Fundamentals of Music Processing

Chapter 1: Music Representations

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www.music-processing.de
Book: Fundamentals of Music Processing

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Musical information can be represented in many different ways. In Chapter 1, we consider three widely used music representations: sheet music, symbolic, and audio representations. This first chapter also introduces basic terminology that is used throughout the book. In particular, we discuss musical and acoustic properties of audio signals including aspects such as frequency, pitch, dynamics, and timbre.
1 Music Representations

Teaser
1.1 Sheet Music Representations

Fig. 1.1

Allegro con brio ($d = 108$)
1.1 Sheet Music Representations

Fig. 1.2

\[
\begin{array}{ccccccccccc}
D^\flat 3 & E^\flat 3 & G^\flat 3 & A^\flat 3 & B^\flat 3 & D^\flat 4 & E^\flat 4 & G^\flat 4 & A^\flat 4 & B^\flat 4 \\
C^\# 3 & D^\# 3 & F^\# 3 & G^\# 3 & A^\# 3 & C^\# 4 & D^\# 4 & F^\# 4 & G^\# 4 & A^\# 4 \\
C3 & D3 & E3 & F3 & G3 & A3 & B3 & C4 & D4 & E4 & F4 & G4 & A4 & B4 & C5
\end{array}
\]
1.1 Sheet Music Representations

Fig. 1.3
1.1 Sheet Music Representations

Fig. 1.4
1.1 Sheet Music Representations

Fig. 1.5

\[ \text{C4} \quad \text{D4} \quad \text{E}_4 \quad \text{F}_4 \quad \text{G}_4 \quad \text{A}_4 \quad \text{B}_4 \quad \text{C}_5 \]

\[ \text{C}_4 \quad \text{D}_4 \quad \text{E}_b^4 \quad \text{F}_4 \quad \text{G}_4 \quad \text{A}_b^4 \quad \text{B}_b^4 \quad \text{C}_5 \]
1.1 Sheet Music Representations

Fig. 1.6

[Diagram of sheet music with annotations for bar lines and measure (bar)]
1.1 Sheet Music Representations

Fig. 1.7
1.1 Sheet Music Representations

Fig. 1.8

Violin
Viola
Violoncello
1.1 Sheet Music Representations

Fig. 1.9

\[\begin{align*}
\text{crescendo} & \quad \text{diminuendo} & \quad \text{piano} & \quad \text{forte} \\
\end{align*}\]
1.1 Sheet Music Representations

Fig. 1.10
1.2 Symbolic Representations

Fig. 1.11
1.2 Symbolic Representations

Fig. 1.12
1.2 Symbolic Representations

Fig. 1.12
1.2 Symbolic Representations

Fig. 1.13

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<th>Channel</th>
<th>Note Number</th>
<th>Velocity</th>
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1.2 Symbolic Representations

Fig. 1.14
1.2 Symbolic Representations

Fig. 1.15

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    <alter>-1</alter>
    <octave>4</octave>
  </pitch>
  <duration>2</duration>
  <type>half</type>
</note>
```
1.3 Audio Representations

Fig. 1.16

- Jump directives
- Repeat with alternative endings
- OMR errors
- Transposing instruments
- Clarinet in B♭
- French Horn in F
- Bassoon
1.3 Audio Representations

Fig. 1.17
1.3 Audio Representations

Fig. 1.17

Pressure–time plot at a specific location

Air pressure deviation

Compression

Rarefaction

Average air pressure

Time
1.3 Audio Representations

Fig. 1.18
1.3 Audio Representations

Fig. 1.18
1.3 Audio Representations

Fig. 1.19
1.3 Audio Representations

Fig. 1.20
### 1.3 Audio Representations

#### Table 1.1

<table>
<thead>
<tr>
<th>Source</th>
<th>Intensity</th>
<th>Intensity level</th>
<th>× TOH</th>
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<td>Threshold of hearing (TOH)</td>
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<td>0 dB</td>
<td>1</td>
</tr>
<tr>
<td>Whisper</td>
<td>$10^{-10}$</td>
<td>20 dB</td>
<td>$10^2$</td>
</tr>
<tr>
<td>Pianissimo</td>
<td>$10^{-8}$</td>
<td>40 dB</td>
<td>$10^4$</td>
</tr>
<tr>
<td>Normal conversation</td>
<td>$10^{-6}$</td>
<td>60 dB</td>
<td>$10^6$</td>
</tr>
<tr>
<td>Fortissimo</td>
<td>$10^{-2}$</td>
<td>100 dB</td>
<td>$10^{10}$</td>
</tr>
<tr>
<td>Threshold of pain</td>
<td>10</td>
<td>130 dB</td>
<td>$10^{13}$</td>
</tr>
<tr>
<td>Jet take-off</td>
<td>$10^2$</td>
<td>140 dB</td>
<td>$10^{14}$</td>
</tr>
<tr>
<td>Instant perforation of eardrum</td>
<td>$10^4$</td>
<td>160 dB</td>
<td>$10^{16}$</td>
</tr>
</tbody>
</table>
1.3 Audio Representations

Fig. 1.21

![Graph showing intensity vs. frequency with thresholds labeled](image)
1.3 Audio Representations

Fig. 1.22
1.3 Audio Representations

Fig. 1.22

![Diagram of audio representations showing amplitude over time with stages: A (attack), D (decay), S (sustain), R (release).]
1.3 Audio Representations

Fig. 1.23
1.4 Further Notes

Fig. 1.24