The Mazurka Project

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Some facets of music

fields of generation

Composer	Performer	Instrument Maker	Audience
Composition	*Performance*	*Instrument*	*Listen*
Music Theory	**?**	**Acoustics**	**Cognitive Psychology**

fields of analysis

Performance data extraction

Reverse conducting

- Listen to recording and tap to beats.
- Tap times recorded in *Sonic Visualiser* by tapping on computer keyboard.

Align taps to beats → **tempo by beat**

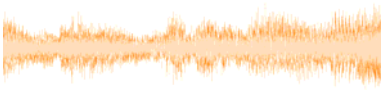
- Reverse conducting is real-time response of listener, not actions of performer.
- Adjust tap times to correct beat locations.
- A bit fuzzy when RH/LH do not play in sync, or for tied notes.

Automatic feature extraction

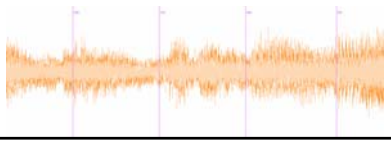
off-beat timings | **individual note timings** | **individual note loudnesses**

Reverse conducting

- Mazurka project using an audio editor called Sonic Visualiser (SV):
  `http://sonicvisualiser.org`

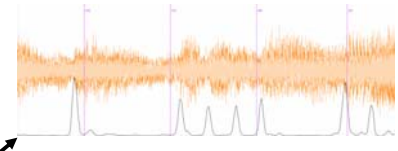


- In SV, you can mark points in time while the audio is playing:



Beat alignment

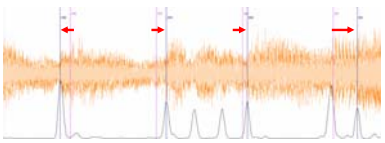
- Taps from reverse conducting are not exactly aligned with the performance.
  primarily due to constant changes in tempo
- How to adjust to actual note attacks?
- Can be difficult to do by eye in audio editor.
- Very time-consuming to do by ear.
- Solution: audio markup plugins in SV to help locate note attacks:



such as: http://sv.mazurka.org.uk/MzAttack

Beat alignment (2)

- With visual aid of markup, correction becomes easy to do by eye:

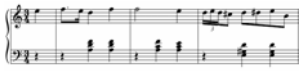


Example:

= tapped times
= aligned to beats

Automatic feature extraction

• Beat times are used to create a simulated performance from the score.



• Score data is in the Humdrum format:
`http://humdrum.org`

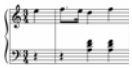
interpolated off-beat times

beat times	left hand	right hand
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

Automatic feature extraction (2)

• Data is translated to a Matlab-friendly format.

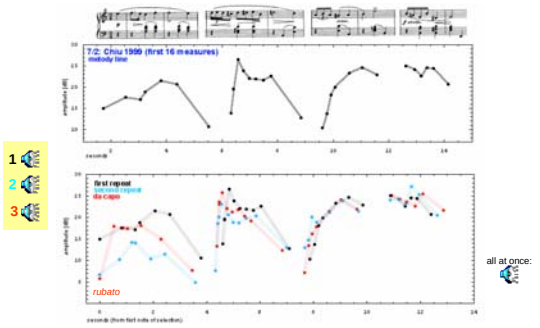
1912	4r	4ee
=1	=1	=1
2558	4r	8.ff
3021	.	16ee
3175	4A 4d 4f	4dd
3778	4A 4d 4f	4ff
=2	=2	=2



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 onsets and loudnesses with program being developed by Andrew Earis.

Dynamics & Phrasing



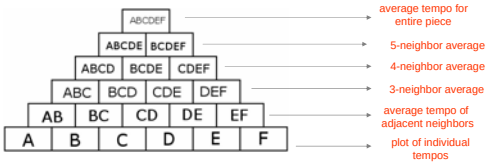
Tempo graphs

Timescapes

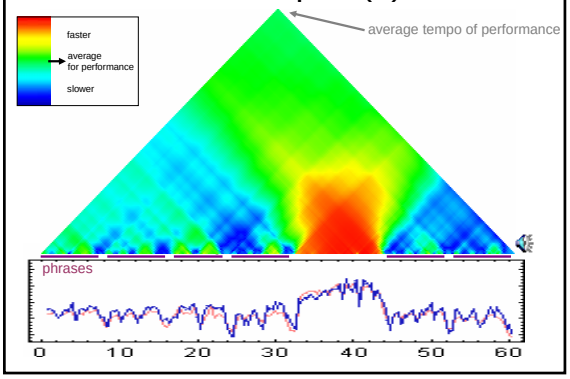
• Examine the internal tempo structure of a performances

• Plot average tempos over various time-spans in the piece

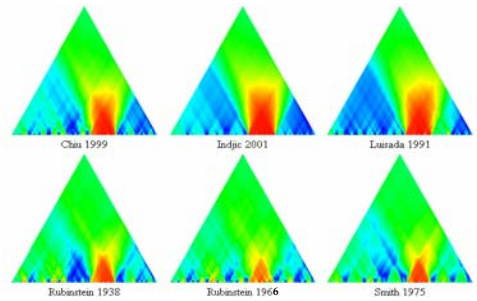
• Example of a piece with 6 beats at tempos A, B, C, D, E, and F:



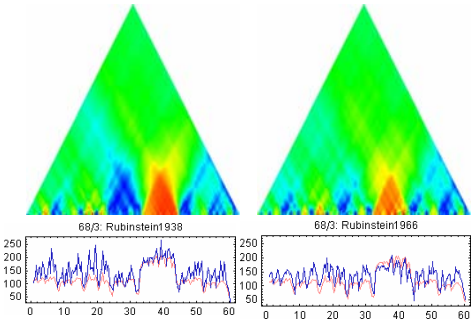
Timescapes (2)



Comparison of performers



Same performer



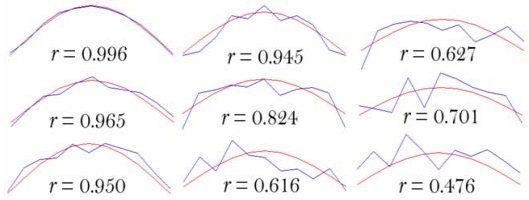
Correlation

Pearson correlation:

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

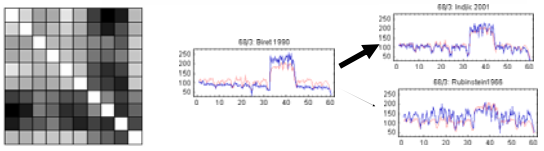
- **Measures how well two shapes match:**

r = 1.0 is an exact match.
r = 0.0 means no relation at all.

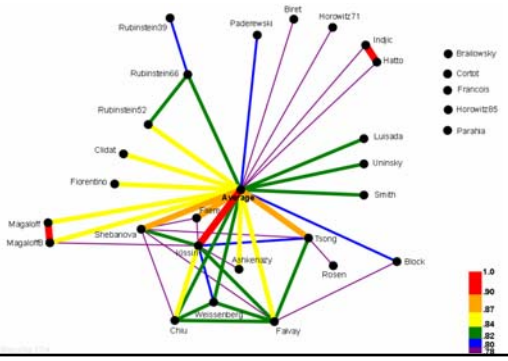


Overall performance correlations

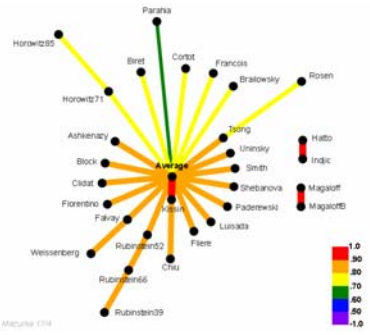
	Bi	Br	Ch	Fl	In	Lu	R8	R6	Sm	Un
Biret	1.	0.92	0.81	0.83	0.95	0.85	0.62	0.5	0.55	0.86
Brailowsky	0.92	1.	0.81	0.86	0.91	0.84	0.66	0.55	0.65	0.85
Chiu	0.81	0.81	1.	0.86	0.86	0.81	0.76	0.74	0.67	0.89
Friere	0.83	0.86	0.86	1.	0.88	0.84	0.73	0.7	0.74	0.89
Indjic	0.95	0.91	0.86	0.88	1.	0.88	0.66	0.59	0.63	0.9
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.



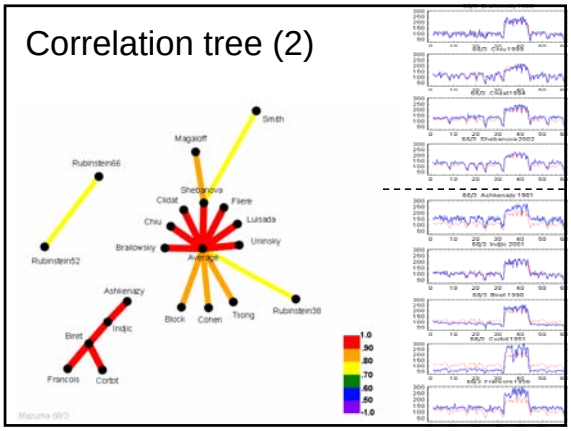
Correlation network



Correlation tree

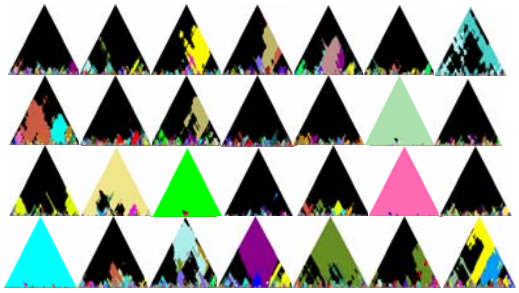


Correlation tree (2)



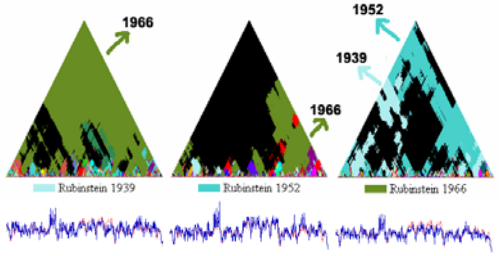
Correlation scapes

- **Who is most similar to a particular performer at any given region in the music?**



Same performer over time

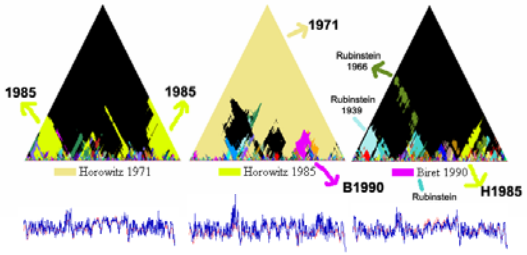
3 performances by Rubinstein of mazurka 17/4 in A minor



(30 performances compared)

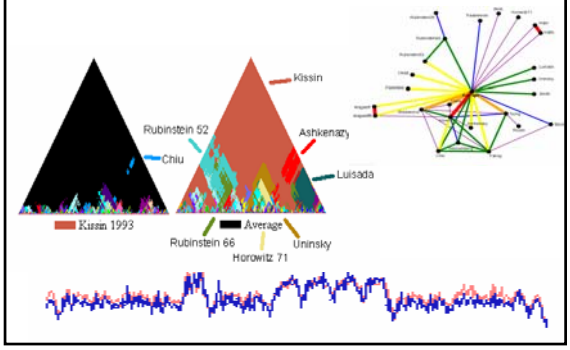
Same performer (2)

2 performances by Horowitz of mazurka 17/4 in A minor
plus Biret 1990 performance.

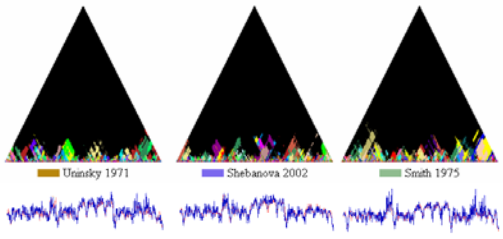


(30 performances compared)

Correlation to average



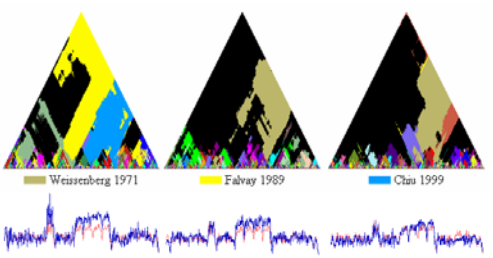
Individual interpretations



- Idiosyncratic performances which are not emulated by other performers.

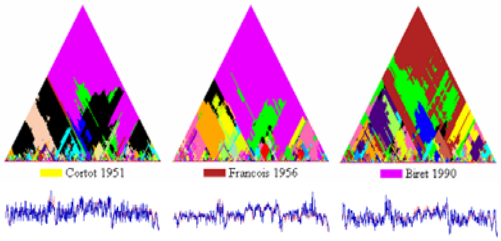
(or I don't have performances that influenced them or they influence)

Possible influences



Student/Teacher

Mazurka in F major 68/3



• Francois and Biret both studied with Cortot,

(20 performances compared)

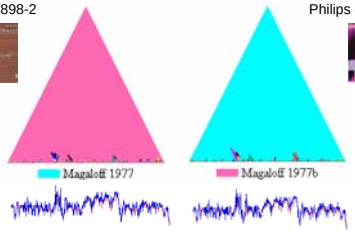
Same source recording

The same performance by Magaloff on two different CD releases

mazurka 17/4 in A minor

Philips 456 898-2

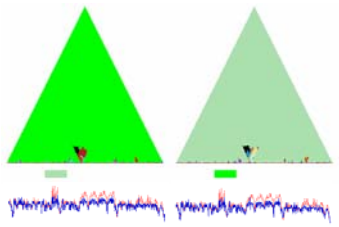
Philips 426 817/29-2



• Structures at bottoms due to errors in beat extraction or interpreted beat locations (no notes on the beat).

Purely coincidental

Two difference performances from two different performers on two different record labels from two different countries.



For further information

CHARM Mazurka Project
AHRC Research Centre for the History and Analysis of Recorded Music

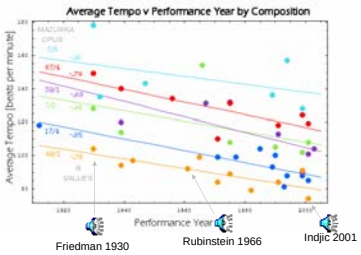
http://www.charm.rhul.ac.uk/

http://mazurka.org.uk

Extra Slides

Average tempo over time

• Performances of mazurkas slowing down over time:



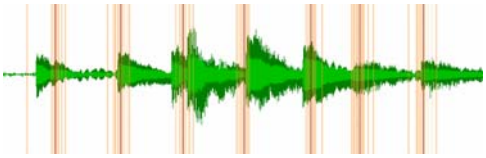
• Slowing down at about 3 BPM/decade

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

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

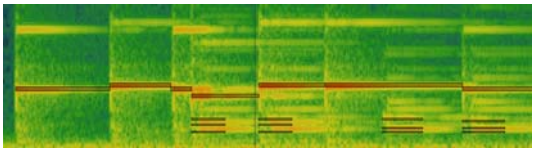
"straight" performance

tempo = avg. of performance

matching performers tempo beat-by-beat:

(pause at beginning)

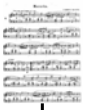
MIDI file imported as a note layer in Sonic Visualiser:



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

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