The Mazurka Project

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Performance Data Extraction

1. Timings of beats.
2. Timings of all event onsets (beats + off-beats).
3. Timings of note onsets of individual notes in chord.

   LH & RH do not always play together, for example.
4. Loudness of individual notes at onsets.

- Not trying to extract note-off information.

  Would be interesting for articulation, slurring and pedaling studies.
- Only working with piano music (Chopin mazurkas)

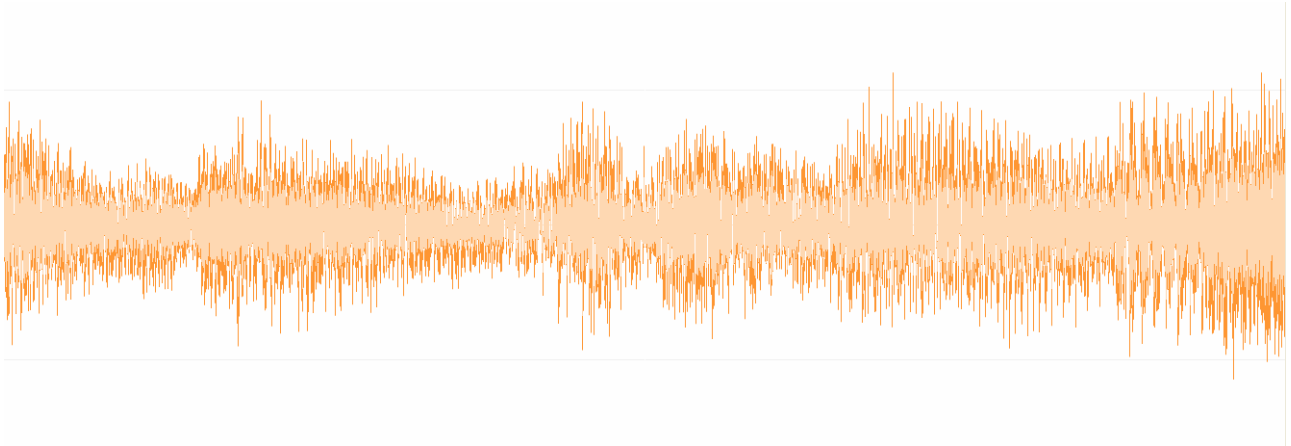
  Nice percussive attack to all notes & note pitch does not change.

Data Entry (1)

- Using audio editor called Sonic Visualiser:

  `http://sonicvisualiser.org`

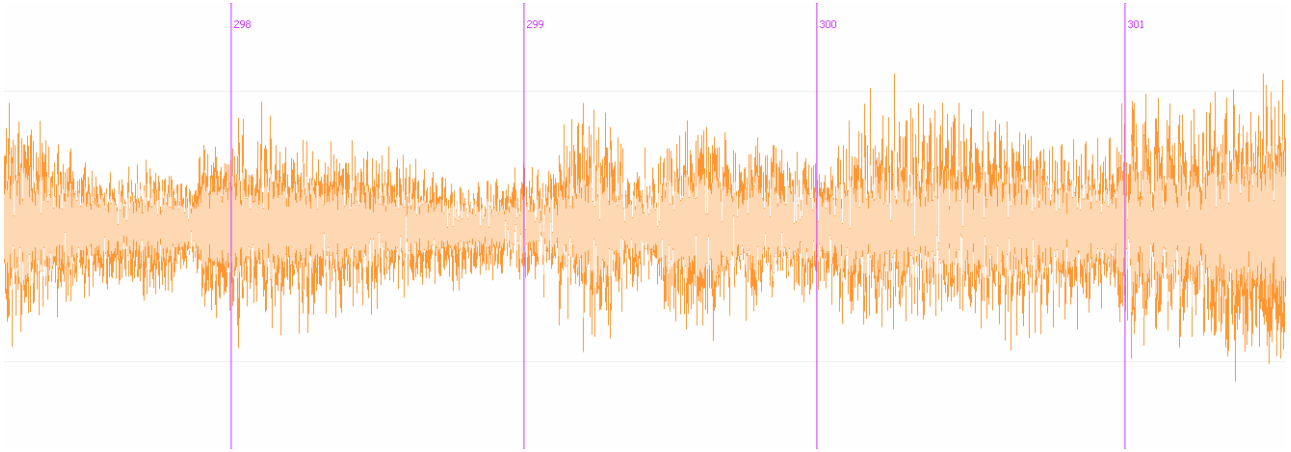
- Load soundfile, which will display waveform on screen:



Data Entry (2)

- Next, tap to beats in music, following score.

- The taps are recorded in Sonic Visualiser as lines:

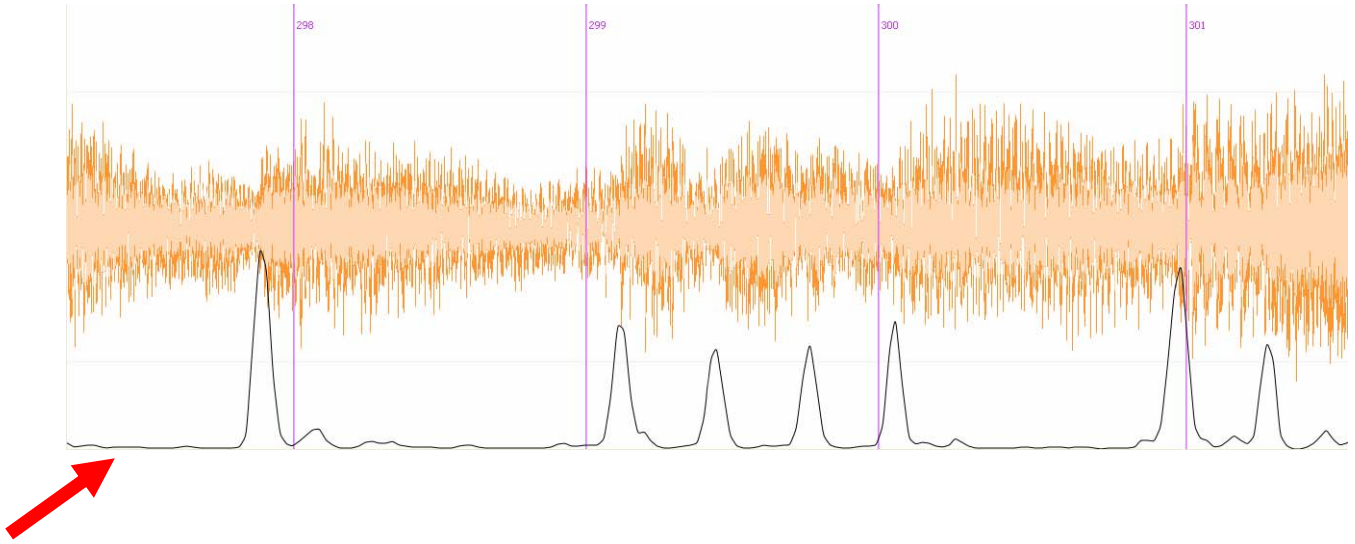


Data Entry (3)

- Then add audio analyses from plugin(s) to help identify note attacks.

- In this example, the MzAttack plugin was used:

  `http://sv.mazurka.org.uk/MzAttack`



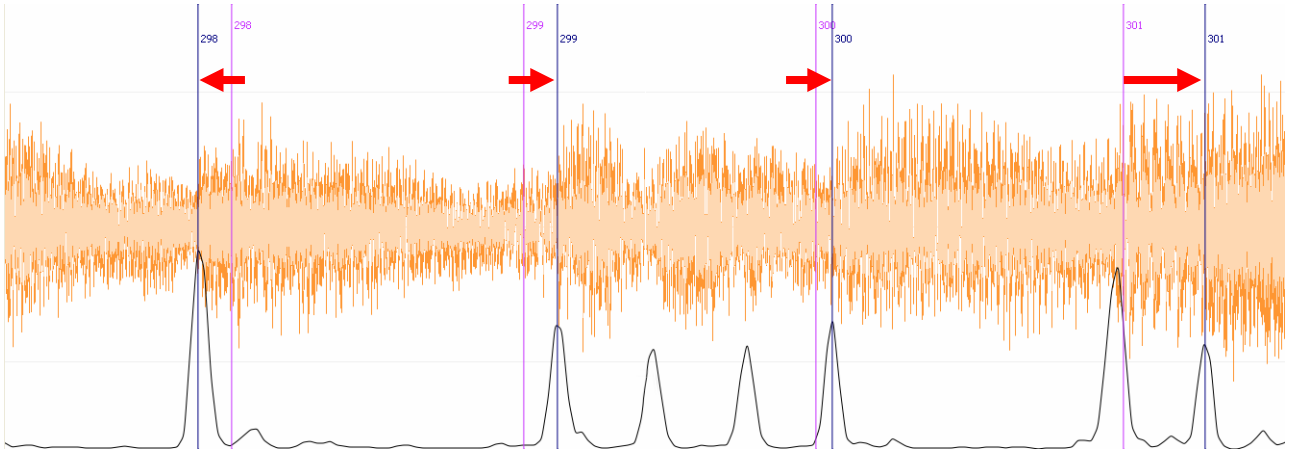
Data Entry (4)

- Adjust the tap times to events in the audio file.

= tapped times

= corrected tap times

•Sonic Visualiser allows you to move tapped lines around:



Data Entry (5)

time	*label*
170.825	295
171.219	296
171.661	297
172.164	298
172.707	299
173.122	300
173.685	301
173.913	302
174.331	303
174.818	304
175.329	305
175.747	306
176.188	307
176.606	308
177.048	309
177.489	310
177.976	311

- Save corrected tap data to a text file.

- Data is in two columns:

    1. Time in seconds
    2. Tap label

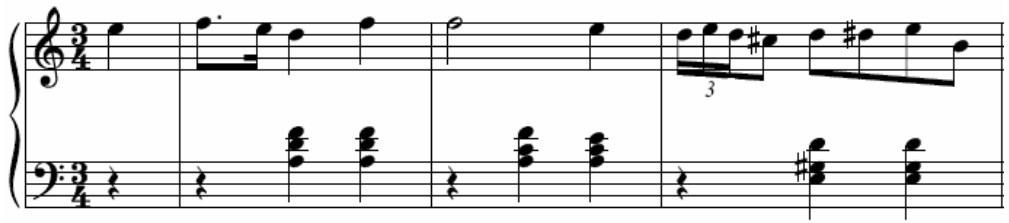
Data Entry (6)

beat times	*left hand*	*right hand*
1912	4r	4ee
=1	=1	=1
2558	4r	8.ff
.	.	16ee
3175	4A 4d 4f	4dd
3778	4A 4d 4f	4ff
=2	=2	=2
4430	4r	2ff
4914	4A 4c 4f	.
5541	4A 4c 4e	4ee
=3	=3	=3
6289	4r	24dd
.	.	24ee
.	.	24dd
.	.	8cc#
6805	4E 4G# 4d	8dd
.	.	8dd#
7219	4E 4G# 4d	8ee
.	.	8b
=4	=4	=4

- Beat times are aligned with score data.
- Score data is in the Humdrum format:

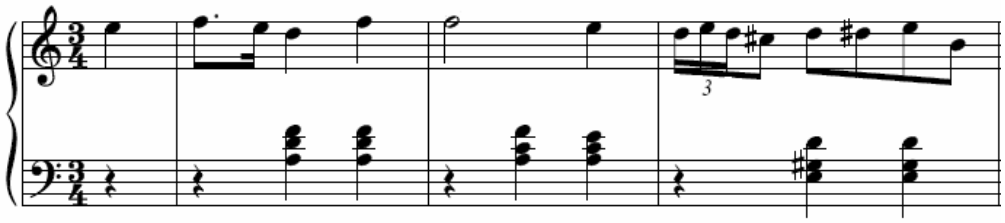
`http://humdrum.org`

Encoded music:



Data Entry (7)

• Timings of off-beats are then estimated from the rhythms in the score.



1912	4r	4ee
=1	=1	=1
2558	4r	8.ff
3021	.	16ee
3175	4A 4d 4f	4dd
3778	4A 4d 4f	4ff
=2	=2	=2
4430	4r	2ff
4914	4A 4c 4f	.
5541	4A 4c 4e	4ee
=3	=3	=3
6289	4r	24dd
6375	.	24ee
6461	.	24dd
6547	.	8cc#
6805	4E 4G# 4d	8dd
7012	.	8dd#
7219	4E 4G# 4d	8ee
7516	.	8b
=4	=4	=4

Data Entry (8)

• Data is translated to a Matlab-friendly format.

1912	4r	4ee
=1	=1	=1
2558	4r	8.ff
3021	.	16ee
3175	4A 4d 4f	4dd
3778	4A 4d 4f	4ff
=2	=2	=2

note onset	notated duration	pitch (MIDI)	metric level	measure	absbeat	hand
1912	646	76	1	0	0	2
2558	463	77	0	1	1	2
3021	154	76	-1	1	1.75	2
3175	603	57	0	1	2	1
3175	603	62	0	1	2	1
3175	603	65	0	1	2	1
3175	603	74	0	1	2	2
3778	652	57	1	1	3	1
3778	652	62	1	1	3	1
3778	652	65	1	1	3	1
3778	652	77	1	1	3	2

• Automatic alignment and extraction of note timings and loudnesses with a program being developed by Andrew Earis.

Performance Simulations

with MIDI files

 Original Recording

MIDI files generated from performance data:

 Straight tempo (dynamics from score) – *i.e.*, no performance data.

 Performance tempo (dynamics from score).

External file — Performance tempo (with automatic errors) plus performance dynamics (exaggerated slightly).

Extracted Performance Data

- What do you do with the data once you have it?
- How to compare different performances of the same piece?
- How to compare performances of different pieces?

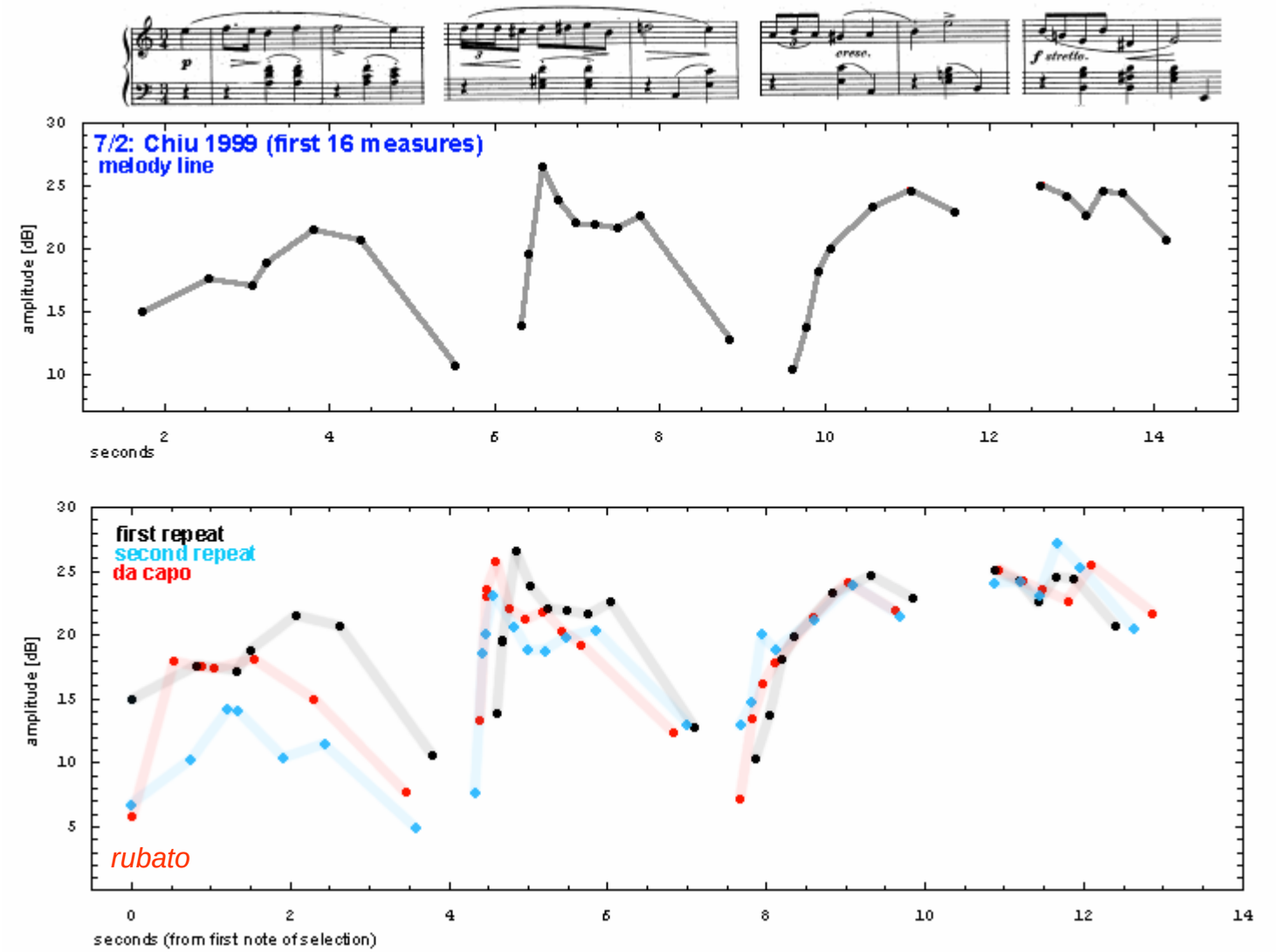
- Currently examining beat tempos, starting to work with dynamics.

Dynamics & Phrasing

1 

2 

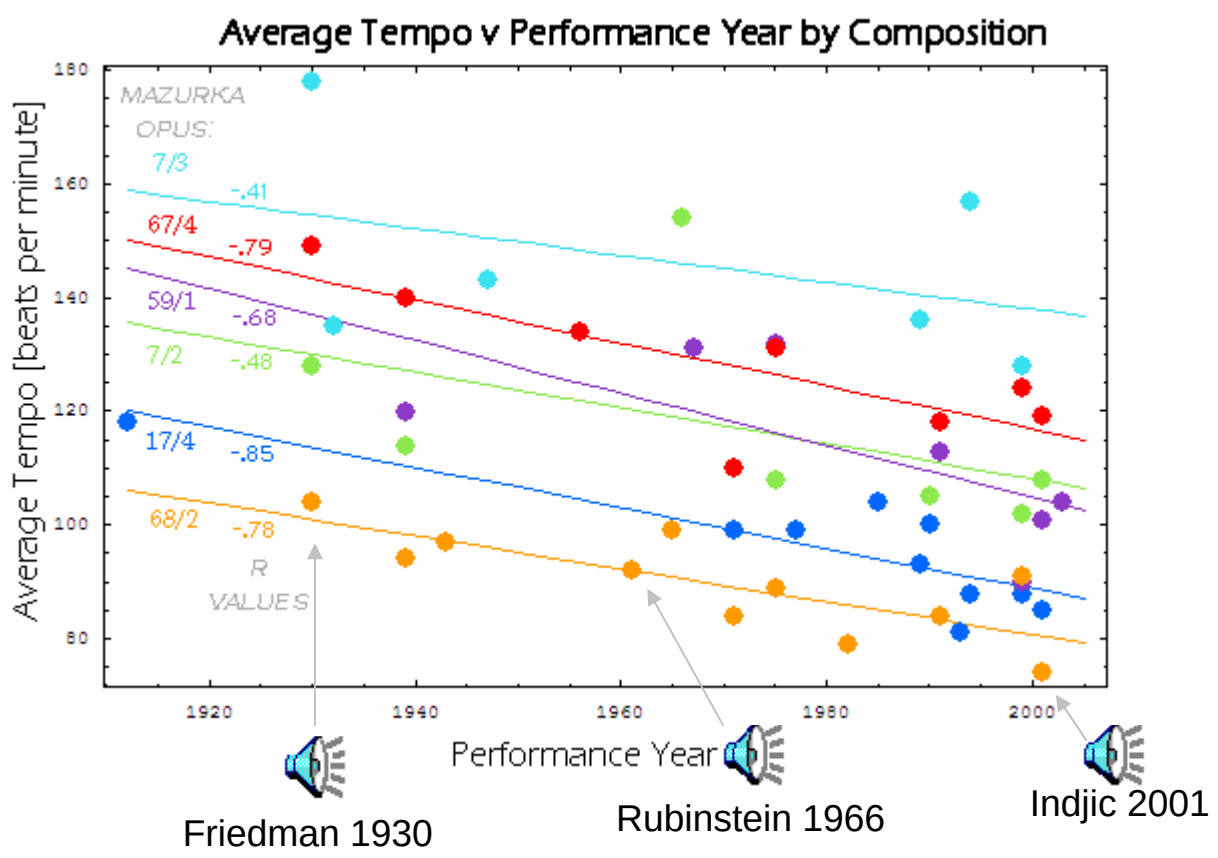
3 



all at once:

Average tempo over time

- Performances of mazurkas slowing down over time:



- Slowing down at about 3 BPM/decade

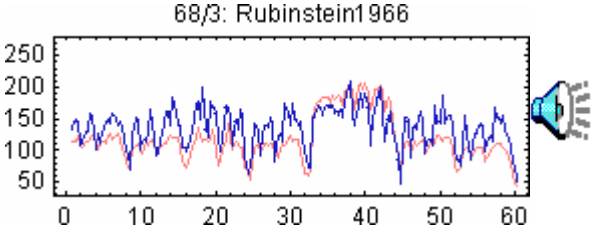
Laurence Picken, 1967: “Centeral Asian tunes in the Gagaku tradition” in *Festschrift für Walter Wiora*. Kassel: Bärenreiter, 545-51.

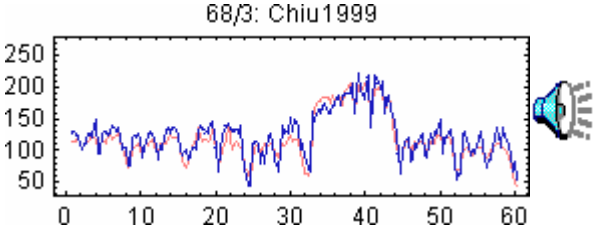
Tempo Curves

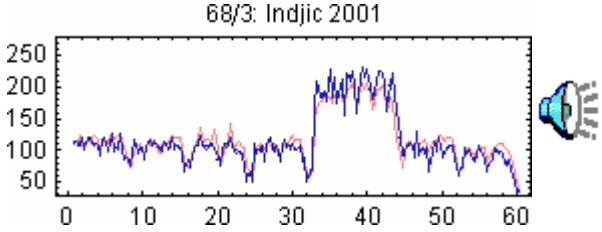
- Beat-by-beat plot of the tempo throughout the performance

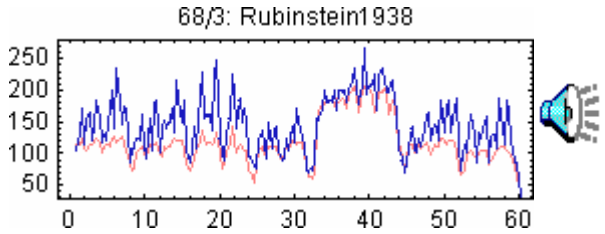
(Red line is average tempo for all 10 performers)

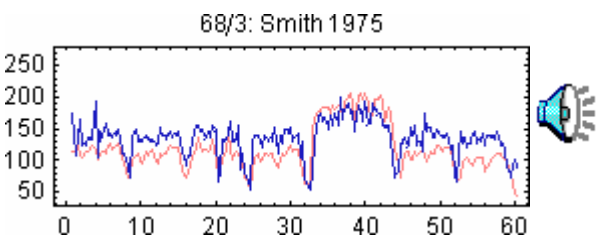
Tempo Graphs

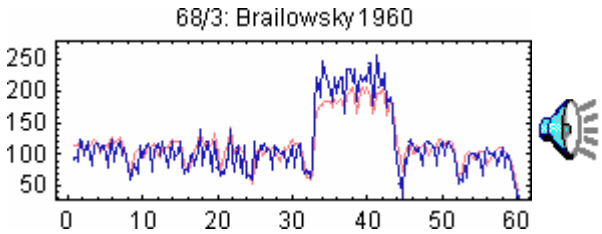


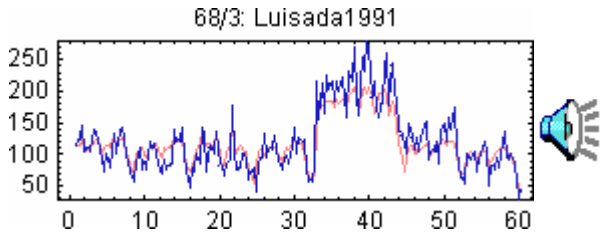


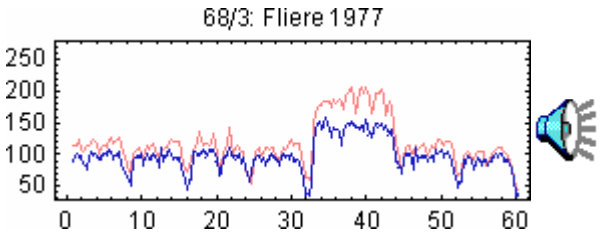


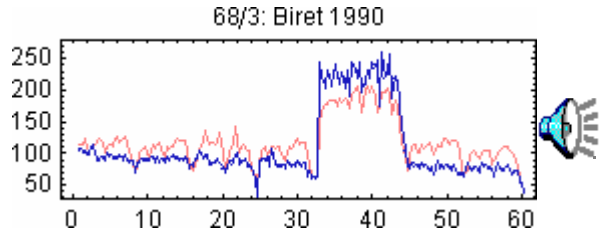


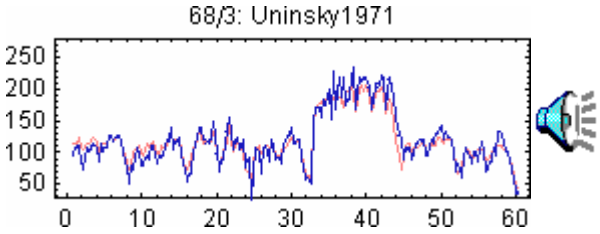






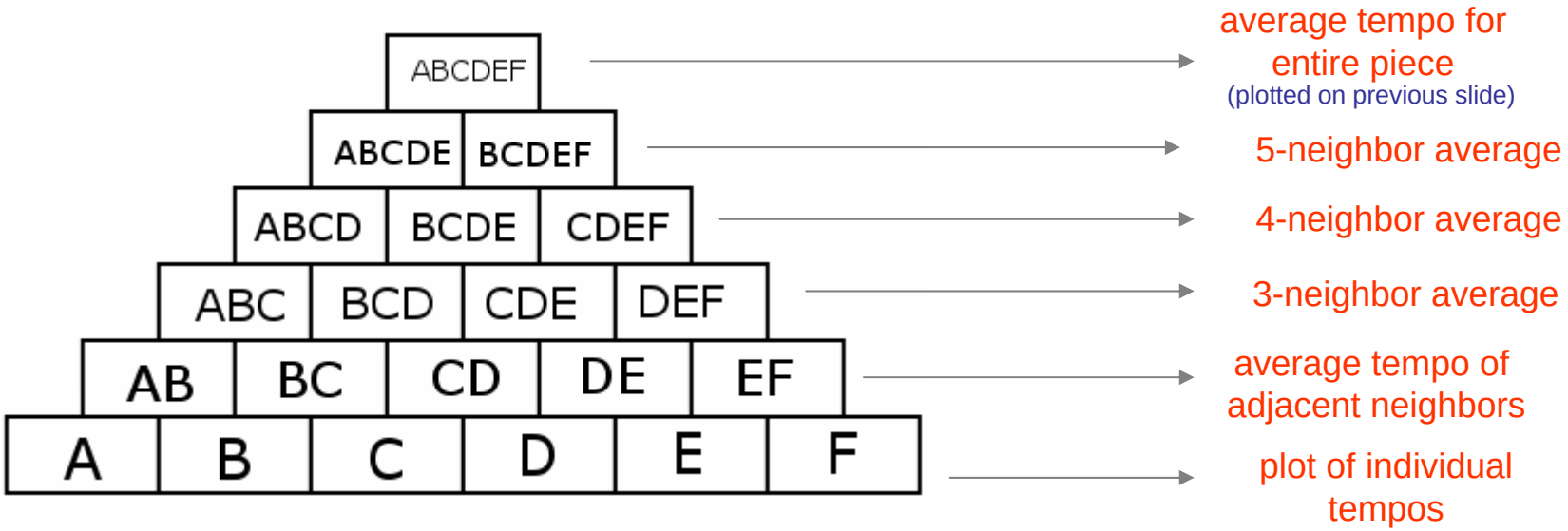




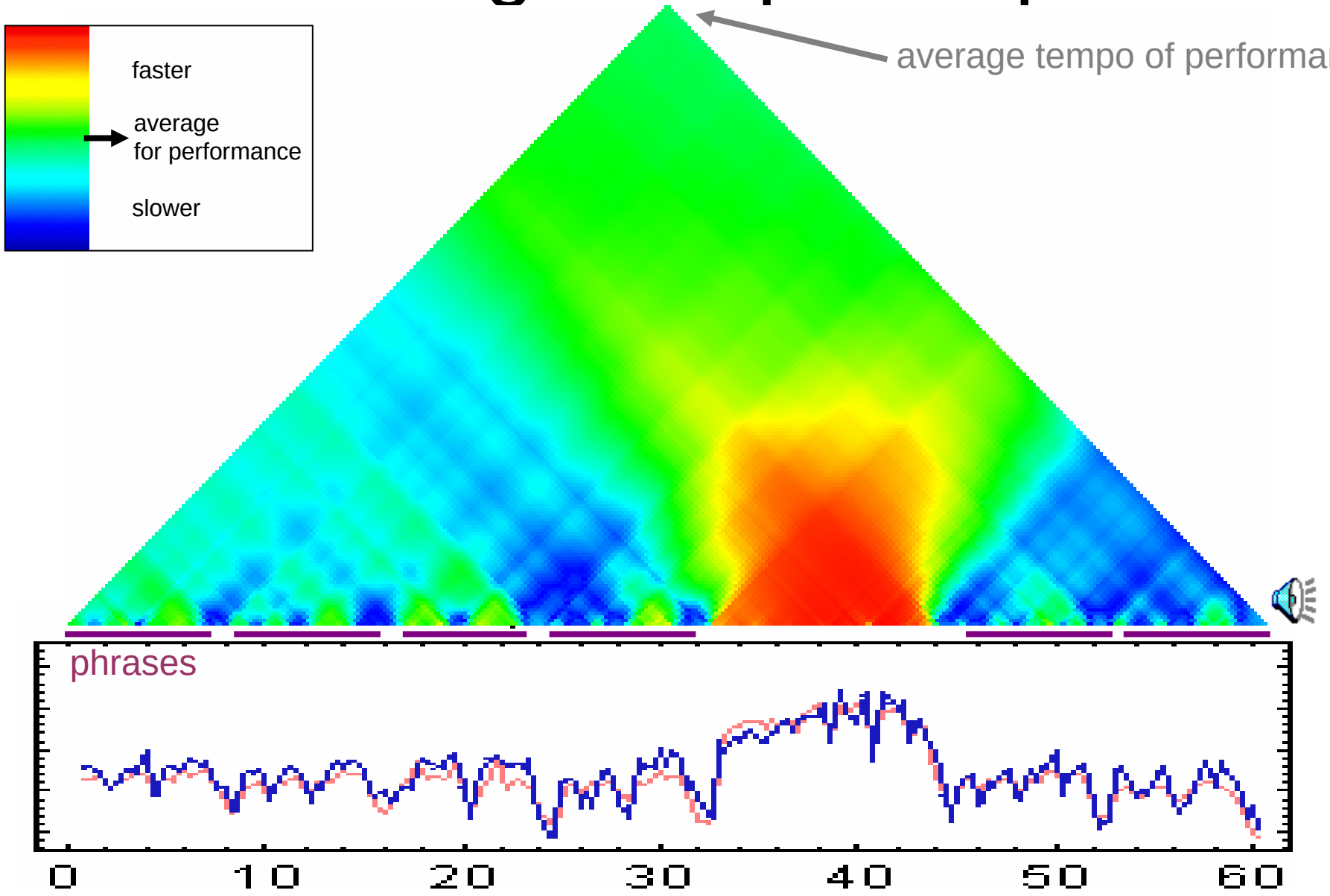


Timescapes

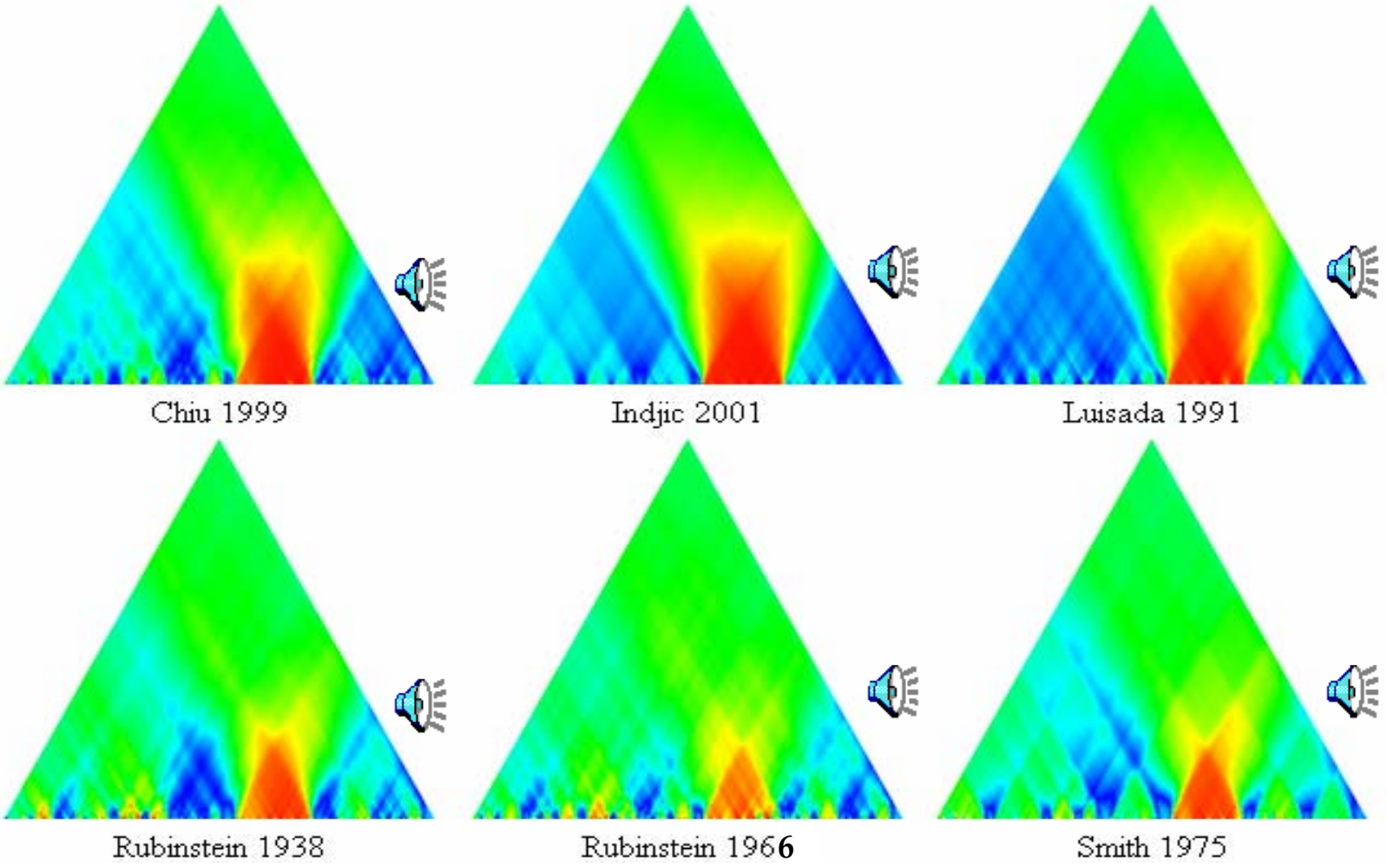
- Examine the internal tempo structure of a performances
- Plot average tempos over various time-spans in the piece
- Example of a piece with 6 beats at tempos A, B, C, D, E, and F:



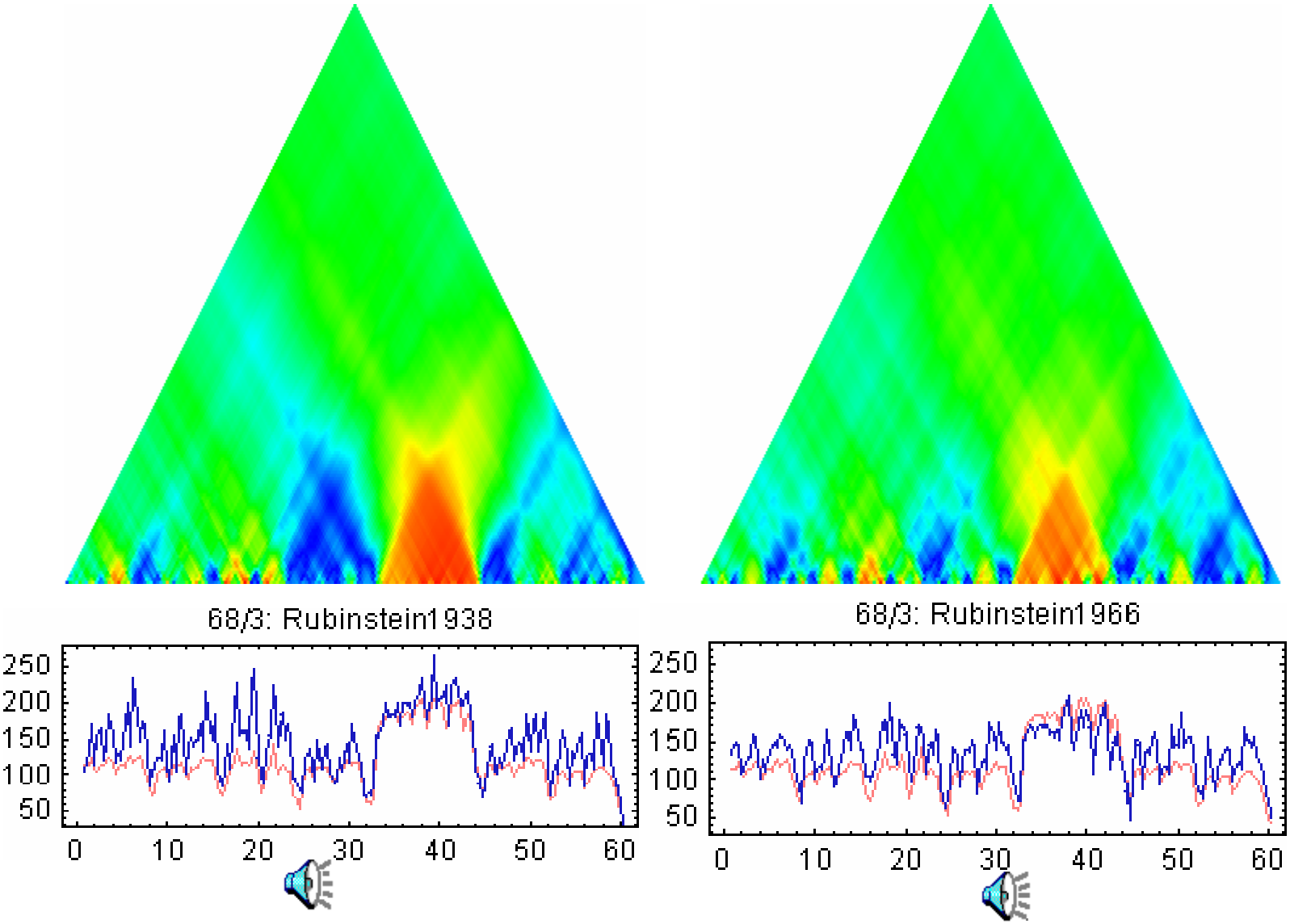
Average-tempo scape



Average tempo over time



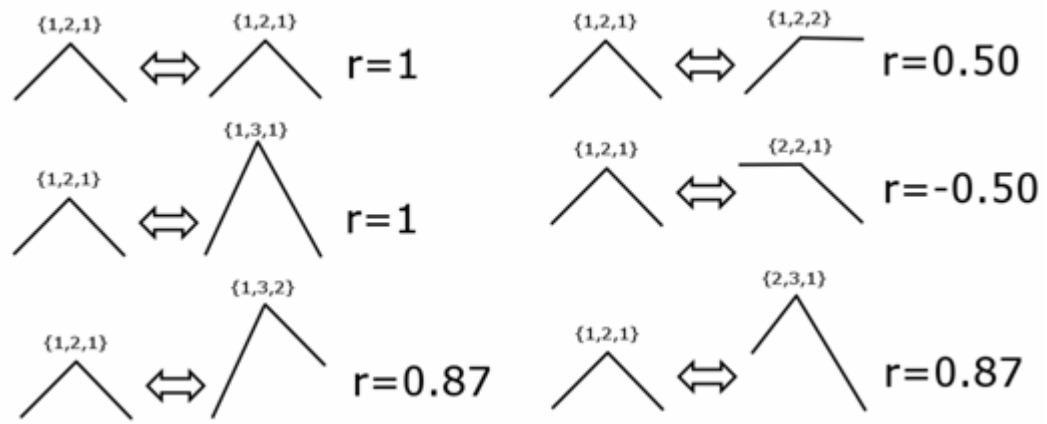
Same Performer

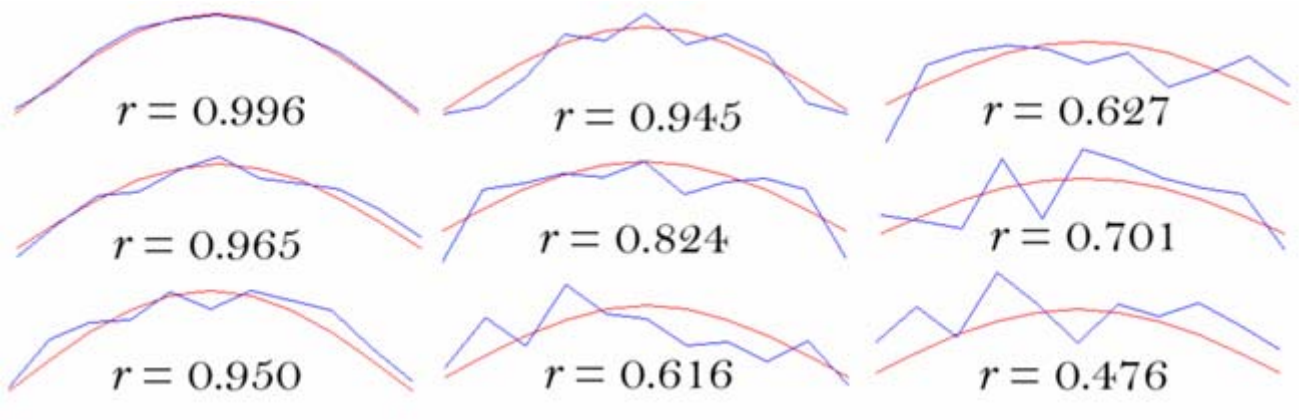


Correlation

Pearson correlation:

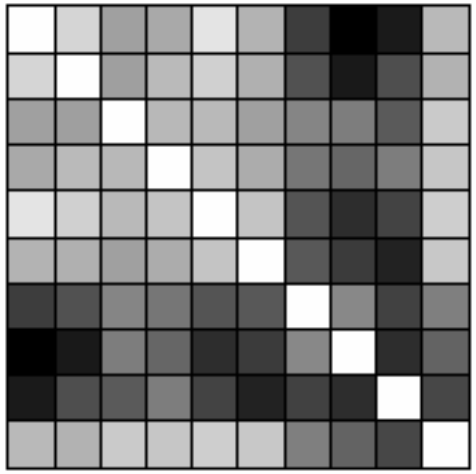
$$\frac{\sum_i (x_i - \bar{x})\,(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

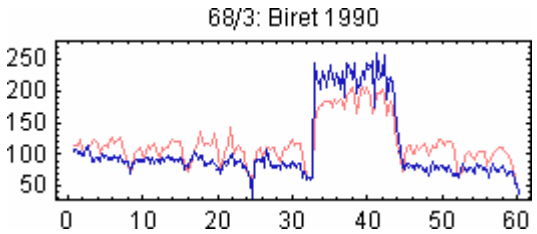


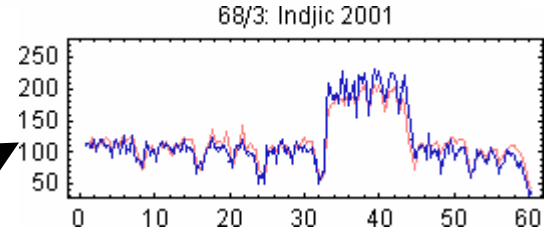


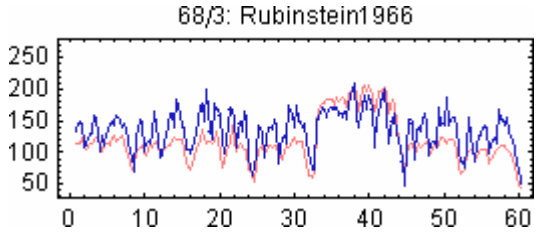
Overall Performance Correlations

	Bi	Br	Ch	Fl	In	Lu	R8	R6	Sm	Un
Biret	1.	0.92	0.81	0.83	0.95	0.85	0.62	0.5	0.55	0.86
Brailowsky	0.92	1.	0.81	0.86	0.91	0.84	0.66	0.55	0.65	0.85
Chiu	0.81	0.81	1.	0.86	0.86	0.81	0.76	0.74	0.67	0.89
Friere	0.83	0.86	0.86	1.	0.88	0.84	0.73	0.7	0.74	0.89
Indjic	0.95	0.91	0.86	0.88	1.	0.88	0.66	0.59	0.63	0.9
Luisada	0.85	0.84	0.81	0.84	0.88	1.	0.67	0.61	0.56	0.89
Rubinstein 1938	0.62	0.66	0.76	0.73	0.66	0.67	1.	0.77	0.62	0.75
Rubinstein 1966	0.5	0.55	0.74	0.7	0.59	0.61	0.77	1.	0.59	0.69
Smith	0.55	0.65	0.67	0.74	0.63	0.56	0.62	0.59	1.	0.64
Uninsky	0.86	0.85	0.89	0.89	0.9	0.89	0.75	0.69	0.64	1.





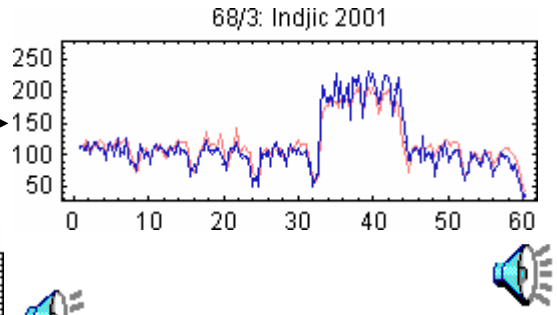




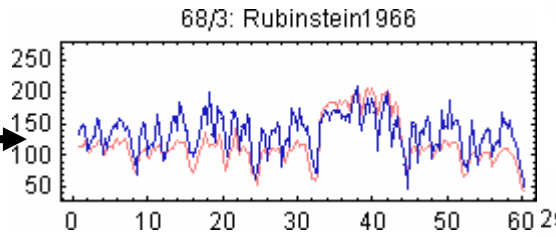
Correlations to the average

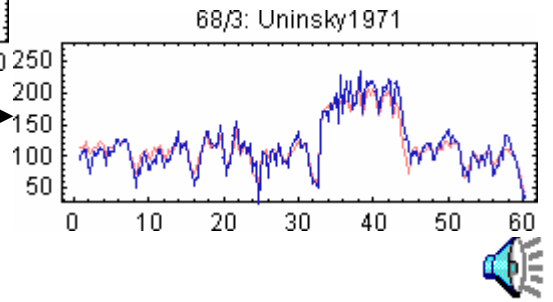
Biret	0.92
Brailowsky	0.93
Chiu	0.92
Friere	0.94
Indjic	0.95
Luisada	0.92
Rubinstein 1938	0.79
Rubinstein 1966	0.72
Smith	0.73
Uninsky	0.95

most like the average

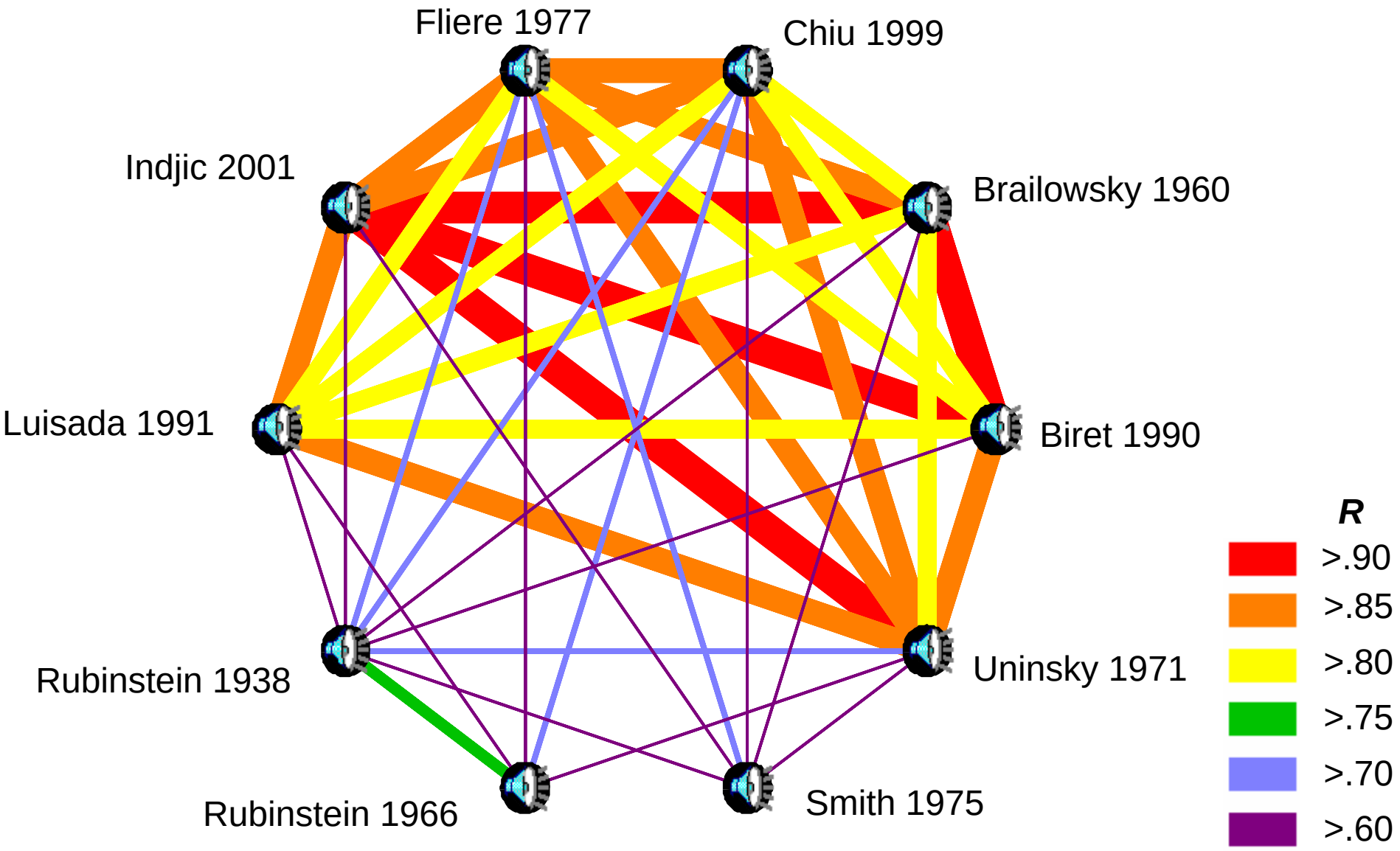


least like the average

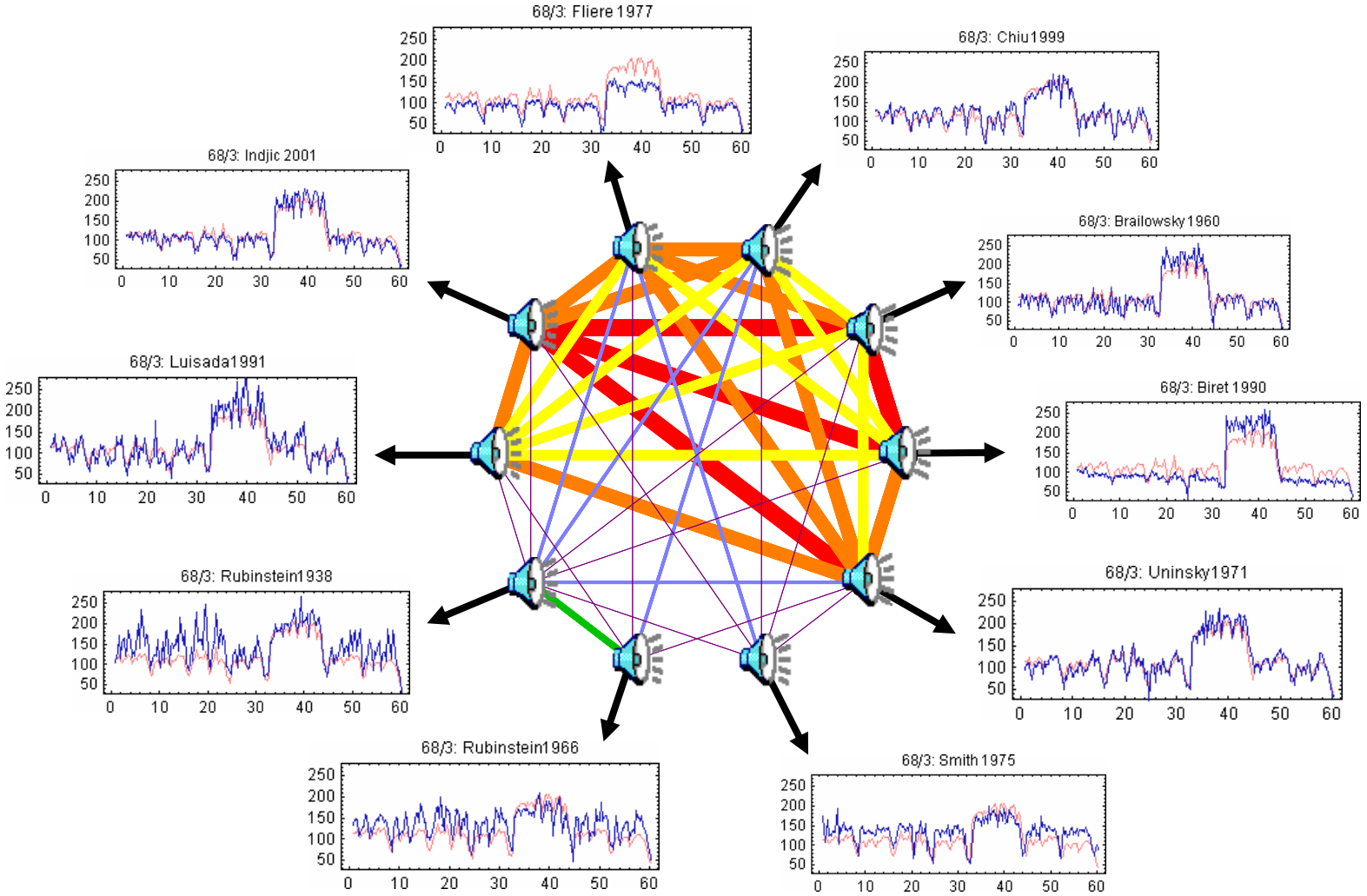




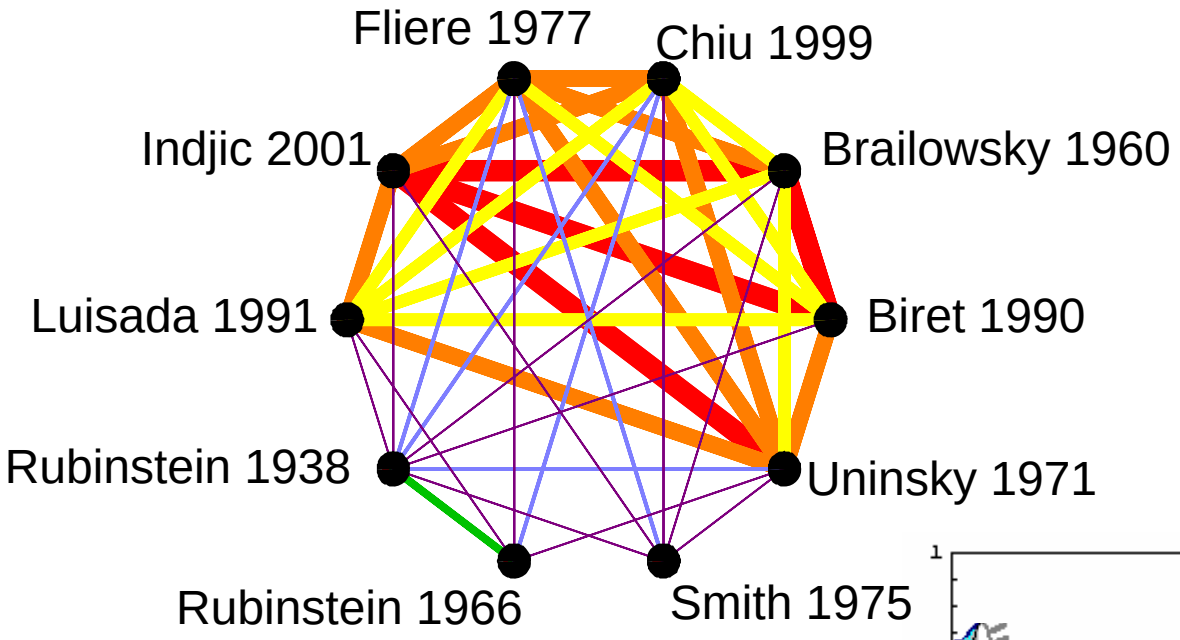
Correlation ring



Correlation Ring (2)



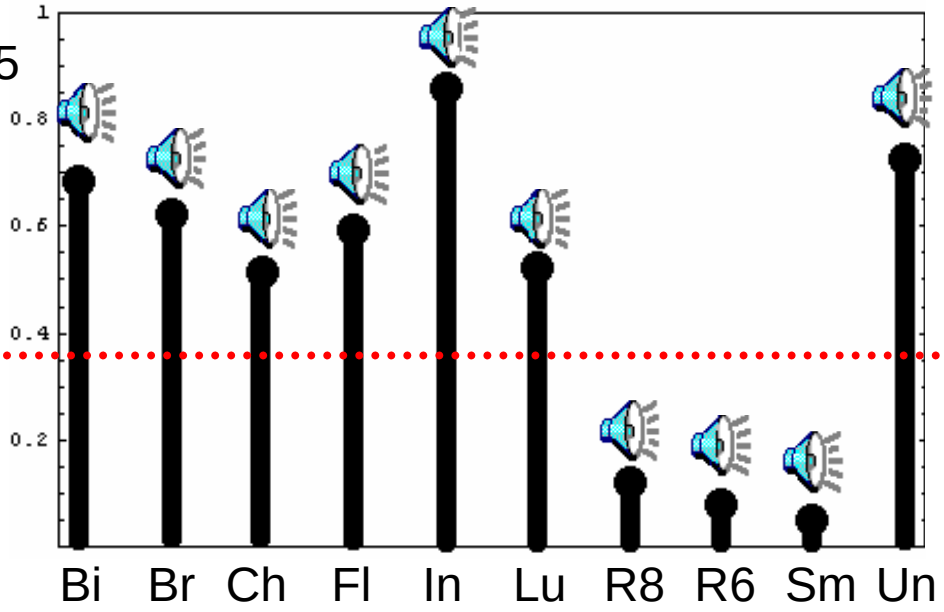
Individual v Common Practice



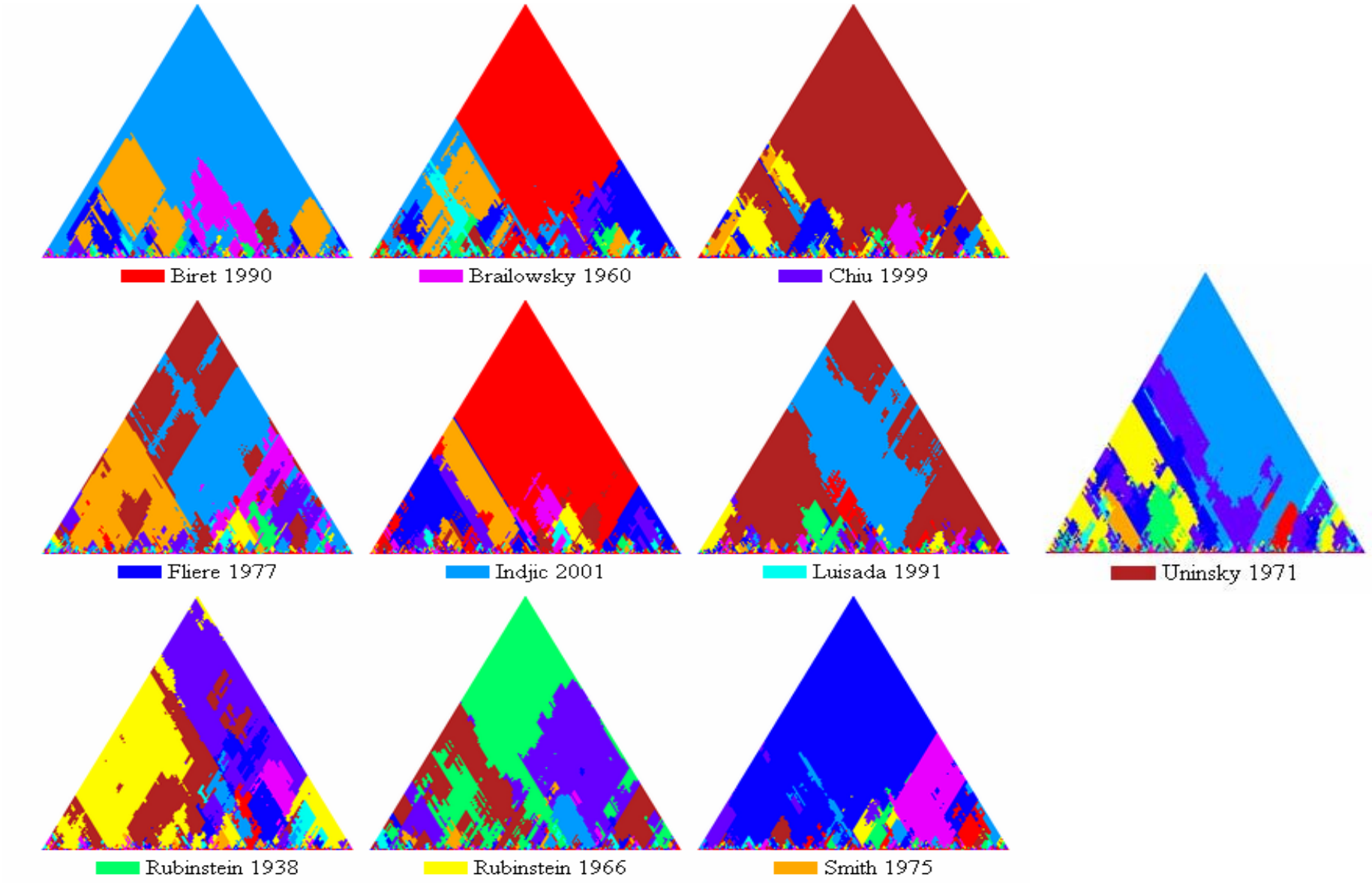
- Showing schools of performance?
- Need more data – only one Polish pianist represented for example

"Common-Practice" Performances

"Individual" Performances



Tempo-correlation scapes



For Further Information

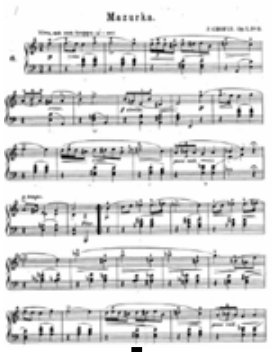
http://www.charm.rhul.ac.uk/

http://mazurka.org.uk

Extra Slides

Input to Andrew's System

Scan the score



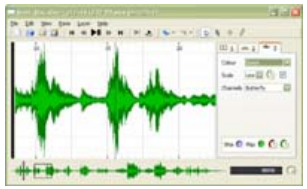
Convert to symbolic data with SharpEye

http://www.visiv.co.uk

Convert to Humdrum data format

http://www.humdrum.org

Tap to the beats in Sonic Visualiser



http://www.sonicvisualiser.org

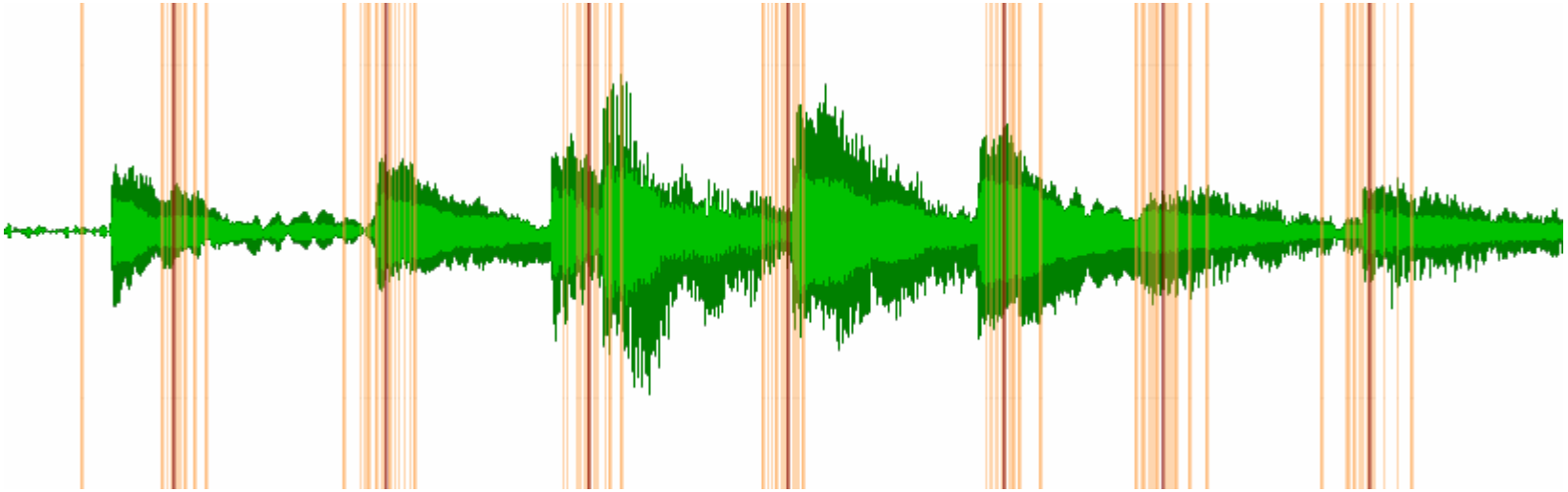
Create approximate performance score

Simplify for processing in Matlab

Reverse Conducting

- Orange = individual taps (multiple sessions) which create bands of time about 100 ms wide.

- Red = average time of individual taps for a particular beat



MIDI Performance Reconstructions

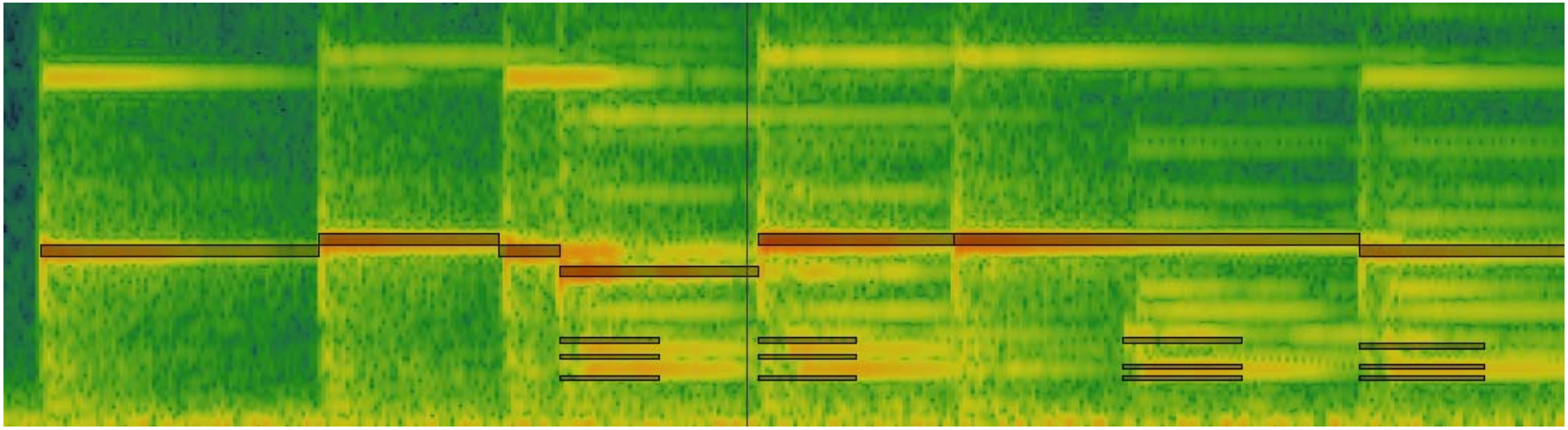
“straight” performance

tempo = avg. of performance

matching performers tempo beat-by-beat:

(pause at beginning)

MIDI file imported as a note layer in Sonic Visualiser:



- Superimposed on spectrogram
- Easy to distinguish pitch/harmonics
- Legato; LH/RH time offsets