Evaluation of Performance-to-Score MIDI Alignment of Piano Duets

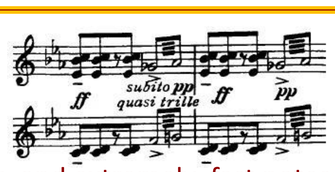
Katie Wolf
University of Minnesota
College of Computer Science
and Engineering

Elaine Chew
University of Southern California
Viterbi School of Engineering
Thornton School of Music

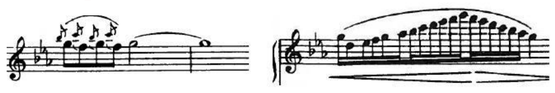
Research Goals

- Create evaluation methods of MIDI-to-MIDI alignment of piano duet parts
- End goal is to create a robust performance-to-score alignment for quantifying ensemble coordination in distributed performance

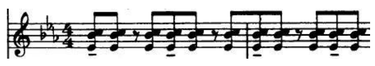
Challenges of Duet Piano Music



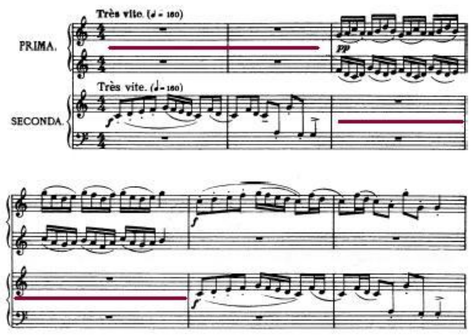
Trills and extremely fast notes such as grace notes and cadenza like runs



Long sequences of repeated notes or chords



Periods of silence when players wait their turn to play



Distance Functions

Euclidean distance

$$ED(A,B) = \sqrt{\sum_{i=1}^{88}(x_{Ai} - x_{Bi})^2}$$

Meron & Hirose distance

$$MHD(A,B) = \frac{|A \cap B|}{|A \cup B|}$$

where A and B are feature vectors

Related Work

ALIGNMENT

Audio-Audio
- Dixon & Widmer (2005) - MATCH: Music Alignment Tool Chest

Synthesized MIDI-Audio
- Ellis & Turetsky (2003) - Ground-Truth Transcriptions of Real Music from Force-Aligned MIDI synthesis
- Hu, Dannenberg, & Tzanetakis (2003) - Polyphonic Audio Matching and Alignment for Music Retrieval

MIDI-Audio
- Soulez, Rodet, & Schwarz (2003) - Improving Polyphonic and Poly-Instrumental Music to Score Alignment
- Raphael (2004) - A Hybrid Graphical Model for Aligning Polyphonic Audio with Musical Scores

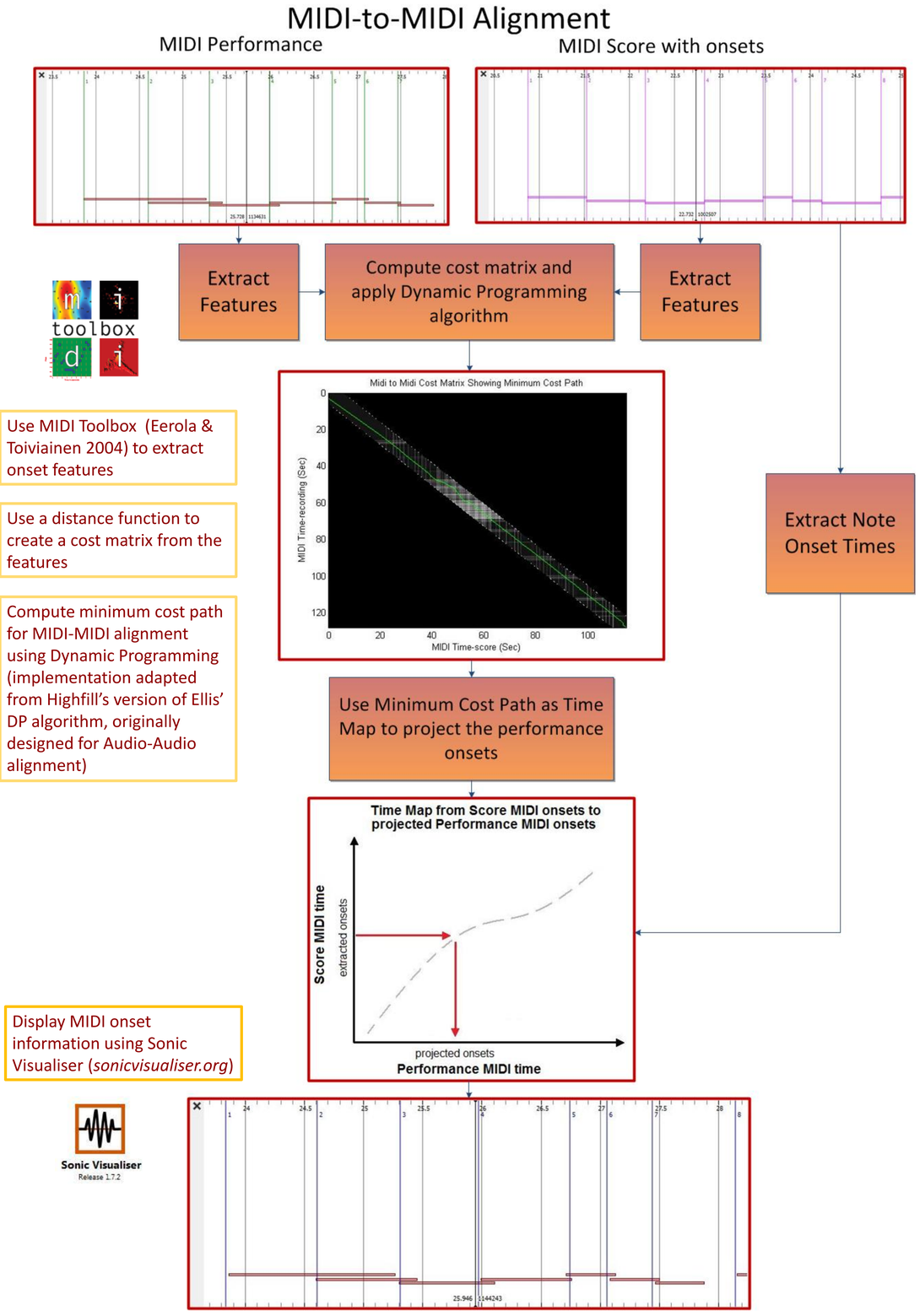
MIDI-MIDI
- Meron & Hirose (2001) - Automatic Alignment of a Musical Score to Preformed Music

EVALUATION

Time Map
- Meron & Hirose Method of Evaluation (2001)

Beat Categorizations (inspiration for note categorization)
- Grosche, Mueller, & Sapp (2010) - What Makes Beat Tracking Difficult? A Case Study on Chopin Mazurkas

MIDI-to-MIDI Alignment



Use MIDI Toolbox (Eerola & Toiviainen 2004) to extract onset features

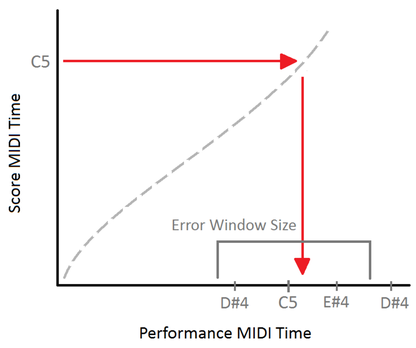
Use a distance function to create a cost matrix from the features

Compute minimum cost path for MIDI-MIDI alignment using Dynamic Programming (implementation adapted from Highfill's version of Ellis' DP algorithm, originally designed for Audio-Audio alignment)

Display MIDI onset information using Sonic Visualiser (*sonicvisualiser.org*)

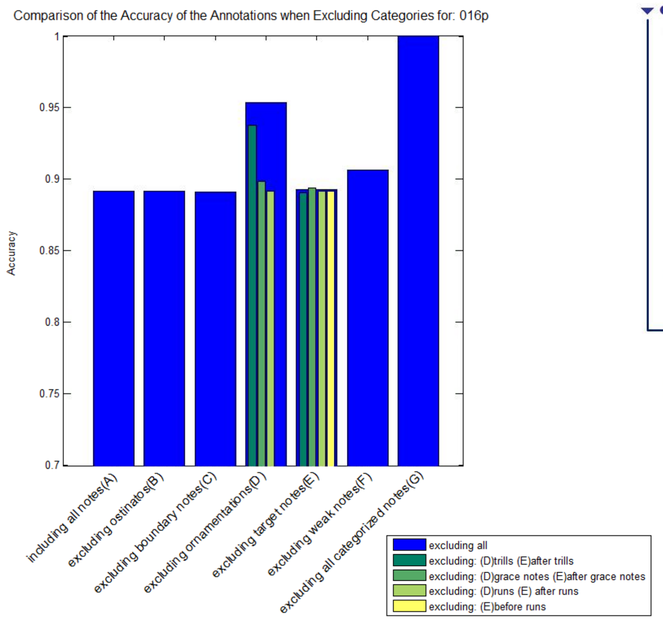
MIDI Performance with projected onsets

Evaluation & Preliminary Results

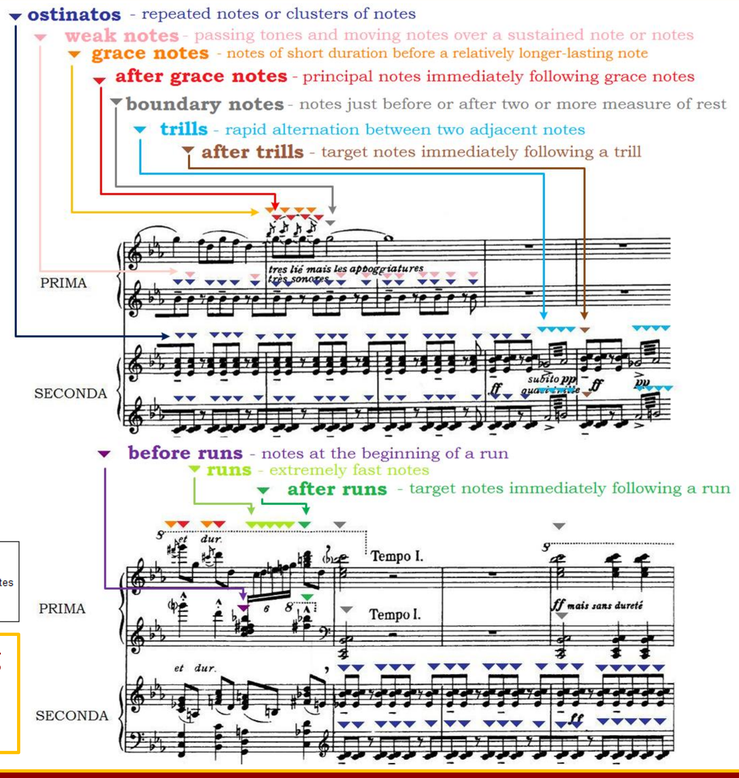


For each note in the score we use the onset time to find the matched time slice in the expressive performance file, and search within a window for that note. If the note is found, then the alignment is deemed correct, and when it is not, we note that an error has occurred.

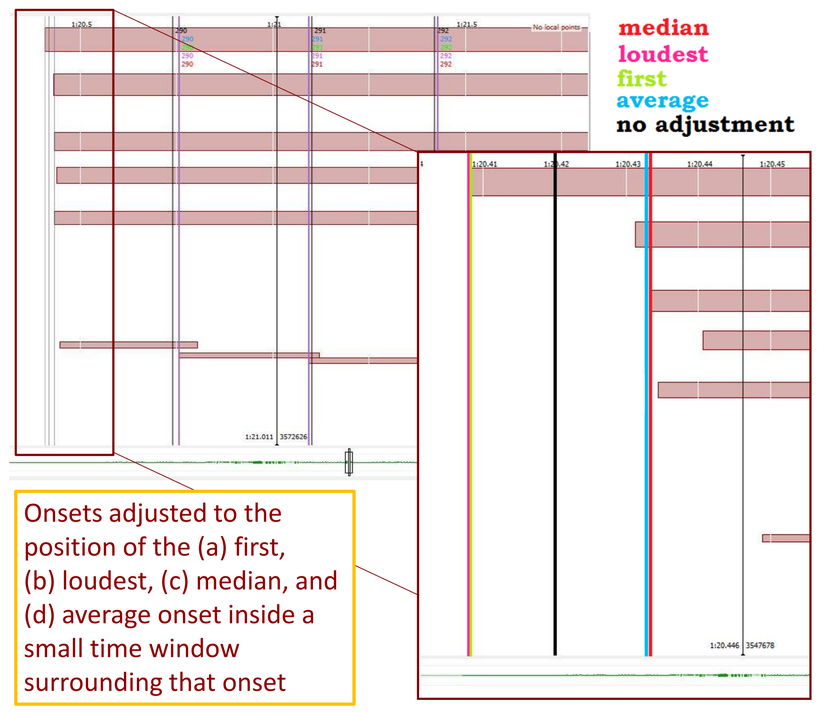
Note Categorization



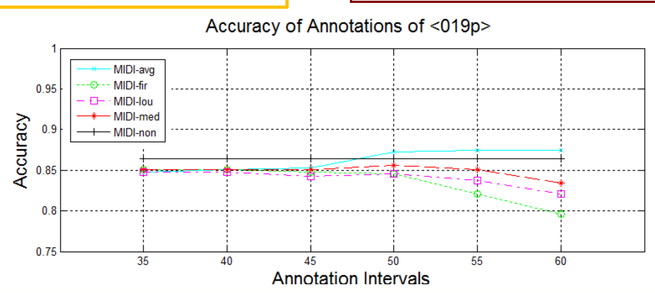
Preliminary results show that labeling and excluding problematic note categories help in accounting for alignment errors



Local Quantization



Onsets adjusted to the position of the (a) first, (b) loudest, (c) median, and (d) average onset inside a small time window surrounding that onset



While no quantization works well, quantization to the average onset works a little better for larger adjustment windows

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