

Werner Goebel: Der Horowitz-Faktor. Einführung in die computer-gestützte Performanceforschung
Institut für Musikwissenschaft, Universität Wien, SoSe 2007, VO+KO, 160.302, G 223, G224

02 Methods I

Introductory chapter:

Clarke, E. F. (2004). "Empirical methods in the study of performance." In *Empirical Musicology. Aims, Methods, and Prospects* edited by E. F. Clarke and N. Cook, (Oxford University Press, Oxford), pp. 77–102.

Parameters of Expressive Performance

- Timing, Tempo
- Intensity
- Articulation
 - attack, tone connection
- Vibrato
- Intonation
- Pedaling
- Bowing (up/down, speed pressure)
- Fingering
- ...

Parameters of Expressive Performance

...at the piano

- Timing, Tempo
- Intensity
- Articulation
 - (attack), tone connection
- (Vibrato)
- (Intonation)
- Pedaling (right – left)
- (Bowing)
- (Fingering)
- ...



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Terminology

“Piano Roll”

Pitch

Time (seconds)

onsets

offsets

Tone connection (articulation)
Legato (overlap)
Staccato (gap)

Inter-onset interval (IOI) in ms
Instantaneous tempo in beats per minute, bpm

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Data Collection

1. From audio, sound recordings (“Audio Annotation”)
 - Advantage: easy to record, all sound archives usable (historic documents, CDs, LPs, etc.), any instrument
 - Disadvantage: event information has to be derived (laborious & limited in possibilities)
2. From movement at sound production

Advantage: precise data; disadvantage: special hardware required

 1. From mechanical movement (piano action, violin bow, ...)
 1. MIDI Keyboards
 2. Computer-controlled pianos, organs, ... → MIDI output
 2. From human movements (arms, fingers, lips, ...)
 - Video capture & image processing
 - “Motion Capture” systems

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MIDI (Musical Instrument Digital Interface)

- Communication standard between digital instruments (introduced 1983)
 - Interface for real-time communication
 - Outdated (too slow), replaced by USB etc.
 - Protocol (extended MIDI etc.) & file format
 - Information about
 - Pitch
 - Tone onset, offset (time value)
 - Dynamics (Velocity)
 - » Usually values between 0 (silent) und 127 (extremely loud)
 - Controller (pedal position, vibrato, etc.)
 - Advantage: general standard (loads of software); expandable
 - Many equivalent formats exist (.boe, .kb, ...)

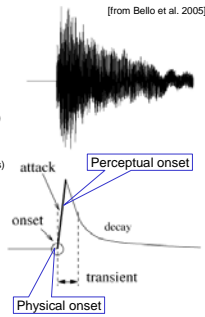
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Audio Annotation

- How do we derive MIDI like information from audio?
 - Onset detection
 - Beattracking (at one particular metric level)
 - Pitch tracking (identify fundamental frequencies)
 - Transcription (audio to score)
- Other methods
 - Tapping along with recordings (Cook, 1995, ...) [imprecise, human error, but fast & easy]

Onset Detection

- Onset of an event (note), change in signal
- Terminology (Bello et al. 2005)
 - Attack (period of envelope increase)
 - Transient (excitation period)
 - Onset (instant, usually beginning of transient)
 - Physical onset (initial change)
 - Perceptual onset (Vos & Rasch, 1981) (occurs 15-6 dB below maximum, tested on pure tones)
- Various methods
 - Time-domain (total energy)
 - Frequency domain (energy per frequency band)
 - Phase-based (see Dixon, 2006)
 - Combined methods...
- Annual Onset-Detection Contest ISMIR-MIREX <http://www.music-ir.org/mirex2006>



Beattracking

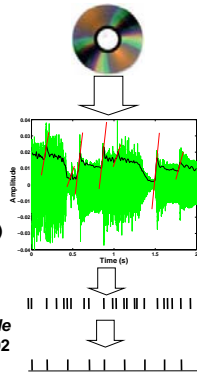
A computer automatically finds the beat (Simon Dixon, 2001)

Automatically beat-tracked:

- **Felicidad** (Gloria Estefan)
- **Michelle** (Bela Fleck and the Flecktones)

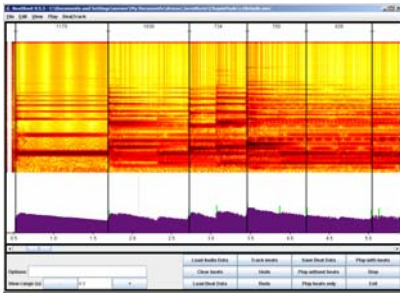
Semi-automatically beat-tracked

- **Maurizio Pollini: Chopin Etude op. 10/3**
- **Krystian Zimmerman: Chopin 4th Ballade op. 52, bars 169-202**



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Interactive Beattracking (Dixon, 2001)



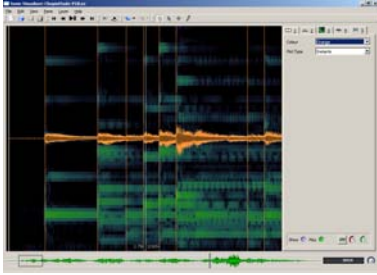
- Onset Detection
- Automatic Beattracking
- Manual correction
- Re-track from certain position
- Text Export

Download "BeatRoot" (free JAVA program):
<http://www.ofai.at/~simon.dixon/beatroot/>

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Sonic Visualiser (Channam et al. ISMIR 2006)



- Layered architecture
 - Stacked onto each other
- Waveform & Spectrogram Displays
- VAMP Plugins:
 - Onset Detection (Craig Sapp)
 - ...
- Text/XML Export

Download SonicVisualiser freely:
<http://www.sonicvisualiser.org/>

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Audio versus MIDI

- AUDIO
 - Acoustic signal
 - "all together"
 - Large files (CD quality: ~10MB/Min)
 - Easy to do:
 - Microphone & ...
- MIDI (or equivalent)
 - Control / event information
 - Pitch
 - On-/Offset,
 - Dynamics (Velocity)
 - Pedal position, ...
 - Very small files (less than ~20KB/Min)
 - Special hardware required
 - Disklavier etc.
 - Can be extracted from audio with special software

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