Perception of Metrical Structure: The Model

Christopher Lee
Presentation by Joann Emmanuel
March 25, 2004
ISE 599

The Model
- Algorithm can yield more than one interpretation of a sequence by changing the tolerance, C.
  - High C good for major syncopation and weak long notes
  - Low C only recognizes long weak notes without syncopation

The Model
- Model is conservative about where the downbeat falls
  - Assumed downbeat on first note
  - Shifted when presented with counter evidence
- Listener prefers no upbeat

The Model
- Model is capable of Metrical Subdivision
  - Ability to detect metrical levels lower than the one already established
  - Model considers effect of Tempo
Establishing Metrical Grouping

- Calculate \( t_1, t_2, \) and \( t_3 \) which mark the onset of three hypothetical units
  1. \( t_1 \) and \( t_2 \) placed on first two notes
  2. \( t_3 \) calculated such that \( t_3 - t_2 = t_2 - t_1 \)
  3. LEV scored based on quality of \( t_3 \) location
  4. If \( \text{LEV} \) > \( C \), \( t_1 \) and/or \( t_2 \) is altered

- Process repeated until satisfactory
- LEV stored added to global counter-evidence

Revision due to \( \text{LEV} > C \)

- Problem occurs on \( t_2 \)
  - UPDATE: Shift the downbeat (\( t_1 \)) to \( t_2 \).
    Recalculate \( t_3 \).
  - Problem is a long note between \( t_2 \) and \( t_3 \)
  - STRETCH: Move \( t_2 \) to the long note. Alter \( t_3 \).

Counter Evidence, LEV

- LEV for a weak long note is 1
  - Ex. Note on \( t_2 \) is longer than note on \( t_1 \)
- LEV for syncopation is 1
  - Ex. Syncopation within a measure
- Combination of both scores 2
- Syncopation over two measures scores 2

Metrical Subdivision

- Routines enable “full parsing” of a sequence
  - Once the high level metrical grouping is established, a search routine determines if notes occur between consecutive beats.
  - A meter-finding routine determines if these notes establish a meter (divide beat into 2 or 3)

- Repeat until no more notes, no more subdivisions
What factors determine subdivision?

- Previous locations of t2?
  - Beat length revision information
  - All but the last location cannot make up a subdivision
- Lee says, This is no good

Why rule is no good

1. Possible that beat revision does not occur. It cannot guide the subdivision process
   - Incorporate supplementary rules (next slide)
2. Supplementary rules don’t make accepted interpretation better than eliminated interpretation
   - All subdivisions must satisfy supplementary rules and main rules
3. Subdivision sensitivity to preset values of C

Supplementary Rules

- A subdivision is eliminated if no note-onset occurs at the beginning of any of the lower-level units
- If both possible subdivisions are thereby eliminated, the process of subdivision is abandoned
- If neither subdivision is eliminated in this way, the binary subdivision is chosen

Tempo Effects

- Tactus?
  - Moderate-tempo pulse in most rhythmic music
  - Range of spontaneous tempo (clapping a steady beat, walking pace, heart beat)
Effect of Tempo

- Algorithm doesn’t work in real time, rather sets the shortest note in the sequence to have a duration of 125ms
- Two ways tempo effects a listener's choice of interpretation
  - Revise metrical grouping to obtain a tactus within a preferred range
  - Cut off point of where no change in meter can occur

Selecting a Tactus

- Algorithm ensures that at least one metrical level provides a suitable tactus
  - If a metrical level has an acceptable tactus, a test routine checks if a different grouping provides a better tactus
  - Revision attempted when...

Revising a Tactus

- Occurs when
  - Two or more levels of grouping have been established
  - New shortest note is shorter than the old shortest note
  - New unit is longer than a preset longest length
- Revision
  - Sets the provisional beat to 4
  - Checks if a revision needs to occur (return to top of slide)

Tactus revision termination

- Algorithm stops looking for high-level grouping when
  - High established unit is longer than longest acceptable
  - At least one lower level grouping has been established
Model Overview

- Model works from left to right
  - Compares consecutive note lengths
  - Considers position with respect to beats
  - Yields a metrical interpretation
- Model can alter the metrical hypothesis
  - Revise position of downbeat
  - Revise length of beat

Only occurs with presence of sufficient counter evidence

Model Overview

- Model is more conservative than previous model
  - Preset tolerance, C
  - Ability to yield different interpretations of a sequence
  - Capable of providing metrical subdivisions
  - Sensitive to tempo effects
    - Try to obtain a tactus within a specified range

Problem – Subdivision

- Algorithm unable to detect lower level grouping that occurs later in the sequence that don’t follow a 2:1 ratio
- Is a subdivision of 3:1 equally perceivable as 2:1?
  - Yes, if set after a strong metric context

Solution – Subdivision

- Use “longnote” routine from Longuet-Higgins and Lee (1982)
  - Need to find a better method rather than a additionally constrain current method
Limitations

- Evaluation Routine
  - Possible to produce poor interpretation
  - Solution: Routine should have a broader scope beyond focusing solely on local information
- Revision Routine
  - Program gives up when no division can be found
  - When listener encounters this problem, he generates a new interpretation from scratch and tries again

Revision – Parallelism

- Model cannot recover from failure to parse a sequence
  - Aborted parsing should automatically attempt again at a lower value of C, or a higher value of C
- Humans perceive things in parallel, not series
  - Algorithm should perform routines in parallel
  - Concurrently observe a range of C to collect many interpretations
  - Use set C to determine which interpretation is best

Revision – Questions

- At what point does the listener abandon a non-preferred interpretation?
  - Gating paradigm
- How much parallelism should be used?
- How is meter perceived?