Transferring Piano Performance Control Across Environments

Authors: Maoran Xu, Ziyu Wang, Gus G. Xia
Music X Lab @ NYUShanghai

Motivation:
- Physical Measurements: Sound effect varies across environments (including room effects and piano devices).
- Psychoacoustic studies: Pianists adjust their performance control (Force, duration and pedaling) in different environments.
- MIDI Representations of performance controls enables replications of music through Player Pianos.

Aim:
- Given Environment A and a piano performance under A, Find an optimal control in Environment B so that performance B sounds like A.

Contributions:
- First method to transfer controls on player pianos to cope with deviation of environments.
- Provide measurements of performance under different environments and conduct listening test upon them.

Transferring Piano Performance Control Across Environments

Measurement of Performance:
- Measured velocity-intensity effect and note duration-audible duration effect.
- Environments has effect on both curves.
- The two factors has interaction effect to each other.
- The pedals of two pianos mostly varies on the effective ranges.

Results:
- Transferring velocity and duration has significant listening effect.
- Listeners could not quite tell the difference between the effect of a sustain pedal and a hold-on note.

Future Works:
- We are currently moving on to explore the pedal transfer methods.
- Online learning can be applied to this algorithm and embedded in MIDI softwares connected to player pianos.

Transfer Method (PETA):
- Defined environmental effect functions
  \[ E_i(v_i, d_i) = f_i(v_i, d_i), \quad \forall (v_i, d_i) \in (L_i, D_i), \quad i = 1, 2 \]
- The optimal transferred control is a minimizer as
  \[ (v^*, d^*) = \arg\min_{(v, d)} \left| E_i(v, d) - (1, D) \right| \]
- Conduct the iterative coordinate-search algorithm until convergence.

Experiments:
- Implemented PETA on Mozart's sonata, Debussy's etudes and Chopin's etudes.
- Conducted a listening test with 20 music players.

Figure: [Image with data points and graphs]

Table: Representing Performance Controls
<table>
<thead>
<tr>
<th>Name</th>
<th>Pitch</th>
<th>Velocity</th>
<th>Onset</th>
<th>Duration</th>
<th>Sustain Pedal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notation</td>
<td>( p )</td>
<td>( v )</td>
<td>( o )</td>
<td>( d )</td>
<td>( S )</td>
</tr>
<tr>
<td>Value</td>
<td>0, 1, \ldots</td>
<td>0, 1, \ldots</td>
<td>127</td>
<td>Sec</td>
<td>Sec</td>
</tr>
</tbody>
</table>

The experiment was conducted at NYUShanghai with two Yamaha Disclavier player pianos.

Contact: maoranxu at ufl dot edu (+1-352-8709-590) or gxia at nyu dot edu

Download Poster: [Link]
Listen to Demos: [Link]