Integrated Computational Gestural and Timbral Mapping for Musical Expressions

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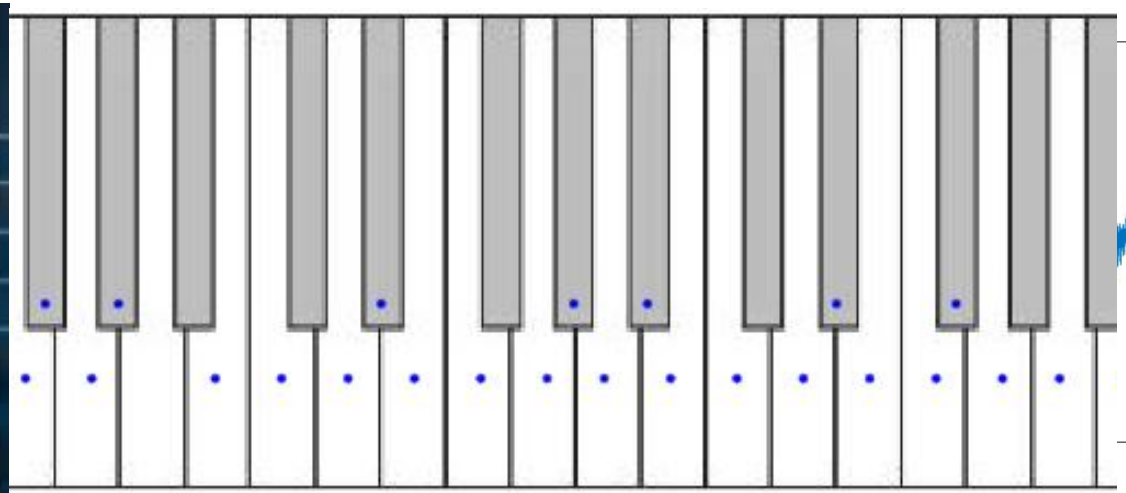
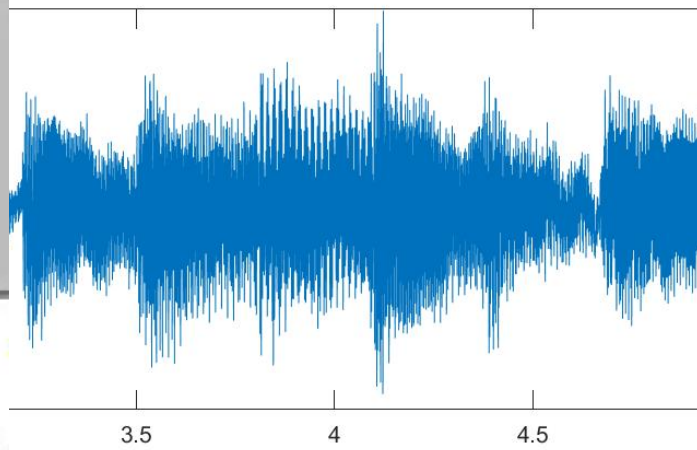
Introduction

- The ultimate artistic achievement for musical instrument performers is to obtain intuitive control and expression.
- Such a full mastery requires years of systematic training that would benefit from computational tools.
- Pedagogical associations between gesture (e.g., hand placement and movements on music instruments) with sonic features (overtones, harmony, texture, articulation, etc.) is an essential part of musical training.

Goals
“mapping intended music concepts into expressive sound seamlessly”

- Build a tool for musical gesture analyses, musical timbral analyses, and mapping gesture analysis with timbral analysis.
- Collect a dataset for exploring the connection between musical gesture and sound
- implement computational analysis and visualization tools.

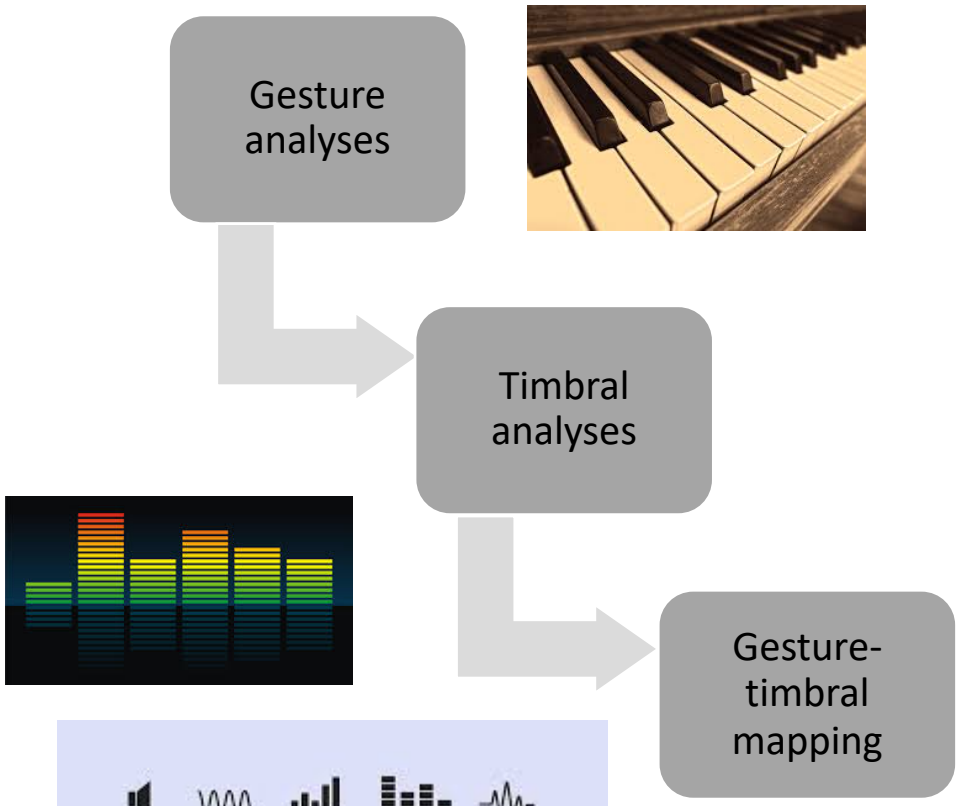




Dataset

- The dataset currently includes synchronized piano performance in MIDI (Musical Instrument Digital Interface) and video format.
- We map the MIDI data (pitch/timing for individual notes and musical expressions) to the piano keyboard to synthesize the movement pattern for the hands.

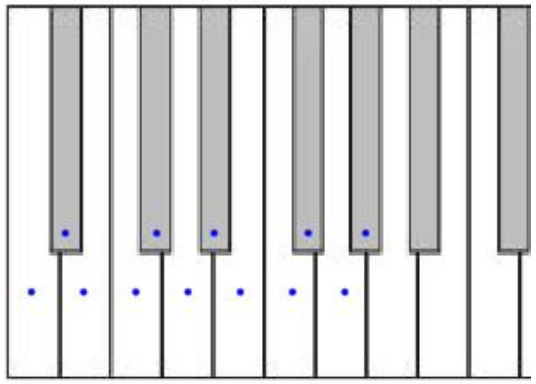
System Architecture

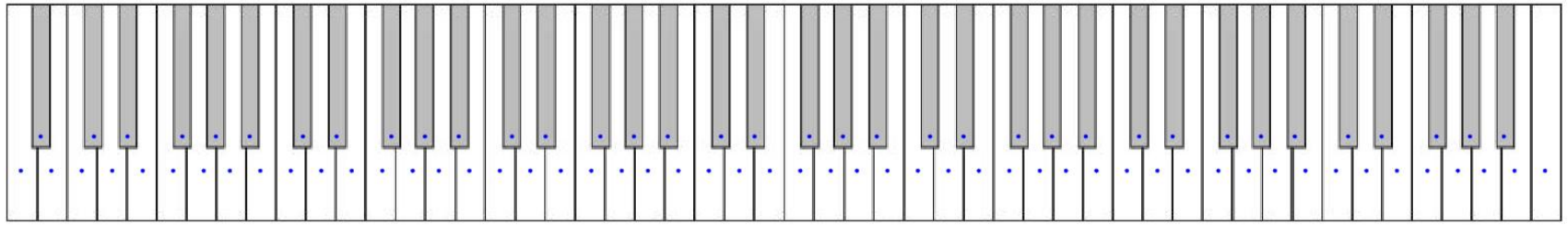


- Musical gesture analyses tracking the figure locations on the keyboard and perform analyses and visualizations.
- Musical timbral analyses process music performance recordings in score and audio-based formats for sound profile analysis.
- Gesture-timbral mapping uses the time synchronization information for connecting gesture analyses and timbral analyses, while providing interactive interfaces.

Musical Gesture Analyses

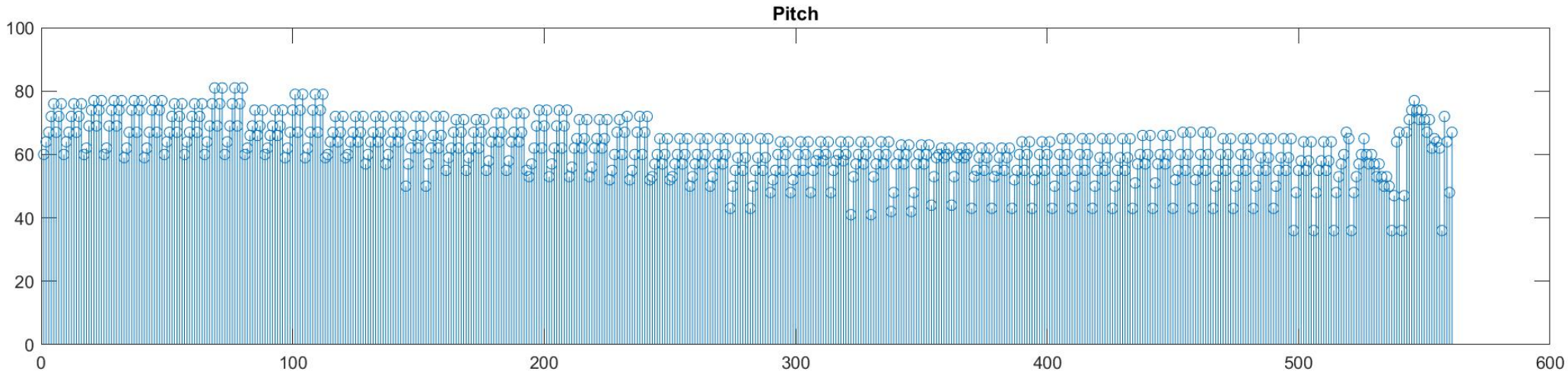
- Build a keyboard gesture model.
- Track finger locations on piano keyboard.





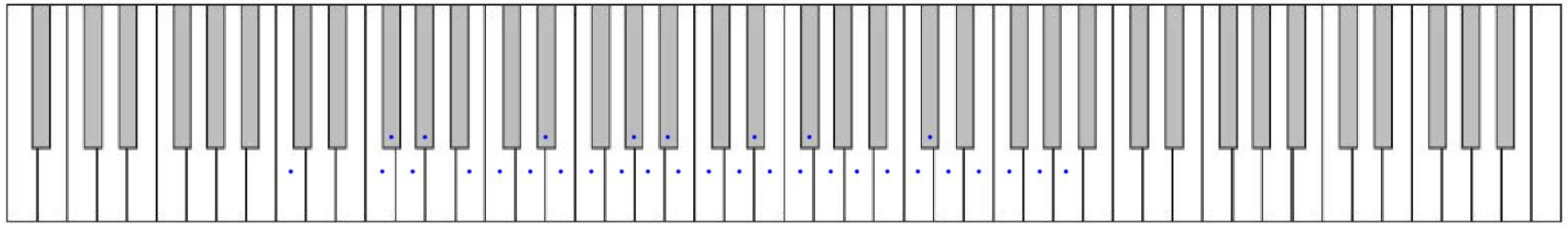
Musical Gesture Analyses

- Extract pitch (key index on piano keyboard).
- Translate pitch to figure locations on the keyboard.

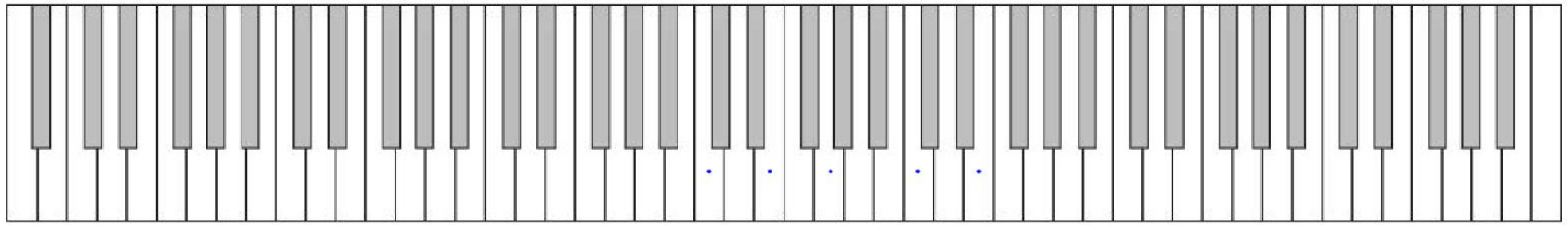


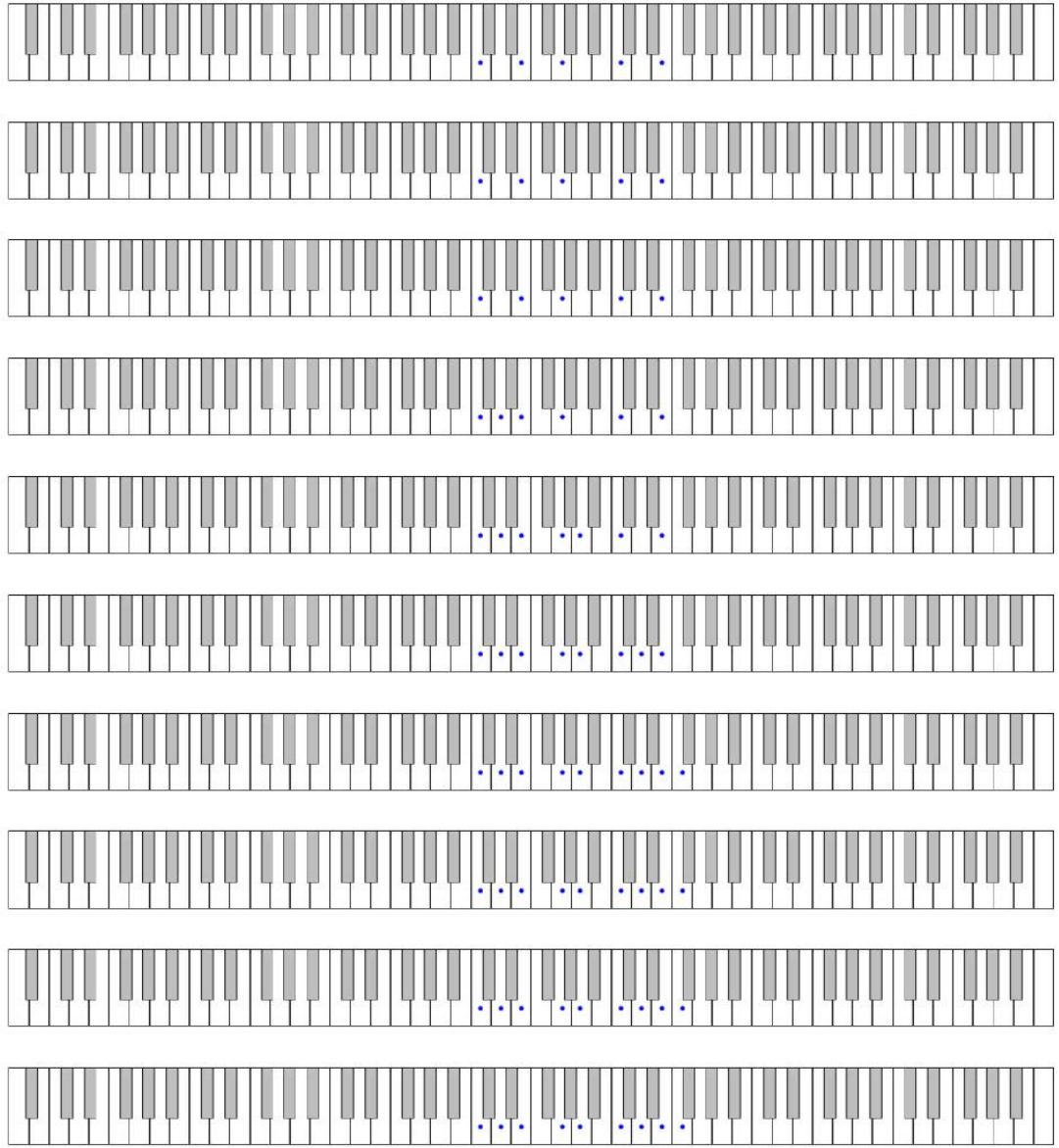
Musical Gesture Analyses

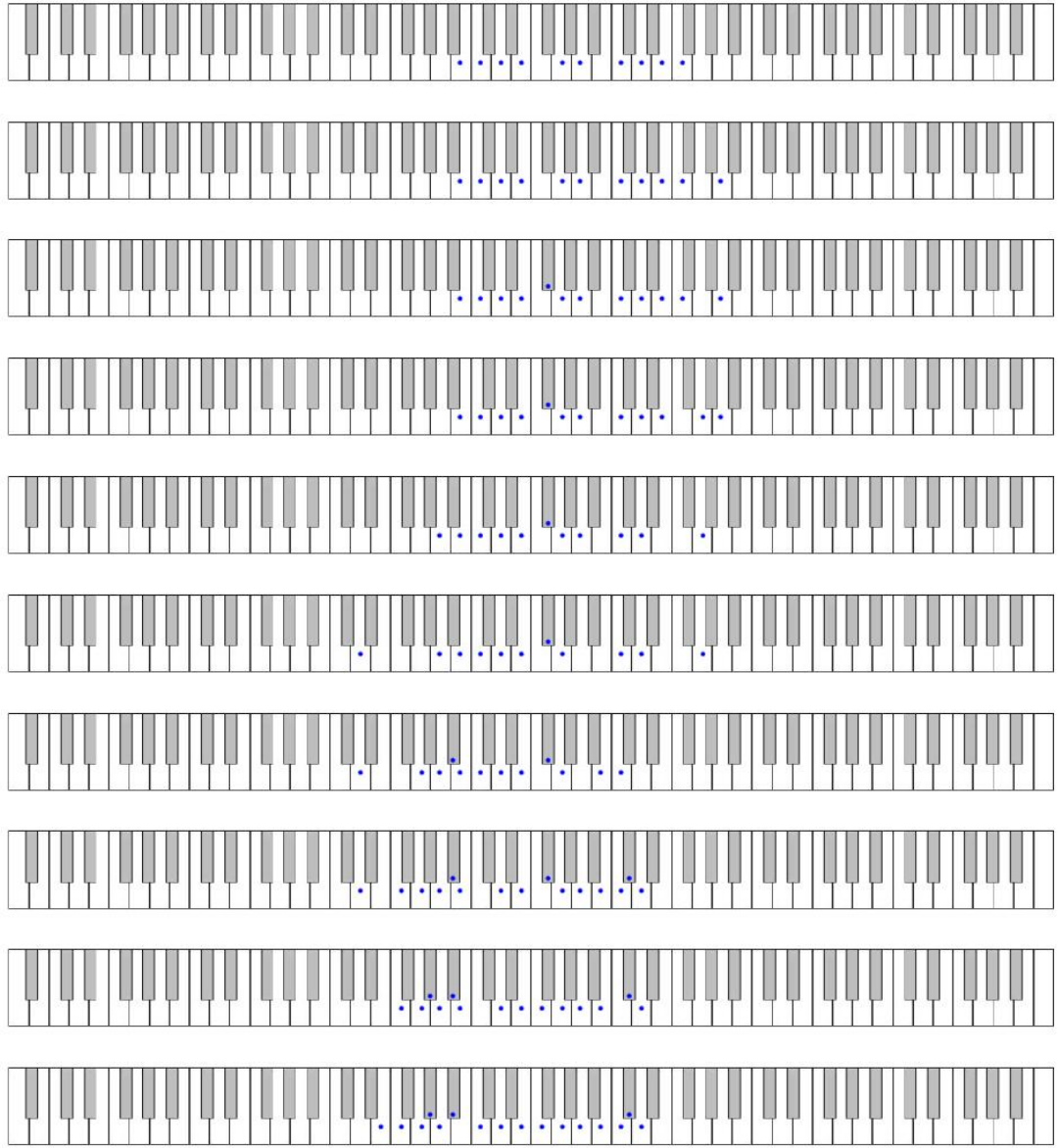
- Plot all pitch locations of a music piece on the keyboard.

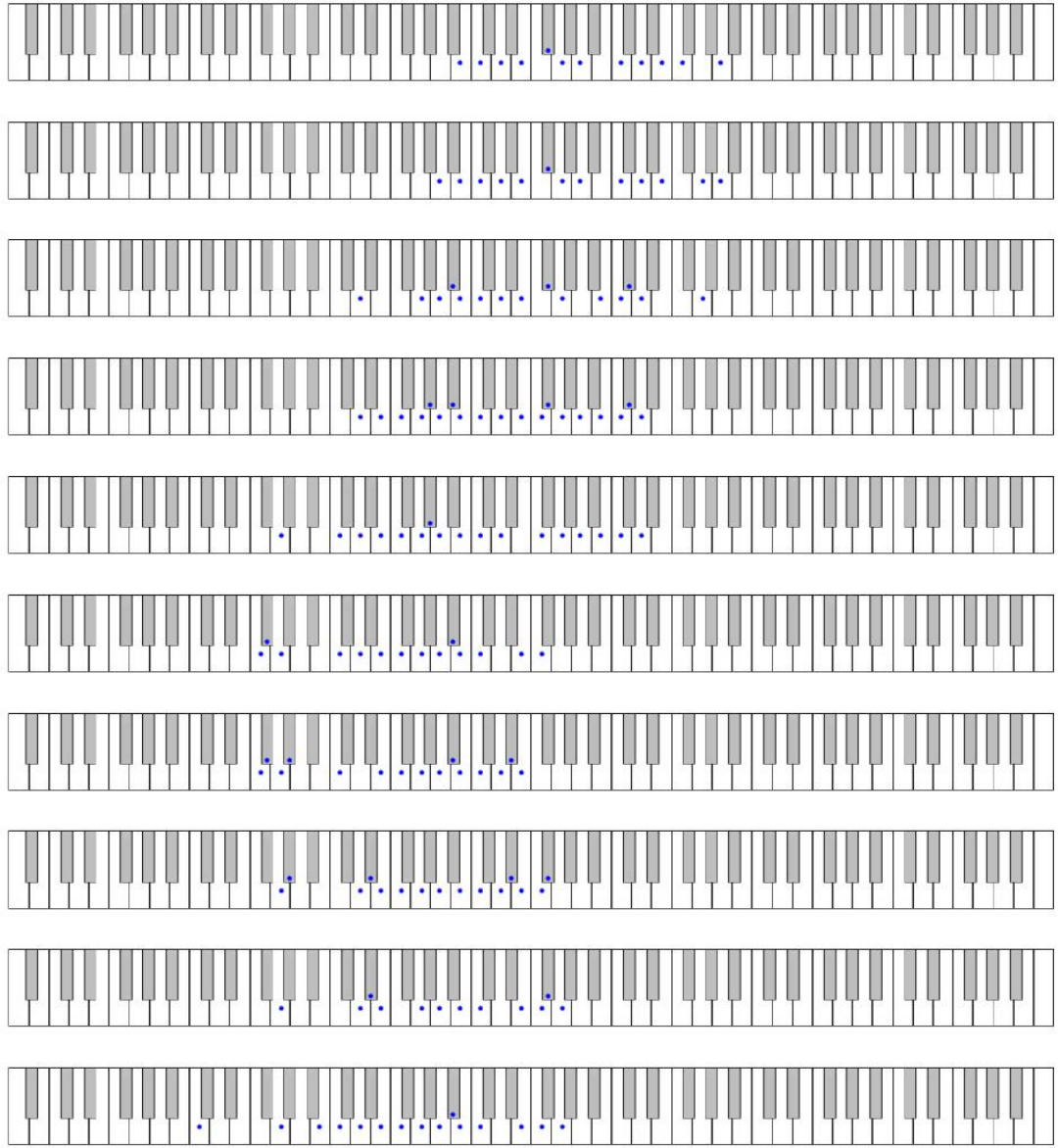


- Plot continuous segments from music score.
- Plot N-gram segments from music score.



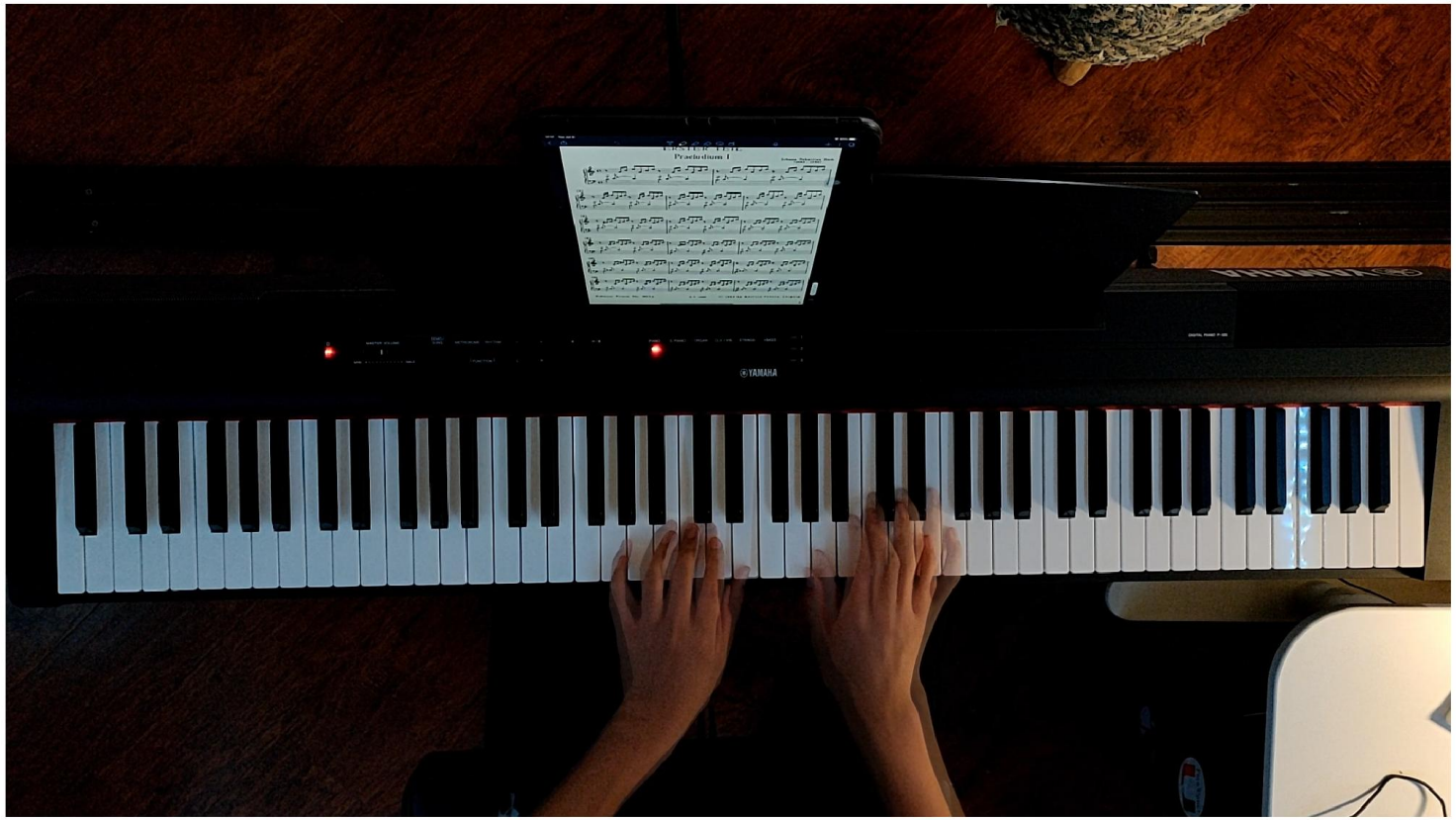






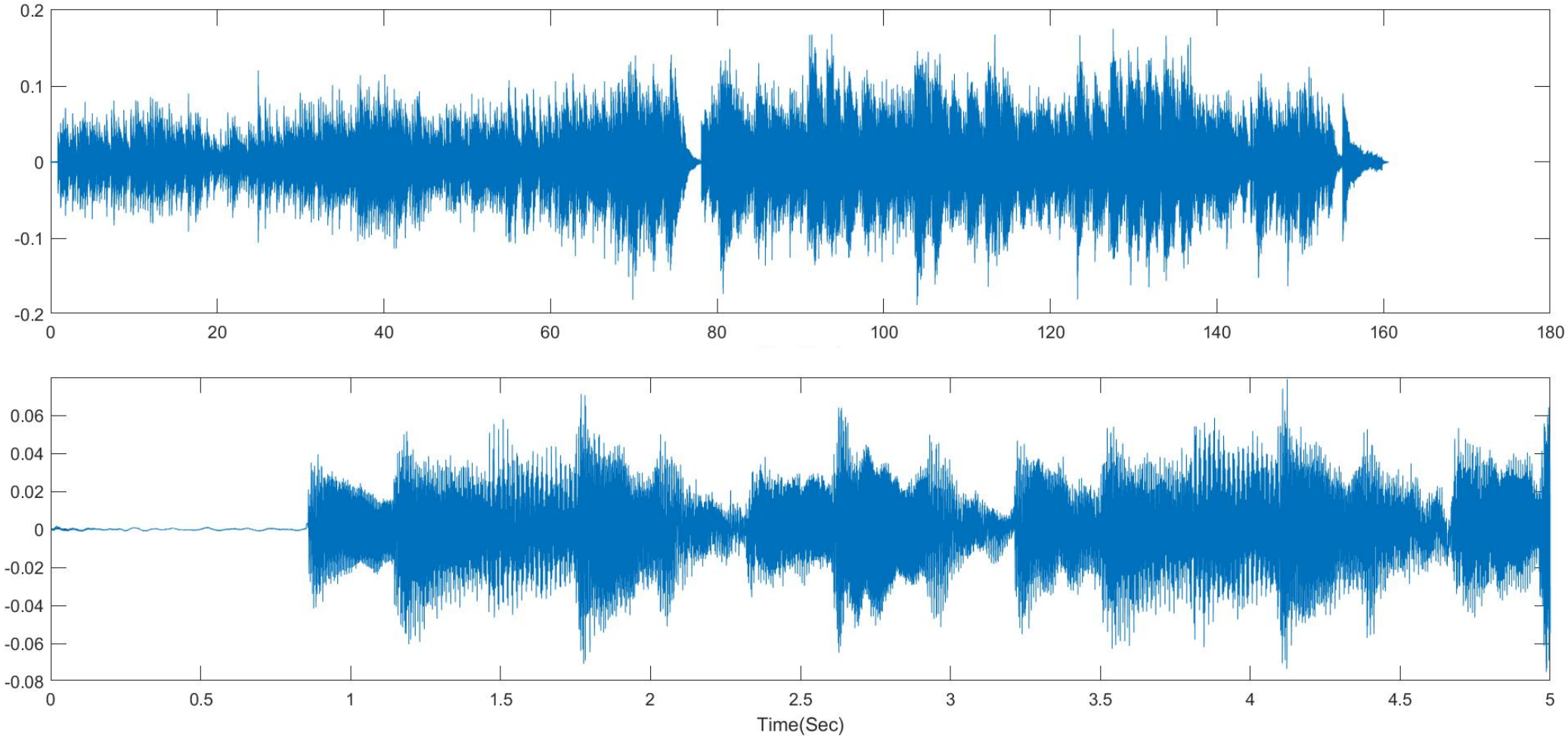
Musical Gesture Analyses

- Video Analytics



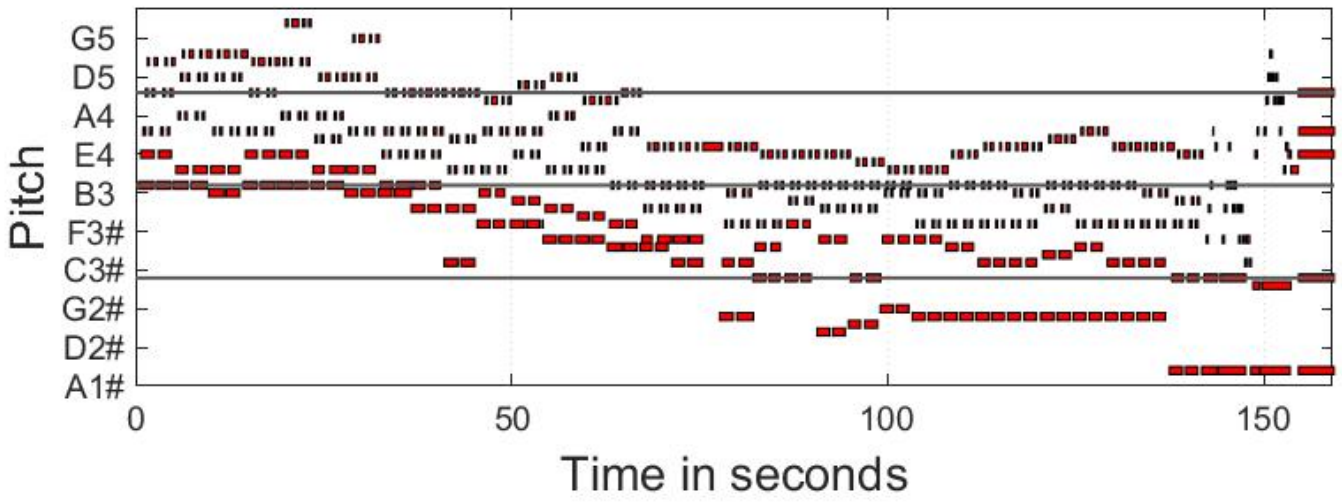
Musical Timbral Analysis

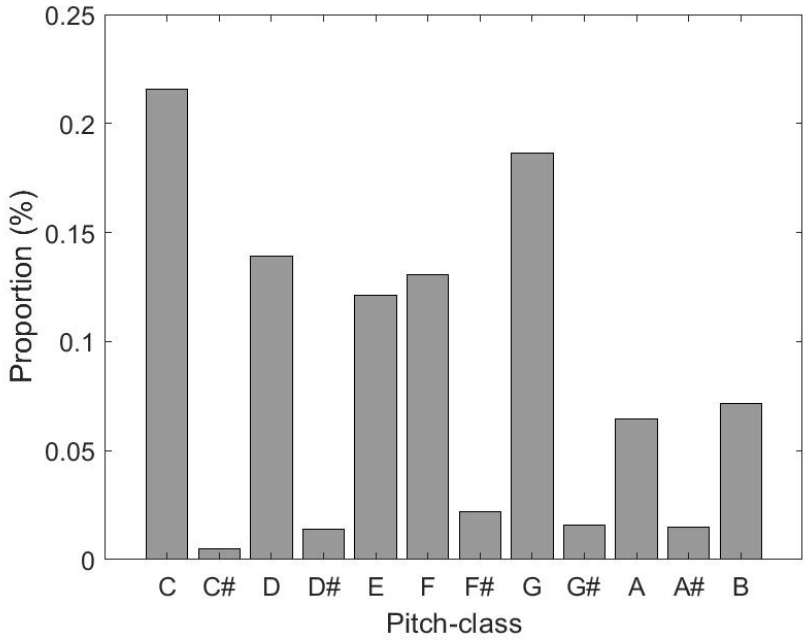
- Time-domain waveform analysis shows the dynamics of a music piece or a segment.



Musical Timbral Analysis

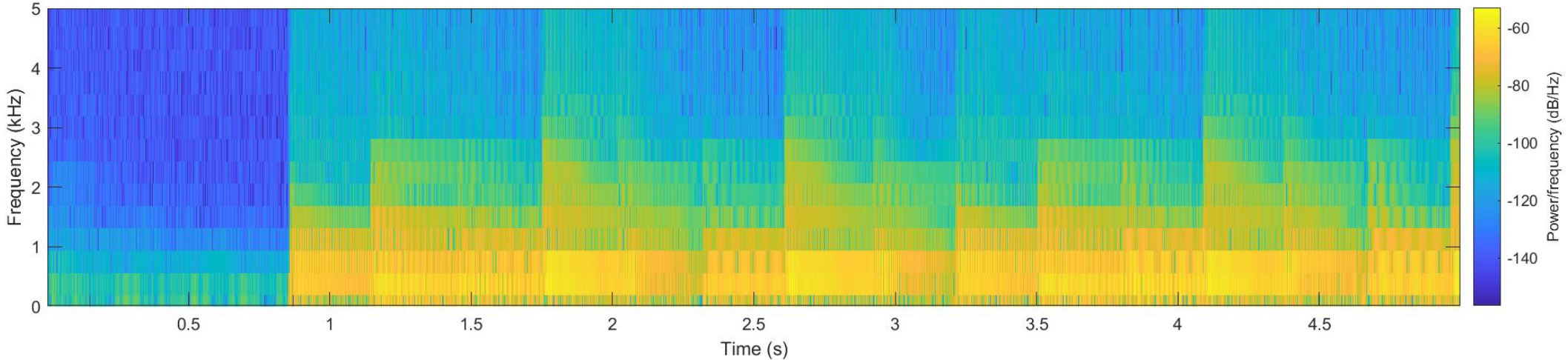
- Symbolic (score-based) music analysis shows the statistical distribution of notes on the keyboard.
- Symbolic analysis can aggregate music notes both for pitch and pitch class (summarize pitches into one octave, assuming octave equivalence).

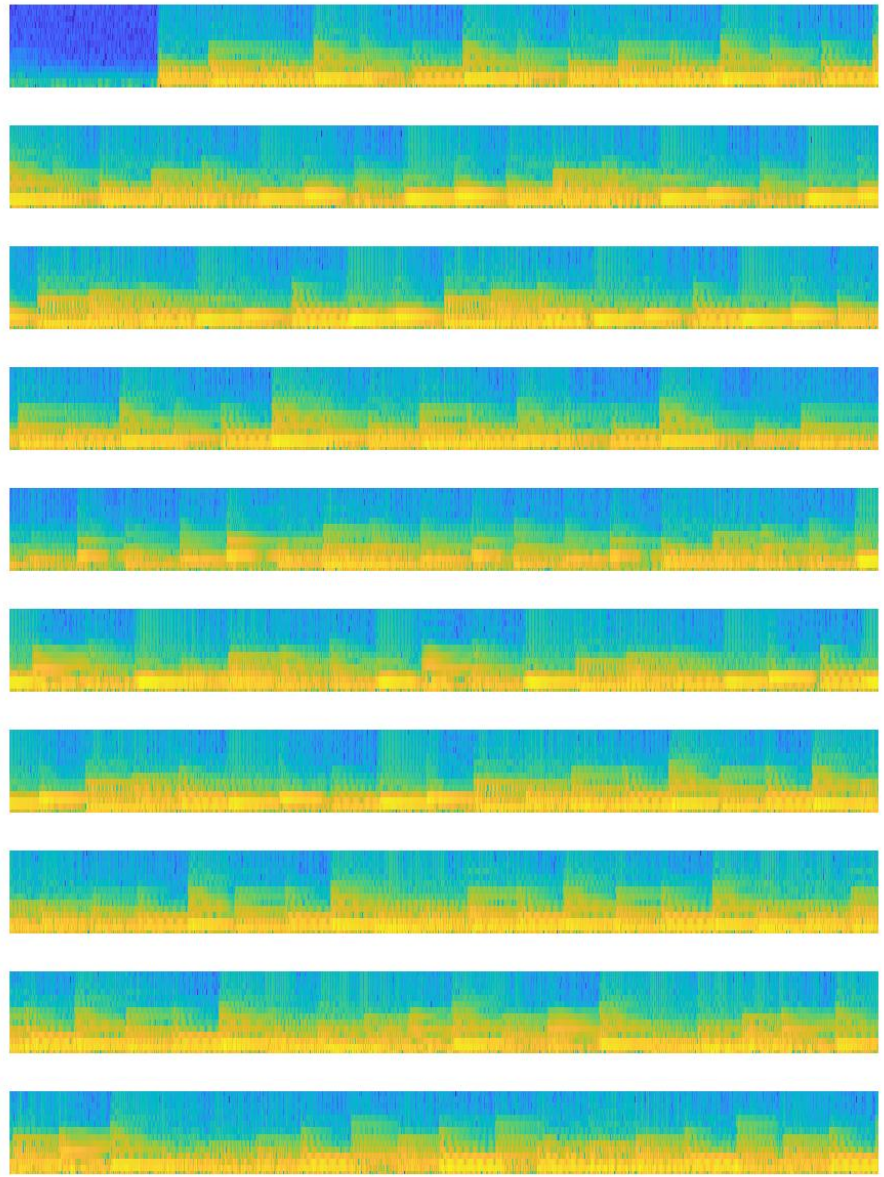




Musical Timbral Analysis

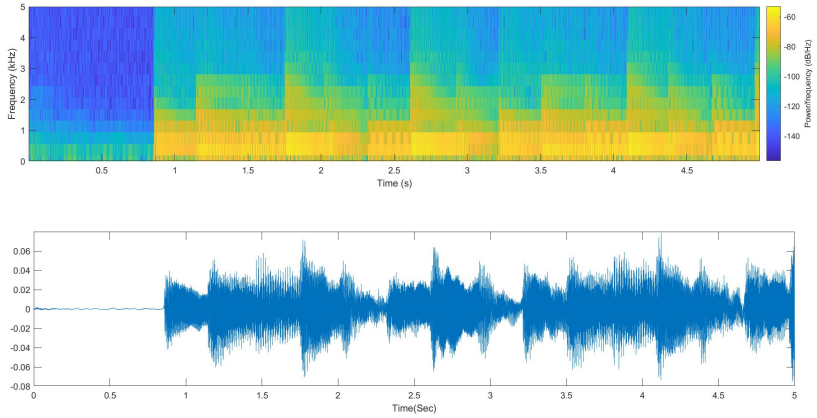
- Time-frequency analysis shows the changes of pitch or timbre over time.
- Piano roll representation shows the start and the end location for each notes and the pitch/dynamics for each notes.
- Spectrogram show the frequency content of a note a sequence of notes.

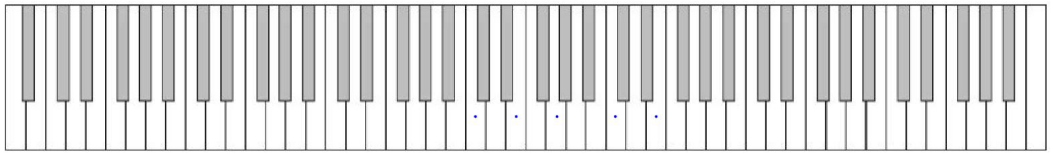




Mapping Gesture Analyses and Timbral Analyses

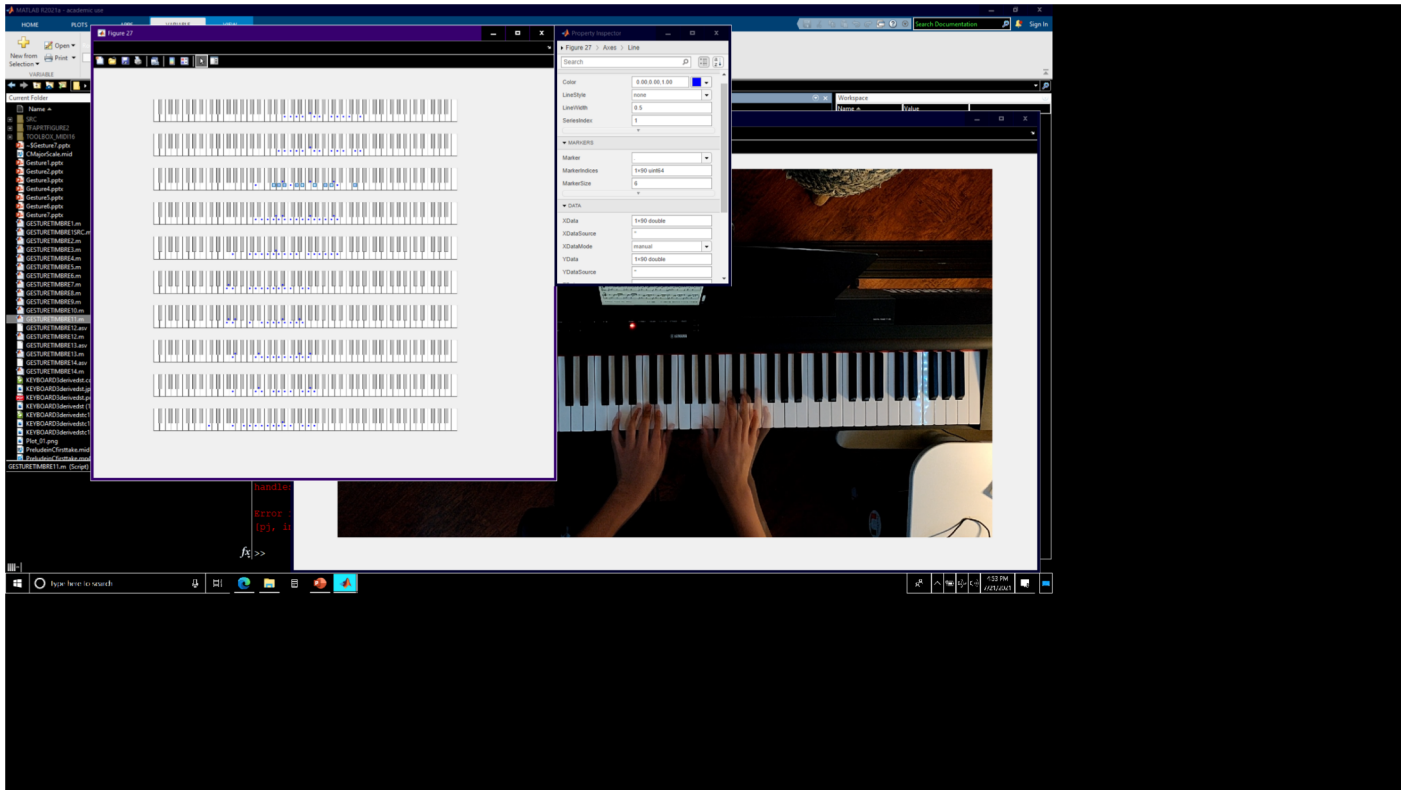
- By connecting the time stamps of the MIDI, audio, and video formats, we implemented a software platform for mapping these formats and their corresponding analyses.





Mapping Gesture Analyses and Timbral Analyses

- We implemented interactive tools that enables musicians and musicologist to navigate the mapping relationships and synchronized multimodal data (MIDI, audio, video, analysis results, and visualization interfaces).



Summary

- We implemented a dataset with synchronized MIDI (music score-based representation), audio and video of piano music performances.
- We map the MIDI data (pitch/timing for individual notes and musical expressions) to the piano keyboard to synthesize the movement pattern for the hands.
- Synthesized movement patterns are connected to synchronize video frames to compare with recorded hand positions and gestures.
- We map each pattern to the synchronized sound.
- This analysis and visualization tool is useful as both a pedagogical tool for training musicians and as an analytical tool for computational musicology.


Thank You!