

A Positive-Evidence Model for Rhythmical Beat Induction

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Basic Concepts

- ◆ Meter: The sense of strong & weak onsets among hierarchical levels of rhythm
- ◆ The pattern is said to be metrical if onsets in a rhythm are related hierarchically

Onsets & Clocks

All seven clocks for Pattern 3 from Experiment 1

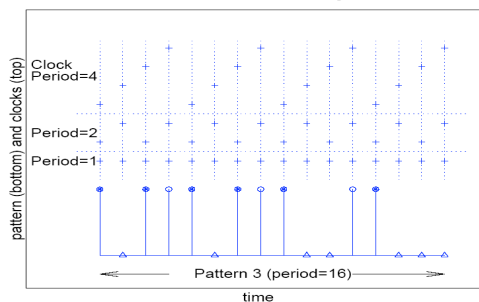


Image From Eck Paper

Onsets & Clocks (cont.)

- ◆ Events at lower frequency in the hierarchy always line up with events in the higher frequency
- ◆ Complex patterns of onsets is hard to interpret meters
- ◆ A common human metrical interpretation of musical segment is to find downbeats
- ◆ Rule-based systems have been used to find the downbeats

Rule-based Models

- ◆ Positive evidences vs. Negative evidences
- ◆ Four Models
 - NEG: A negative-evidence model
 - POS: A positive-evidence model
 - HYBRID: Combine both together
 - NPOS: A normalized positive-evidence model

NPOS

- ◆ Accent onsets (Positive Evidences) are primarily responsible for beat induction
 - An isolated onset
 - The 2nd of two adjacent onsets
 - The 1st and last of three or more adjacent onsets

NPOS (cont.)

- ◆ Model sensitive to a preferred tempo of 600 ms
 - Only clocks less than half the period of the pattern are generated
 - Clocks with periods cannot be evenly divided into the pattern period are discarded

Counting Downbeats

- ◆ $S = f(O^+, O^-, R)$
- ◆ Definition of f
 - NEG: $_R + O^-$
 - ◆ Does not work well with tempo variation
 - POS: $_O^+ + O^-$
 - ◆ Fundamentally flawed, fastest clock always picked
 - HYBRID: $_{-pos} POS -_{-neg} NEG$
 - ◆ Consider influence of POS & NEG respectively
 - NPOS: $O^+ / (O^+ + O^- + R)$
 - ◆ Assume all listeners attend primarily to positive evidence
 - ◆ Normalized the score by the period of the clock being matched

Counting Downbeats (cont.)

- ◆ People tend to tap at or near a comfortable rate regardless of pattern presentation rate
- ◆ $TNPOS = NPOS - \sqrt{\Delta}$
 - Δ represents the degree to which the period of a candidate beat assignment differs from a preferred rate (600 ms)

Experiments

- ◆ Dataset 1 – McAuley & Semple 1999
 - Tests for both musician & non-musician
 - Six patterns used: Pulse, March, Waltz, Swing, Skip, and Cross
 - Overall, TNPOS has the best performance (67% for all subjects)
 - The result justify that positive evident is the simplest and most effective way to predict beats

Experiments (Cont.)

- ◆ Dataset 2 – Parncutt (1994)
 - Six different rates from very fast to very slow
 - Six patterns same as in dataset 1
 - TNPOS has the best performance overall

Experiments (Cont.)

- ◆ Dataset 3 – Povel & Essens (1985)
 - 35 patterns consists of 16 elements: nine onsets & seven rests
 - Subjects listen to the music again and again. Then reproduce 4 periods of the sequence they had just heard.
 - NPOS shows good linear regression results, as well as fewest number of the categories

Rule-based systems for downbeats prediction

- ◆ It is a simple way to do downbeats prediction, with a limited extent
- ◆ Beat induction is a property of pattern and listener together
- ◆ Rule-based system is difficult to account for pieces without sufficient global pattern structure

Conclusion

- ◆ A rule-based model assuming that positive evidences are primary info pieces for beat induction
- ◆ A simple and effective approach comparing to existing models
- ◆ Work needs to be extended to more complex patterns