Introduction to Audio Content Analysis

Module 7.2: Representation of Pitch in Music

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introduction

overview

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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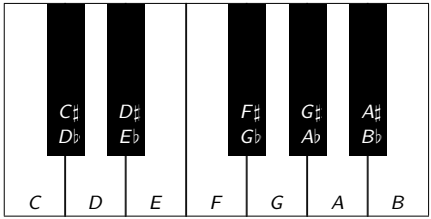
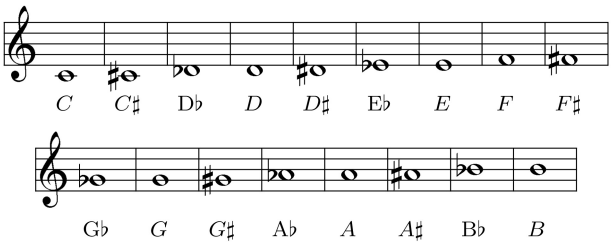
musical pitch

notation and names

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

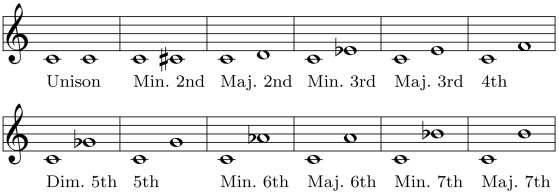




0	1	2	3	4	5	6	7	8	9	10	11
C	C♯/D♭	D	D♯/E♭	E	F	F♯/G♭	G	G♯/A♭	A	A♯/B♭	B

musical pitch
intervals

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



musical pitch

MIDI pitch

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

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

MIDI pitch mapping to *pitch class*

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

musical pitch

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musical pitch
(MIDI) pitch distance

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

- 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

- **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 scales: vocals, string instruments, trombone, ...
  - pitch possibilities to adjust frequency: guitar, wind instruments, ...

musical pitch
intonation & vibrato

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summary
lecture content

- **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