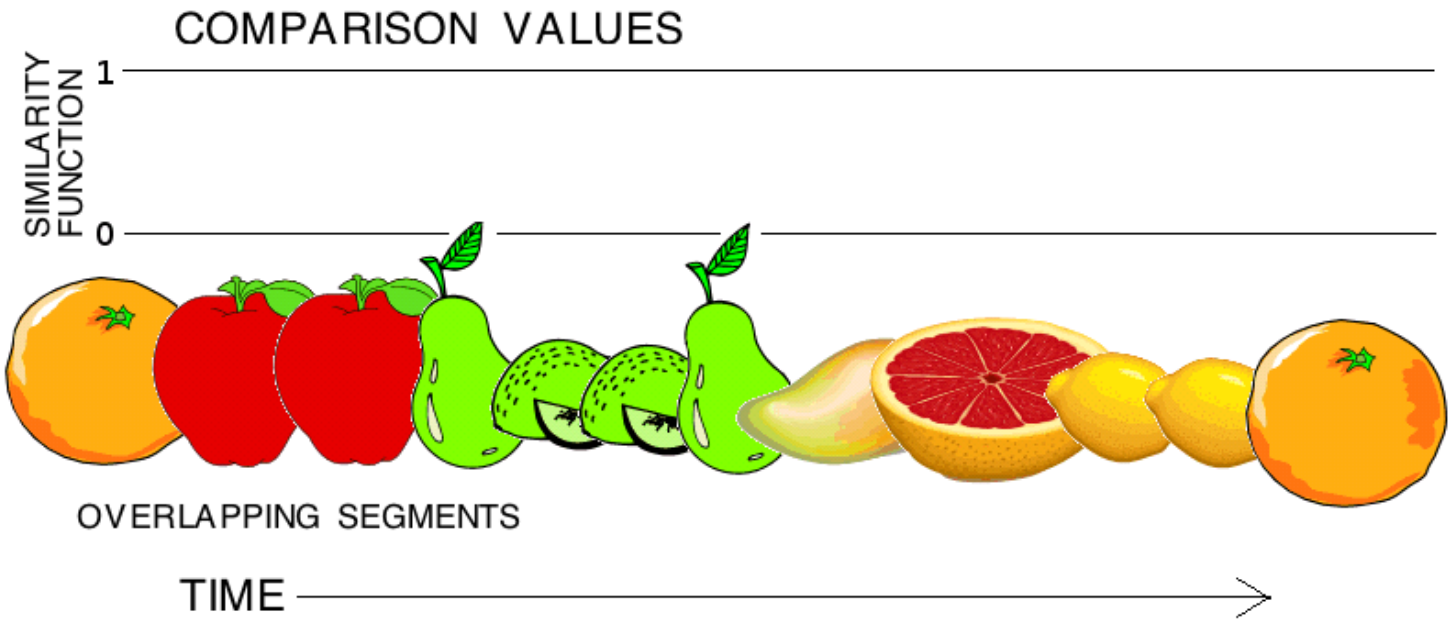
Future directions:

- The next step would be to analyse several compositions of the same type by the same composer in order to draw **more general conclusions about the composer's formal conventions**.

- Finally, we could go further and make comparisons between the formal techniques of different composers.

Comparison Structure Analysis

- Main parts of the CSA: 1) overlapping segmentation, 2) mathematical comparison function, 3) comparison set 4) result graph.



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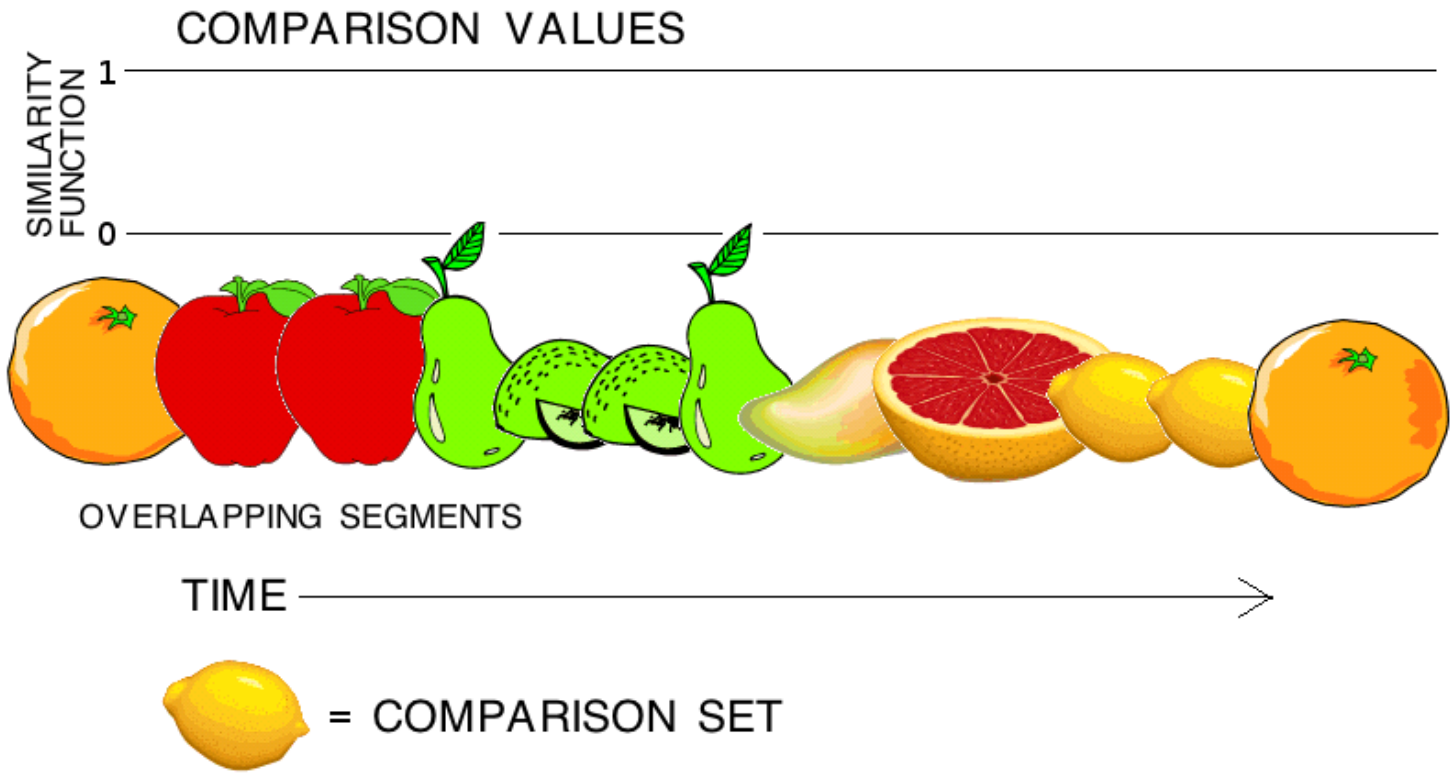

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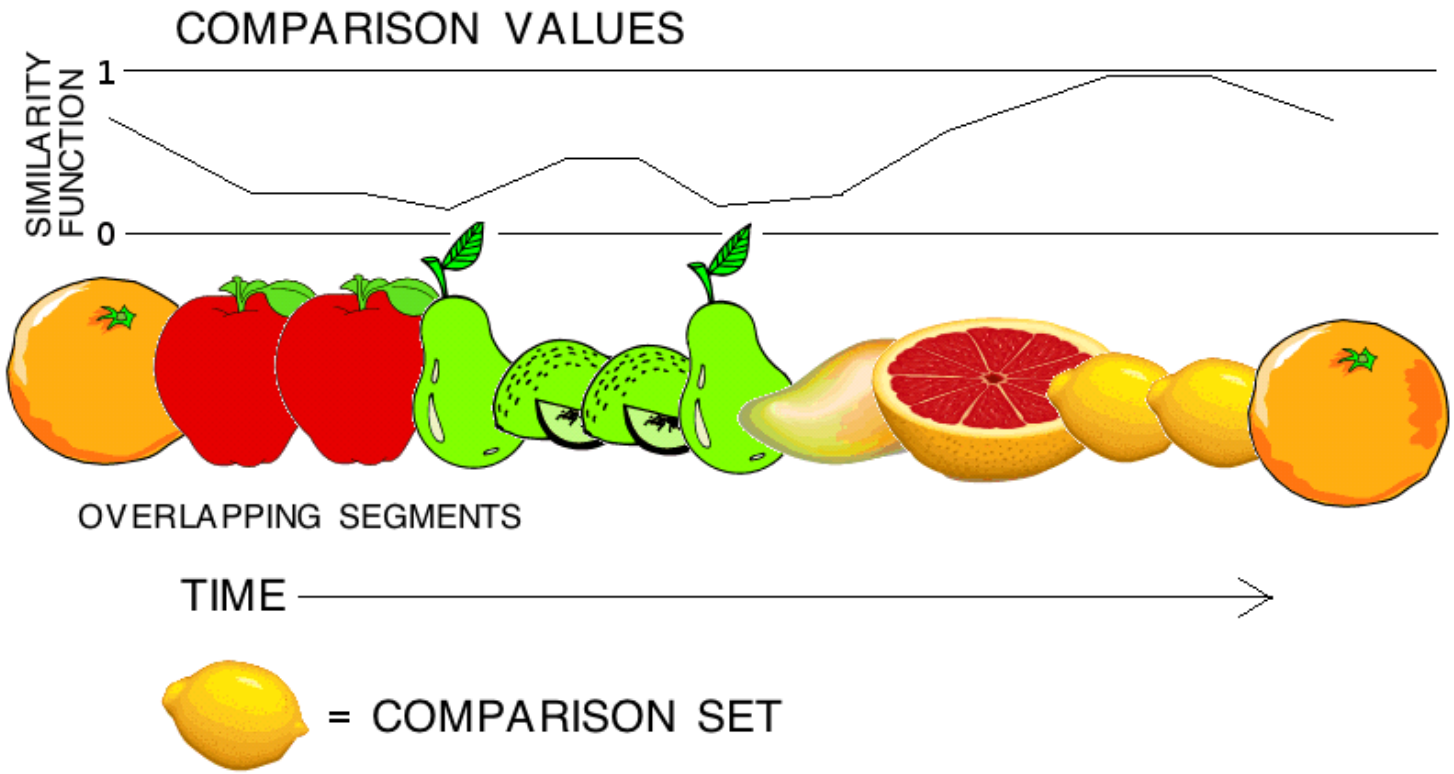

Comparison Structure Analysis

- An automatic, computer-aided analytical method for music analysis, developed by the author and prof. Erkki Huovinen. [3,4]

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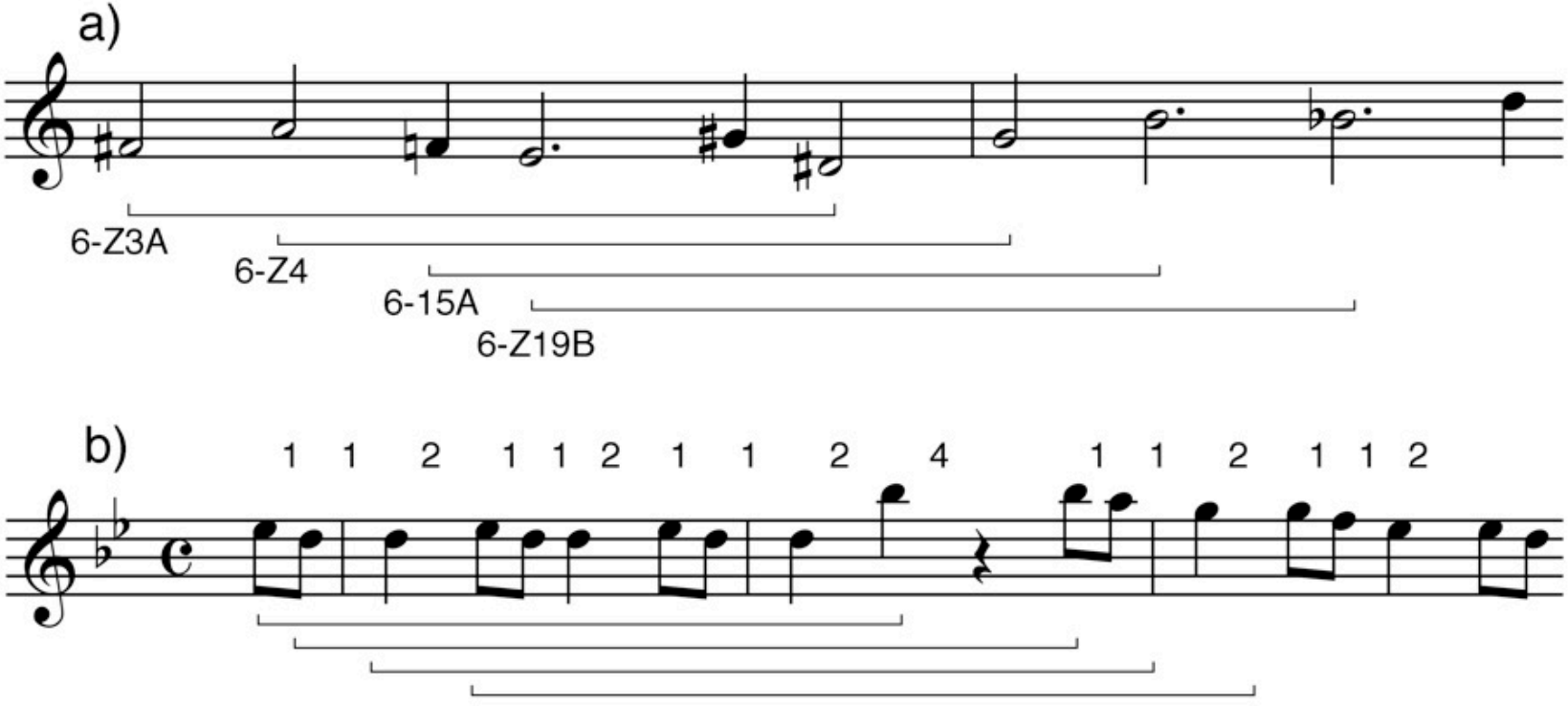
- CSA can be applied **to different dimensions of music**.

- Produce **dynamic representations of musical properties** by **evaluating the prevalence of a chosen musical data (comparison) structure through a musical piece**.

- A ***comparison structure*** may refer to a mathematical vector, a set, a matrix or another type of data structure and even a combination of data structures.

Comparison Structure Analysis

- CSA depends on an abstract systematic segmentation that allows for a statistical or mathematical survey of the data. Here is seen two simple segmentation examples of one-dimensional 1) melodic and 2) rhythmic data. [5]



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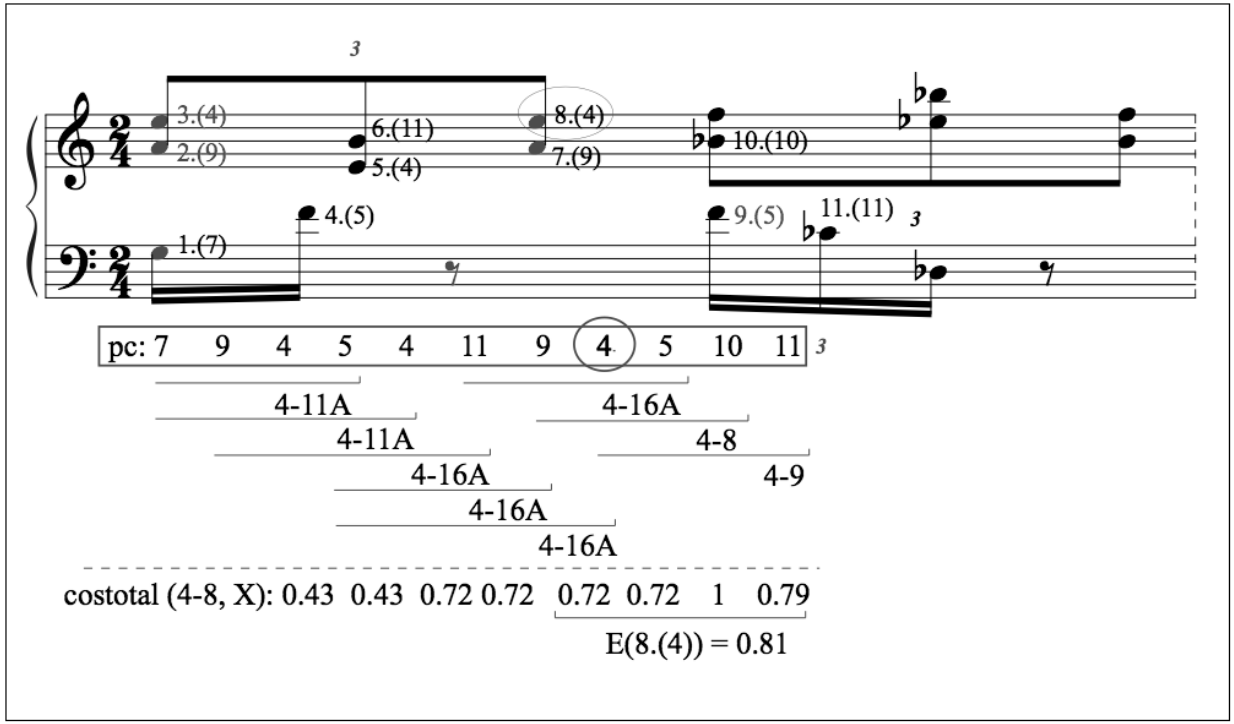
- 'Tail segmentation' gives comparison value for each note.



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- ’Tail segmentation' gives comparison value for each note.
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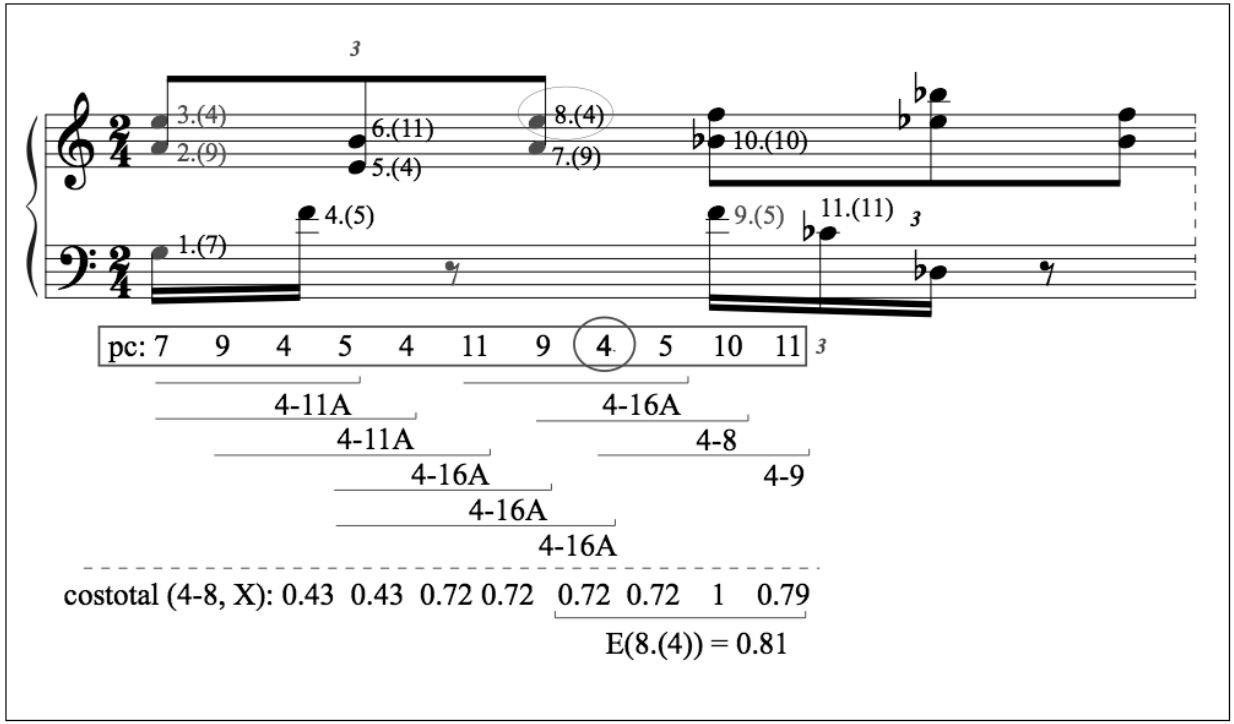

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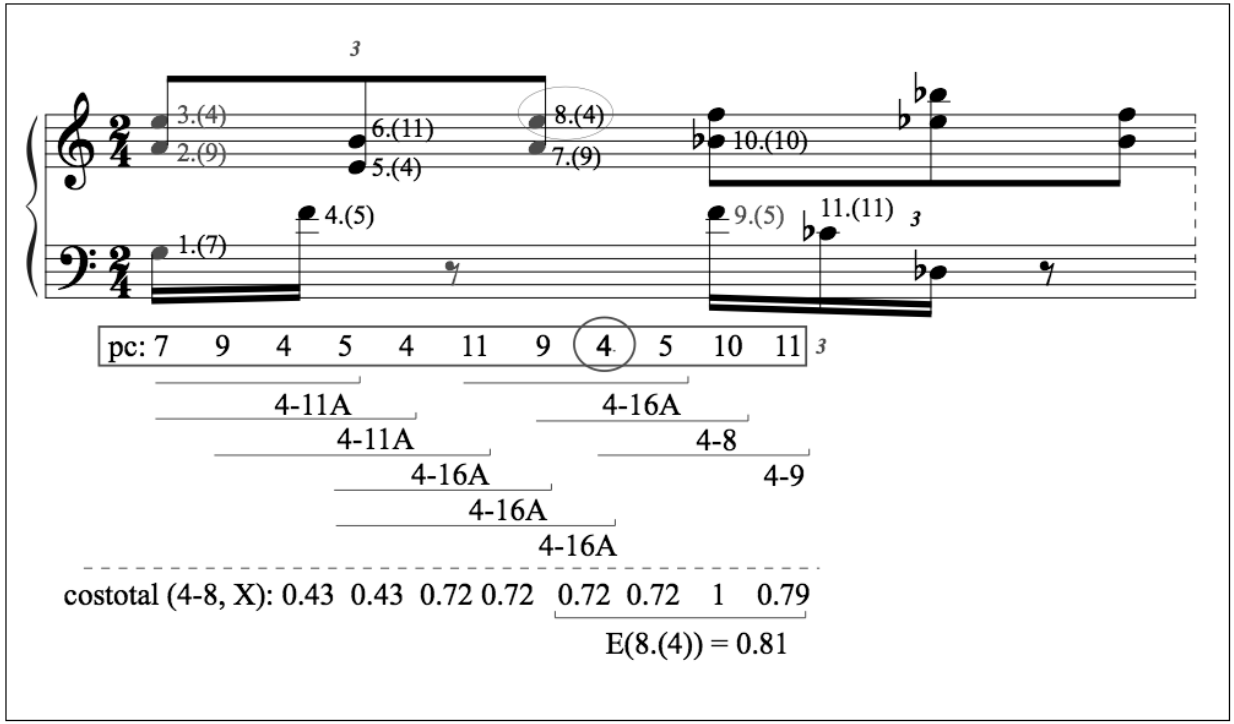
- The first eight tetrachordal sets are marked with Forte-names.



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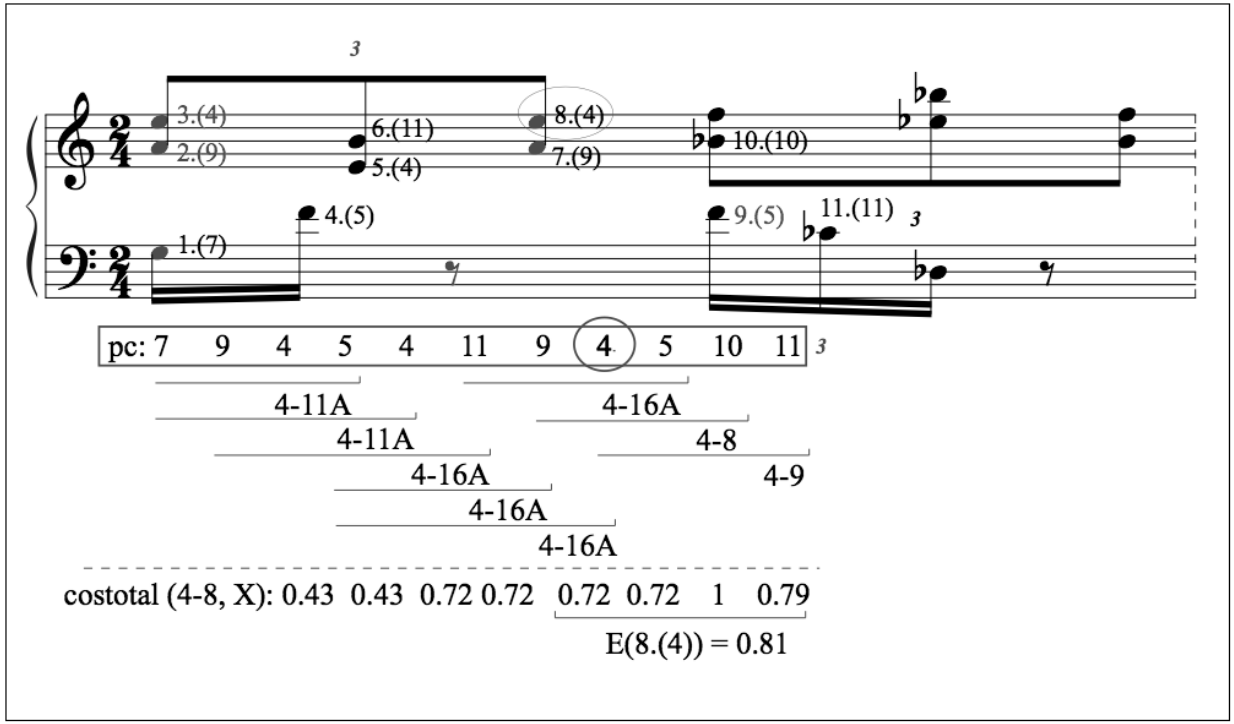
- Comparison function is costotal.



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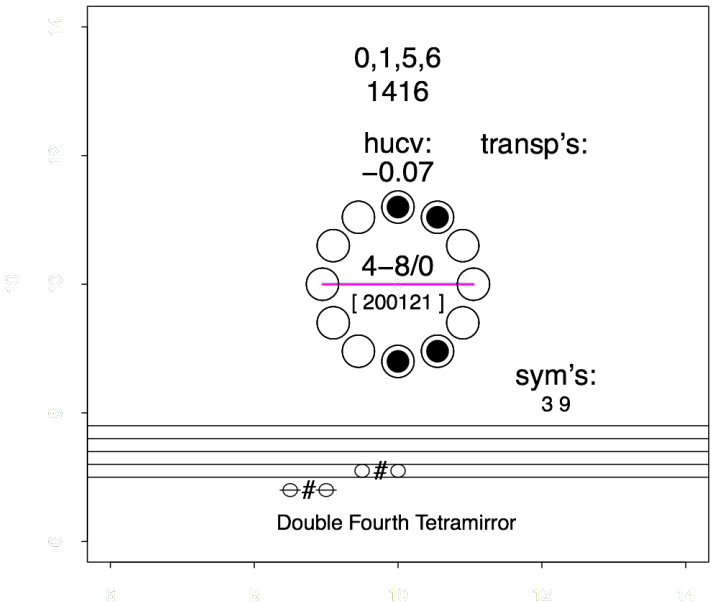
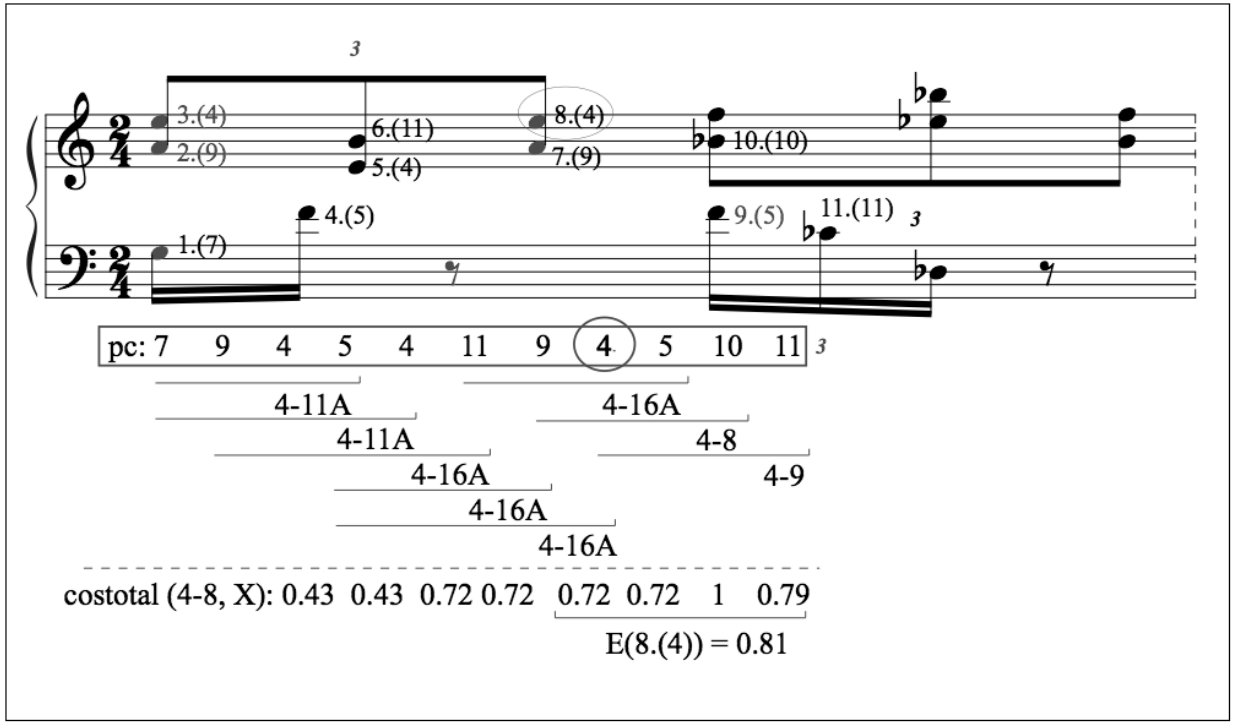
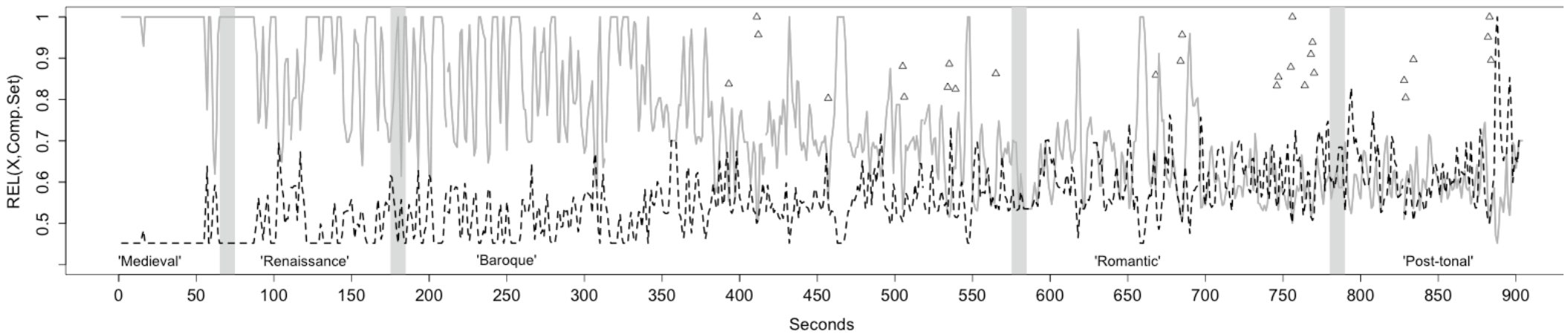
- Comparison function is costotal.
- Comparison set is 4-8.





Comparison Structure Analysis

- A CSA of Olli Linjama, Improvisation nr 756 (2004).



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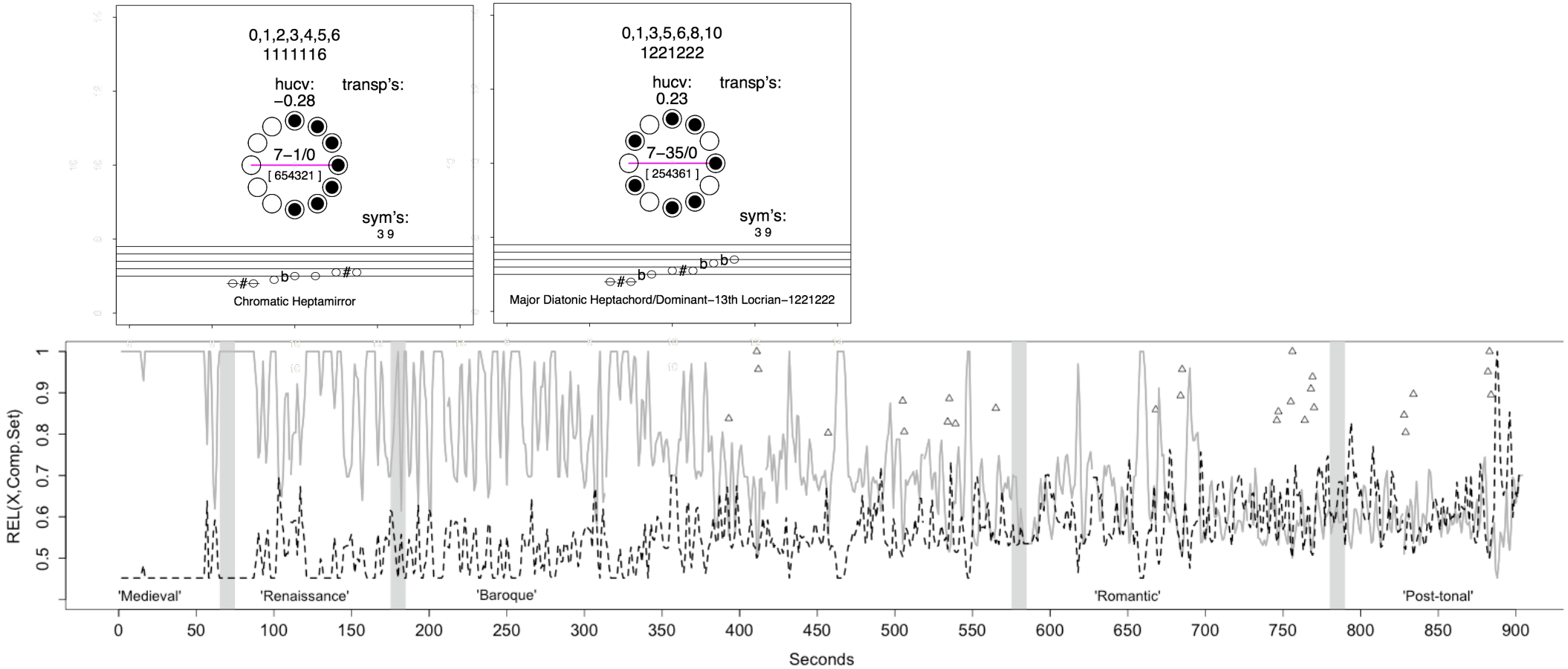

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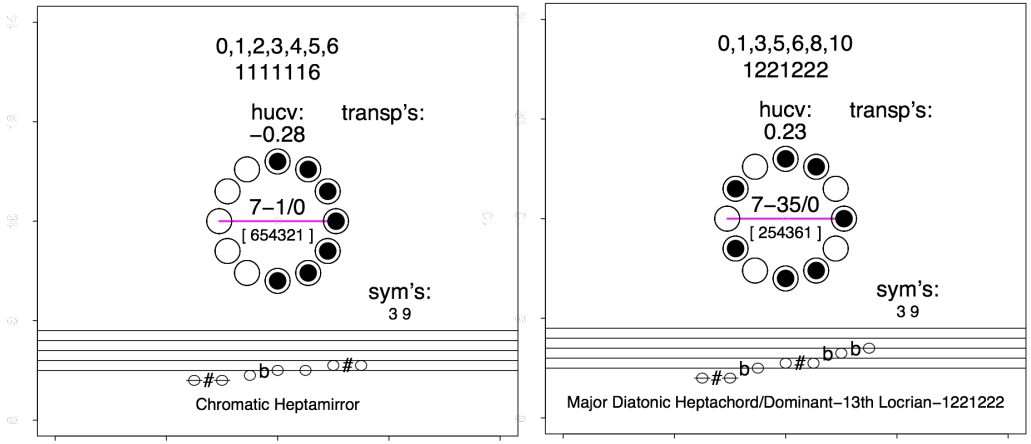

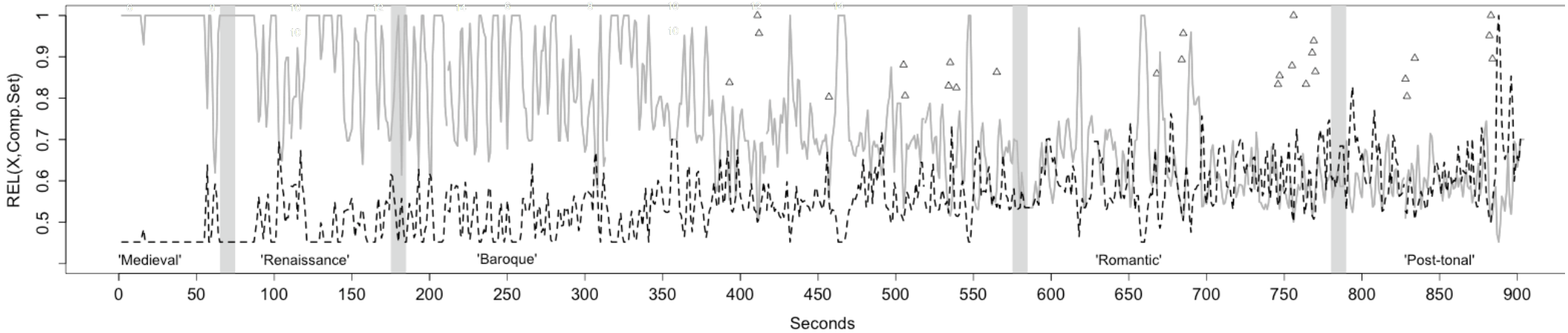

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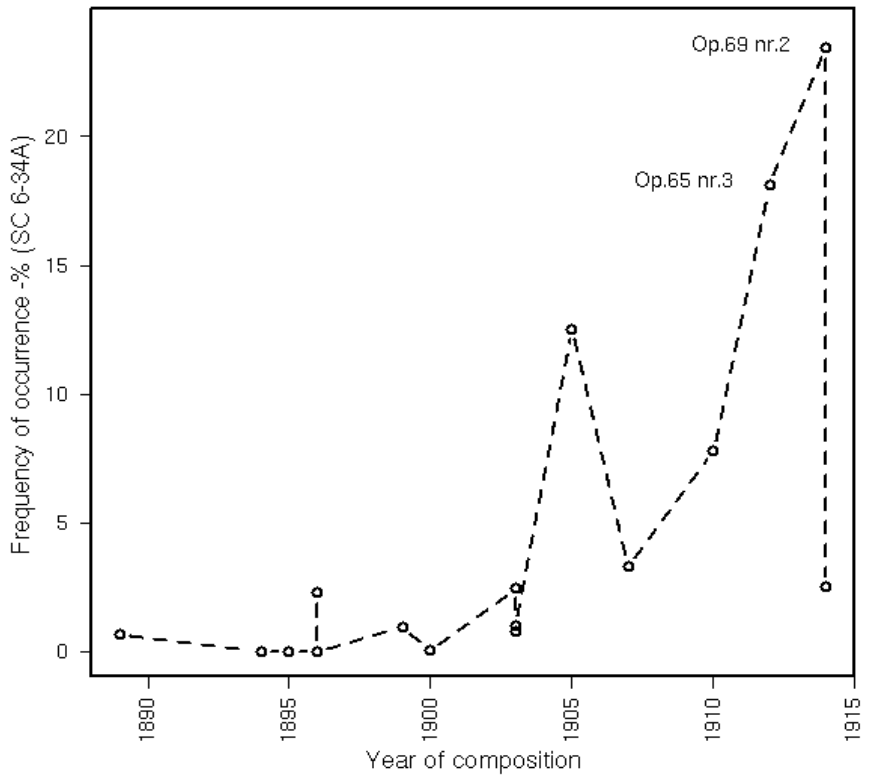
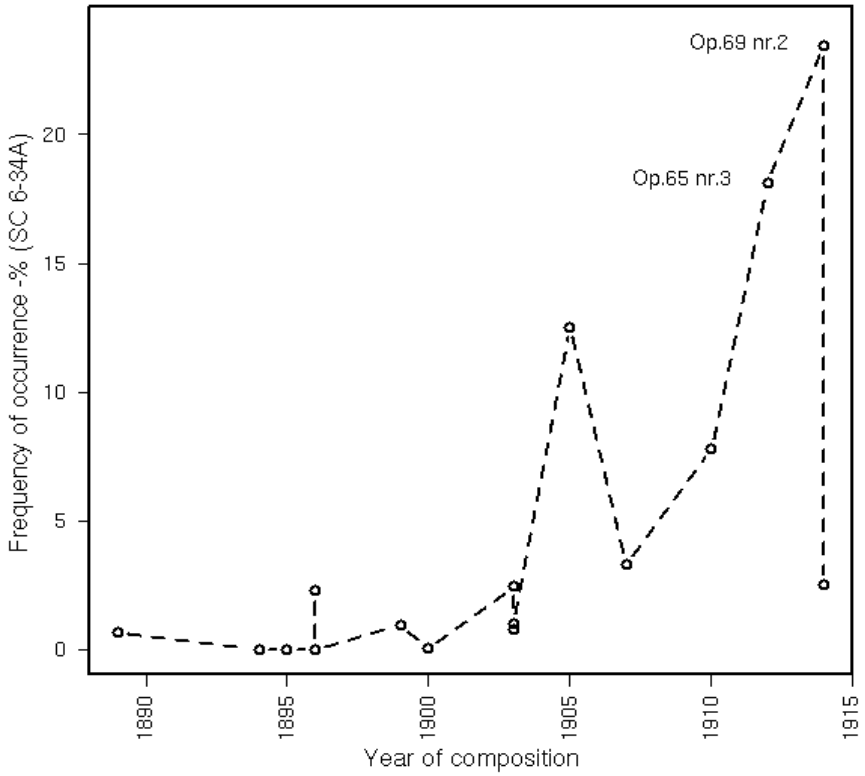
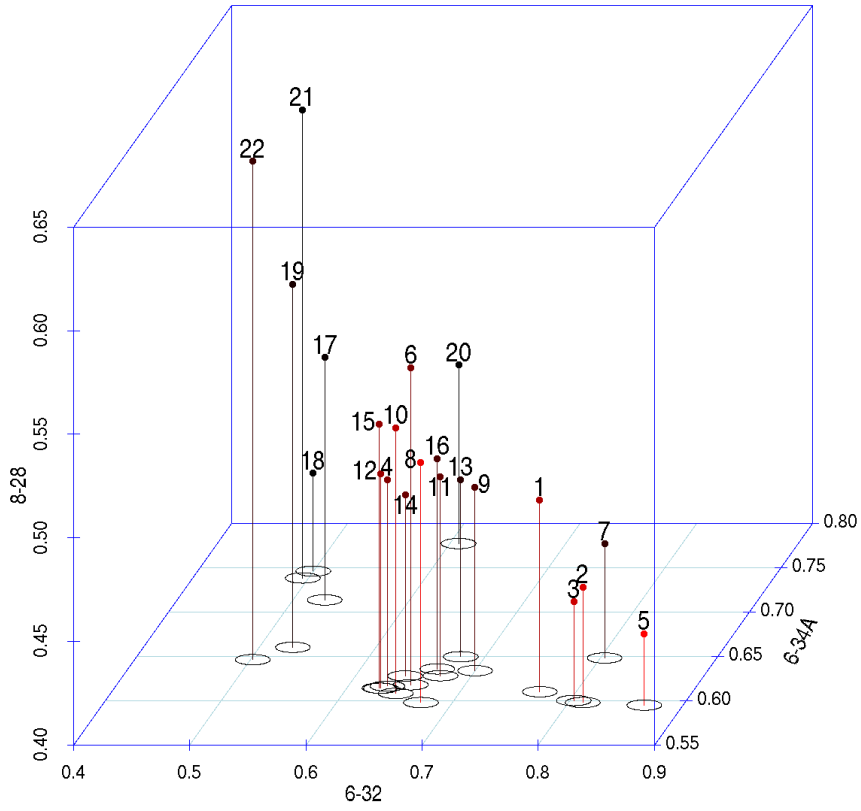


Comparison Structure Analysis

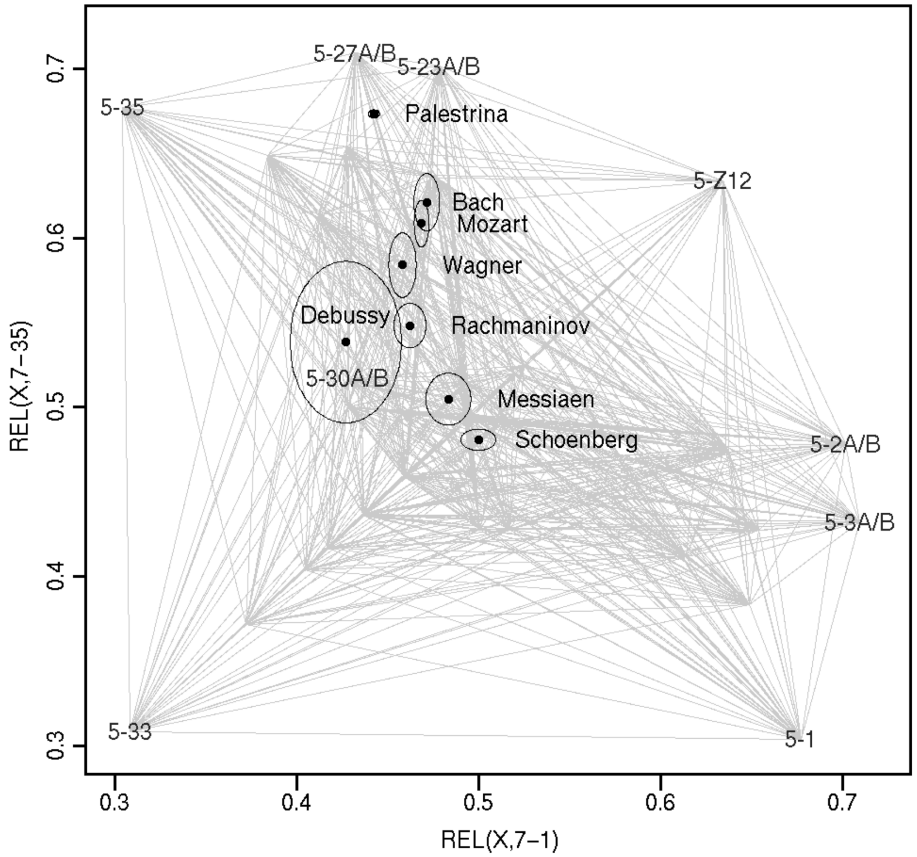
1) The prevalence of SC 6-34A in A. Scriabin's 22 piano pieces. 2) Centroids of the same pieces in *costotal* 8-28/6-34A/6-32-space. 8-28 = an ”octatonic” set-class. [6]





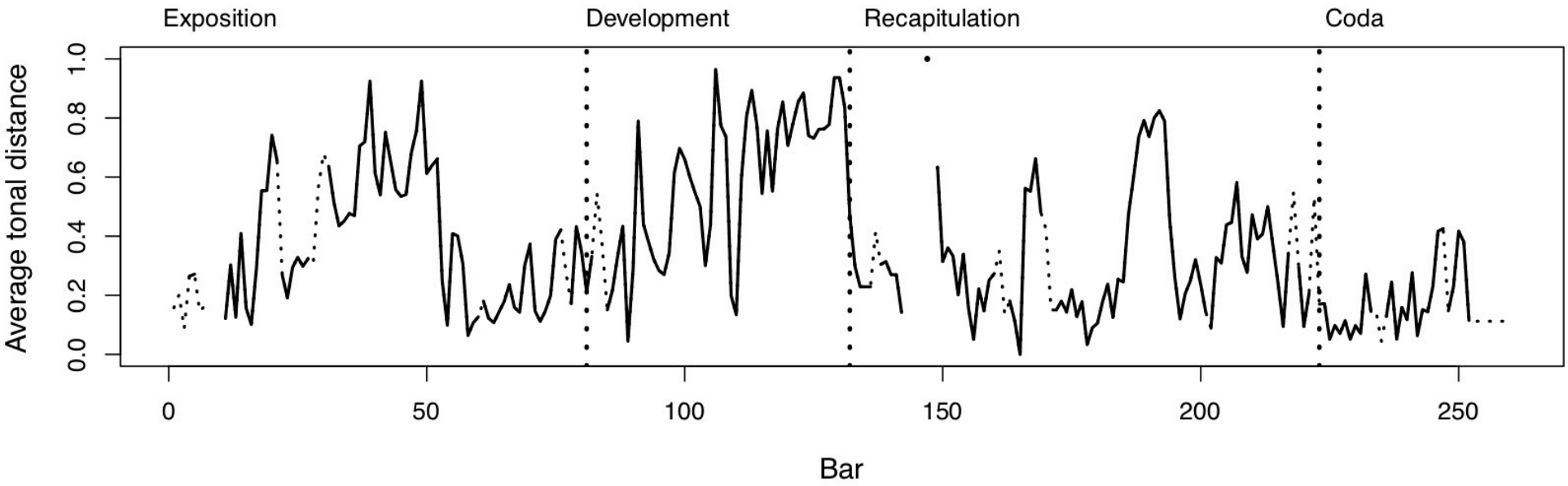
Comparison Structure Analysis

Composer-specific centroids represented in a REL7–1/7–35 space with pentachordal tail segmentation. [4]



Comparison Structure Analysis

- Relative tonality CSA-curve. Brahms, String Quartet in C-minor, op. 51 nr.1. [7]



Tonality analysis with Vector Sequence Model

- With Miika Karttunen, a sculpturer and matematician in Turku.

Tonality analysis with Vector Sequence Model

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- We are looking for the shape of music, to make that invisible art visible – even palpable.

Plastic model of W.A. Mozart's *Finale of symphony nr. 40*.

Tonality analysis with Vector Sequence Model

- Vector Sequence Model (VSM) is a procedure that **maps musical MIDI data into virtual sculptural form**.

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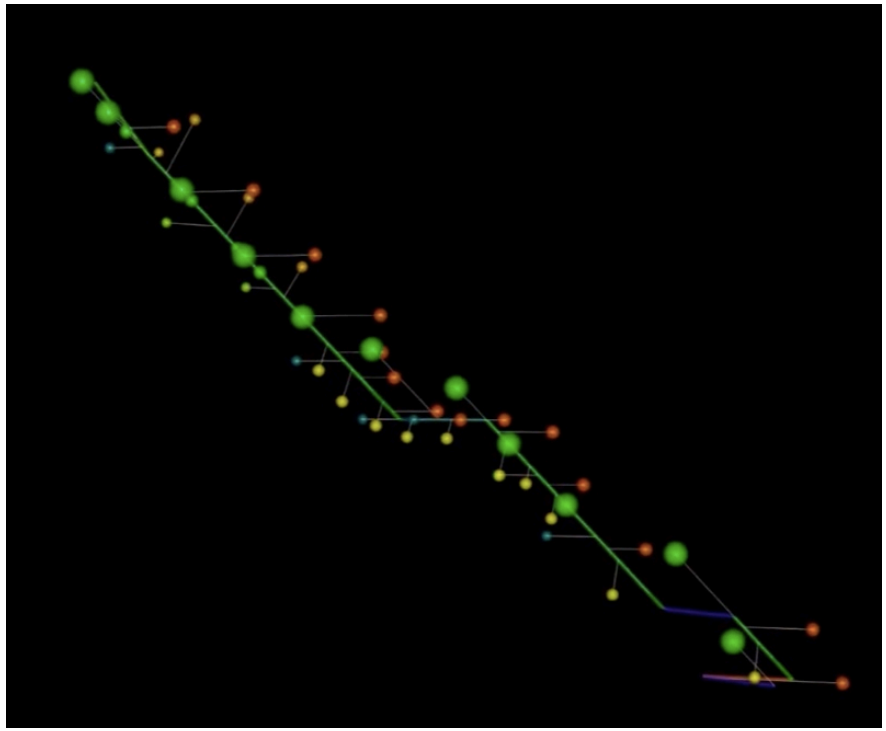
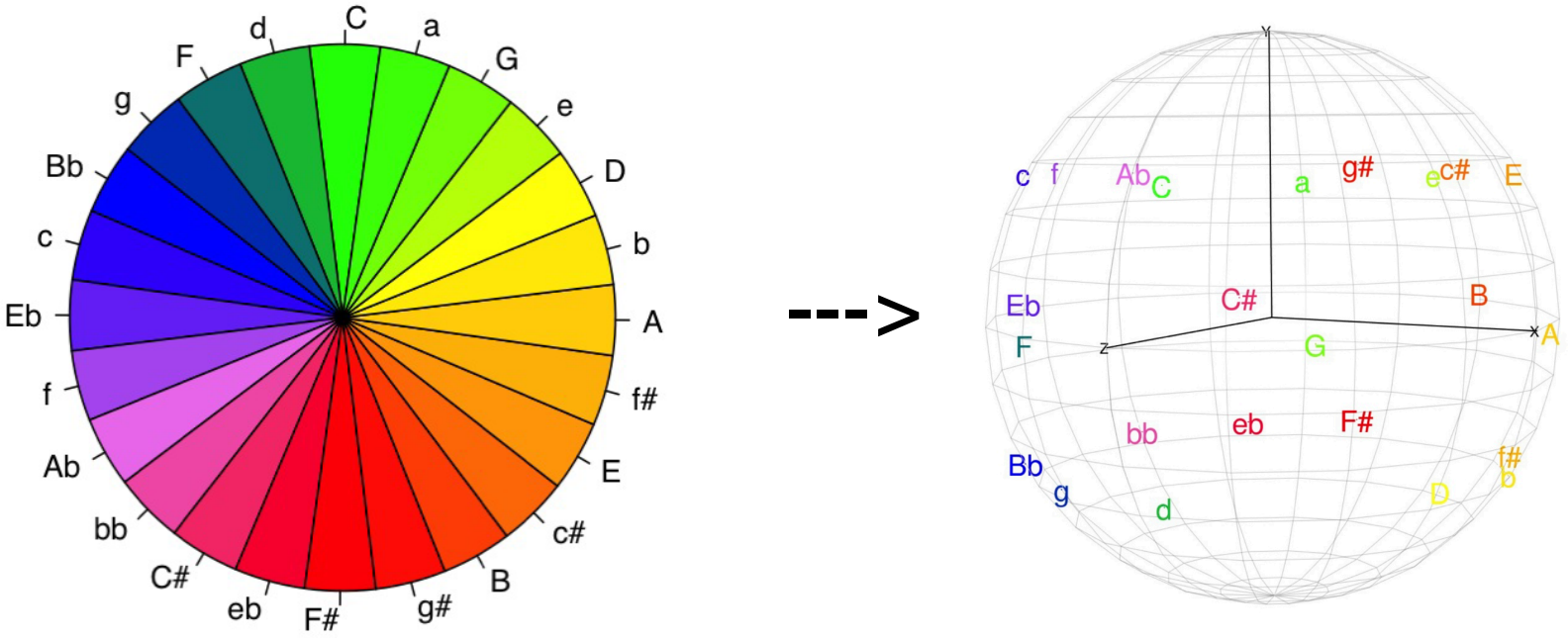
- Its analytical strength is based on the **tonality detection** of music.

- With VSM, **musical time is associated with vectors and their movements in three-dimensional space**.



Tonality analysis with Vector Sequence Model

For the purpose, we have developed a three-dimensional version of the traditional key circle of fifths, **major-minor key ball**.



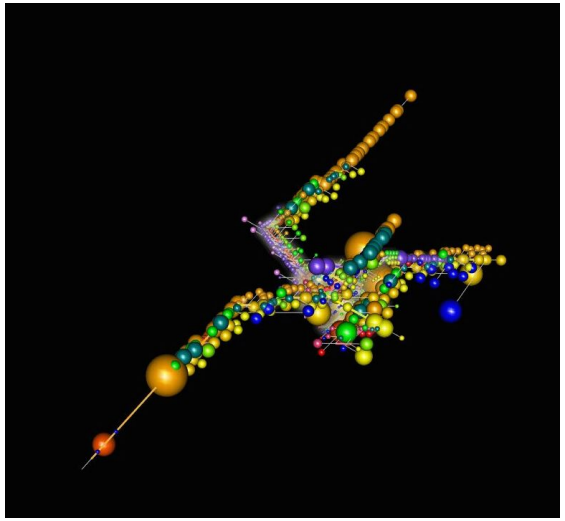
Tonality analysis with Vector Sequence Model

1) MIDI list

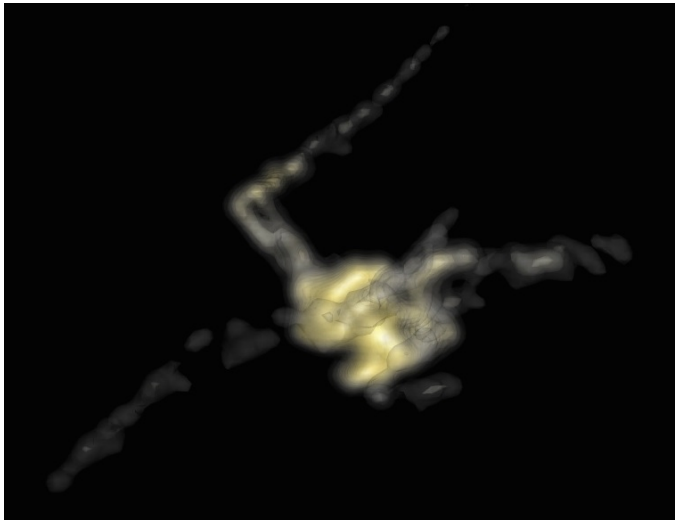
```
0, 0, Header, 0, 1, 1024
1, 0, Start_track
1, 0, SMPTE_offset, 0, 0, 0, 0, 0
1, 0, Time_signature, 4, 2, 24, 8
1, 0, Key_signature, 0, "major"
1, 0, Tempo, 666669
1, 0, Program_c, 0, 0
1, 0, Program_c, 1, 0
1, 0, Program_c, 2, 0
1, 0, Program_c, 3, 0
1, 0, Program_c, 4, 0
1, 0, Program_c, 5, 0
```

->

2) Wireframe model

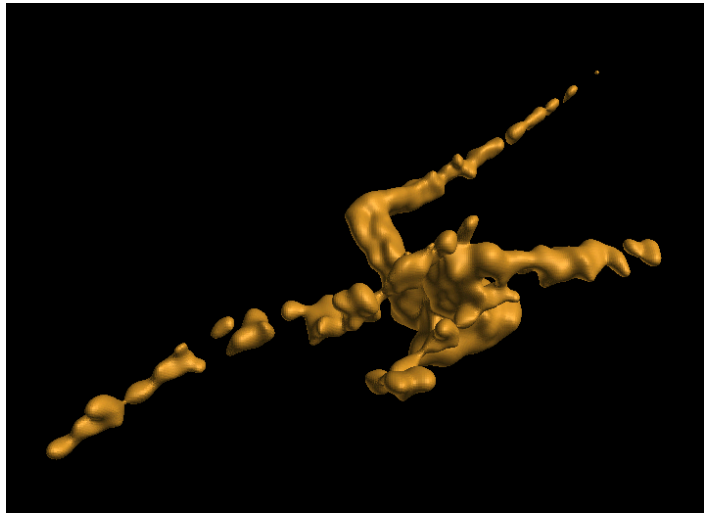


3) Kernel density estimation



4) Outermost layer of KDE

->

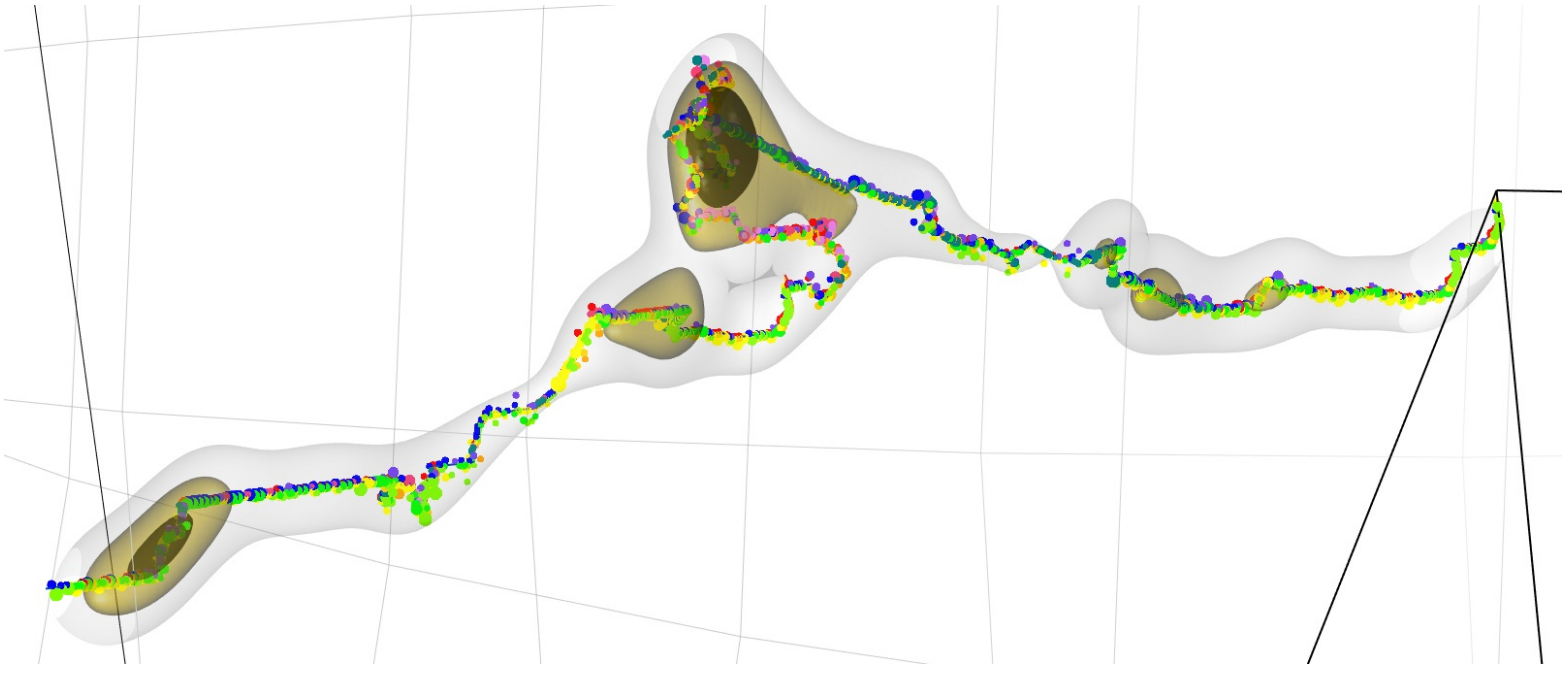


A. Tenkanen "Vanitatum vanitas" (2016)

Tonality analysis with Vector Sequence Model

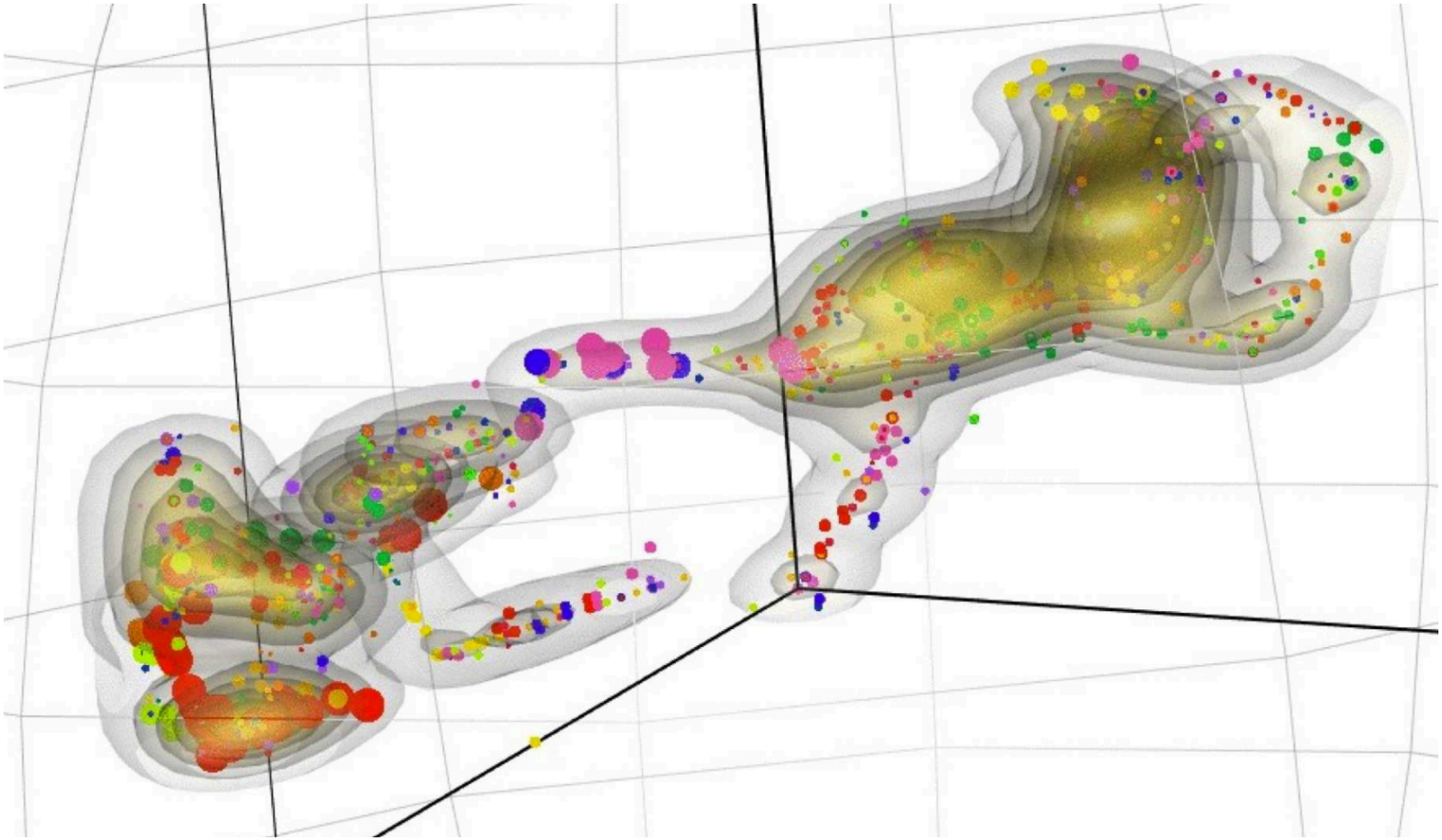
- Vector sequence model of W.A. Mozart's 4th movement in Symphony nr. 40.

- "The compass of modulation in the final movement's development section is among the most remote in classical symphonies." A. Schönberg.

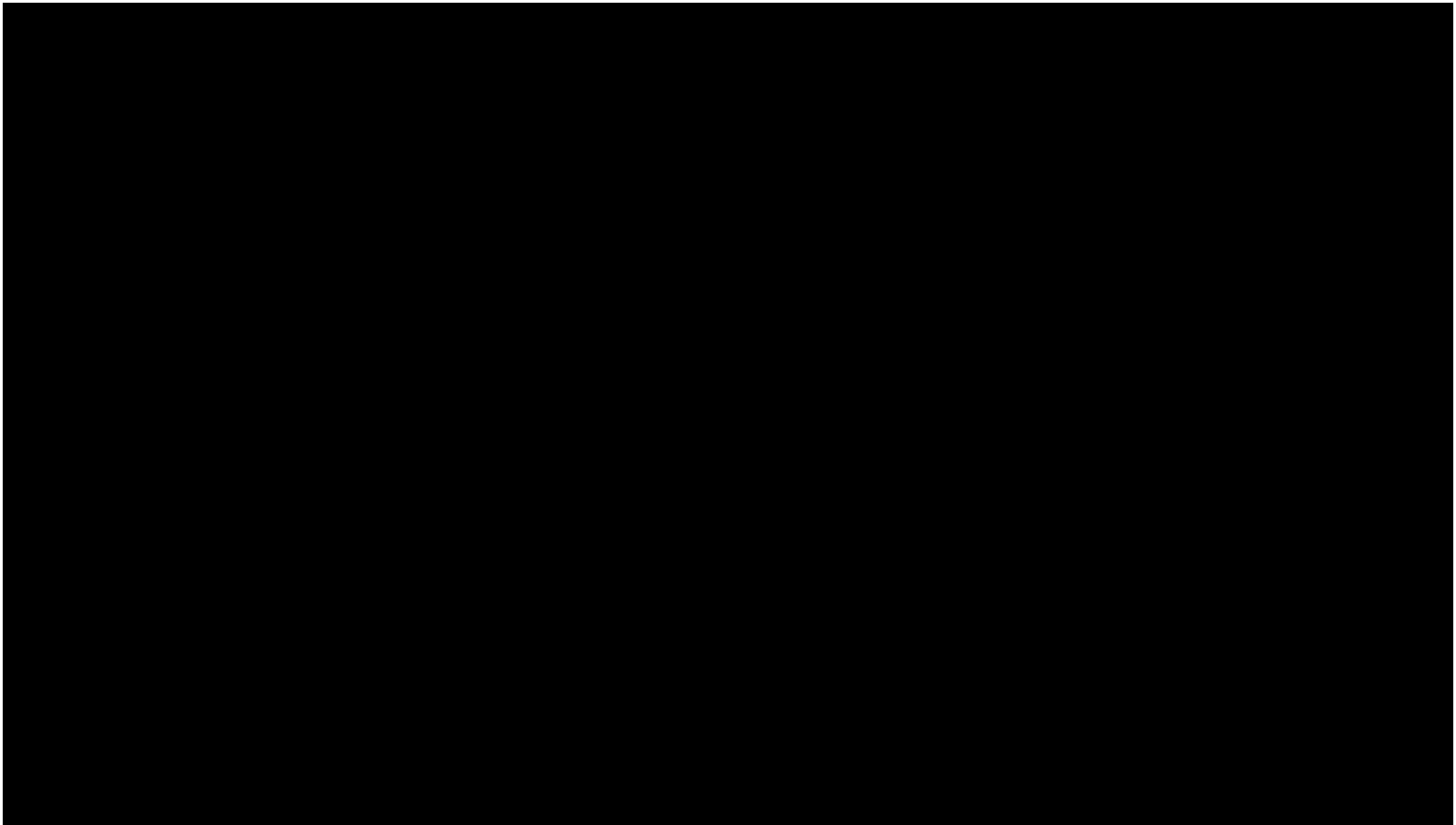


Tonality analysis with Vector Sequence Model

- VSM mapping of Olivier Messiaens's Apparition of the Eternal Church.



Tonality analysis with Vector Sequence Model



[1] Tenkanen, Atte: *Comparison Structure Analysis*. Doctoral thesis, Turun yliopisto. Annales Universitatis Turkuensis Ser B 327, Humaniora. (2010)

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Thank you!