Optimizing DTW-Based Audio-to-MIDI Alignment and Matching

Colin Raffel and Daniel P. W. Ellis

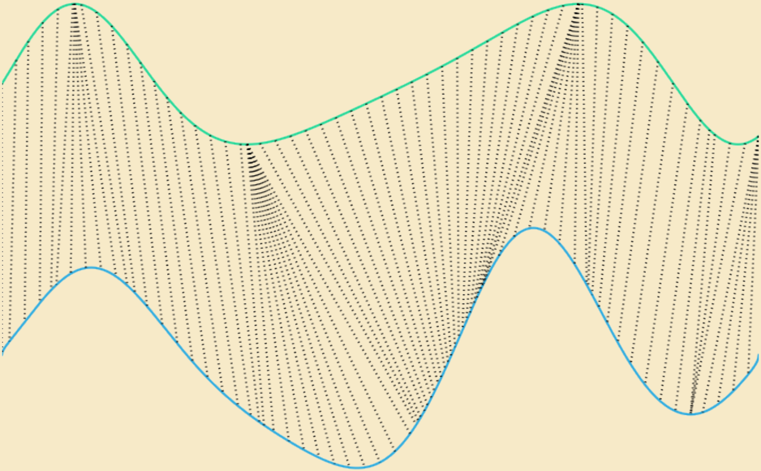
41st IEEE International Conference on Acoustics, Speech and Signal Processing
March 23, 2016

Lab ROSA

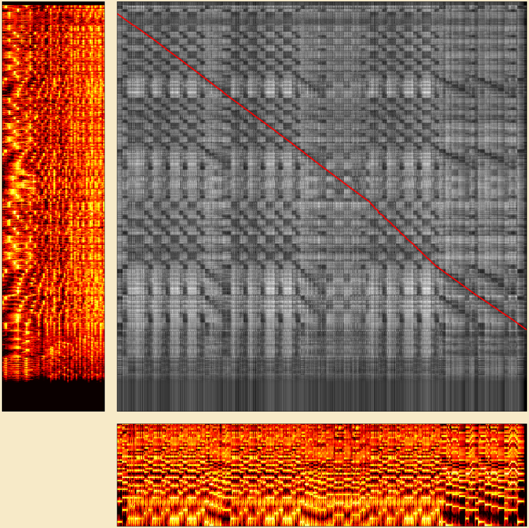
NATIONAL SCIENCE FOUNDATION NSF

IGERT Integrative Graduate Education and Research Traineeship

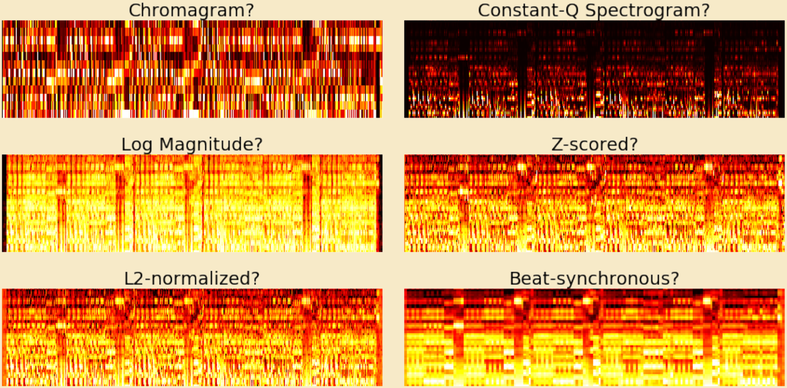
Dynamic Time Warping



DTW for Audio-to-MIDI Alignment



System Design: Representation?



Chromagram?

Constant-Q Spectrogram?

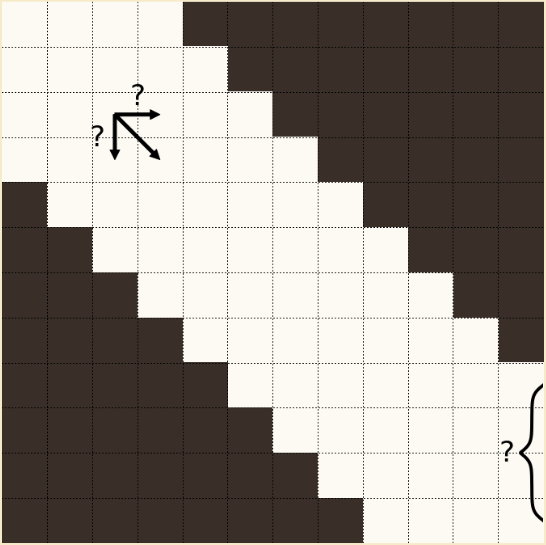
Log Magnitude?

Z-scored?

L2-normalized?

Beat-synchronous?

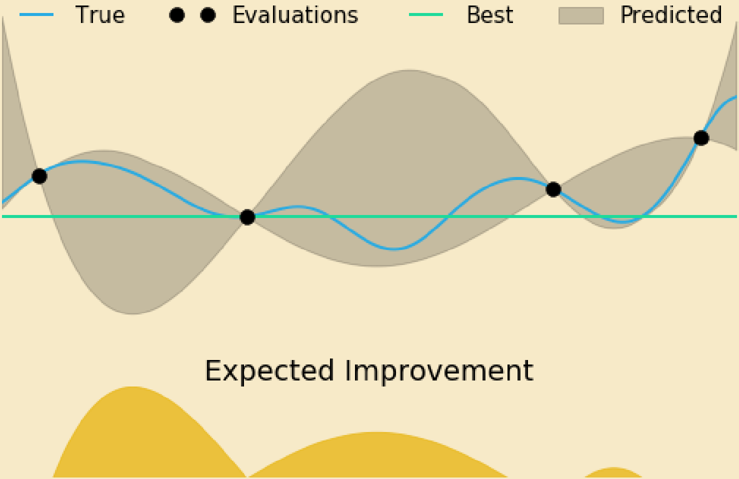
System Design: Path Constraints?



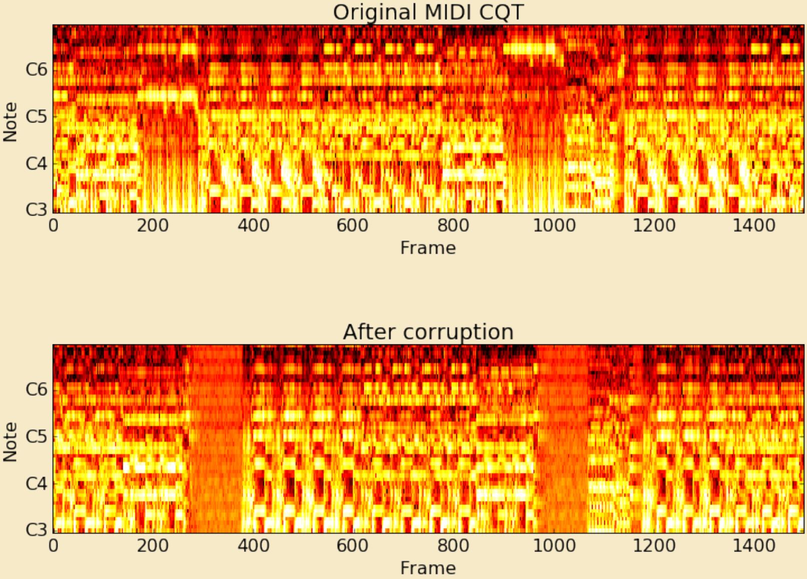
System Design: Score Reporting?

$$\text{score} = \frac{\sum_{i=1}^{|p_m|} D[p_m[i], p_a[i]] + \Phi(i)}{|p_m| \frac{\sum_{i=\min(p_m)}^{\max(p_m)} \sum_{j=\min(p_a)}^{\max(p_a)} D[i,j]}{|\max(p_m) - \min(p_m)| |\max(p_a) - \min(p_a)|}}$$

Bayesian Optimization

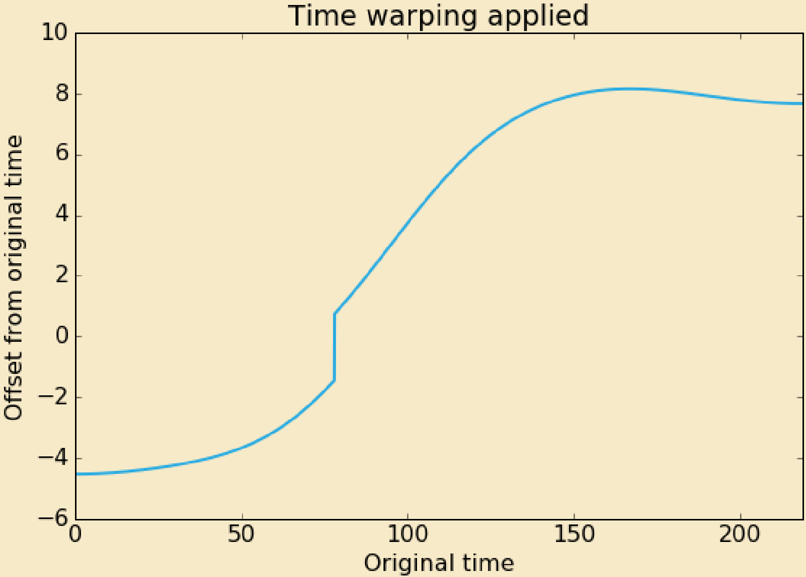


Idea: Synthetic Alignment Data

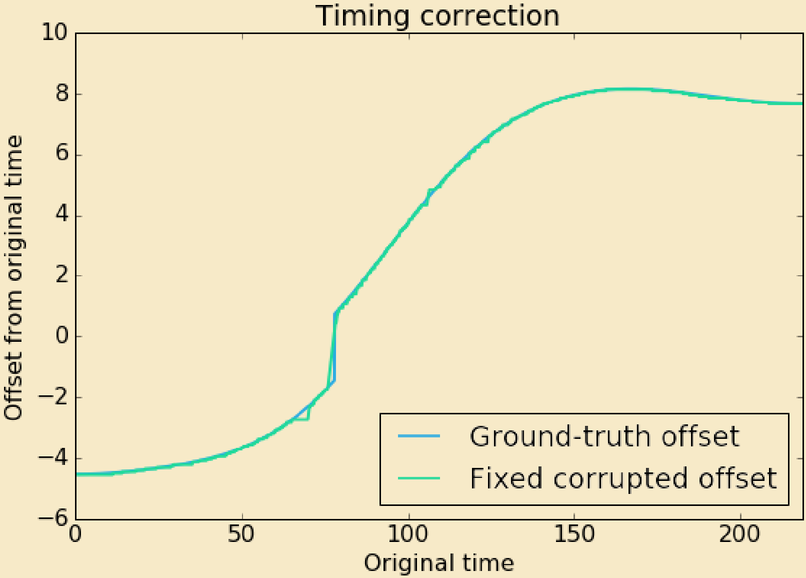

Original MIDI CQT

After corruption

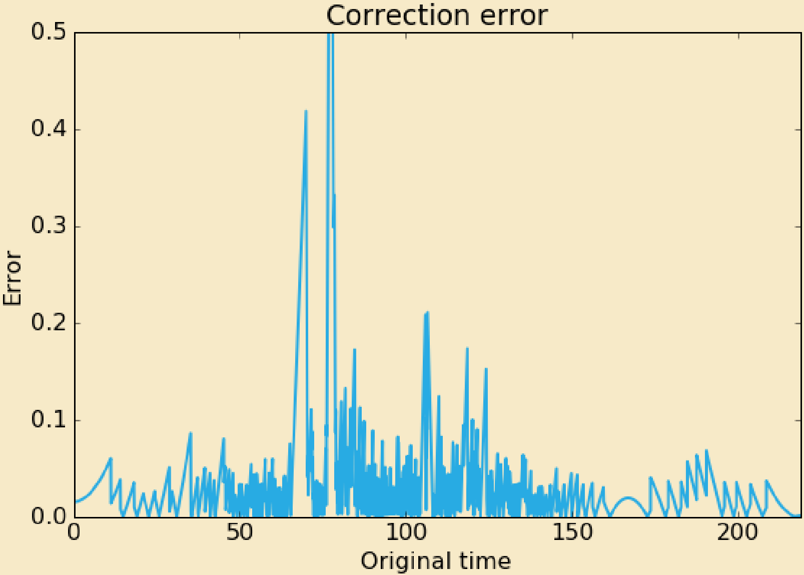
Artificial Time Warping



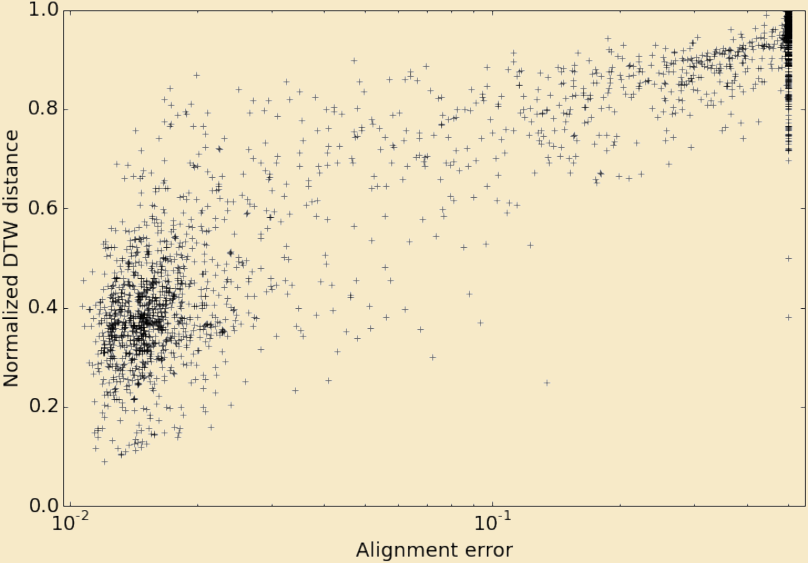
Correcting Time Warping



Measuring Error



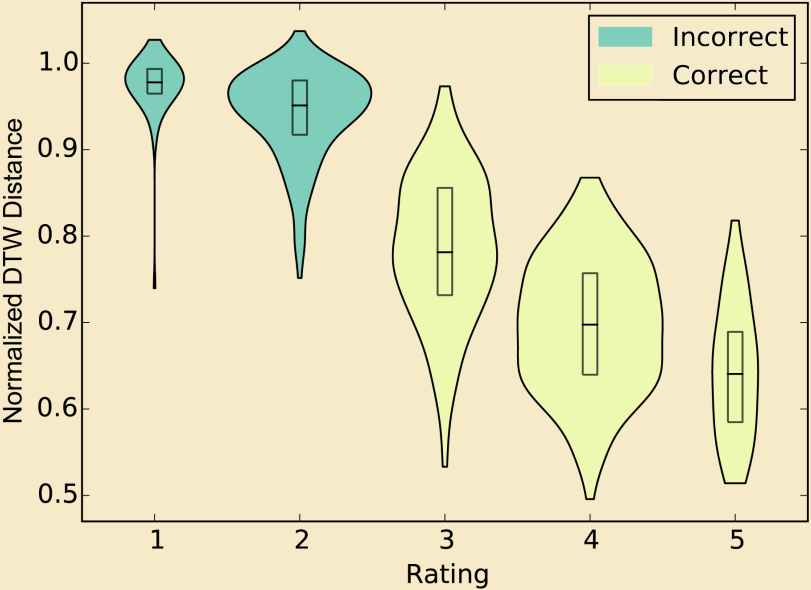
Score Normalization Search



Best System:

- Use log-magnitude constant-Q spectrograms
- Don't beat synchronize
- L2 normalize spectra (cosine distance)
- Don't z-score spectrograms
- Use median distance as non-diagonal penalty
- Force sequences to match up to 96% of shorter
- Don't use a band path constraint
- Include penalties in confidence score
- Normalize by path length and submatrix mean

Real-World Test



Pointers

http://bit.ly/alignment-overview
http://github.com/craffel/alignment-search
http://github.com/craffel/pretty-midi
http://github.com/craffel/djitw
http://github.com/bmcfee/librosa

craffel@gmail.com