It Don't Mean a Thing
(If It Ain't Got That Swing)

Estimating Swing Ratios and Soloist Micro-timing from Jazz Recordings with Aligned Beat Grids

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Overview

- Introduction
  - Swing ratio
  - Ensemble timing

- Automatic method
  - Swing ratio estimation
  - Log-lag ACF analysis

- Preliminary results
  - Dataset / Comparison to prior work
  - Example cases
  - Log-lag ACF

- Futher steps

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Introduction: Swing ratio

- „Jazz music is supposed to swing" (Friberg & Sundström 2002)

  - Lengthening odd (on-beat) 8th notes
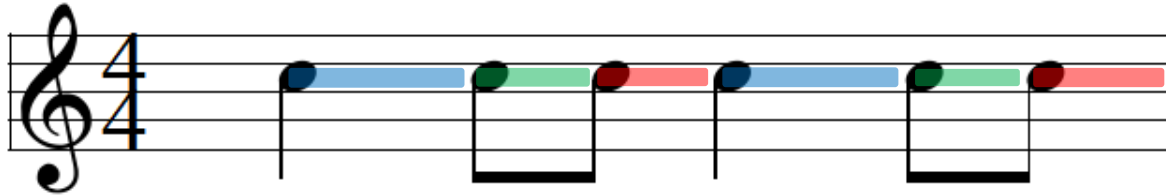
  - Shortening even (off-beat) 8th notes
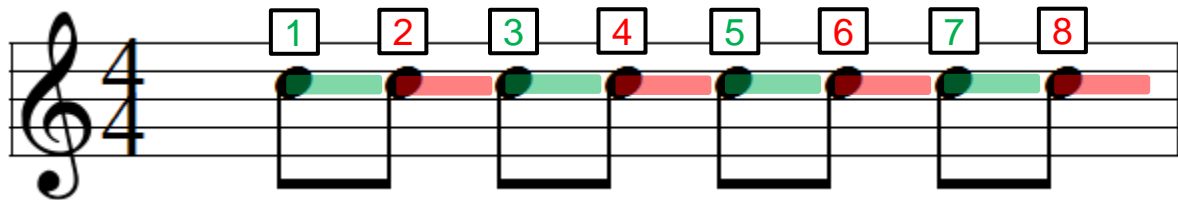
  - Ratio of long 8th to short 8th → swing ratio s_r

  - 1 → straight binary   2 → tied-triplet
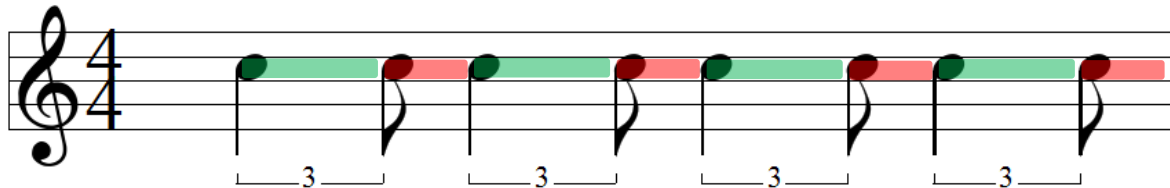
Introduction: Swing ratio

- Jazz drummers often use typical cymbal pattern inducing the swing (4th, long 8th, short 8th, 4th, long 8th, etc. …)

- Relation between swing ratio and relative note durations:

$$s_r = \frac{long\ 8th}{short\ 8th}$$

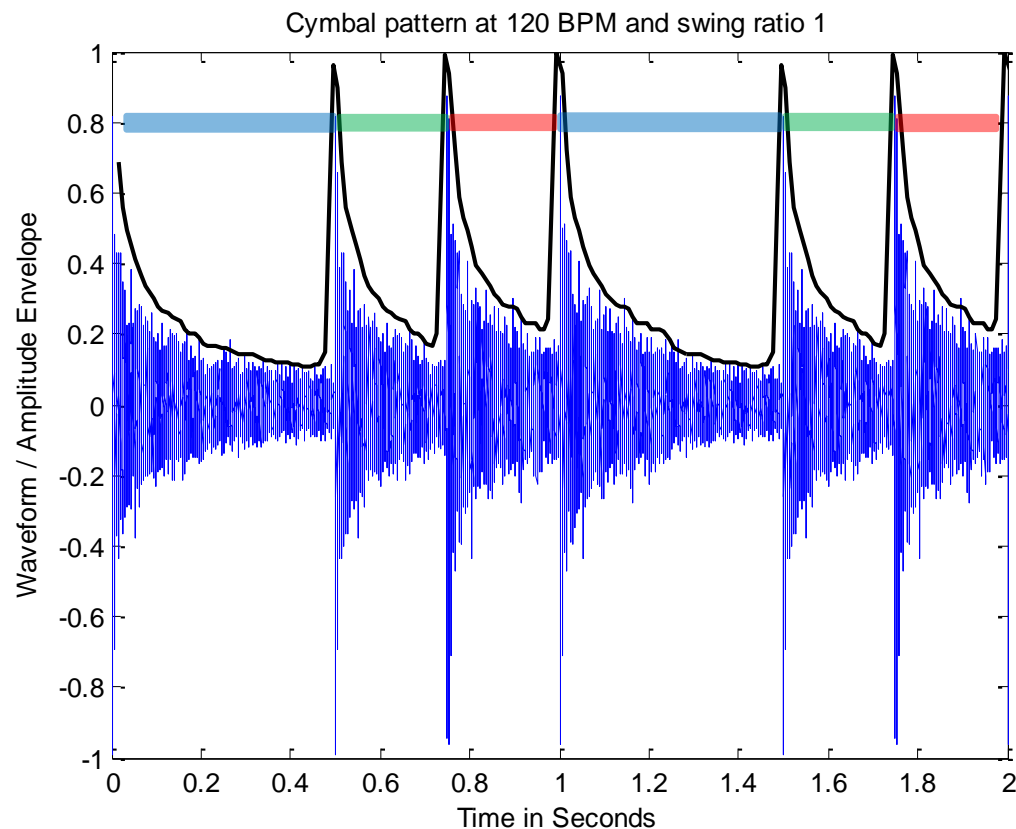$$long\ 8th = \frac{s_r}{1 + s_r}$$

$$long\ 8th + short\ 8th = 1$$

$$short\ 8th = \frac{1}{1 + s_r}$$

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Introduction: Swing ratio

- Illustrative example: Swing ratio 1

Cymbal pattern at 120 BPM and swing ratio 1

$$s_r = \frac{0.25}{0.25} = 1$$

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Introduction: Swing ratio

- Illustrative example: Swing ratio 2

Cymbal pattern at 120 BPM and swing ratio 2

$$s_r = \frac{0.333}{0.167} = 2$$

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Introduction: Swing ratio
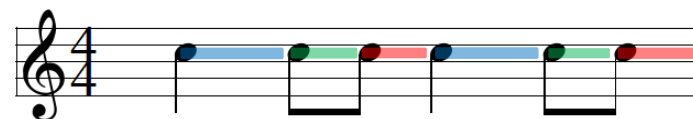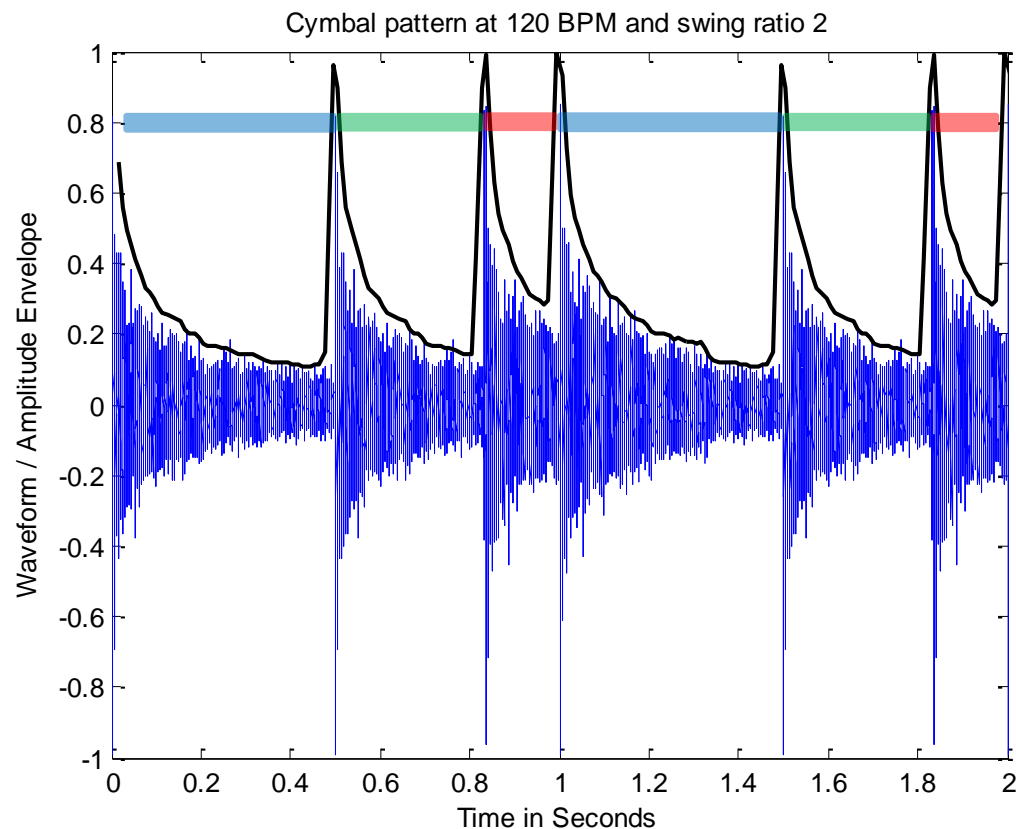
- Illustrative example: Swing ratio 3

Cymbal pattern at 120 BPM and swing ratio 3
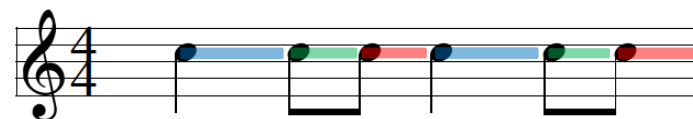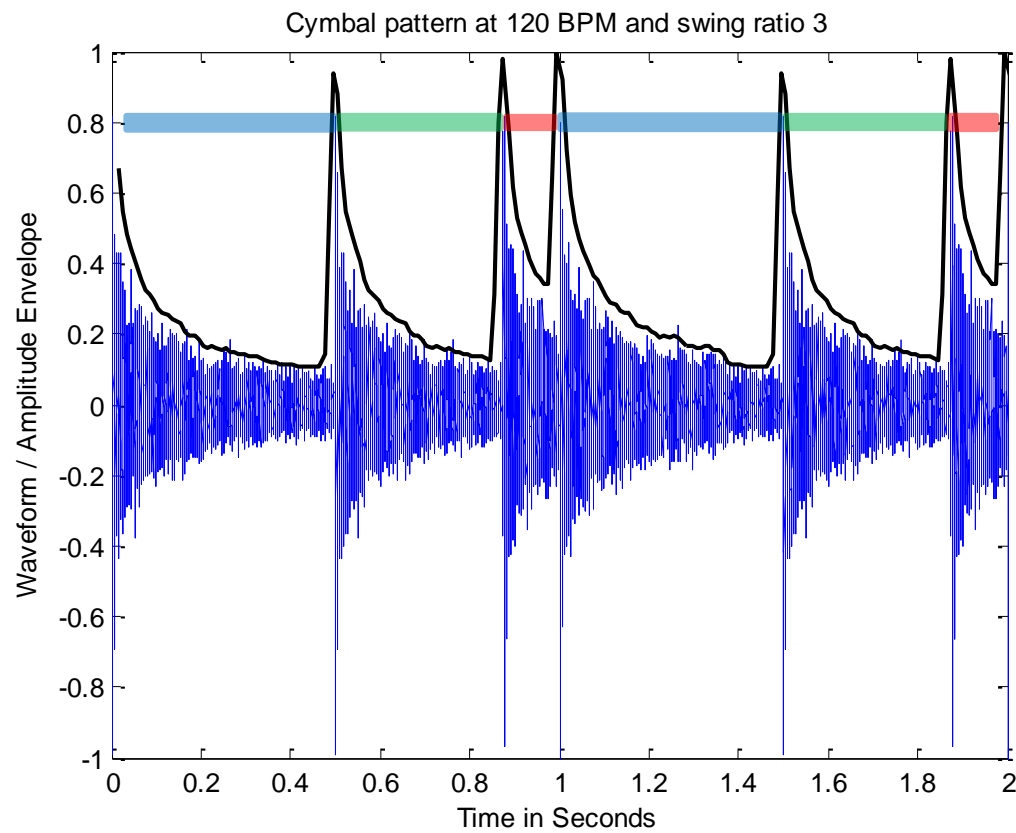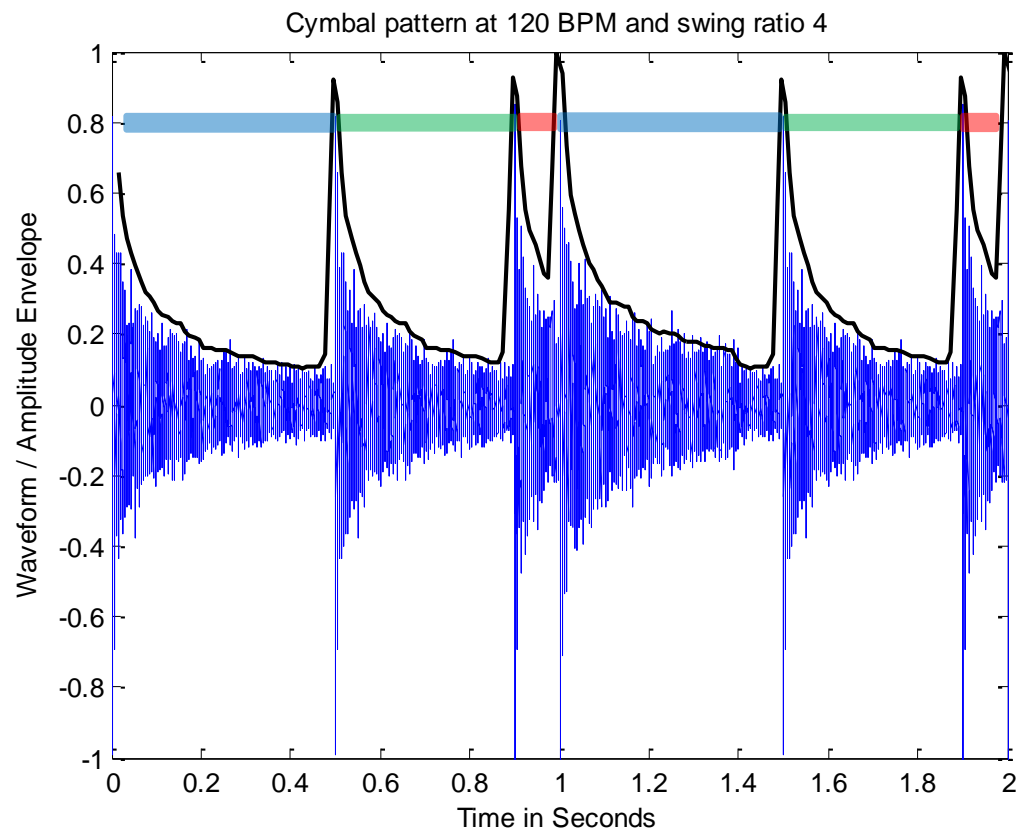
$$s_r = \frac{0.375}{0.125} = 3$$

Introduction: Swing ratio
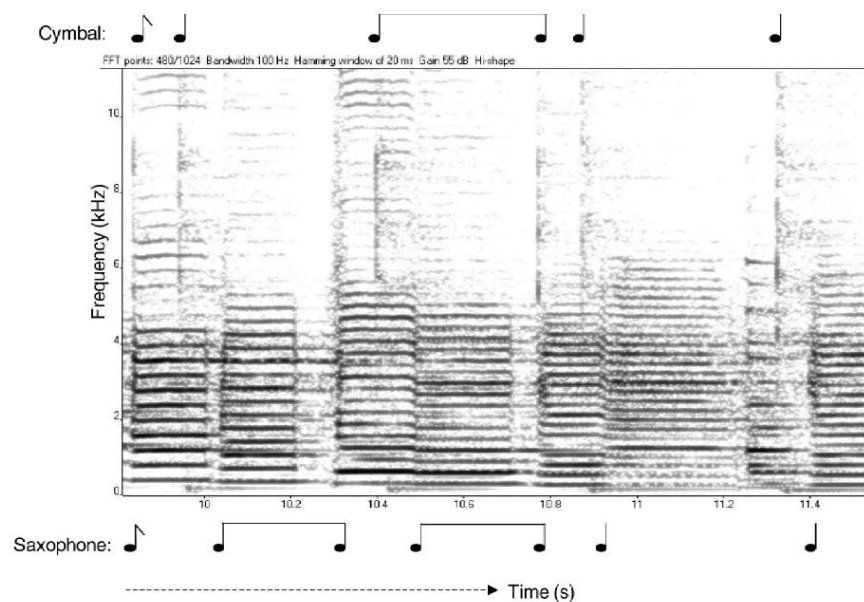
- Illustrative example: Swing ratio 4

Cymbal pattern at 120 BPM and swing ratio 4

$$s_r = \frac{0.4}{0.1} = 4$$

Introduction: Ensemble timing

- **Friberg's observations:**
  - Less pronounced swing of the soloist (wind instruments)
  - Large onset delay w.r.t. on-beat
  - Small onset delay w.r.t. off-beat (coincide with cymbal)
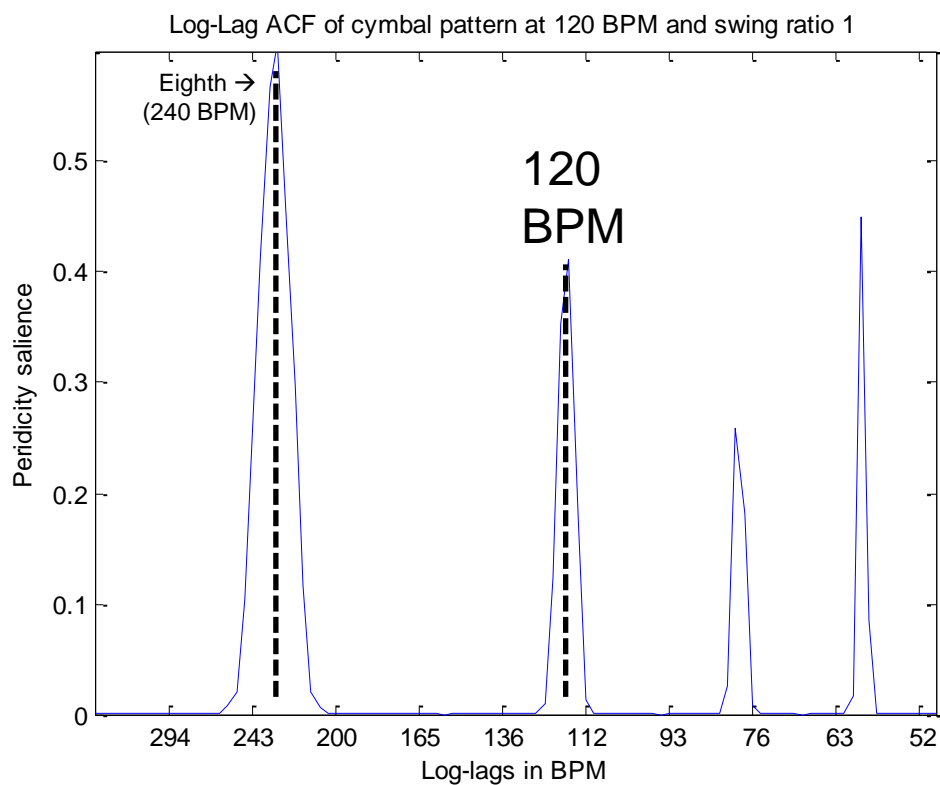
Automatic method: Swing ratio estimation

- Compute spectrogram from solo excerpts via STFT
- Detection of percussive onsets candidates
- Heuristics to retain only onsets in upper freq. band
- Detection of onset ‚triplets' within one beat (plus tolerance)
- Derivation of swing ratio

- Matching of soloist onsets to the previously found ‚triplets'
- Derivation of swing ratio from matched ‚triplets'
- Measurement of onset delay w.r.t. on-beat and off-beat

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Automatic method: Log-lag ACF analysis

- Ommit error-prone steps:
  - Cymbal onset detection
  - ‚triplet' selection from onsets

- Autocorrelation on onset detection function
  - Resample ACF to logarithmically-spaced lag-axis
  - Tempo differences turn into shifts (Gruhne & Dittmar 2009)
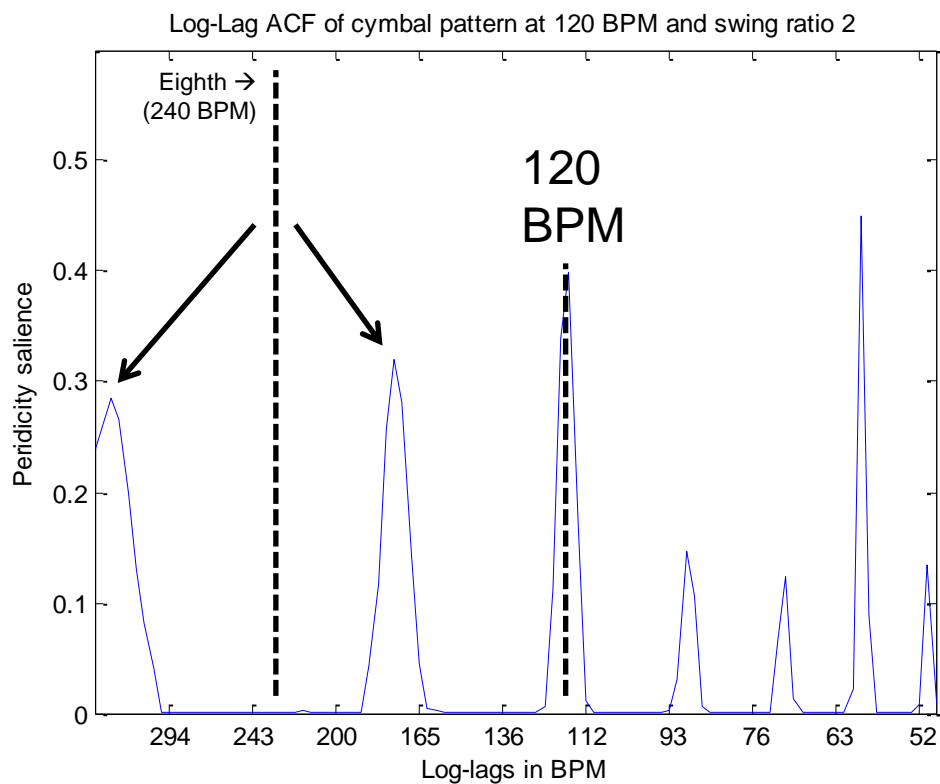 - Common rhythmic patterns are retained

Automatic method: Log-lag ACF analysis
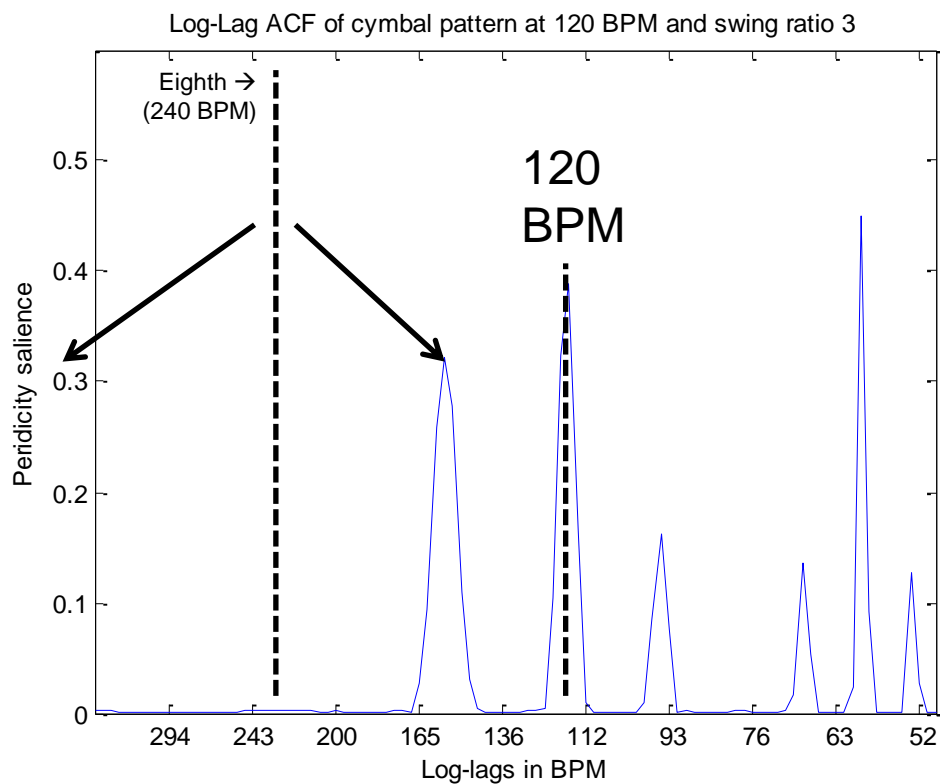
- Illustrative example: Swing ratio 1

Log-Lag ACF of cymbal pattern at 120 BPM and swing ratio 1

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Automatic method: Log-lag ACF analysis

- Illustrative example: Swing ratio 2

Log-Lag ACF of cymbal pattern at 120 BPM and swing ratio 2

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Automatic method: Log-lag ACF analysis

- Illustrative example: Swing ratio 3

Log-Lag ACF of cymbal pattern at 120 BPM and swing ratio 3

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Automatic method: Log-lag ACF analysis

- Illustrative example: Swing ratio 4

Log-Lag ACF of cymbal pattern at 120 BPM and swing ratio 4

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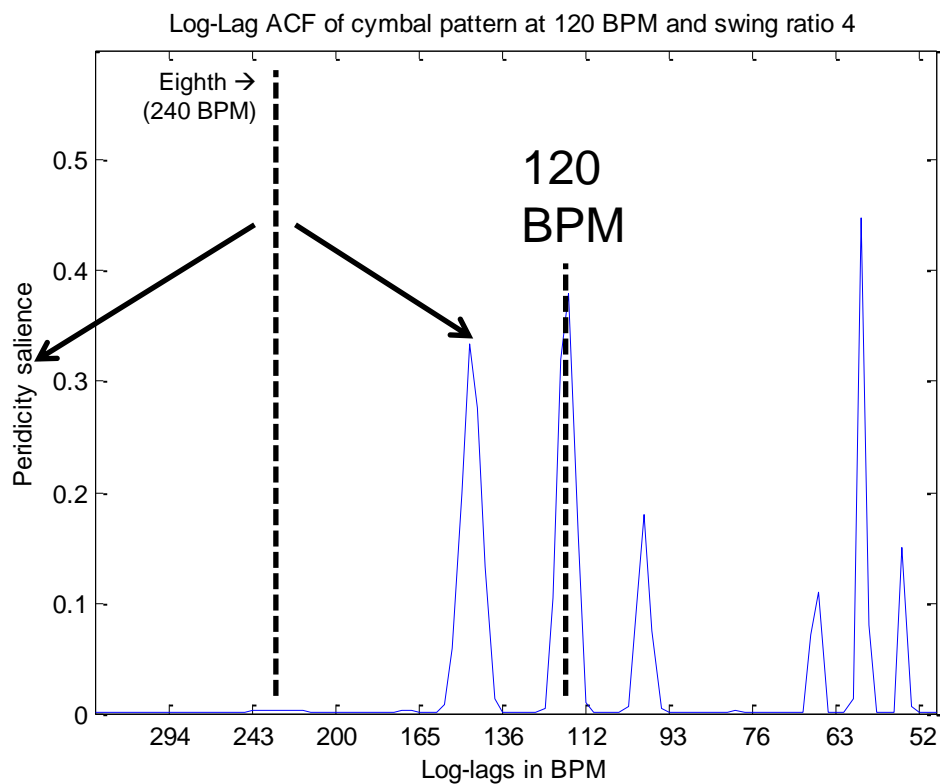
Preliminary results: Dataset

- **Subset of the Jazzomat data**
  - Rhythm feel: Swing
  - Manually aligned beat grids available
  - Manually transcribed solo wind instruments play 8th lines
  - Relatively steady drum beat
  - Only 'reliable' results shown here

Drummers:

```
'Billy Higgins'
'Dennis Chambers'
'Louis Hayes'
'James Cobb'
'Roy Porter'
'Max Roach'
'Bob Neel'
'Steve Gadd'
'Al Harewood'
'Albert 'Tootie' Heath'
'J.C. Heard'
'Stan Levey'
'Nick Martins'
'Elvin Jones'
'Chico Hamilton'
'Connie Kay'
'Billy Hart'
'Art Taylor'
'Gergory Hutchinson'
'Briand Blade'
'Harold Granowsky'
'Philly Joe Jones'
'Jack DeJohnette'
'Kenny Clarke'
'Tony Williams'
'Frank Isola'
'Dennis Charles'
'Carl Allen'
'Joe Chambers'
'Gregory Hutchinson'
'Don Lamond'
```
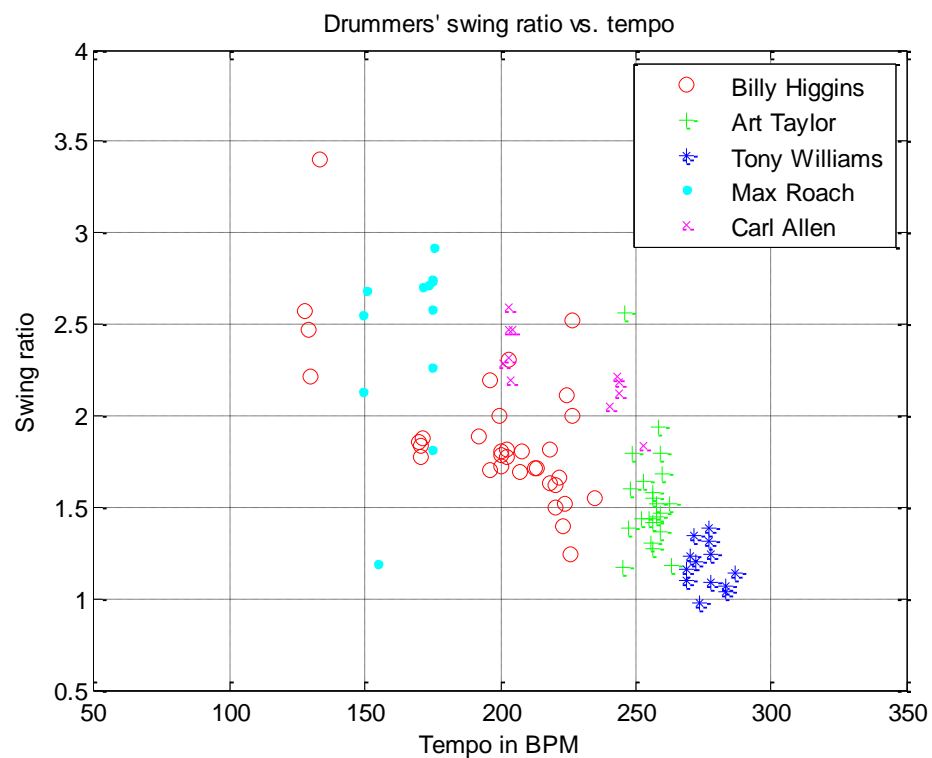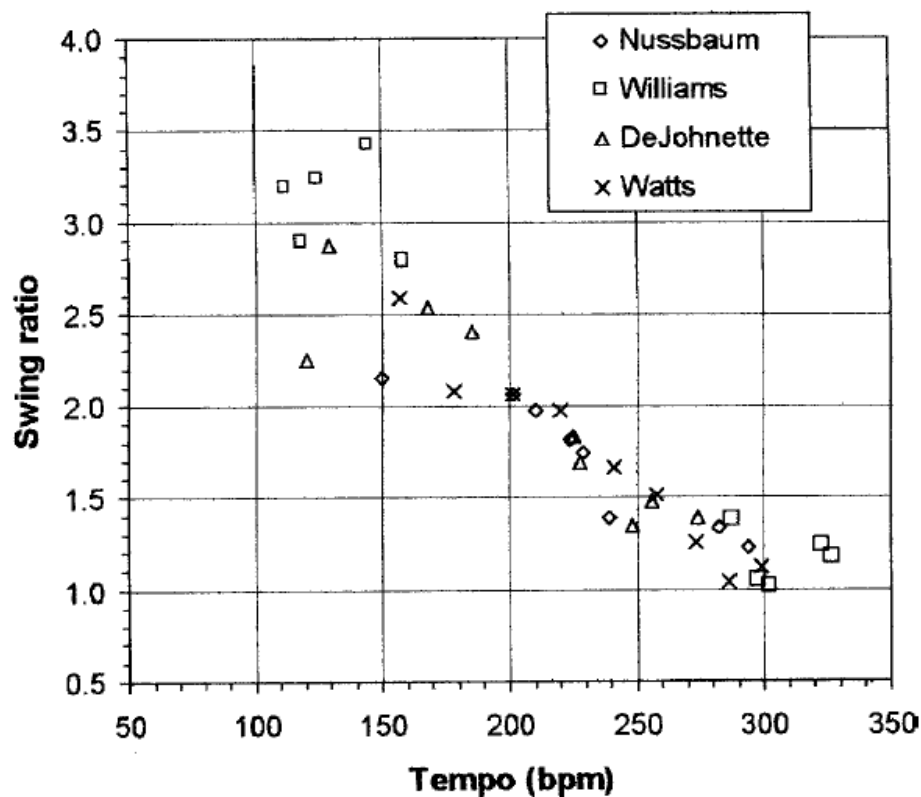
Soloists:

```
'Art Pepper'
'Bob Berg'
'Charlie Parker'
'Chet Baker'
'David Murray'
'Dexter Gordon'
'Dizzy Gillespie'
'Don Ellis'
'J.J. Johnson'
'John Abercrombie'
'John Coltrane'
'Joshua Redman'
'Lee Konitz'
'Lee Morgan'
'Miles Davis'
'Milt Jackson'
'Ornette Coleman'
'Lucky Thompson'
'Sonny Rollins'
'Stan Getz'
'Steve Lacy'
'Wayne Marsh'
'Wayne Shorter'
'Wynton Marsalis'
'Zoot Sims'
```

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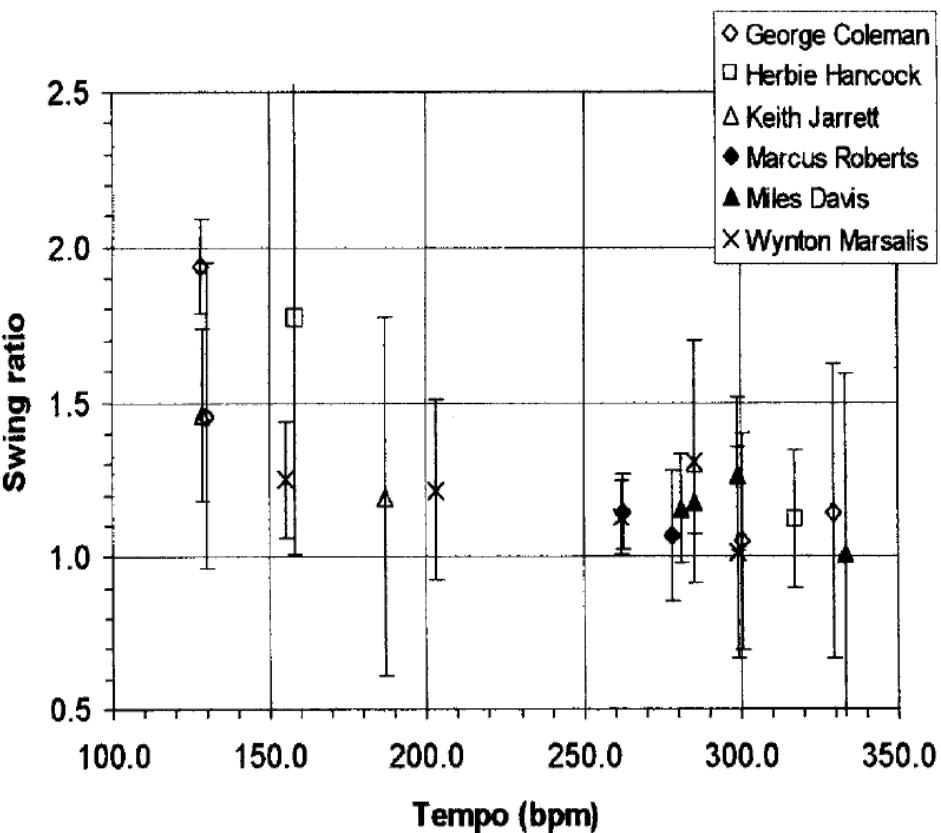# Preliminary results: Drummers' swing ratio

Friberg & Sundström 2002:   Jazzomat @ AudioLabs:
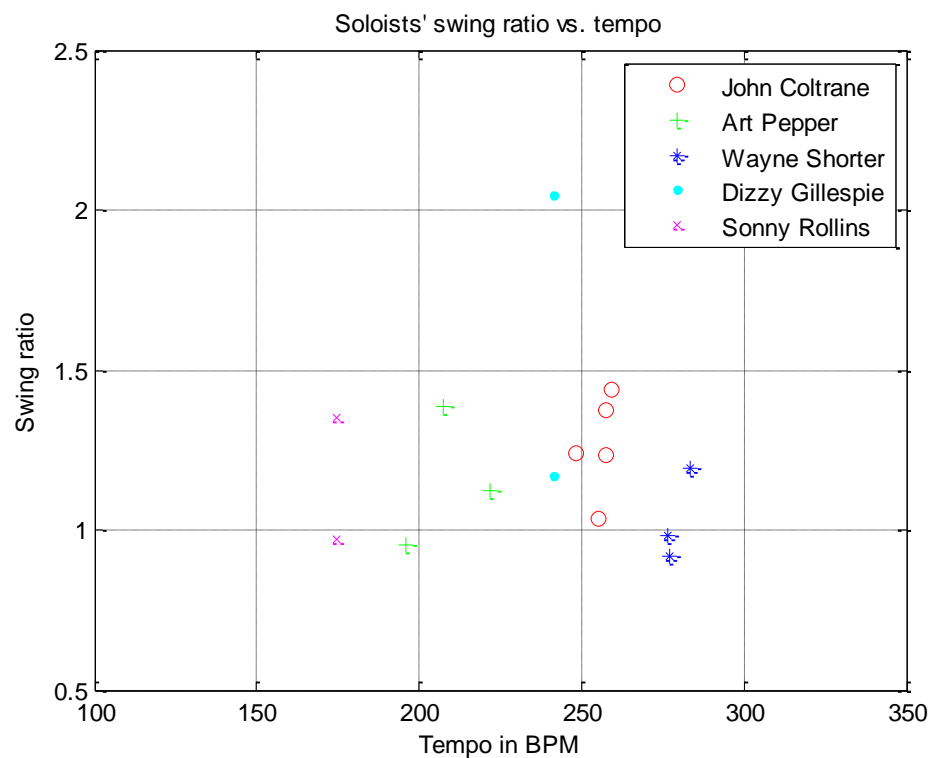
Preliminary results: Soloists' swing ratio
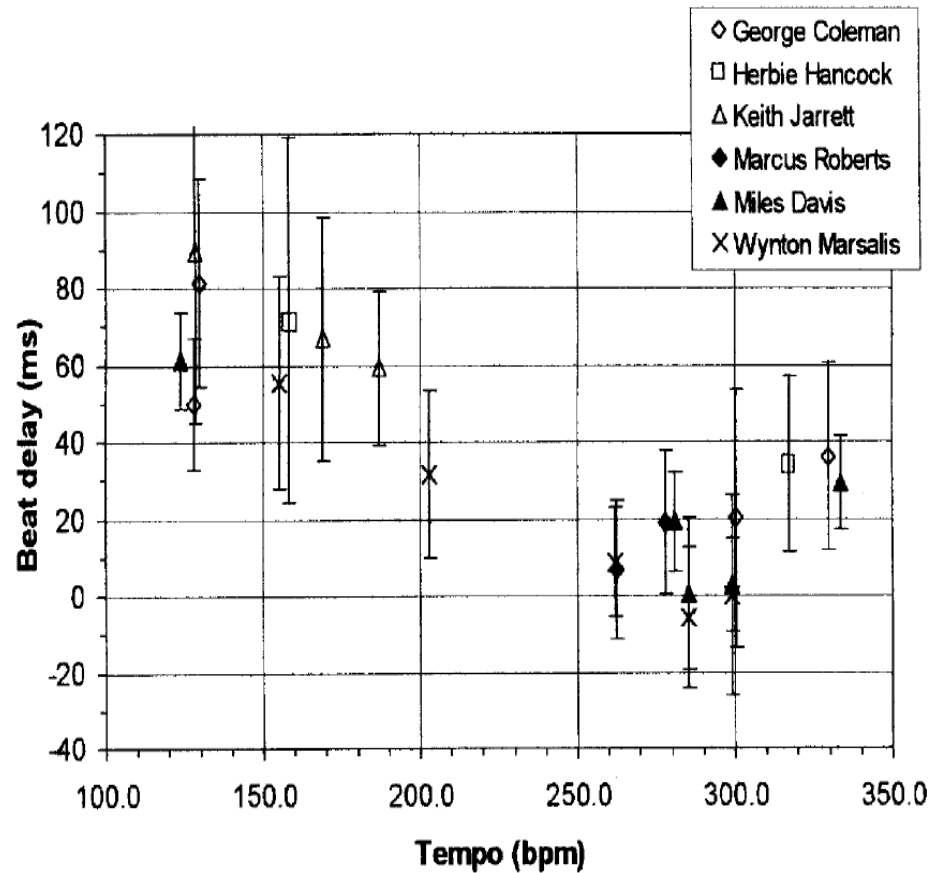
Friberg & Sundström 2002:   Jazzomat @ AudioLabs:
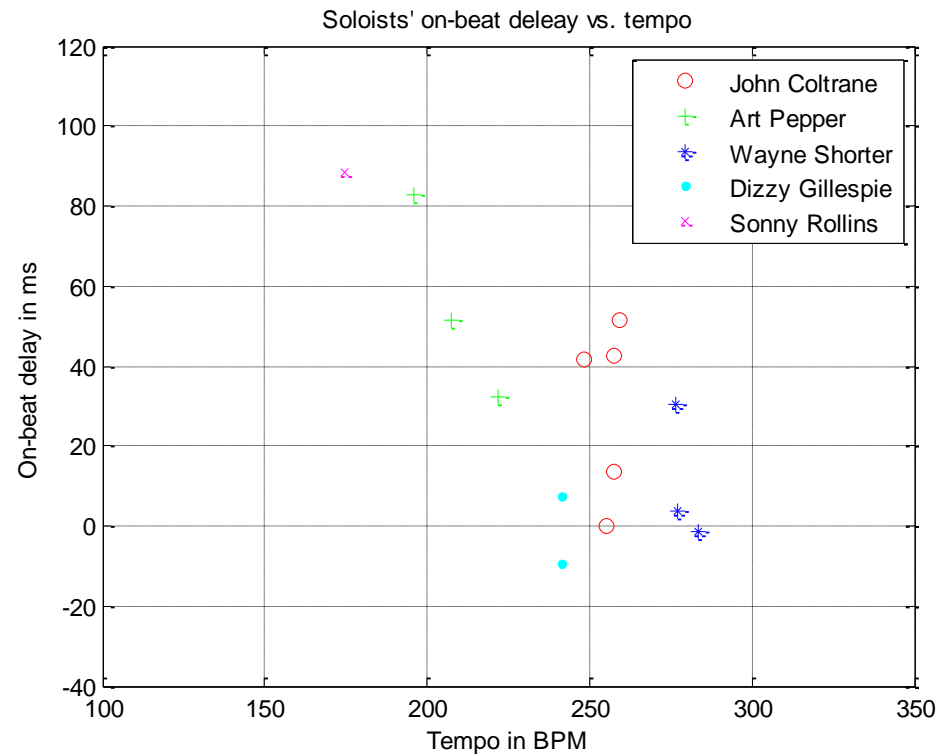
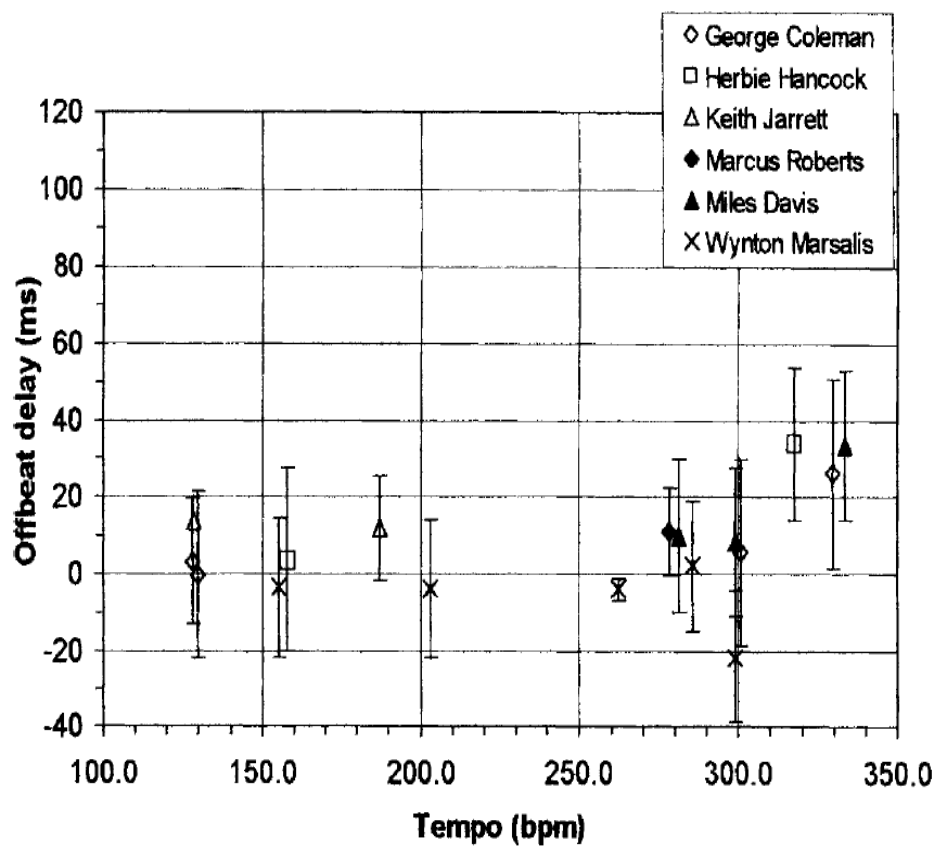# Preliminary results: Soloists' on-beat delay

Friberg & Sundström 2002:

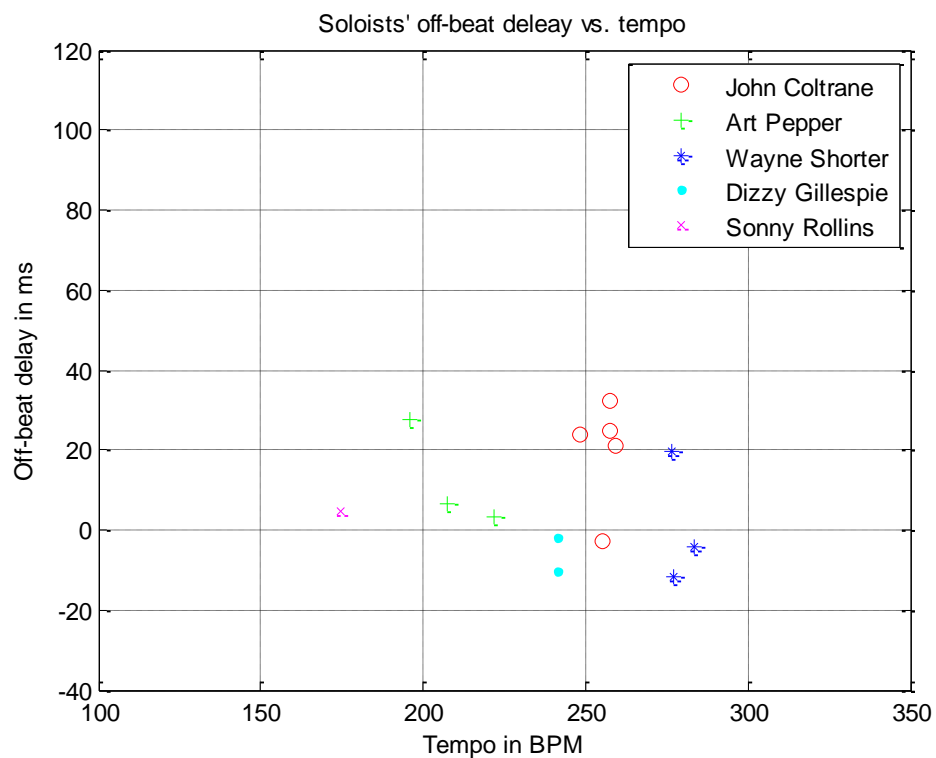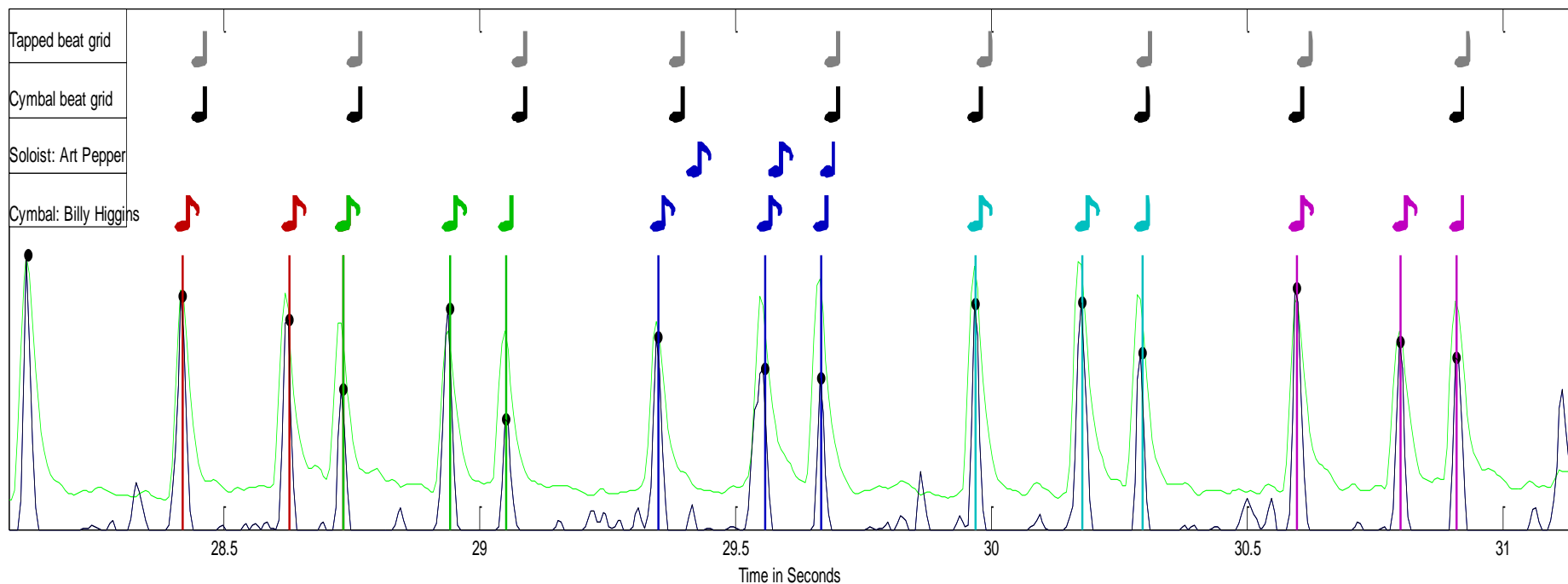
Jazzomat @ AudioLabs:

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Preliminary results: Soloists' off-beat delay

Friberg & Sundström 2002:

Jazzomat @ AudioLabs:

Preliminary results: Example cases

Art Pepper – Blues for Blanche:

Preliminary results: Example cases

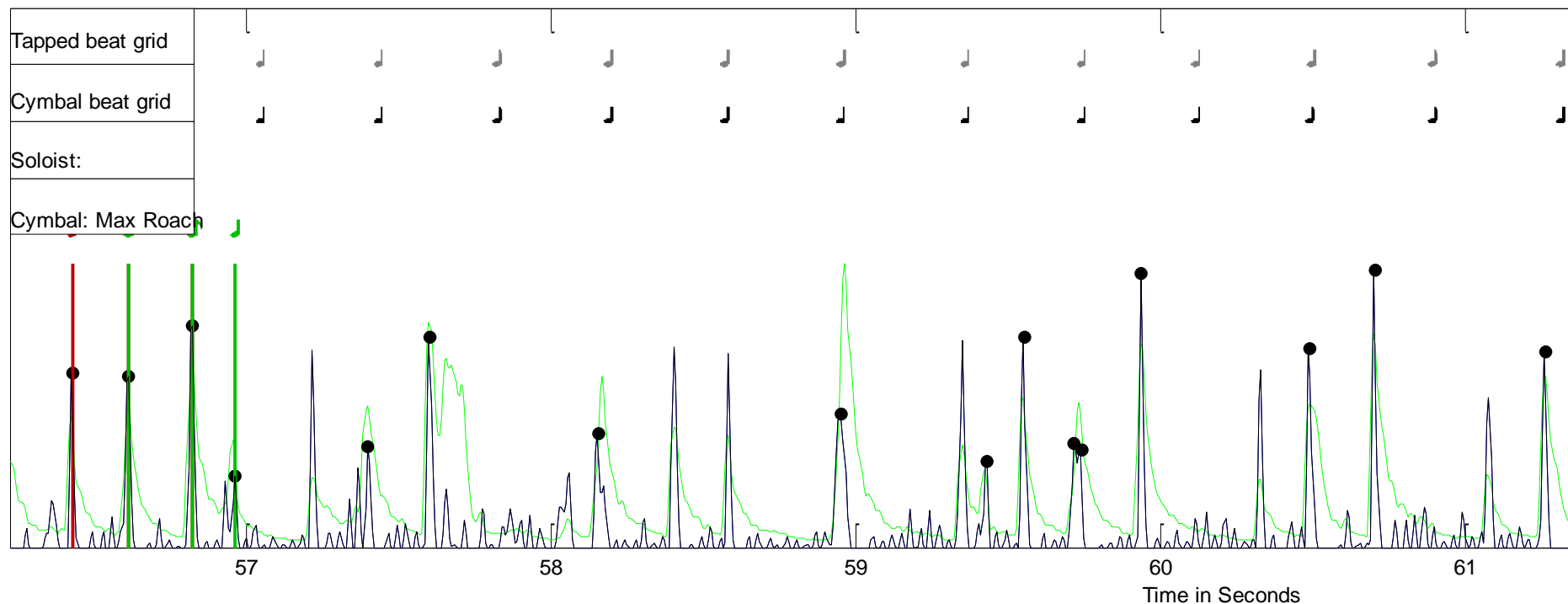Steve Lacy – Let's Cool One:
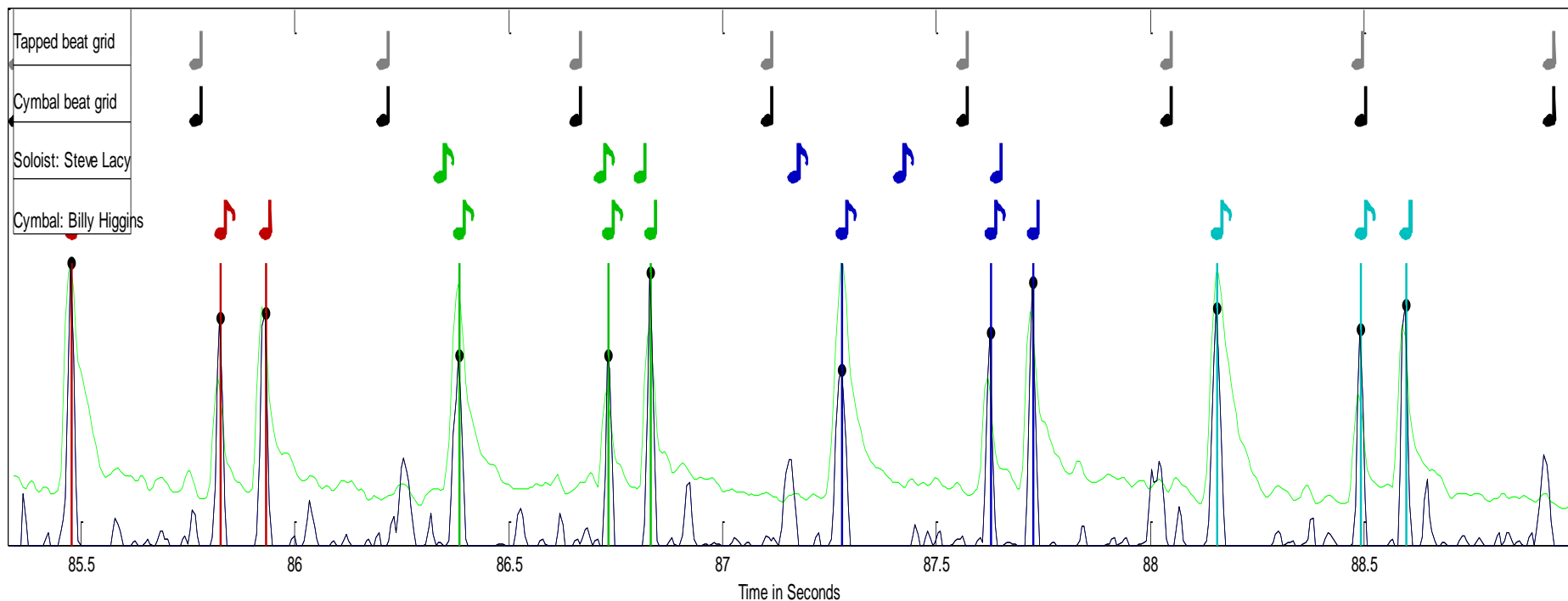
Preliminary results: Example cases
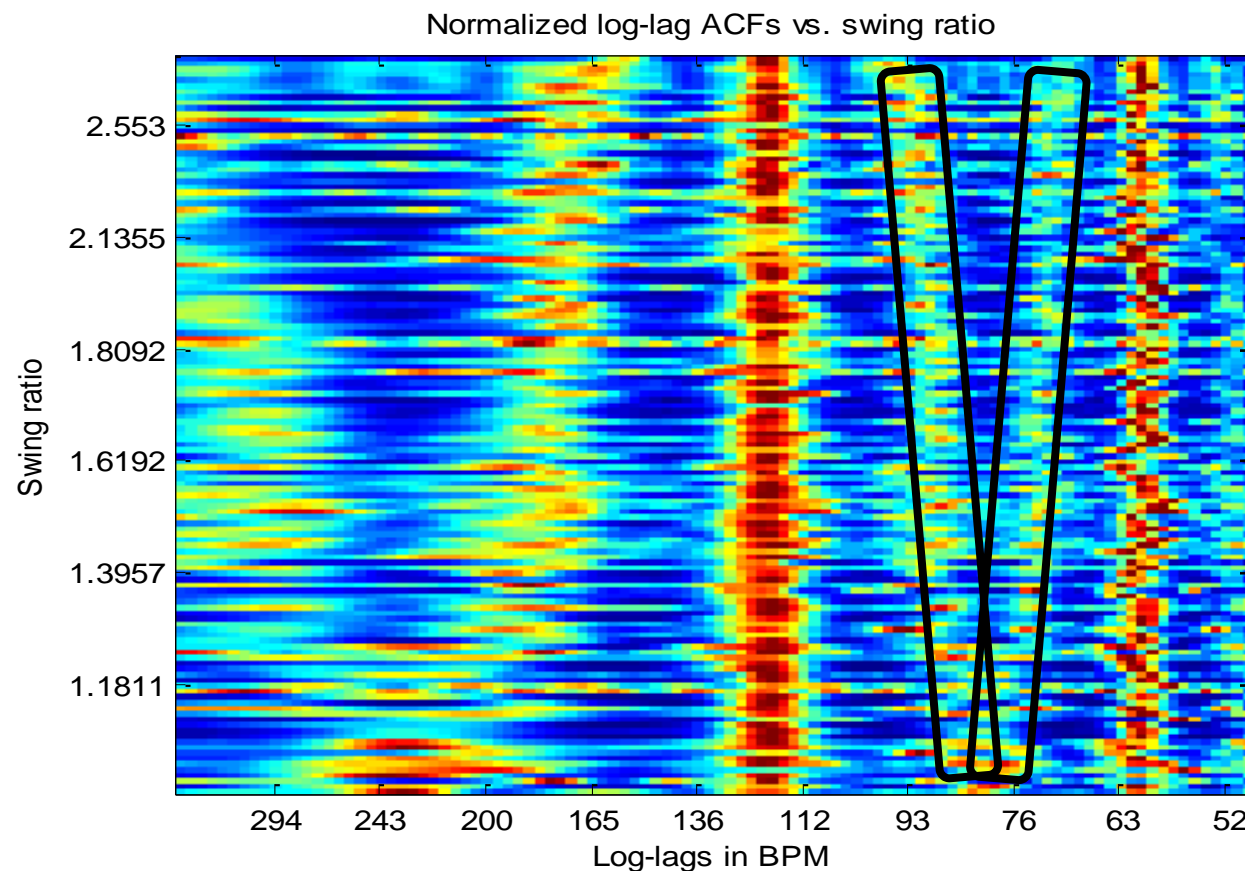
Clifford Brown – George's Dilemma:

MelID: 36 - Clifford Brown - George's Dilemma

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Preliminary results: log-lag ACF

- Log-lag ACF shape correlates to swing ratio
- Very noisy

Normalized log-lag ACFs vs. swing ratio

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Further steps

- More elaborate onset detection for cymbals
  - NMF-based drum transcription (Dittmar & Gärtner 2014)
  - Refine onsets using center of gravity in onset frame
- Automatic detection of outliers
- Systematically evaluate usage of log-lag ACF

- Ingest automatically refined beat grid back to Jazzomat DB

- Correct editorial metadata inconsistencies

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References

- Anders Friberg & Andreas Sundström, „Swing Ratios and Ensemble Timing in Jazz Performance: Evidence for a Common Rhythmic Pattern", Music Perception, 2002

- Matthias Gruhne & Christian Dittmar, "Improving Rhythmic Pattern Features Based on Logarithmic Preprocessing", Proceedings AES International Conference, 2009

- Christian Dittmar & Daniel Gärtner, "Real-time transcription and separation of drum recordings based on NMF decomposition", Proceedings of the 17th International Conference on Digital Audio Effects, 2014

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