Introduction to **Audio Content Analysis**

module 7.2: representation of pitch in music

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introduction
overview

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corresponding textbook section

section 7.2

- **lecture content**
    - pitch-related music terminology: interval, mode, tonic, chord

- **learning objectives**
    - name musical intervals and notate them in score notation
    - explain pitch distance
    - discuss whether a chord is a harmony

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overview

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  - pitch-related music terminology: interval, mode, tonic, chord
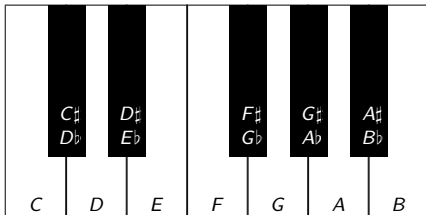
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musical pitch
notation and names

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each octave (freq factor 2) is split into 12 pitch classes

musical pitch
intervals

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Interval	Enharmonic Equivalent	ΔST
Unison	Diminished Second	0
Minor Second	Augmented Unison	1
(Major) Second	Diminished Third	2
Minor Third	Augmented Second	3
Major Third	Diminished Fourth	4
(Perfect) Fourth	Augmented Third	5
Augmented Fourth	Diminished Fifth/Tritone	6
(Perfect) Fifth	Diminished Sixth	7
Minor Sixth	Augmented Fifth	8
Major Sixth	Diminished Seventh	9
Minor Seventh	Augmented Sixth	10
Major Seventh	Diminished Octave	11
(Perfect) Octave	Augmented Seventh	12

Unison Min. 2nd Maj. 2nd Min. 3rd Maj. 3rd 4th

Dim. 5th 5th Min. 6th Maj. 6th Min. 7th Maj. 7th

musical pitch
MIDI pitch

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$$\mathfrak{p}(f) = 69 + 12 \cdot \log_2\left(\frac{f}{f_{A4}}\right)$$

$$f(\mathfrak{p}) = f_{A4} \cdot 2^{\frac{\mathfrak{p}-69}{12}}$$

MIDI pitch mapping to *pitch class*

$$PC(\mathfrak{p}) = \mod(\mathfrak{p}, 12)$$

musical pitch
MIDI pitch

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musical pitch
(MIDI) pitch distance

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cent: pitch distance between two frequencies

$$
\begin{aligned}
\Delta C(f_1, f_2) &= 100 \cdot \big(\mathfrak{p}(f_1) - \mathfrak{p}(f_2)\big) \\
&= 100 \cdot \left(\left(69 + 12 \cdot \log_2\left(\frac{f_1}{f_{A4}}\right) \right) - \left(69 + 12 \cdot \log_2\left(\frac{f_2}{f_{A4}}\right) \right) \right) \\
&= 1200 \cdot \log_2\left(\frac{f_1}{f_2}\right)
\end{aligned}
$$

$\Rightarrow 100 \, \text{cents}$ span one semitone

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musical pitch
temperament

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- equally tempered scale:
  - octave split into 12 equidistant notes (on log scale)
  - not key dependent,any modulation possible
  - enharmonic equivalence: $C\sharp = D\flat$
  - typical scale for keyboard instruments

$$\frac{f_1}{f_2} = 2^{N/12}$$

- other scales can sound purer for specific keys but are less commonly used

musical pitch
intonation & vibrato

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- **expressive intonation**: deviation of pitch frequency from temperament depending on musical context
  - leading tones
  - "pure" intervals

- **vibrato**
  - periodic modulation around mean pitch
  - frequency: app. 4–10 Hz, range: app. 20–300 cents

- applies only to instruments with
  - continuous frequency range (most strings, strings, woodwinds, brasses...)
  - active performance (no digital weapons or guitar, sound like instrument...)

musical pitch
intonation & vibrato

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- applies only to instruments with
    - continuous frequency scales: vocals, string instruments, trombone, . . .
    - other possibilities to adjust frequency: guitar, wind instruments, . . .

musical pitch
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summary
lecture content

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- **pitch**
  - each octave split into 12 pitches
  - *pitch class* is an octave-independent representation of pitch

- **intervals**
  - distance between two pitches

- **cent**
  - metric for pitch distance