Visualizing Harmony
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Krumhansl-Schmuckler Algorithm
• Statistical measurement of the key
• Add durations of each pitch class
• Compare duration pattern to key prototype
• Choose best match as the key

Example: Typical major key distribution of notes:

Example data measured from music:

Well-Tempered Clavier (2)

Well-Tempered Clavier

Result of Humdrum key command:
Estimated key: C major (r=0.8640) confidence: 22.3%
<table>
<thead>
<tr>
<th>Fugue</th>
<th>Key</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C major</td>
<td>59.2%</td>
</tr>
<tr>
<td>2</td>
<td>C minor</td>
<td>70.1%</td>
</tr>
<tr>
<td>3</td>
<td>C# major</td>
<td>78.0%</td>
</tr>
<tr>
<td>4</td>
<td>C# minor</td>
<td>38.9%</td>
</tr>
<tr>
<td>5</td>
<td>D major</td>
<td>15.1%</td>
</tr>
<tr>
<td>6</td>
<td>D minor</td>
<td>56.5%</td>
</tr>
<tr>
<td>7</td>
<td>E-flat major</td>
<td>15.8%</td>
</tr>
<tr>
<td>8</td>
<td>D# minor</td>
<td>44.2%</td>
</tr>
<tr>
<td>9</td>
<td>E major</td>
<td>8.8%</td>
</tr>
<tr>
<td>10</td>
<td>E minor</td>
<td>45.4%</td>
</tr>
<tr>
<td>11</td>
<td>F major</td>
<td>39.9%</td>
</tr>
<tr>
<td>12</td>
<td>F minor</td>
<td>51.4%</td>
</tr>
<tr>
<td>13</td>
<td>F# major</td>
<td>15.6%</td>
</tr>
<tr>
<td>14</td>
<td>F# minor</td>
<td>52.1%</td>
</tr>
<tr>
<td>15</td>
<td>D major</td>
<td>18.5%</td>
</tr>
<tr>
<td>16</td>
<td>G minor</td>
<td>44.8%</td>
</tr>
<tr>
<td>17</td>
<td>A-flat major</td>
<td>33.5%</td>
</tr>
<tr>
<td>18</td>
<td>G# minor</td>
<td>62.1%</td>
</tr>
<tr>
<td>19</td>
<td>E major</td>
<td>3.8%</td>
</tr>
<tr>
<td>20</td>
<td>A minor</td>
<td>87.0%</td>
</tr>
<tr>
<td>21</td>
<td>B-flat major</td>
<td>44.7%</td>
</tr>
<tr>
<td>22</td>
<td>B-flat minor</td>
<td>57.5%</td>
</tr>
<tr>
<td>23</td>
<td>B major</td>
<td>16.3%</td>
</tr>
<tr>
<td>24</td>
<td>F# minor</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

**Well-Tempered Clavier (3)**

**Book 2:**

- Compositions are usually not all in one key
- How much music to consider when determining key?
- 4 measures is often good
- Depends on meter, rhythm, etc.

**Window Size**

- Compositions are usually not all in one key
- How much music to consider when determining key?
- 1 measure is usually not enough

**Window Size**

- Safe way is to consider all window sizes for analysis
2D Plot for Key Analyses

Window Size

Time

Start of piece

End of piece

One pixel for analysis result
Entire piece analyzed

Analysis window shrinks

Slide window to end of piece one pixel at a time.

Key to Color Mapping

- Rainbow mapped to circle of fifths
- Mostly a diatonic mapping
- Sufficient for tonal harmony
- Any mapping is possible
- Brightness/Contrast can also be used

For example:
Major/Minor \iff{} Bright/Dark
Example: Mozart Sonatina

Linear Picture of Key

C G D F C

2D Picture of Key

Logarithmic Scaling

Key of Piece
Strong Keys
Weak Keys
Tonicizations
Cadences
Chords

WTC1 Fugue 3

Schubert Variations
Atonal Music

Webern Op. 27, Mvmt. 1
Mozart Sonatina in C, Mvmt. 1

Pre-Tonal Music

Petrus de Cruce Motet (13th century)
Webern Op. 27 (20th century)

Extended Tonality

Scriabin
Op. 11 Prelude No. 4

Plot Variations

Ambiguity

Plot Variations

Clarity
Further Information

- Keyscape website:
  http://www-ccrma.stanford.edu/~craig/keyscape

- Written description:
  Presented at ICMC 2001, Havana, Cuba
  http://www-ccrma.stanford.edu/~craig/papers/01