Measuring Tonal Articulations in Compositions

MaMuX Computational Analysis Special Session
5-6th April 2008, IRCAM, Paris

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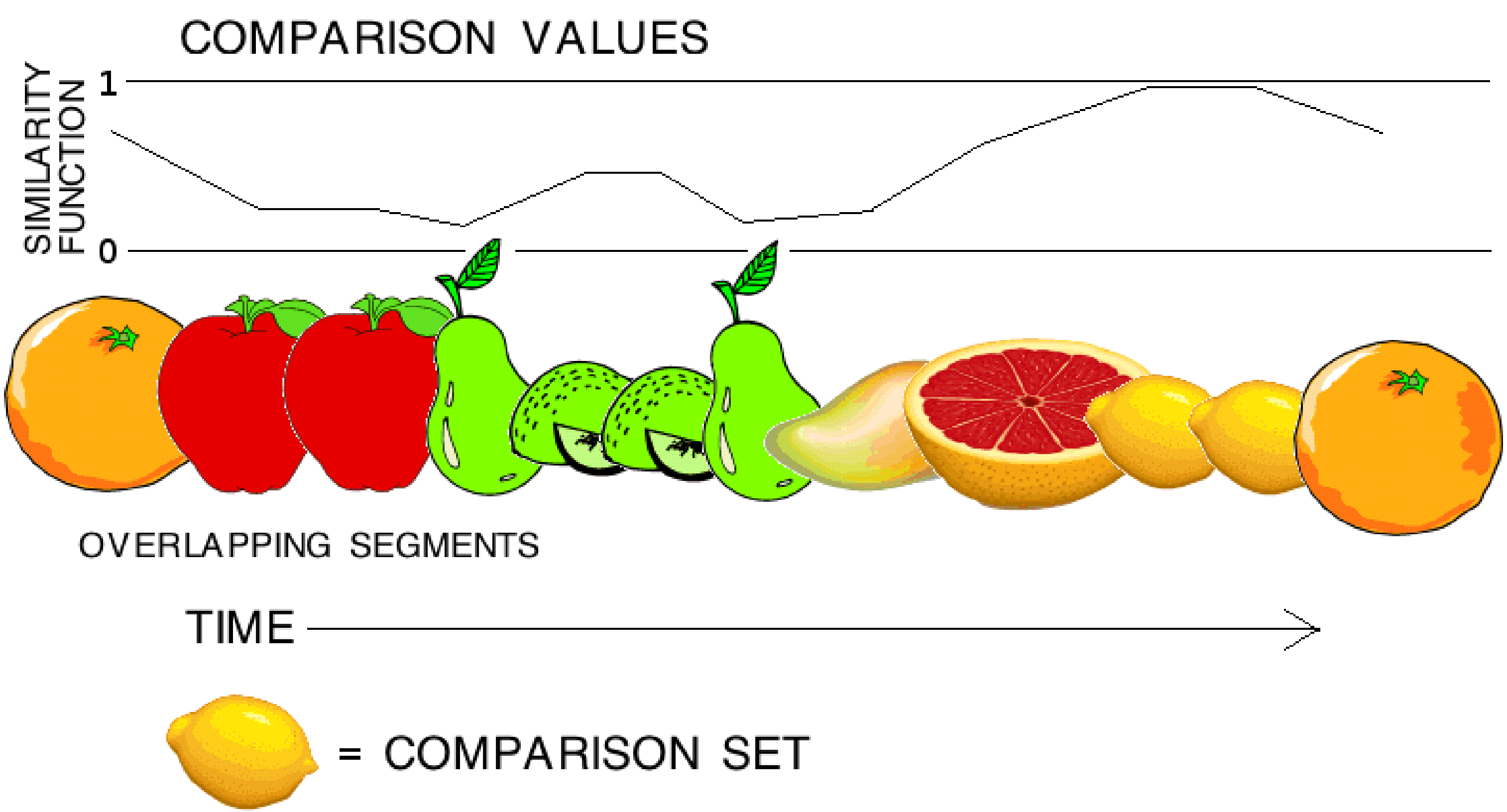
Comparison Set Analysis

- I demonstrated the *comparison set analysis* -method in Berlin MCM 2007...[1]



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- In CSA musical units like pitch classes in a composition are segmented into overlapping sets of the same cardinality.
- These segments are then compared with a selected *comparison set*, constructed from similar units.

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- The comparison set embodies a chosen musical property whose *prevalence* is then evaluated in the composition.

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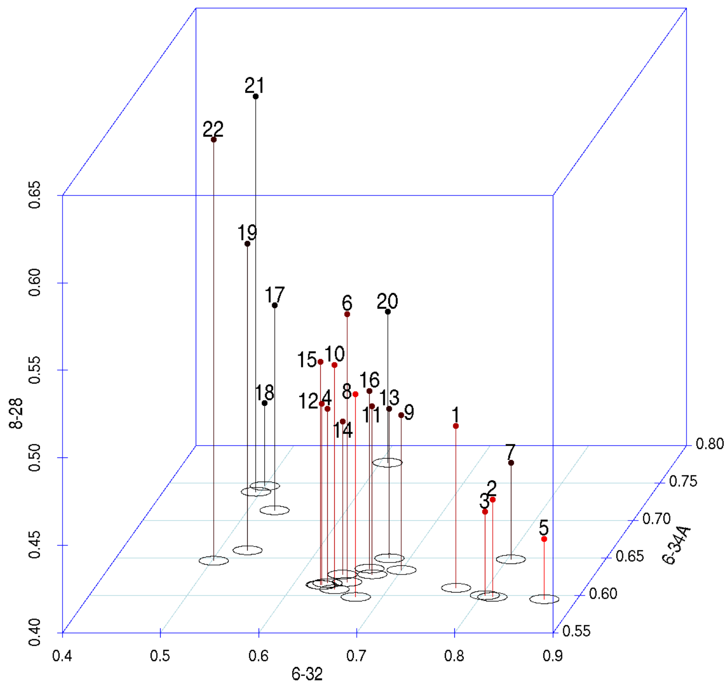
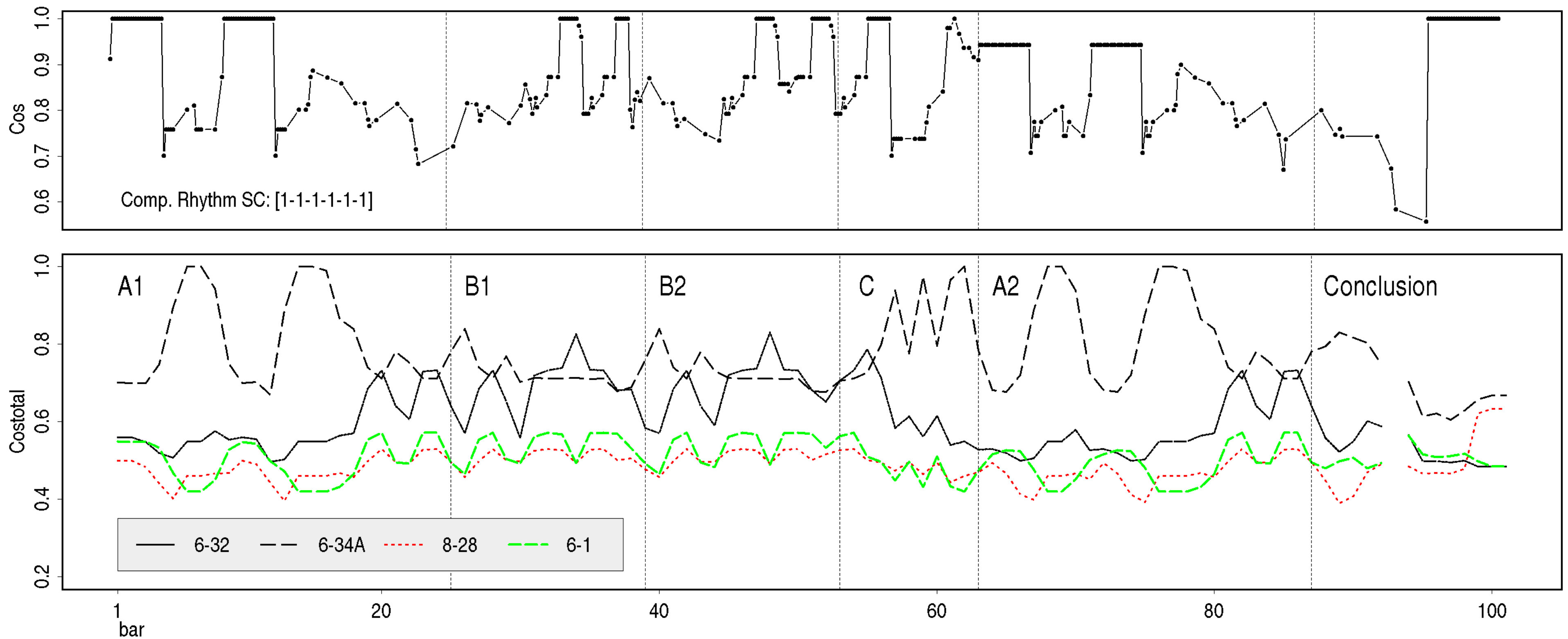
- The results can be presented in different types of graphs.



Comparison Set Analysis

- In Berlin MCM 2007 the method was applied to Scriabin's music (op. 65/3).
- CSA was applied to rhythm- and (pc)set classes:



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- Some well-known similarity functions (REL, IcVSIM, cosine) which measure distances between abstract set classes were utilized.
- However, though the measurements attained by set class similarities can reveal the overall chordal character of a piece in a certain moment...
- ...the system is insufficient to express such chordal qualities which are related to tonality or 'referential pitches'.

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Comparison Set Analysis

- To come to grips with this problem some sort of measure which preserves the pitch class information (pcset transpositions) is needed.
- If we had such a function, we could, perhaps, search, for instance, referential chord candidates for post-tonal compositions.
- Or – by comparing all the pitch class set segments derived from a piece to all pitch class set segments– we would be able to find, with respect to tonality, the most uncommon places in a surface level of the composition ???

Two algorithms for pitch-class based distances

- In this presentation two algorithms for comparing pitch-class based distances between pitch-class sets are introduced.

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- Thus, the pitch class information is preserved and utilized instead of using the prime form set classes as was the case earlier.

Two algorithms for pitch-class based distances

- The second function will later be used together with earlier methods. The main goal of this study is to develop a kind of *multi-parameter comparison set analysis* for classification and musical segmentation.

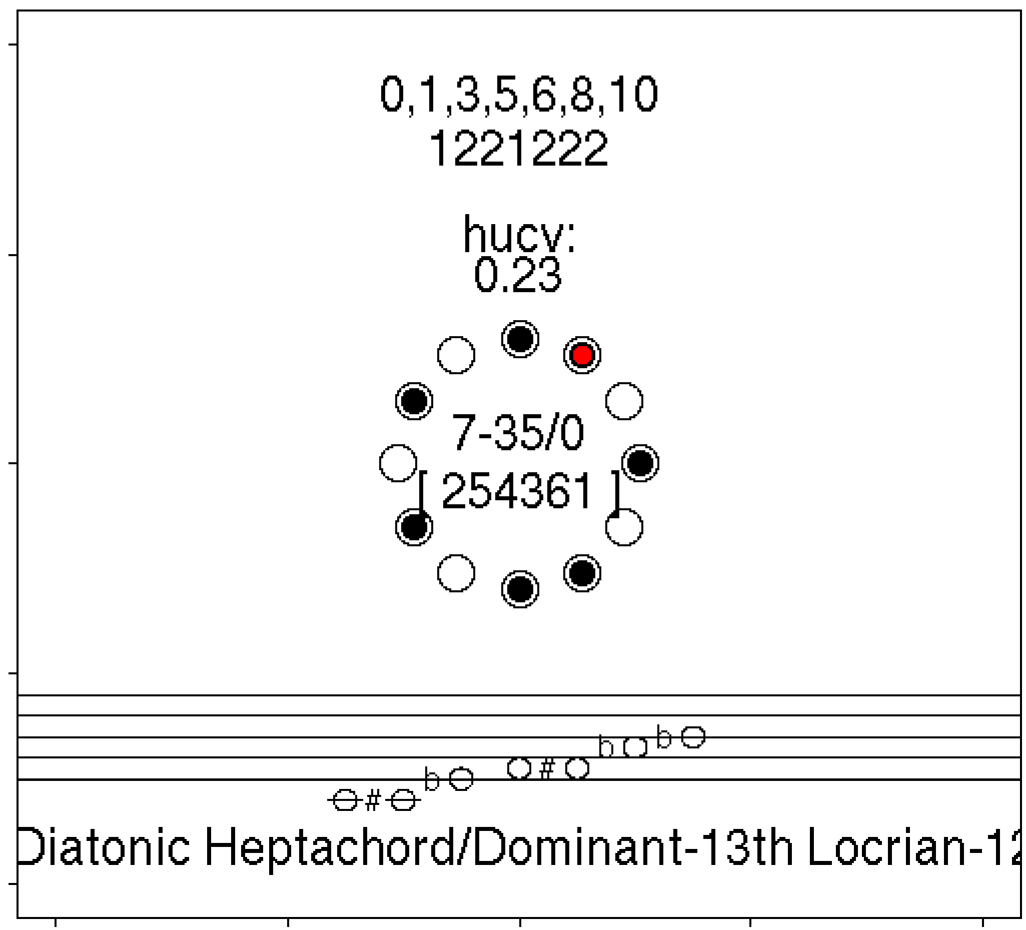
Two algorithms for pitch-class based distances

- The second function will later be used together with earlier methods. The main goal of this study is to develop a kind of *multi-parameter comparison set analysis* for classification and musical segmentation.
- However, analyses which have been carried out with the help of these functions can also be used as a preparatory survey for more traditional analyses.

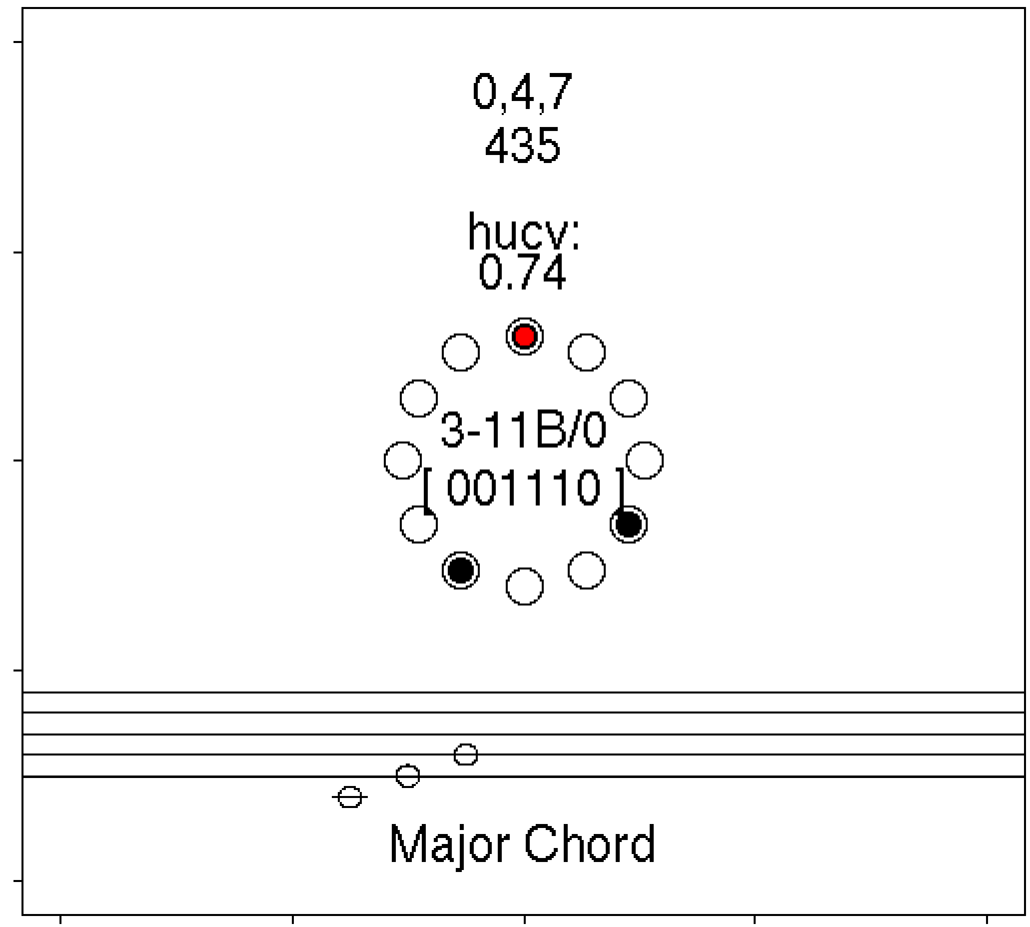
Two algorithms for pitch-class based distances

- The long explanations related to the algorithms are here removed, but some results are presented next...

Some Tonal Center (TC) -examples



Some TC-examples



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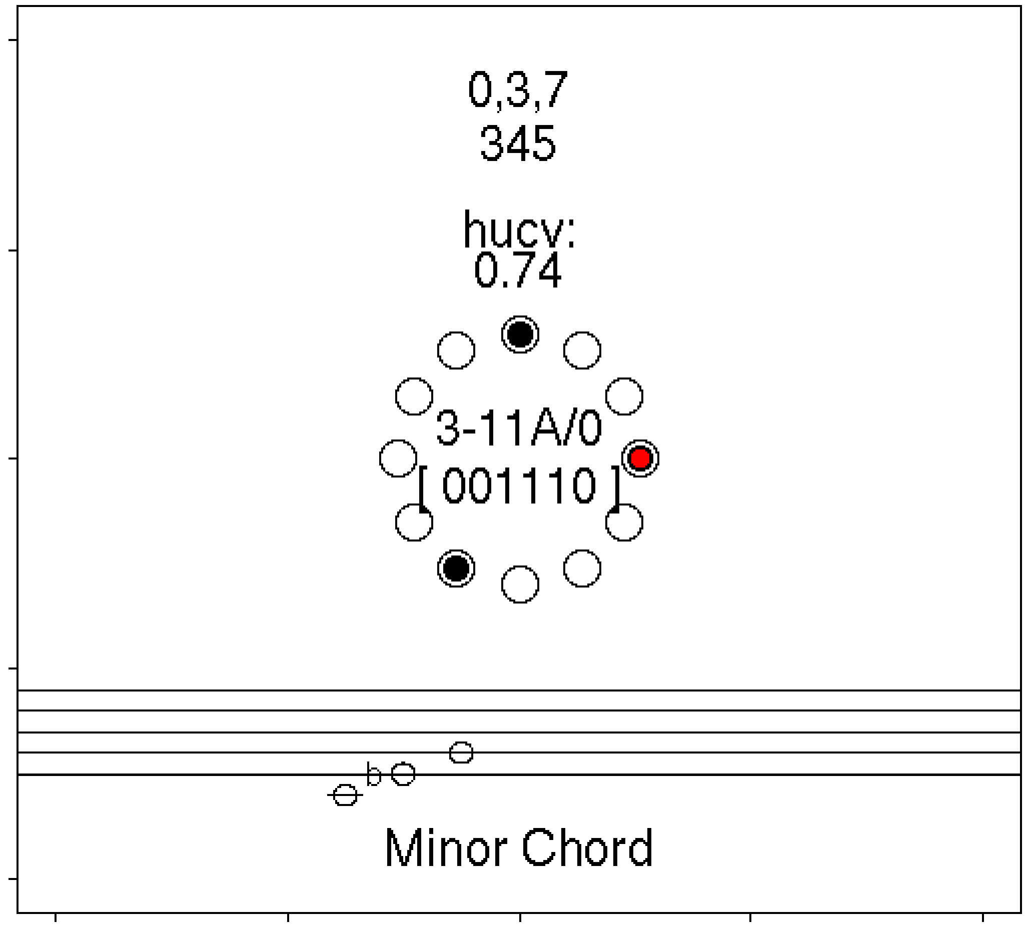

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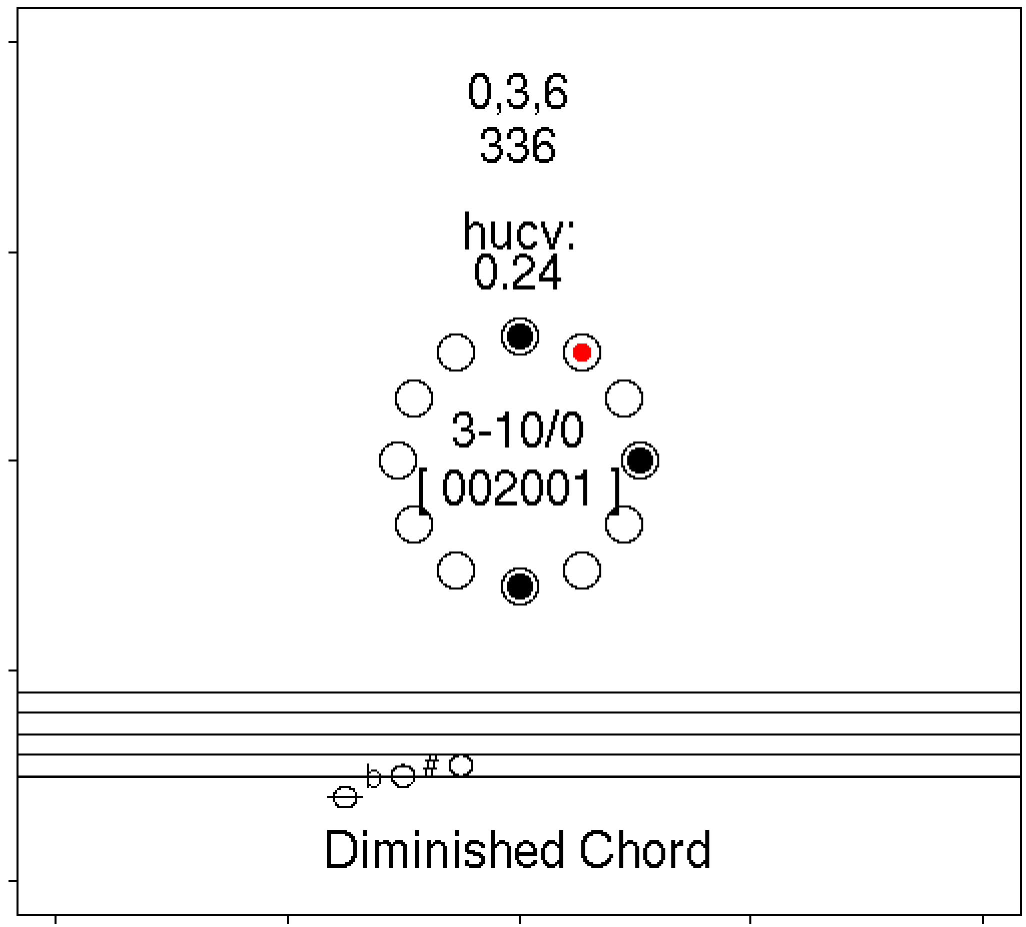

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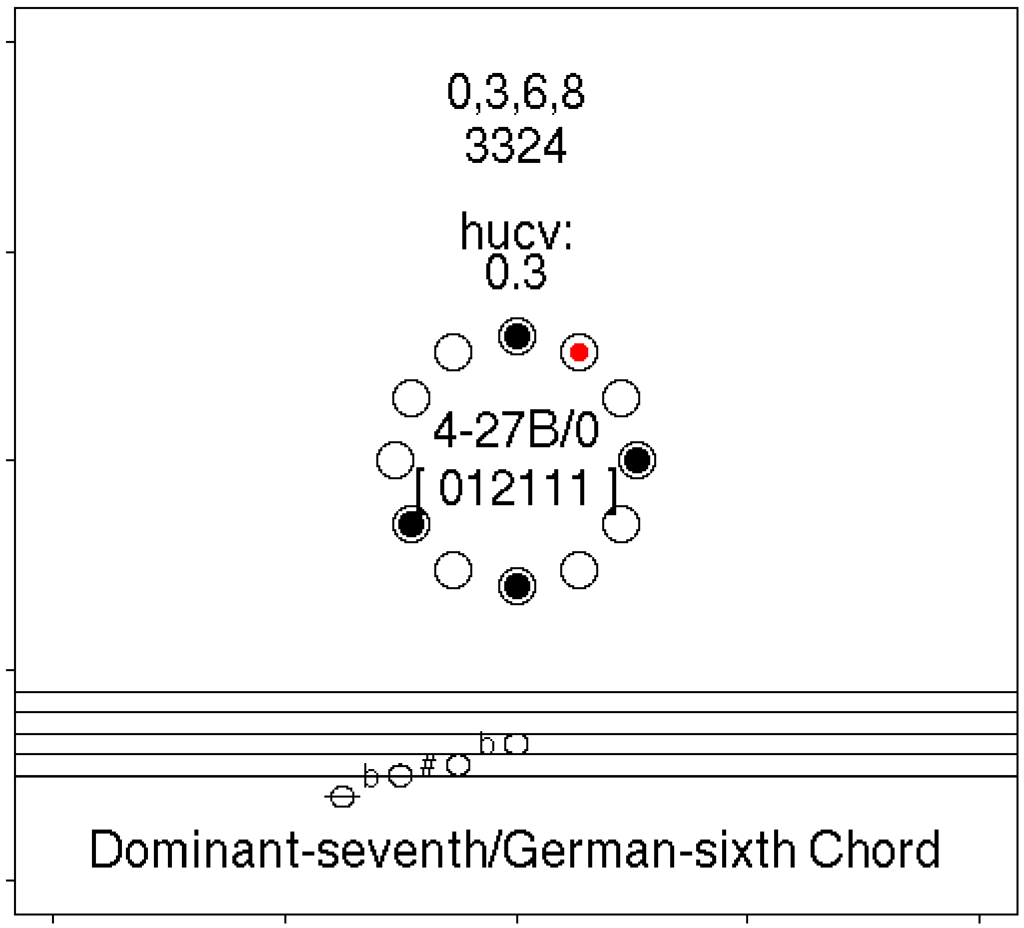

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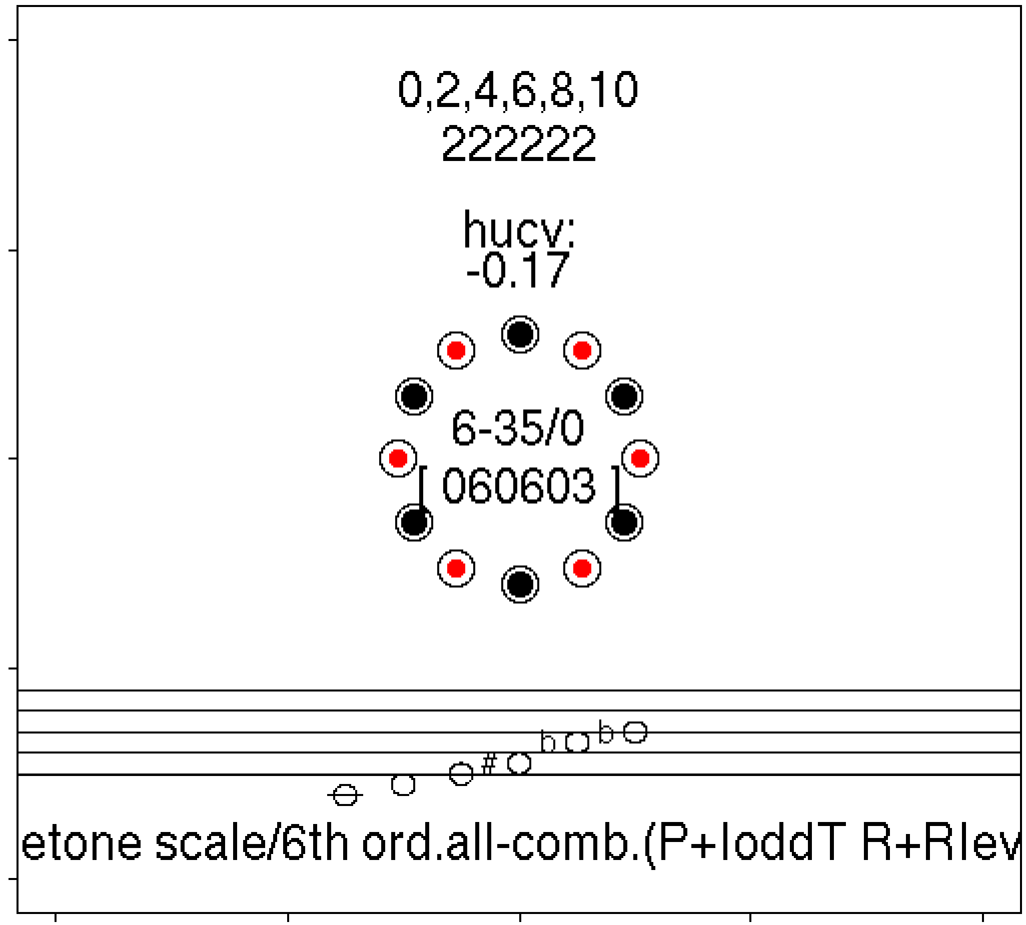

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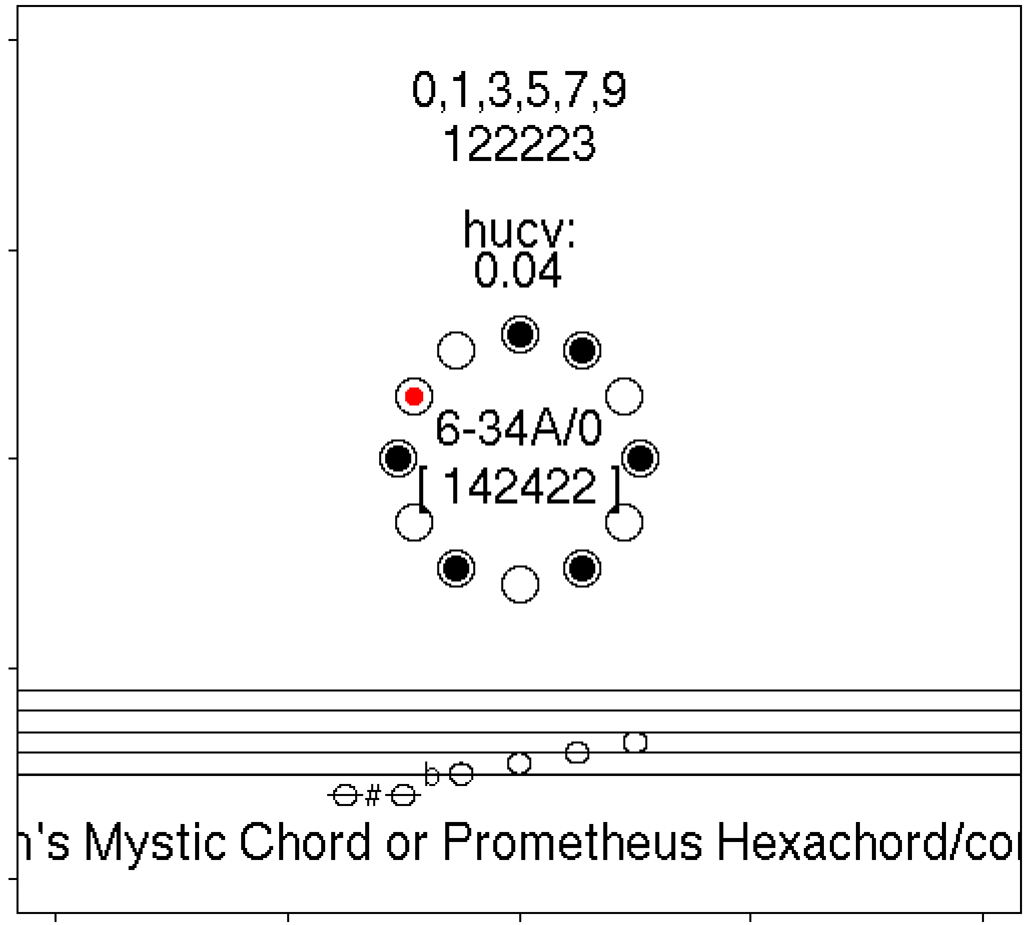
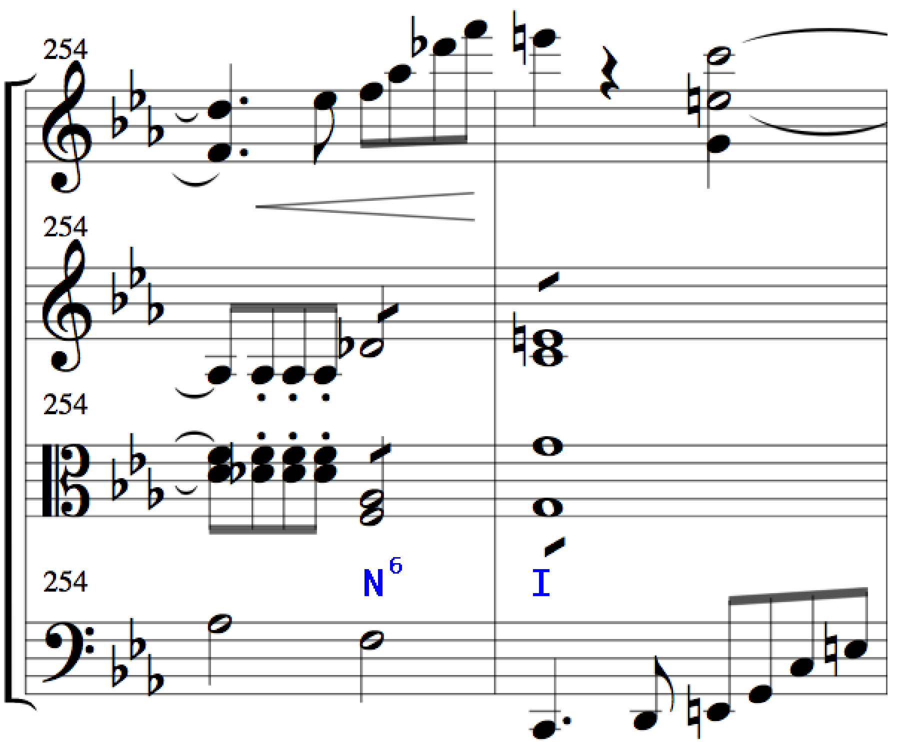
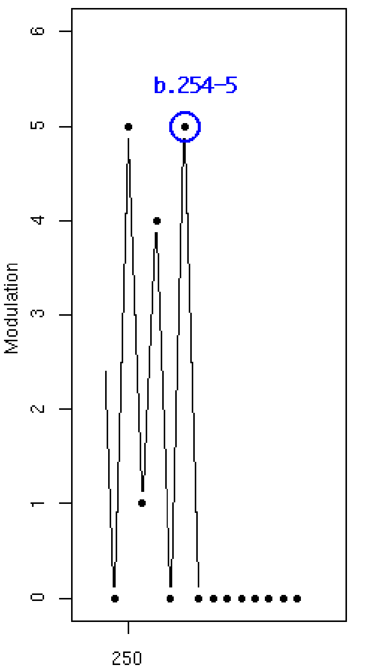


Tonal center -algorithm

- Tonal center-algorithm is later applied to measure 1) local (bar-based) tonalities, and after that 2) TC-differences between consecutive bars.
- Neapolitan relation between two bars:





About imbricated segmentation

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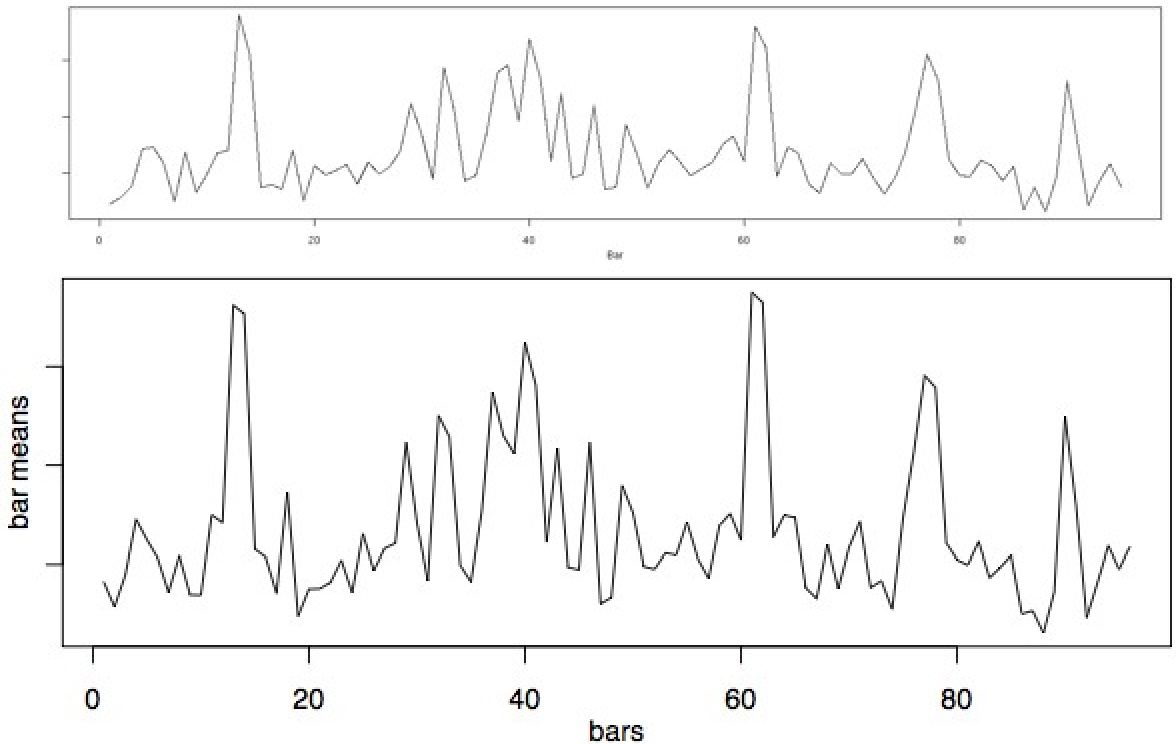
- Comparison set analysis can depict the musical structure of a piece by generating the different kind of trend curves.
- Before it is possible to 'draw' analysis pictures, such a segmentation method is needed, which creates the overlapping sets of the same cardinality for CSA.
- There are several alternatives for imbricated segmentation system but, regardless of the method, the overall results obtained are similar (because of the bar-based means).

About imbricated segmentation

- The effect of the segmentation. Two different segmentation methods, same analysis object. Segmentation cardinality 4. Tondist-function.



About imbricated segmentation

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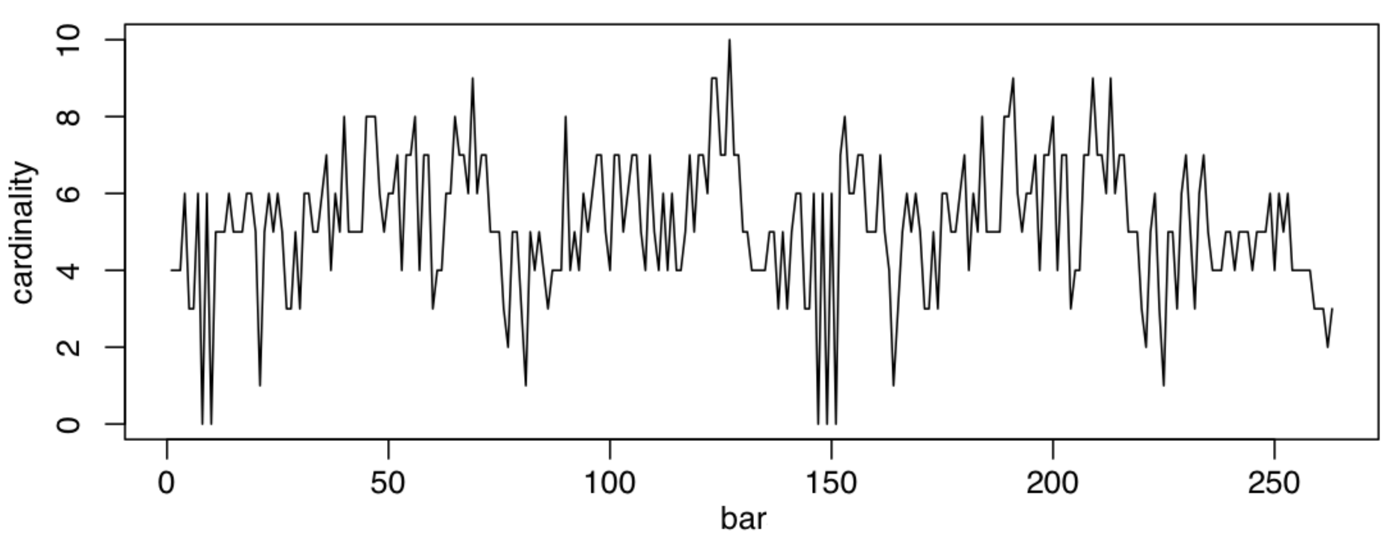
- Temporally consecutive note events are at first set to a (midi event-) list. If there are simultaneous notes, they are listed from bottom up.
- Duplicate pitch-classes with exactly the same onset time are removed and only the lowest note occurrence is preserved (thus, instrumentation has no effect on calculations).

About imbricated segmentation

- Each note belongs to the tightest segment of consecutive notes of the chosen cardinality.
- In Brahms the pentachordal segmentation is well justified because the calculations are based on bar means and the mean cardinality in bars is *5.36* (median is *5*).

Cardinality per Bar, Brahms, op.51:1



About imbricated segmentation

- In the next picture:

The marked note c (midi pitch 60) in bar 54 belongs –according to the segmentation– to the set {0,3,5,8,10}. This pentachord is the tightest among other alternatives which the note c belongs to. Its temporal extent is one quarter note (here 1024 ticks). Other alternatives are longer. If there are several segment alternatives of same length, the first one is selected.

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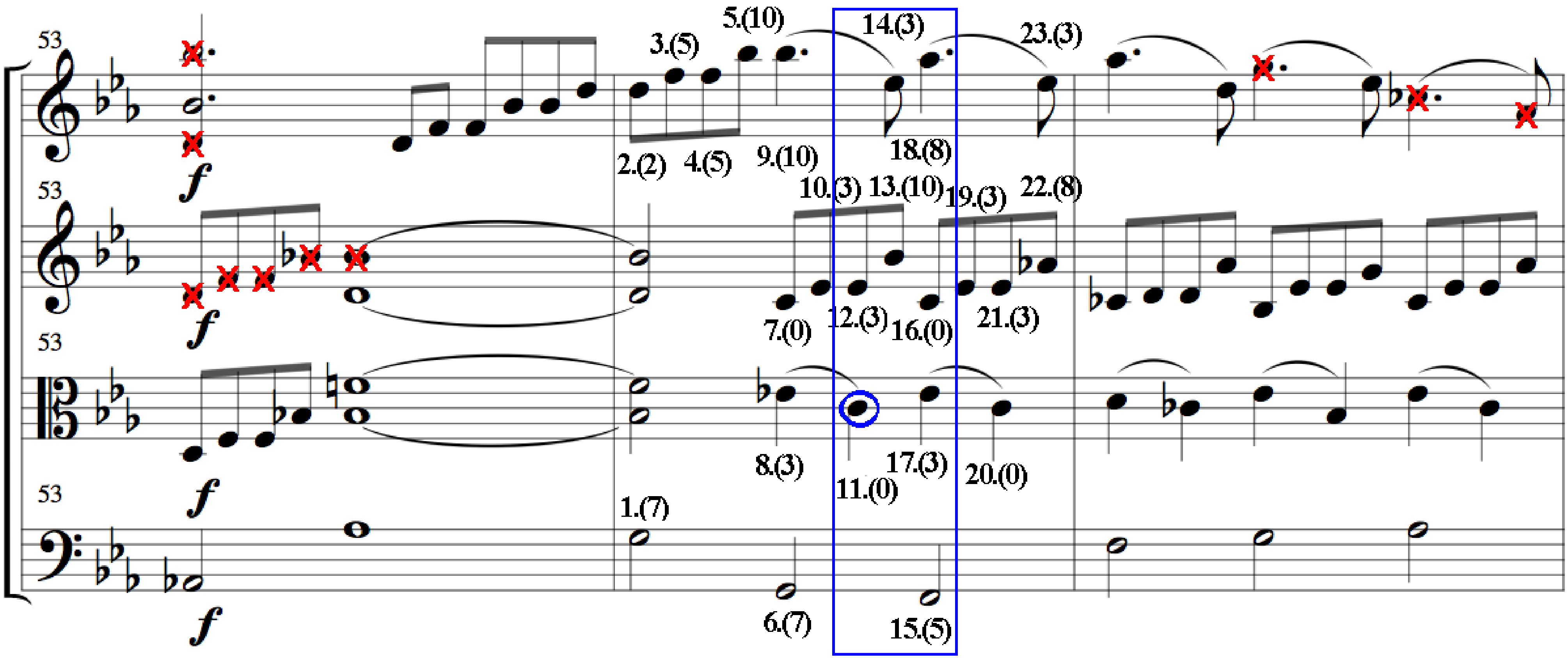
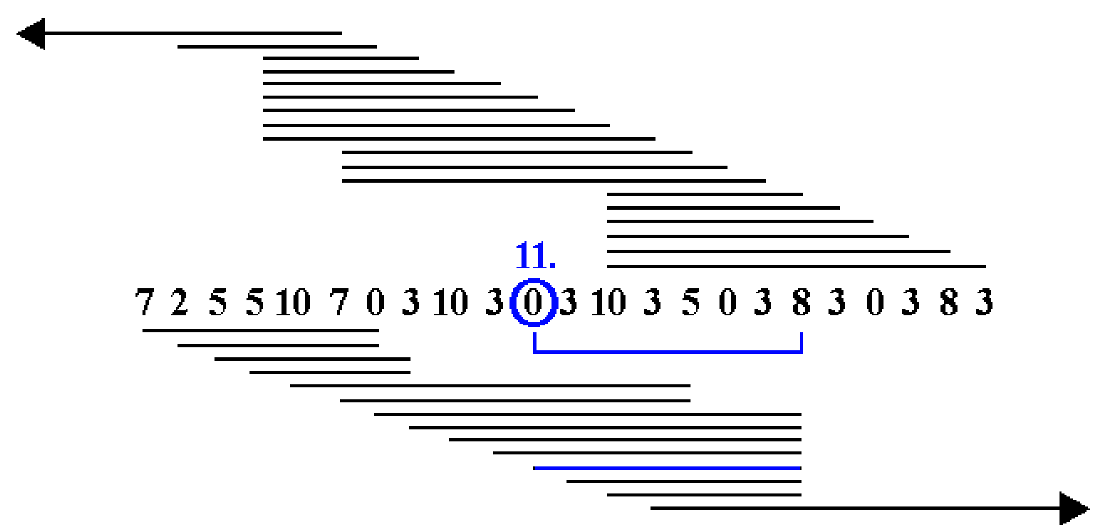
- So, for each note (see the list on the left side) we get a pitch-class set of its own.



	Bar	Tick	Dur	Pc	Pitch	SegWth	SC	pc1	pc2	pc3	pc4	pc5
1011	54	325632	2048	7	55	2048	130	0	2	5	7	10
1012	54	325632	512	2	74	2048	130	0	2	5	7	10
1013	54	326144	512	5	77	1536	130	0	3	5	7	10
1014	54	326656	512	5	77	1024	130	0	3	5	7	10
1015	54	327168	512	10	82	1024	130	0	3	5	7	10
1016	54	327680	2048	7	43	1024	130	0	3	5	7	10
1017	54	327680	512	0	60	1024	130	0	3	5	7	10
1018	54	327680	1024	3	63	1024	130	0	3	5	7	10
1019	54	327680	1536	10	82	1024	130	0	3	5	7	10
1020	54	328192	512	3	63	1536	130	0	3	5	7	10
1021	54	328704	1024	0	60	1024	130	0	3	5	8	10
1022	54	328704	512	3	63	1024	130	0	3	5	8	10
1023	54	329216	512	10	70	512	130	0	3	5	8	10
1024	54	329216	512	3	75	512	130	0	3	5	8	10
1025	54	329728	2048	5	41	512	130	0	3	5	8	10
1026	54	329728	512	0	60	512	130	0	3	5	8	10
1027	54	329728	1024	3	63	512	130	0	3	5	8	10
1028	54	329728	1536	8	80	512	130	0	3	5	8	10
1029	54	330240	512	3	63	1024	130	0	3	5	8	10
1030	54	330752	1024	0	60	1024	126	0	3	5	8	11
1031	54	330752	512	3	63	1024	126	0	3	5	8	11
1032	54	331264	512	8	68	512	124	2	3	5	8	11
1033	54	331264	512	3	75	512	124	2	3	5	8	11

Imbricated pentachords



Brahms op. 51 nr 1:1

- In the first analysis all pentachordal segments have been compared to all other segments (4693 pcs) by using the *tondist*-function.

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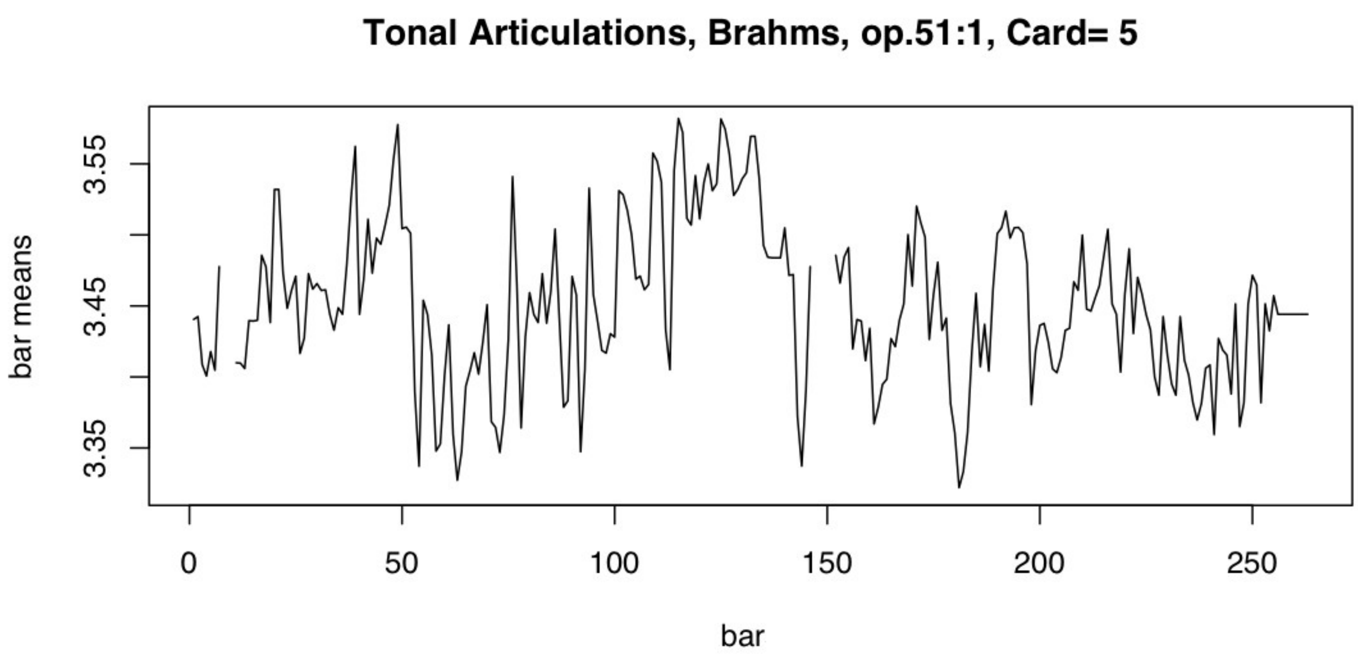
- Then the bar based mean values have been calculated.



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- Are there other possibilities for the segmentation cardinality in Brahms op. 51 nr 1:1?

    3: because the harmony is mainly trichordal?

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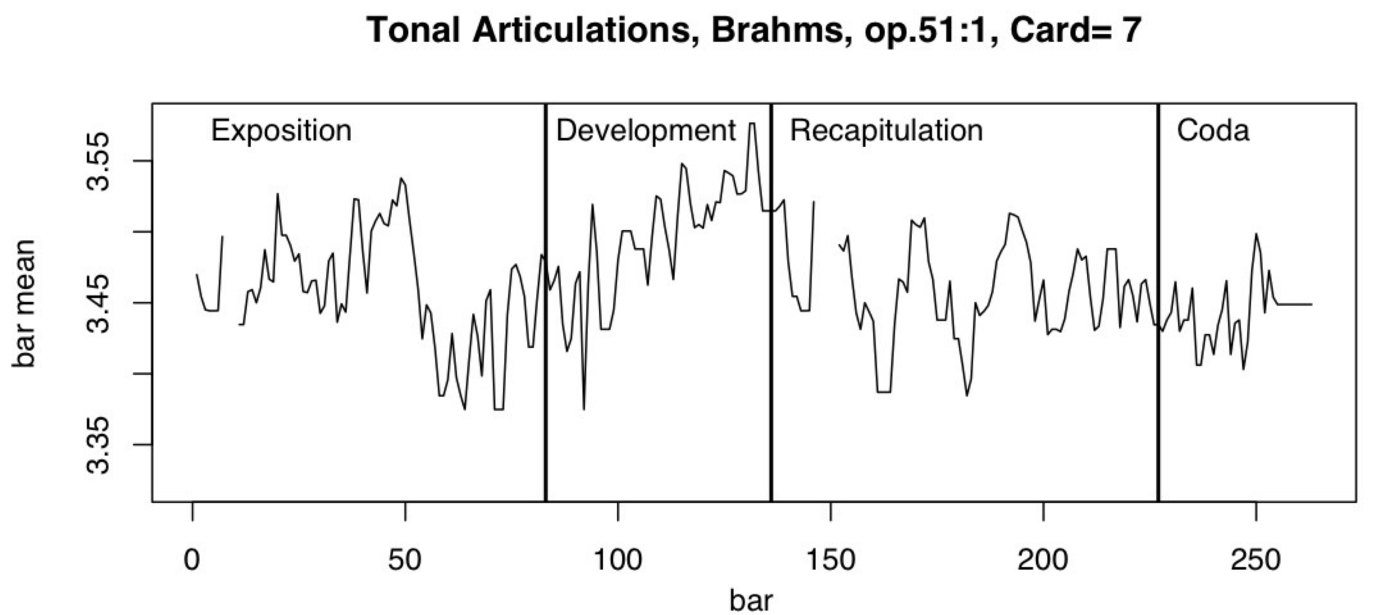
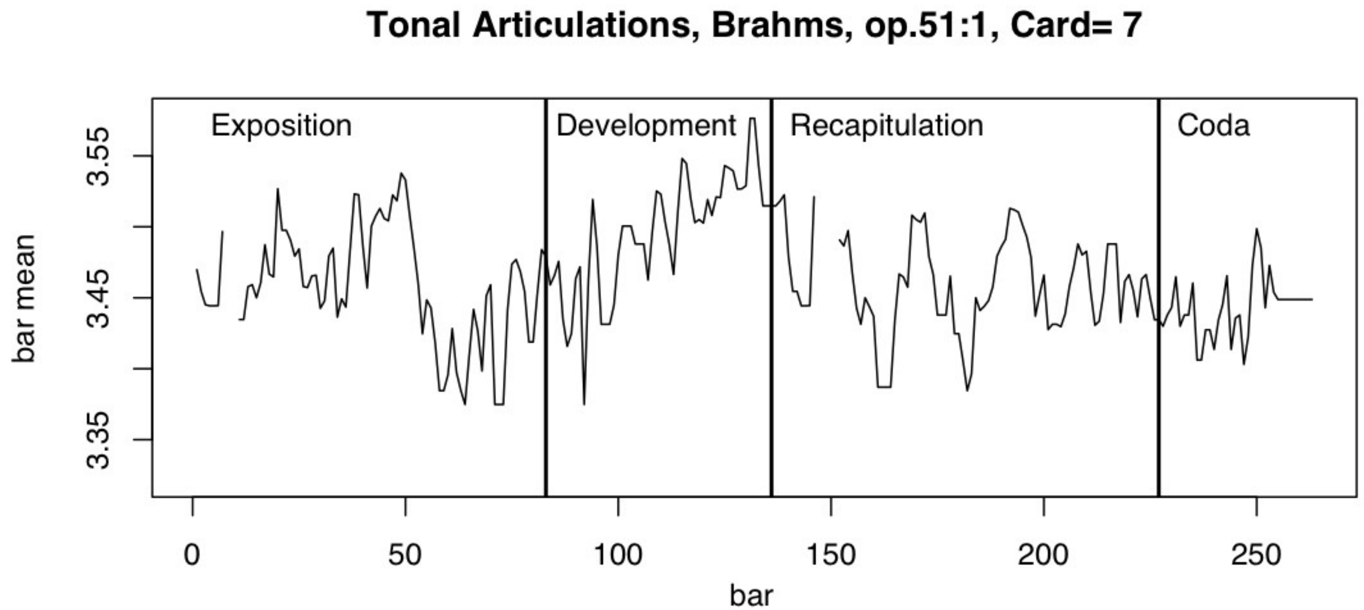
    3: because the harmony is mainly trichordal?

    7: tonal scales consist of 7 pitch-classes?



Brahms op. 51 nr 1:1

- Segmentation cardinality 7 gives a little smoother curve than if card. 5 is used.
- The same picture reveals, for instance, tonally the most extraordinary places in the piece, in the end of the development section, bars 131-2.



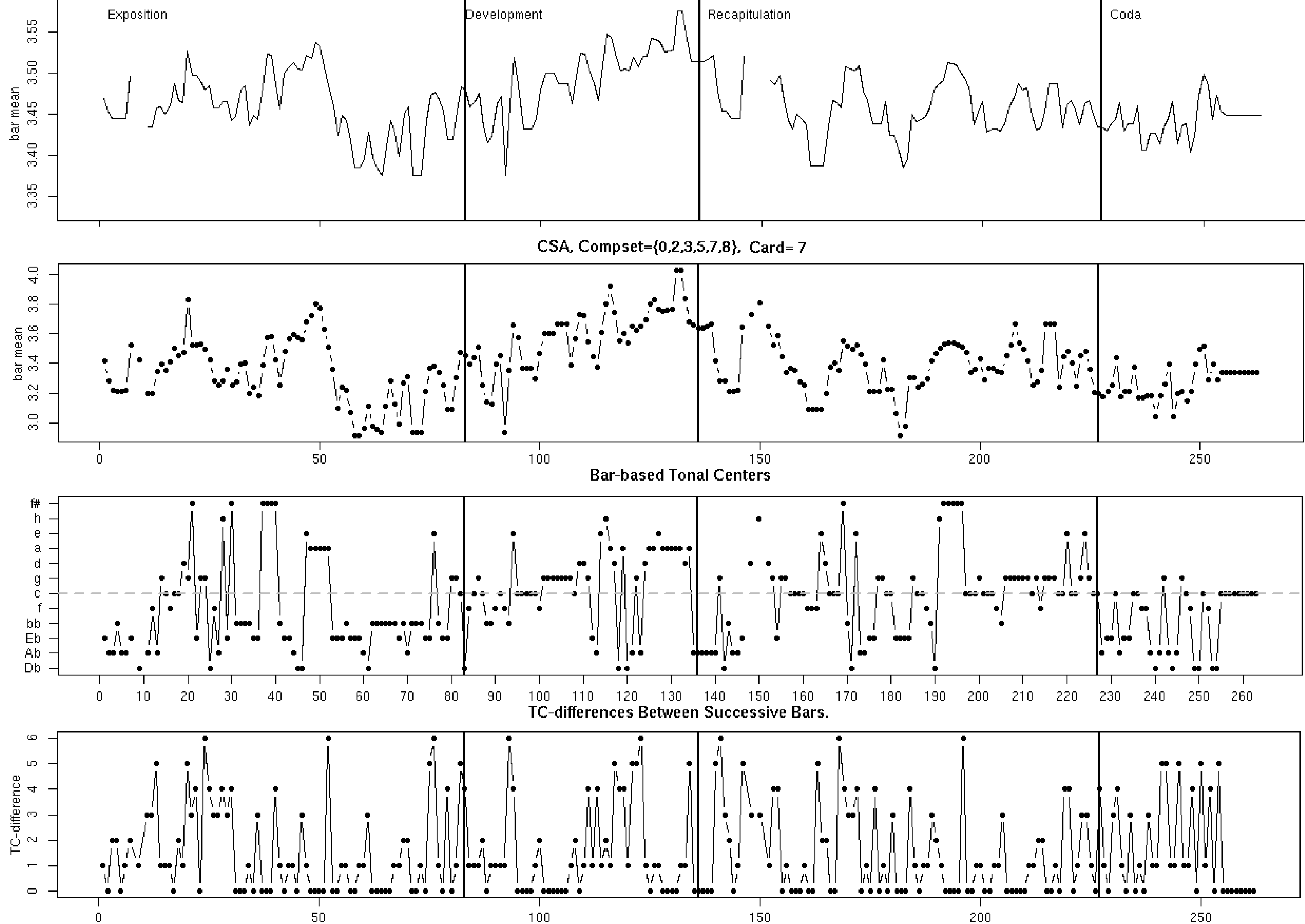
Brahms op. 51 nr 1:1

- Three other pictures have beed added to the next image.

  The second one shows the tondist-curve when the comparison set is built by the 6 most common pitch-classes {0,2,3,5,7,8} found from the piece. S.c.=7.

  For the third picture the pitch-classes in each bar have been exploited to calculate bar-based 'tonal centers'.

  Above mentioned TC:s have been presented in the lowest plot: it reveals the TC-differences between the bar-based TC:s. For example, toncent-algorithm has recognized Db- and C-centers in the end of the piece and the TC-difference between them is 5.



Exposition
Development
Recapitulation
Coda
bar mean
CSA, Compset={0,2,3,5,7,8}, Card= 7
bar mean
Bar-based Tonal Centers
f#
h
e
a
d
g
c
f
bb
Eb
Ab
Db
TC-differences Between Successive Bars.
TC-difference

Observations

- [P.1] The development section seems to contain the most intensive trend which goes towards the most distant tonality in the piece (compared to the 'mean tonality' of the piece).
- [P.4] However, it contains two fairly plain sections tonally, around the bars 100 and 130 (so, just in the end of the development). The piece –as a whole– seems to be tonally quite intensive and without strong cadenses.
- [P.3] Though the key in the piece is, for the most part, marked with three flats, the most common TC:s are 0 (51 bars) and 7 (38) and then 3 (32) and 8 (29).

Observations

- So, the piece is not so 'flat'. A-minor and C-major are well represented. There is a strengtening tendency towards C-major.
    - Exposition: C-major is almost totally avoided.
    - Development: a-minor shortly present.
    - Recapitulation: several flashes of C-major.
    - Coda: C-major is established.

References

[1] Atte Tenkanen. *Tracking Features with Comparison Sets in Scriabin's Study Op. 65/3.* Presentation in MCM 2007, Berlin.

[2] Huovinen E. & Tenkanen A. 2008. Bird’s Eye Views of the Musical Surface - Methods for Systematic Pitch-Class Set Analysis.To appear in *Music Analysis*. Vol 26 (1-2). DOI: 10.1111/j.1468-2249.2008.00267.x.

Thanks!