Polyphonic Music Retrieval: The N-Gram Approach

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PATTERN EXTRACTION AND ENCODING:

- Encode polyphonic music piece as an ordered pair of onset time and pitch
- Group pitches with similar onset times together as musical events
- Using the gliding window, the sequence of events are divided into overlapping sub-sequences of n different adjacent events, each with its unique onset time
- All possible monophonic sequences are extracted in constructing the corresponding musical words

INDEXING AND RETRIEVAL SYSTEM:

- Collection – around 10,000 polyphonic musical performances in the MIDI format
- Indexing Tool – Lemur Toolkit with the Okapi BM25 function for weighting
- Music-friendly inputs

EXPERIMENTAL DESIGN:

Index Files and Experimental Factors

<table>
<thead>
<tr>
<th>Index</th>
<th>Pitch</th>
<th>Rhythm</th>
<th>Polyphonic Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>P3</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>P2</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>P1</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Error Simulation

- Monophonic queries – Query by Humming (QBH)
- Polyphonic queries – Query by Example (QBE)
- NewInterval = Interval + D. z
- NewRatio = Ratio + exp(D. z)

Test Collection

- Collection – Around 10,000 music documents obtained from the Internet and divided into training and test sets
- Relevance judgements – assumptions based on Ulderek and Zobel (1999)

RESULTS AND CONCLUSIONS:

- Experimental Series: 1. Preliminary Investigation
- 2. Query by Melody, Fault-Tolerance and Comparative Study
- 3. Robustness and Envelopes
- 4. Proximity Analysis

- Monophonic query: Query by Humming (QBH)
- Polyphonic query: Query by Example (QBE)

- Structured and Proximity Based Operators

- Monophonic query: Query by Humming (QBH)
- Polyphonic query: Query by Example (QBE)

- Query Formulation using Nested Phrase Operators

- Retrieval Measures with Adjacent and Concurrent N-G

- A promising performance despite the large number of index terms with full-music indexing of polyphonic music – enabling retrieval from a polyphonic collection without the need for melody extraction algorithms

- Proven the usefulness of using n-grams in polyphonic music retrieval – retrieving from a polyphonic music collection with both monophon and polyphonic queries

- Introduced a non-linear function to map intervals to text letters, and analysed how to best quantise ratio ranges in order to incorporate rhythm information

- Development of a state-of-the-art test collection and the use of error models for fault-tolerance investigation