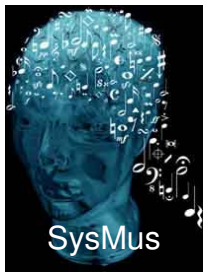
ISPS 2011 – 11th International Symposium on Performance Science,
Toronto, Canada, 24 – 27 August 2011



An accent-based approach to performance rendering:

Music theory meets music psychology

Erica Bisesi, Richard Parncutt & Anders Friberg

Expressive piano performance

- **Music performance research involves**
  - music theory and analysis
  - systematic musicology: acoustics, information sciences, psychology
  - music performance studies in humanities and education

- **Our aim:**

  understand expressive timing and dynamics by
  - measuring timing and dynamics in excellent performances
  - developing theories about timing and dynamics
  - implementing these theories in a computer algorithm
  - generating and evaluating automatic performances

Expressive piano performance

- Analysis of timing and dynamics:
  - Bruno Repp, Eric Clarke, Caroline Palmer
- Kinematic models:
  - Neil Todd, Anders Friberg, Johan Sundberg
- Perceptual models:
  - Ed Large, Henkjan Honing, Caroline Drake
- Historical context:
  - Nicholas Cook

Expressive piano performance

performed by **Anna Kravchenko**

An example: musical timing

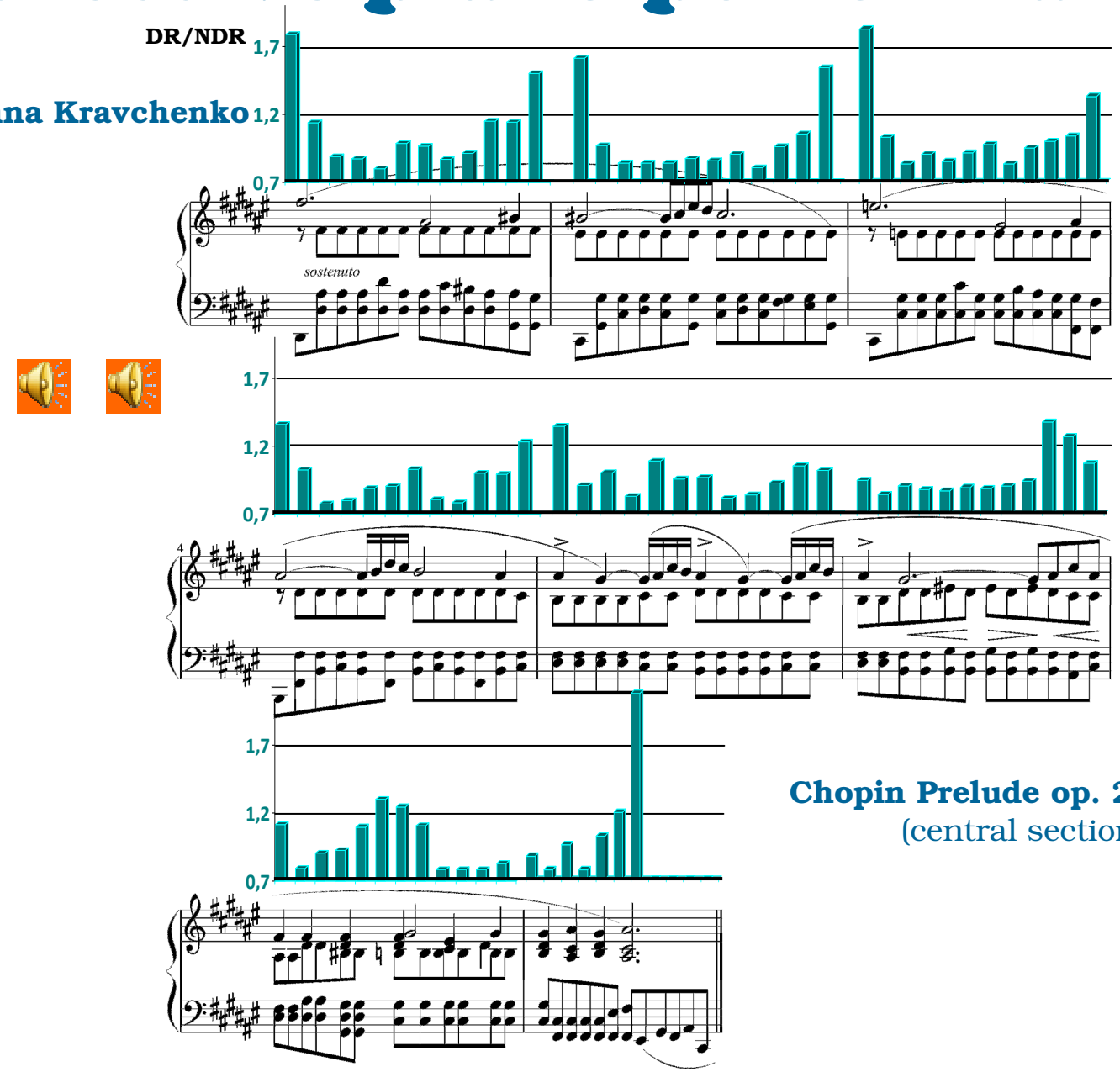
Chopin Prelude op. 28 no. 13
(central section)

24/08/2011

Expressive piano performance

performed by **Anna Kravchenko**

An example: musical timing



Chopin Prelude op. 28 no. 13
(central section)

Our project

- **Our aim** is to explore the complex relationship between musical expression (as perceived by listeners and performers) and corresponding physical parameters (such as timing and dynamics).

- For that purpose, we have extended Director Musices (Friberg et al., 2006) in a new direction, incorporating the Parncutt's theory of accents (Parncutt, 2003) into the previous set of rules.

- **Our approach** is highly interdisciplinary, in the sense that we regard the sciences, humanities and musical practice as equally important.

What is an "accent"?

What accents do:

- attract attention of listener
- give a feel for what is important
- clarify structure
- facilitate musical communication

A broad definition (Parncutt, 2003):

- **immanent** (in the score):
  - ✓ metrical, grouping, melodic, harmonic
- **performed** (in the sound):
  - ✓ dynamic, durational, articulatory, timbral

What is an "accent"?

What accents do:

- attract attention of listener
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- clarify structure
- facilitate musical communication

A broad def

- **immaner**
  - ✓ metric
- **performe**
  - ✓ dynan

ACCENTS	*IMMANENT*	*PERFORMED*
time	grouping metrical	agogic (onset time) articulatory (duration)
pitch	melodic harmonic	intonation
loudness	dynamic	stress
timbre	instrument orchestration	coloration

Table 1: Parncutt's (2003) taxonomy of musical accents.

Music theory and analysis

An accent-based approach to music analysis

(Bisesi, E. & Parncutt, R. (2010). Poster presented at *Kreativität, Struktur und Emotion - Kongress der Gesellschaft für Musiktheorie Hochschule für Musik*, Würzburg, Germany, 7-10 October 2010)

Q: What do listeners perceive in the *structure* of a piece of music (i.e. not loudness, timbre, meaning)?

A: Two aspects of relationships between structural elements:

a) **segmentation** (hierarchical)

b) **accents** (salient events)

Q: How can we best describe that?

A: Ask a group of expert listeners!

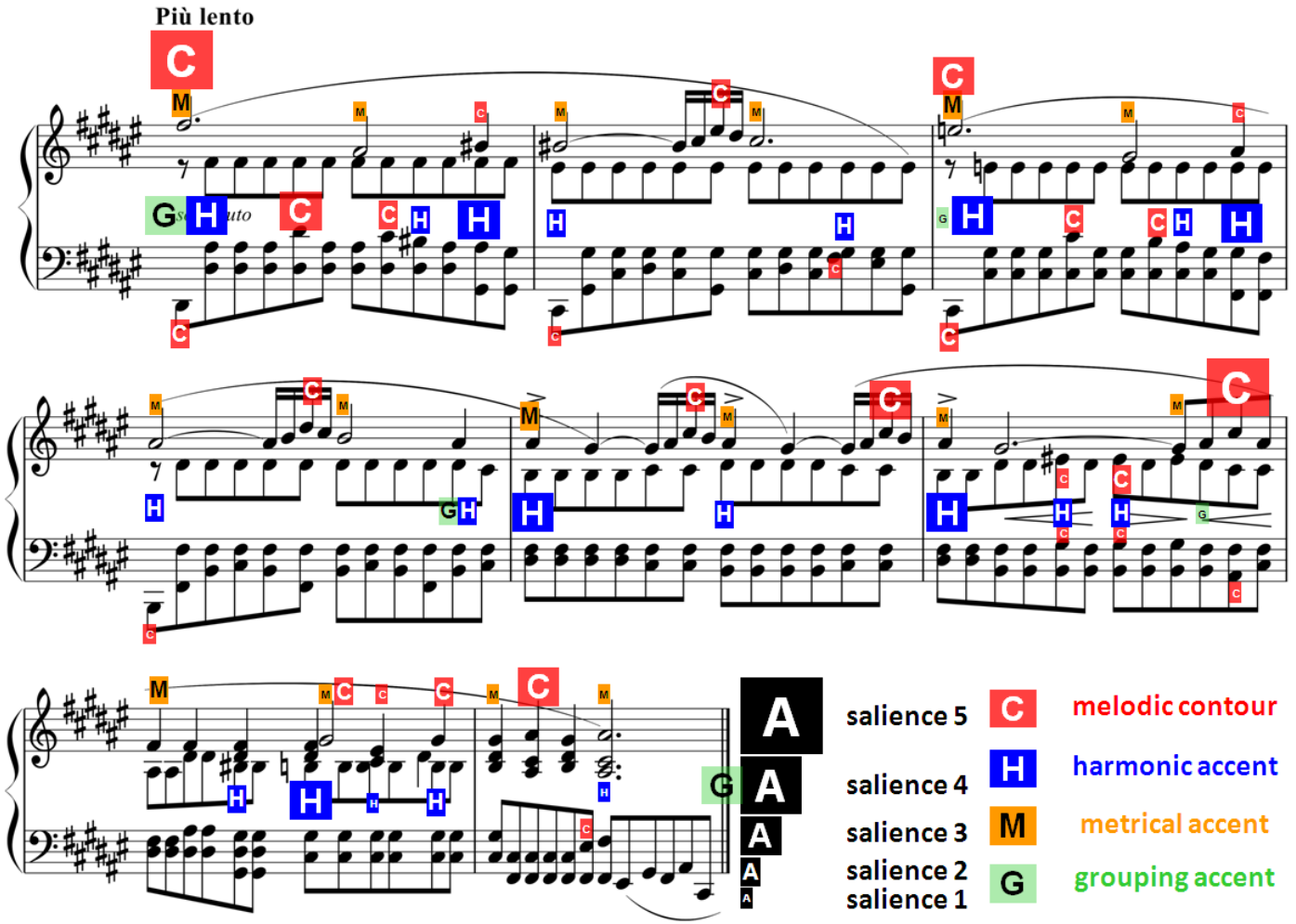
Musical theory and analysis

Our analysis produced

- SEGMENTATION
  - ✓ start and end of phrases
  - ✓ hierarchical level of phrasing
  - ✓ climax of each phrase and subphrase

- ACCENTS
  - ✓ accent position
  - ✓ their kind (melodic, harmonic, metric, grouping)
  - ✓ their salience
  - ✓ their range of action

Model for Accents



Music performance

Expression in Romantic piano music

criteria for choice of score events for emphasis

(Bisesi & Parncutt (2011). Poster presented at *SMPC 2011, Rochester*, NY, USA, 11-24 August 2011)

Q: In what aspects do great pianists agree when selecting score events (immanent accents) for local emphasis?

Q: What are the features characterizing individual performers' styles or clusters of performances?

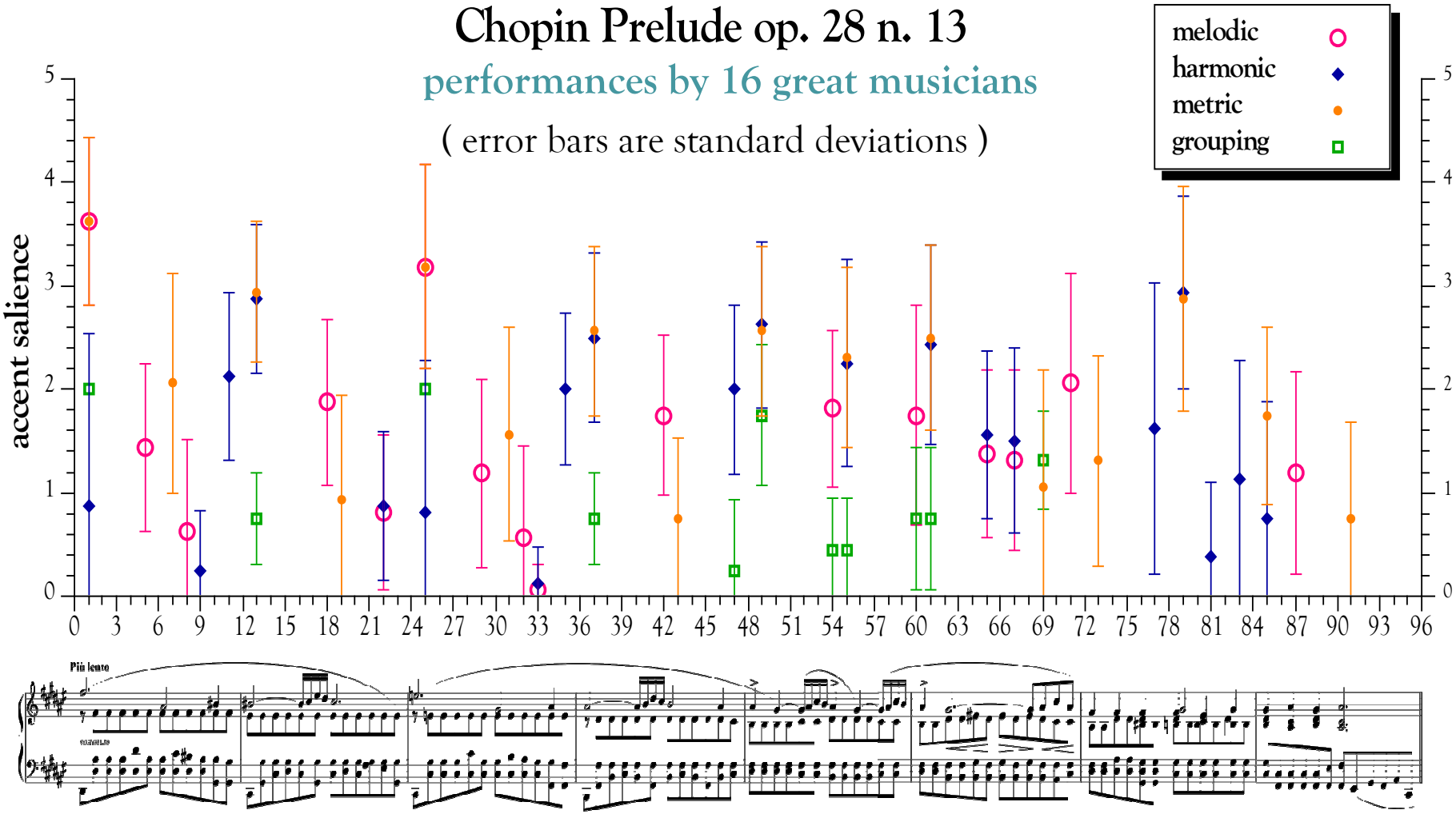
Q: How do individual performers or groups of performers emphasize immanent accents by mean of performed accents?

Methodology

Material: 16 high-quality commercial recordings of Chopin Prelude op. 28 no. 13 (Argerich (1977), Arrau (1973), Ashkenazy (1978), Baremboim (1976), Biret (1992), Bolet (1974), Cortot (1942), François (1959), Kehrer (1992), Kissin (1999), Kravtchenko (2005), Lympany (1995), Magaloff (1975), Perahia (1975), Pogorelich (1989), and Pollini (1975)).

Procedure: We have independently listened to diverse commercially available recordings of Chopin Prelude op. 28 no. 13 (central section) and intuitively marked salient features of each pianist's performance. We are formulating intuitive individual principles for selecting and emphasizing score events.

Results (i)


Chopin Prelude op. 28 n. 13
performances by 16 great musicians
(error bars are standard deviations)
melodic
harmonic
metric
grouping
accent salience
0 1 2 3 4 5
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96
Più lento

Results (i)

performances by 16 great musicians

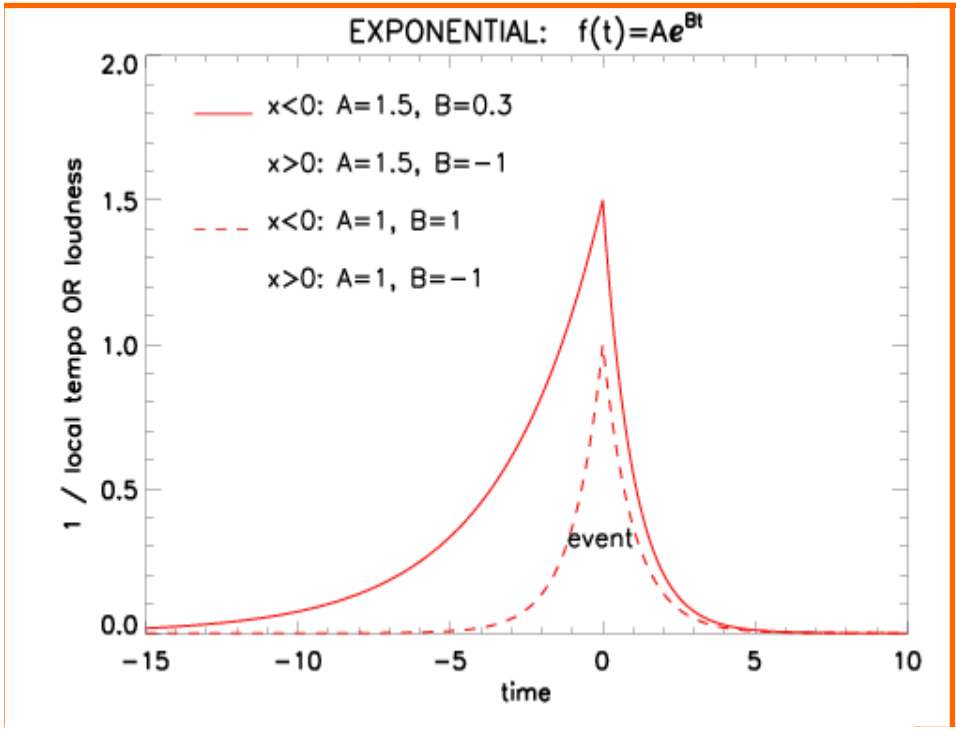
- more emphasis on metric (M) and melodic (C) accents?
- more agreement among pianists on melodic and metric accents?

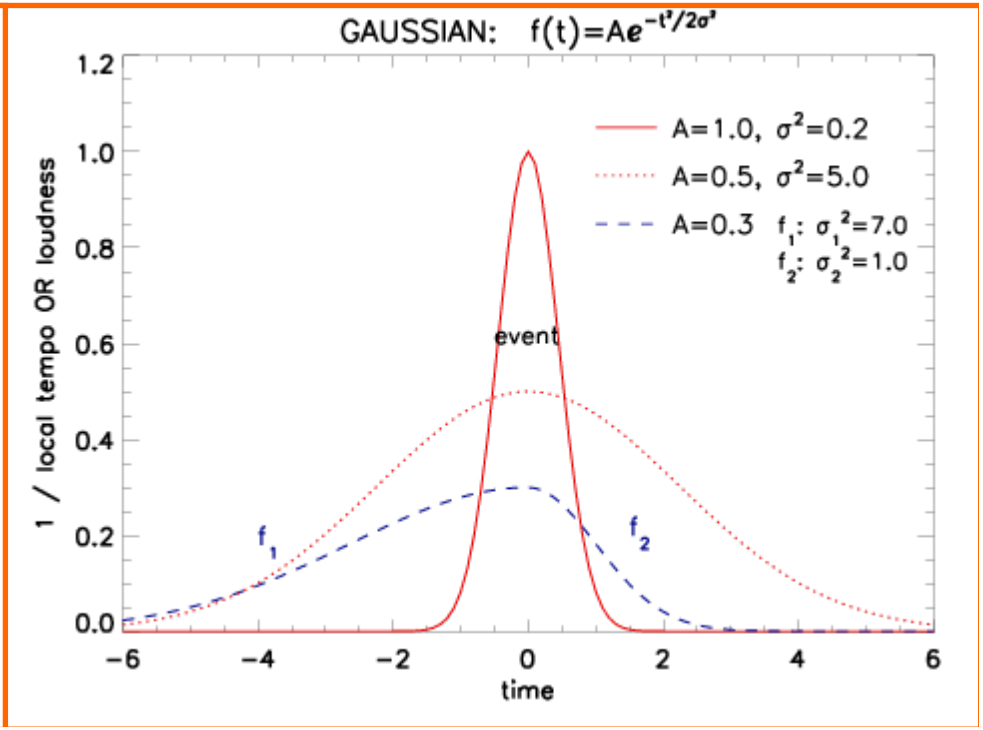
accent	C	H	M	G	total
total number of accents	15	20	16	12	63
% of pianists emphasizing the accent	82	71	86	64	76
% of accents emphasized by more than 68% of pianists	80	65	75	50	68

Mathematical modeling

Mathematical modeling

- tempo and dynamics fluctuate *gradually* or *suddenly*
- model gradual fluctuations (e.g. *ritardando*) by curve fitting
- curves can be added together





Computer implementation

Computer implementation

- Director Musices (DM) is a computer program that enables a musical score to be performed automatically. The result of a long-term research project at the KTH, Stockholm, it comprises performance rules that change specific note properties, including timing, duration, intensity, and frequency *(Friberg, Bresin & Sundberg, 2006).*

  Input: musical score → Output: "musical" performance
  Method: adjust timing, loudness, etc. by music-structural "rules"

- We have developed DM in a new direction, which allows us to relate expressive features of a performance not only to global or intermediate structural properties, but also accounting for local events *(Bisesi & Parncutt, 2011, Bisesi et al., 2011).*

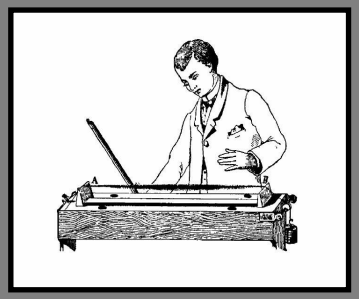
Results (ii)

Director Musices 2.7.1 compiled: 30/7/2011 20:10

File Edit Rules Display Play Tools Help

prelude28-13_expressive.mus

Type	Act	Name	Instrument type	Channel	Synth	BankMSB	BankLSB	Program	Volume	Pan	Reverb	Delay
Mono-Track	☑	piano	String	1	SBlive			1 Acou Grand Piano	0			0
Mono-Track	☑	piano	String	1	SBlive			1 Acou Grand Piano	0			0
Mono-Track	☑	piano	String	1	SBlive			1 Acou Grand Piano	0			0
Mono-Track	☑	piano	String	1	SBlive			1 Acou Grand Piano	0			0
Mono-Track	☑	piano	String	1	SBlive			1 Acou Grand Piano	0			0



Accents.pal

Play performed	-1.0	Leap-Tone-Duration
Play nominal	1.0	Accent-Main-Sl
Init&Apply	1.0	Accent-Main-Dr
Apply		Normalize-Sl ☐
Scale: 1.5		Normalize-Dr ☑
Save as..	0.0	Final-Ritard

☐ log to file

☐ log to score

○ No-Sync

◉ Melodic-Sync

○ Simple-Mel-Syr

Score

Start time (ms) 0

piano

ACCENT-SL (0 3 2.69 LINEAR LINEAR) (2 2 0.66 LINEAR LINEAR) (3 3 1.0 LIN
ACCENT-DR (0 3 3 LINEAR LINEAR) (2 2 2.16 LINEAR LINEAR) (3 3 1 LINE

piano

ACCENT-SL
ACCENT-DR

piano

ACCENT-SL (1 1 1.36 LINEAR LINEAR)
ACCENT-DR

piano

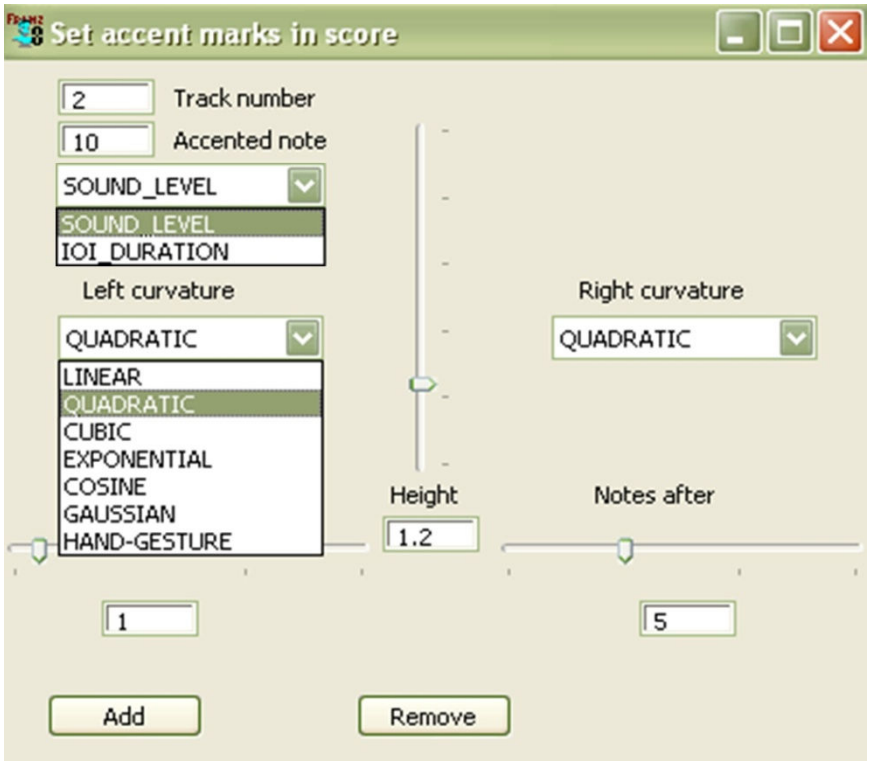
ACCENT-SL (2 2 2.0 LINEAR LINEAR) (2 2 1.0 LINEAR LINEAR)
ACCENT-DR (2 2 2.0 LINEAR LINEAR) (2 2 1.0 LINEAR LINEAR)

piano

ACCENT-SL (1 1 2.5 LINEAR LINEAR) (1 1 1.5 LINEAR LINEAR)
ACCENT-DR

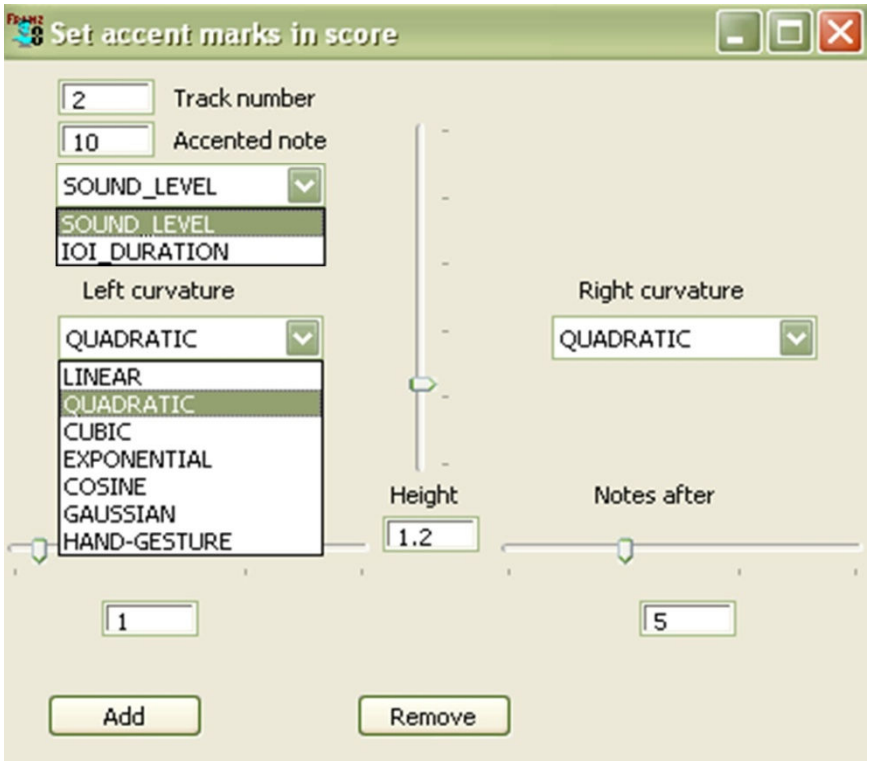
Zoom y-axis + - x-axis + - Show Vars.. ☑ x-axis: ndr (dr) Redraw

Results (ii)



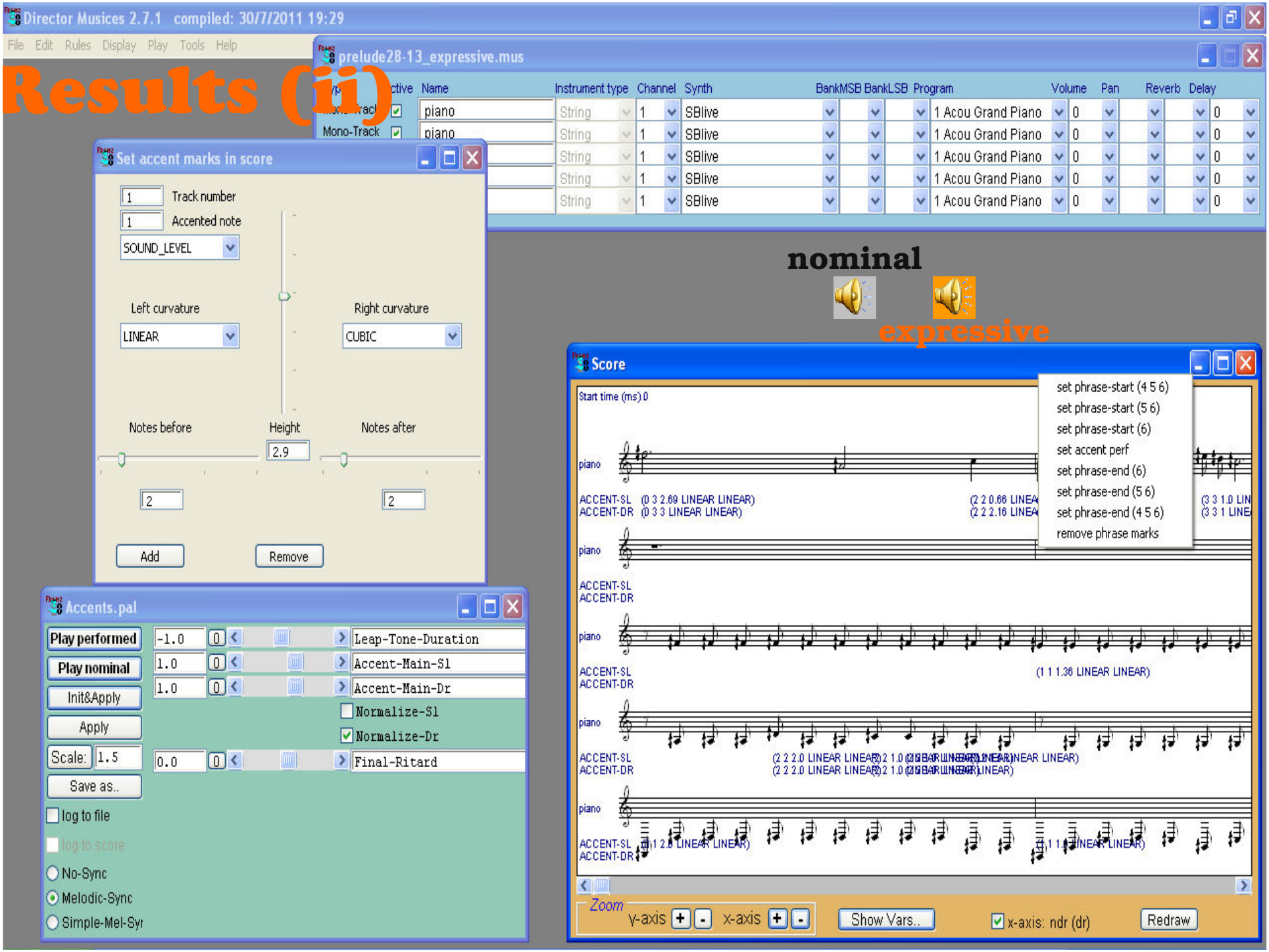
- The perceptual salience of the performed accent function depends on the area under a graph of beat duration or loudness against time.
- The greater the accent salience, the greater the height and/or width of the function.
- The curvature is not only connected with the perceptual salience, but also with the motion and emotional content.

Results (ii)

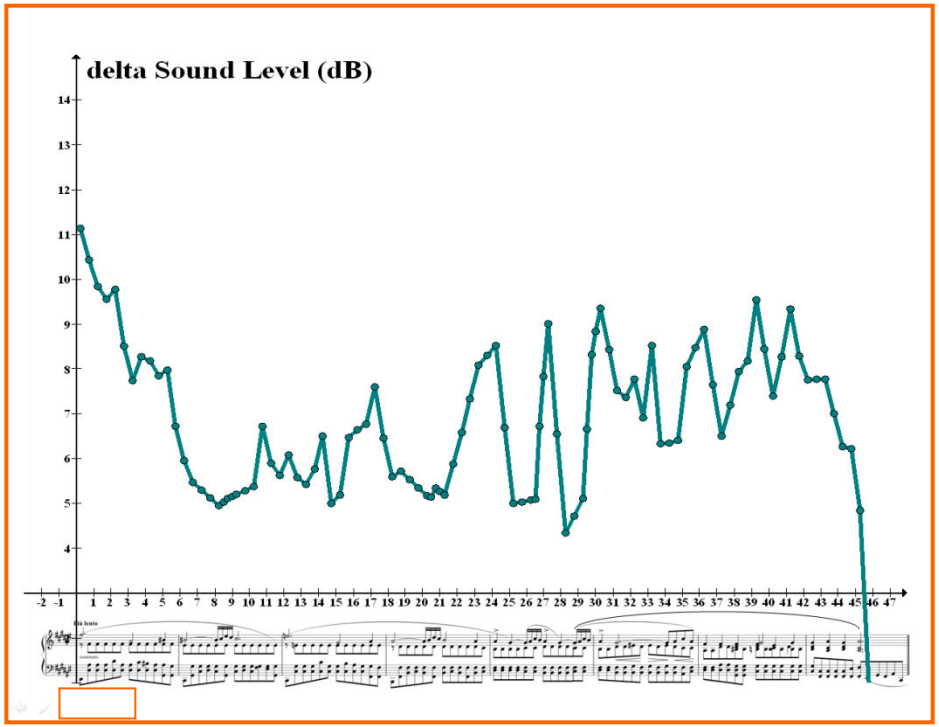


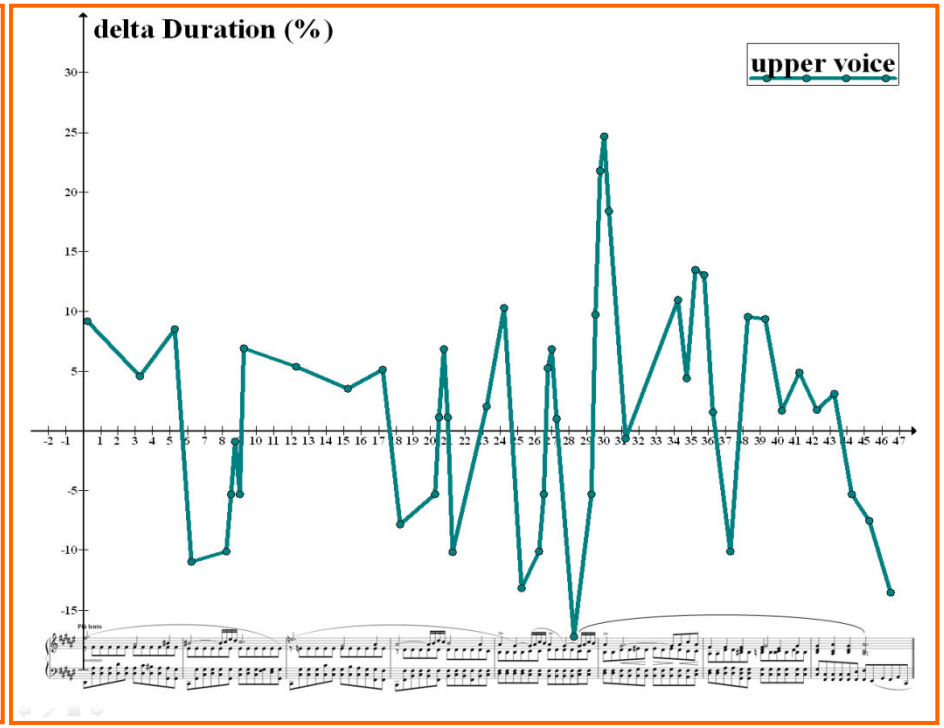
$$peak + \frac{W_1 + W_2}{2} = S + 1$$

- Units for P, W1 and W2 are defined so that a value of 1 corresponds to an increment of 4 dB in the sound level and 20% timing deviations respectively.


Director Musices 2.7.1 compiled: 30/7/2011 19:29
File Edit Rules Display Play Tools Help
Results (ii)
prelude28-13_expressive.mus
Name Instrument type Channel Synth BankMSB BankLSB Program Volume Pan Reverb Delay
piano String 1 SBlive 1 Acou Grand Piano 0
Mono-Track piano String 1 SBlive 1 Acou Grand Piano 0
String 1 SBlive 1 Acou Grand Piano 0
String 1 SBlive 1 Acou Grand Piano 0
String 1 SBlive 1 Acou Grand Piano 0
Set accent marks in score
Track number
Accented note
SOUND_LEVEL
Left curvature
LINEAR
Right curvature
CUBIC
Notes before
Height
2.9
Notes after
Add
Remove
nominal
expressive
Score
Start time (ms) 0
set phrase-start (4 5 6)
set phrase-start (5 6)
set phrase-start (6)
set accent perf
set phrase-end (6)
set phrase-end (5 6)
set phrase-end (4 5 6)
remove phrase marks
piano
ACCENT-SL
ACCENT-DR
Zoom
y-axis
x-axis
Show Vars..
x-axis: ndr (dr)
Redraw
Accents.pal
Play performed
Play nominal
Init&Apply
Apply
Scale: 1.5
Save as..
log to file
log to score
No-Sync
Melodic-Sync
Simple-Mel-Syr
Leap-Tone-Duration
Accent-Main-Sl
Accent-Main-Dr
Normalize-Sl
Normalize-Dr
Final-Ritard

Results (ii)





Conclusions

- The accent procedure can reproduce the patterns of timing and dynamics of the phrasing-based formulation (Bisesi & Parncutt, 2011). In an informal listening test, 10 out of 12 participants (5 of 6 musicians and 5 of 6 non-musicians) preferred the accent-based formulation, and several stated that it had more variation of timing and dynamics from one phrase to the next (Bisesi & Parncutt, 2011).

- Advantage of a bottom-up approach: different sub-phrases can be modeled independently from one another, which would make the model more parsimonious.

- Higher variability in the profiles of timing and dynamics can produce a wider spectrum of performances.

Future research

- Enable the program to distinguish among different kinds of accents (melodic, harmonic, metric, grouping).
- Map the accents' salience into profiles of timing and dynamics (5x2 free parameters).

- Evaluate different renditions (by pianists, theorists and musicologists), and adjust model accordingly (by trial-and-error).
- Map out possible ranges of parameter values or fields in multidimensional parameter space that correspond to musically acceptable performances.

- Merge the previous approach (based on phrasing) with the new one (based on accents).

- Specify small parameter ranges that correspond to particular qualities of performance as expressed by words obtained from a separate qualitative study (such as bright and dark, joyful and sad, static and dynamic, expected and surprising).

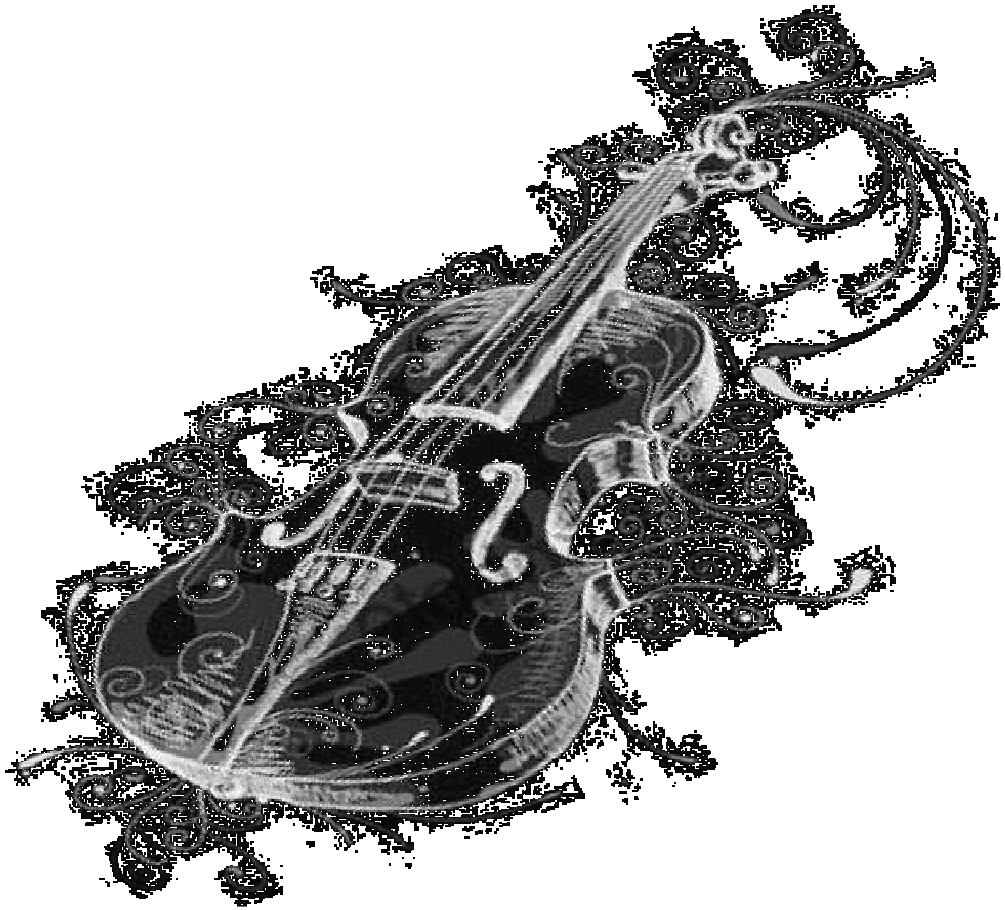
Implications

- The theory can be applied in expressive music performance pedagogy. Students can learn the theory by working with a computer interface to create renderings of pieces that they are currently studying.

- In the process they will select immanent accents for accentuation and adjust the corresponding model parameters to achieve a desired result. They will then be in a position to apply the ideas behind the model in their performance and teaching.

"Quelli che s'innamoran di pratica sanza scienzia
son come 'l nocchier ch'entra in navilio senza timone o bussola,
che mai ha certezza dove si vada"

Leonardo da Vinci



"Wir können überhaupt nicht denken,
ohne unsere fünf Sinne zu gebrauchen"

Albert Einstein