

The Composer's Materials

Module 1 of *Music: Under the Hood*

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Outline

- Basic elements of music
- Musical notation
- Harmonic partials
- Intervals and chords
- Keys
- Cadences
- Temperament
- Alternative Scales
- Just tuning



Basic Elements of Music

- **Rhythm**

- Everyone loves music with a “beat”
 - Some composers emphasize rhythm
 - Stravinsky, jazz composers, pop stars
- Rhythm is ever-present
 - Heartbeat, walking
 - Same tempos reflected in music!
- Rhythm and dance are universal
 - Dance seems to be genetic in humans



Basic Elements of Music

- **Melody**

- **Based in song**

- Some composers emphasize melody
 - Chopin, Broadway composers

- **Song is basic to human expression**

- May be original form of communication
 - Later replaced by language



Western Music

- **Harmony**

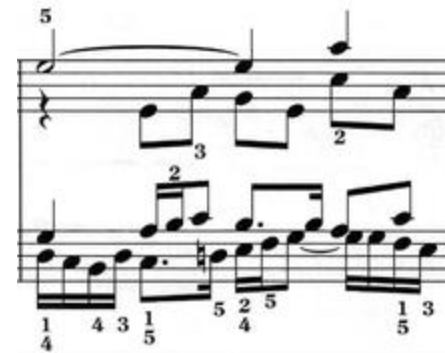
- A fundamental characteristic of music

- Even a single tone creates harmony (upper partials)
- Allows us to make sense of tones sounded together

- **Counterpoint**

- Interaction of different “voices”

- We can follow the voices if they are in harmony.



Western Music

- **Abstraction**

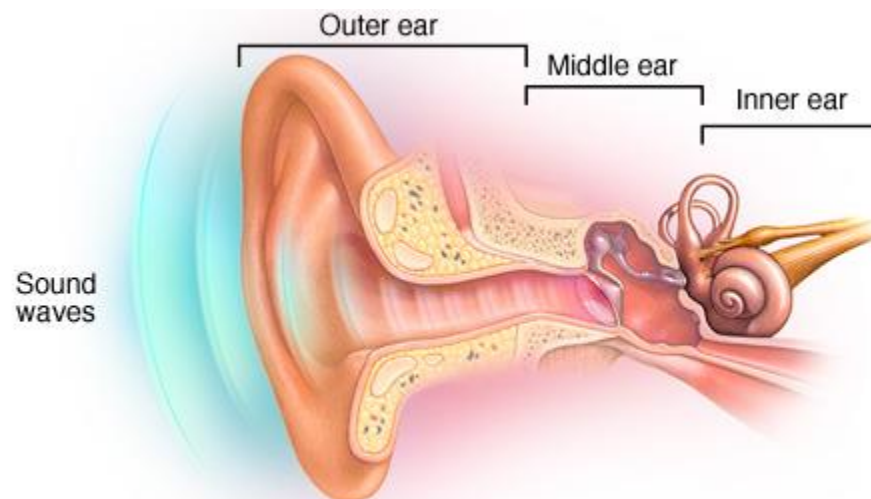
- Western music is fundamentally abstract
 - Rather than representational.
 - Exceptions: Beethoven's *Pastoral Symphony*, etc.
- Most **visual** art is representational
 - Exception: Islamic art
 - Even “abstract” art is often representational



Western Music

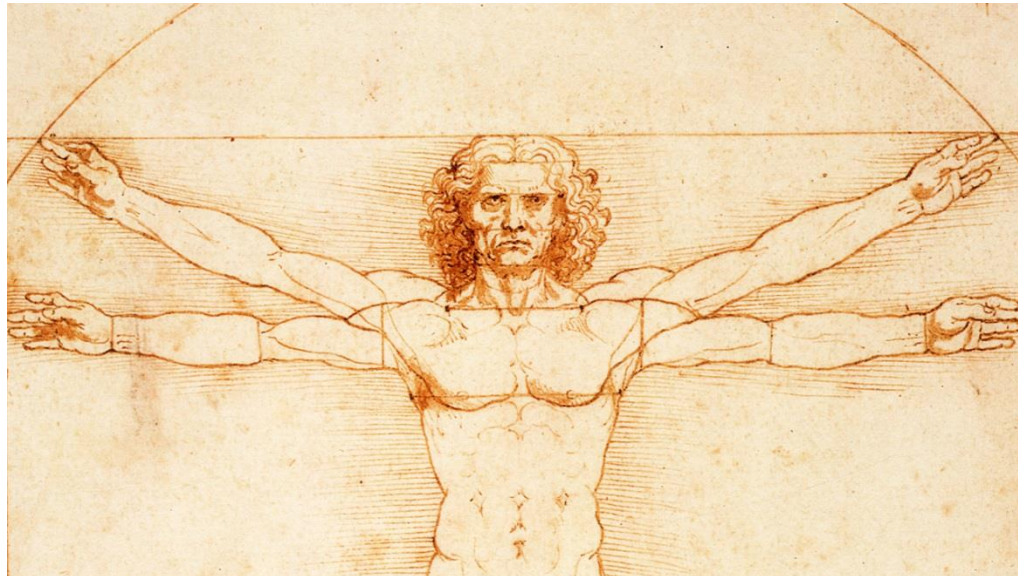
- **It is complex**

- The ear is analytic like no other sense
 - Breaks down every sound into its components
 - The eye cannot do this.
 - Western music takes advantage of this.
- This allows us to understand multiple voices
 - Makes harmony & counterpoint possible.



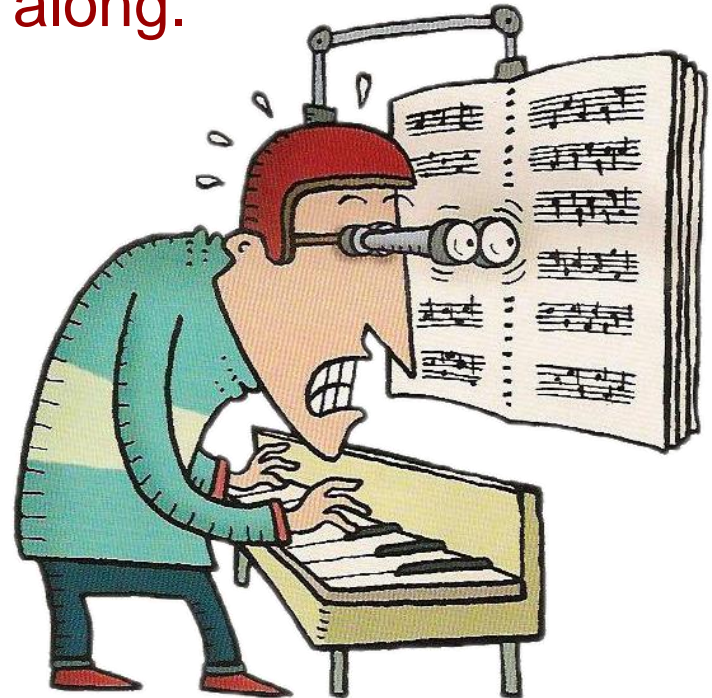
Western Music

- **Basic challenge of Western music**
 - Make abstract music intelligible
 - This course is about how composers do this.
 - Address the full human being
 - Intellectual as well as emotional.



Musical Notation

- One doesn't "read" music as one reads French.
 - It is a **graphic** representation
 - The development of notation made Western music possible.
 - You will catch on as we go along.



Musical Notation

[Audio file](#)

Low notes appear lower
High notes appear higher

Piano

8 Consecutive notes form a scale using white notes on the piano.

Pno.

Treble clef

Bass clef

Musical Notation

15 Notes that are vertically aligned sound together

Pno.

The image shows a piano score for measures 15 through 22. The right hand (treble clef) plays chords in measures 15, 16, 17, and 18, then rests in measures 19, 20, 21, and 22. The left hand (bass clef) plays chords in measures 15, 16, 17, and 18, then rests in measures 19, 20, 21, and 22. The notes in the first four measures are vertically aligned, illustrating that notes that are vertically aligned sound together.

23 Notes with more black move faster

Pno.

The image shows a piano score for measures 23 through 26. The right hand (treble clef) plays a sequence of notes that become increasingly dense and faster, while the left hand (bass clef) plays rests in all four measures. This illustrates that notes with more black (sharps) move faster.

Musical Notation

27 Attaching a sharp makes the note a half-step higher (the next highest black key on the piano).

Pno.

This is called the chromatic scale.

The image shows a piano score for a chromatic scale starting on G4. The score is written for piano (Pno.) and consists of two staves: a treble clef staff and a bass clef staff. The treble staff begins with a whole rest, followed by a series of eighth notes: G4, G#4, A4, A#4, B4, B#4, and C5. The bass staff begins with a whole rest, followed by a series of eighth notes: G3, G#3, A3, A#3, B3, B#3, and C4. The text 'This is called the chromatic scale.' is written in the center of the music.

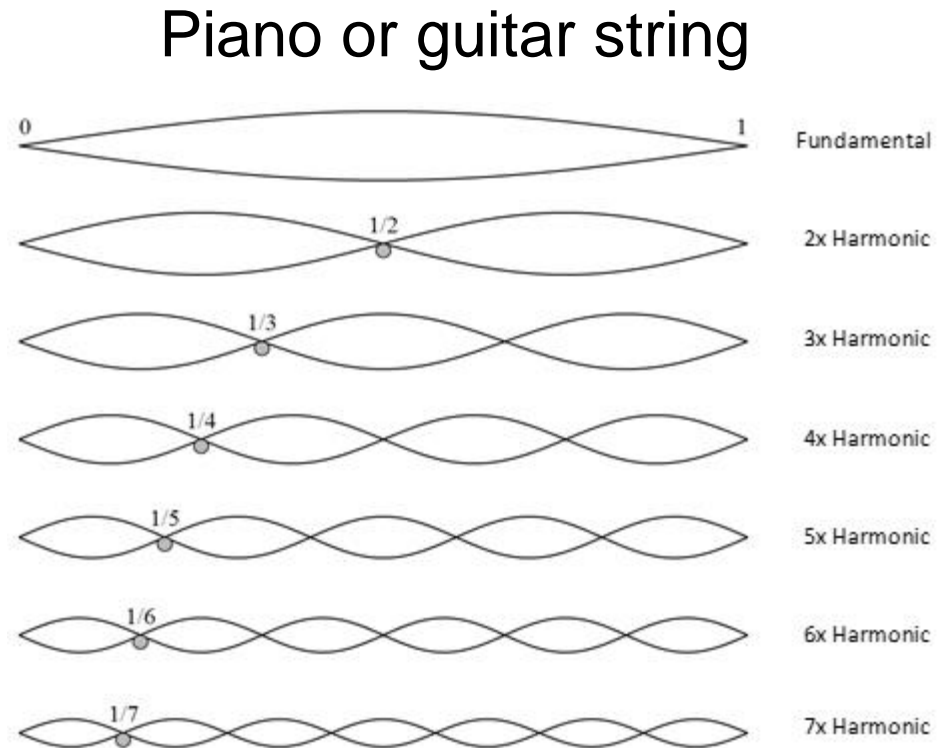
34 Attaching a flat makes the note a half-step lower (the next lowest black key on the piano).

Pno.

The image shows a piano score for a chromatic scale starting on G4 and moving downwards. The score is written for piano (Pno.) and consists of two staves: a treble clef staff and a bass clef staff. The treble staff begins with a series of eighth notes: G4, Gb4, F4, Fb4, E4, Eb4, and D4. The bass staff begins with a series of eighth notes: G3, Gb3, F3, Fb3, E3, Eb3, and D3. The piece concludes with a double bar line.

Harmonics

- Acoustic instruments generate **harmonics** of each tone
 - Multiples of the original frequency.
 - Also called **harmonic partials** or **overtones**
 - 1st overtone = 2nd harmonic



Harmonics

- Harmonic series
 - Add harmonics one at a time...

[Audio file](#)

Flute

1st 2nd 3rd 4th 5th 6th 7th 8th

Fundamental

This one is slightly flatter than played

Harmonics

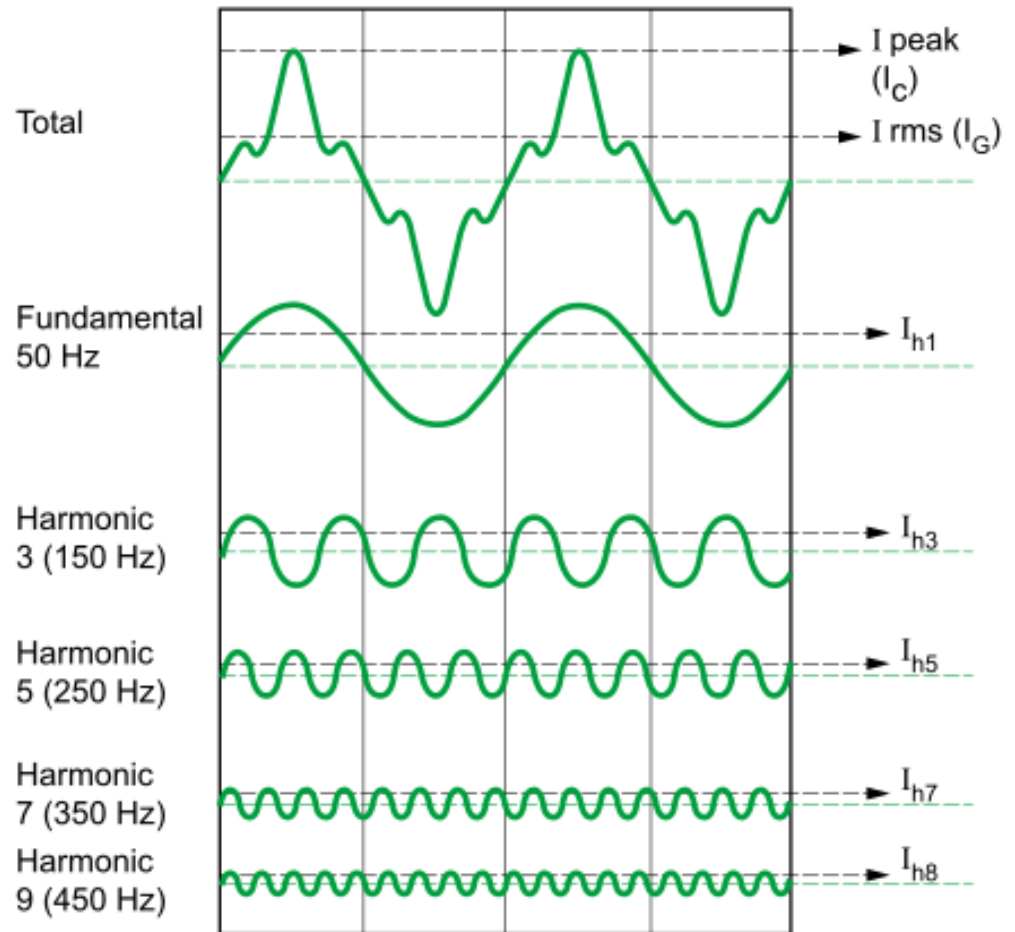
- Musical timbre

- is based on the relative strength of harmonics

- This is **Fourier analysis**

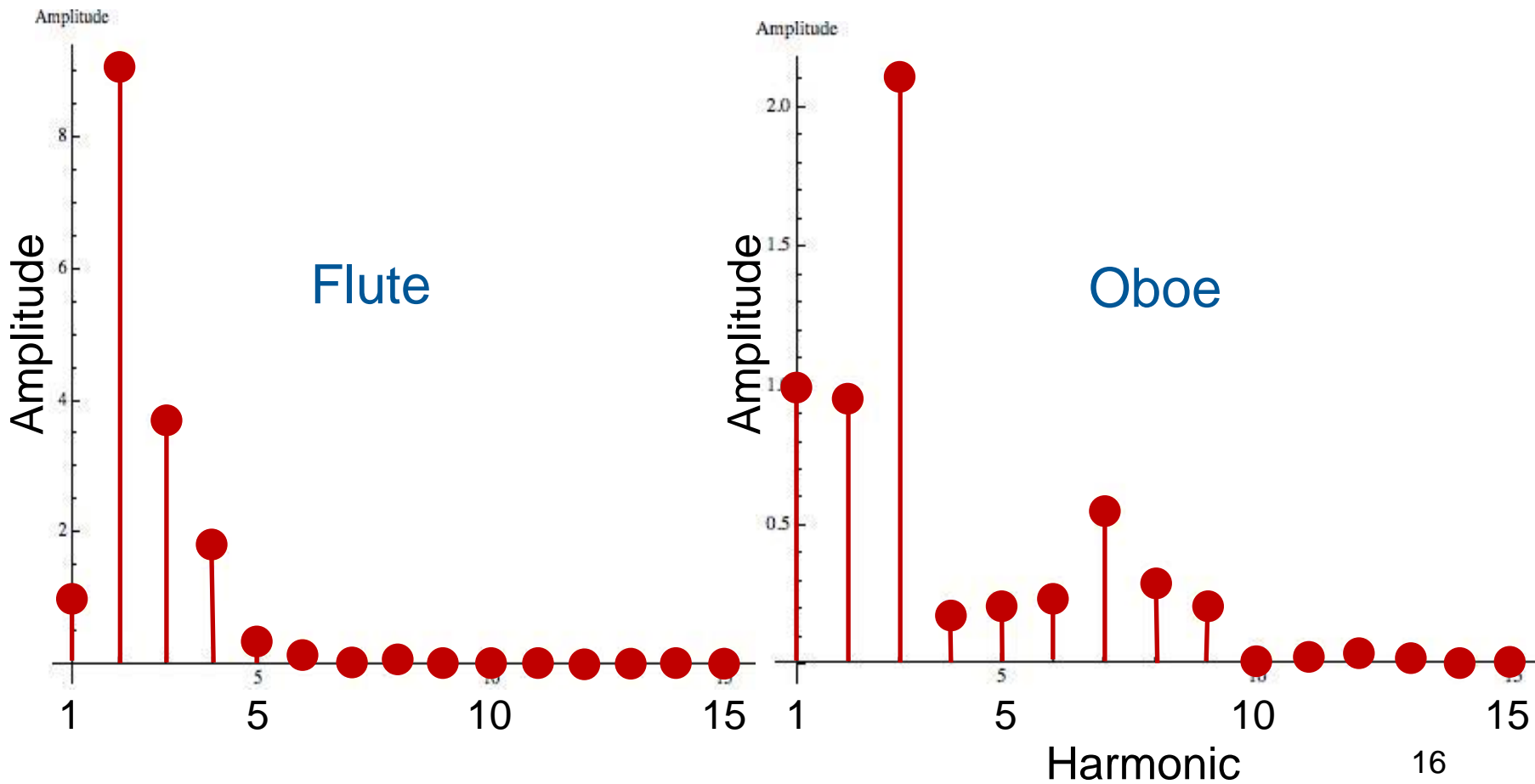


- The ear performs Fourier analysis!



Harmonics

For example...



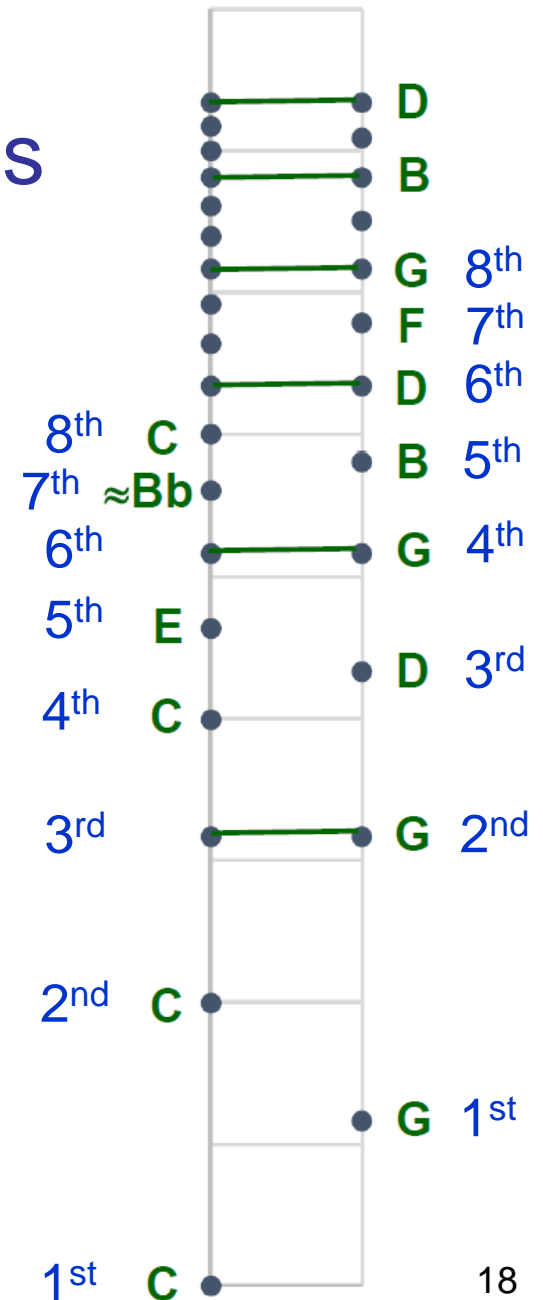
Harmonious Intervals

- It is easy to recognize intervals whose frequencies have simple ratios.
 - They have many harmonics in common.

Harmonious Intervals

- It is easy to recognize intervals whose frequencies have simple ratios.
 - They have many harmonics in common.
 - For example, a **perfect fifth**...

Harmonics of C and G,
which have frequency ratio 2:3



Harmonious Intervals

- Example
 - Perfect fifth C-G

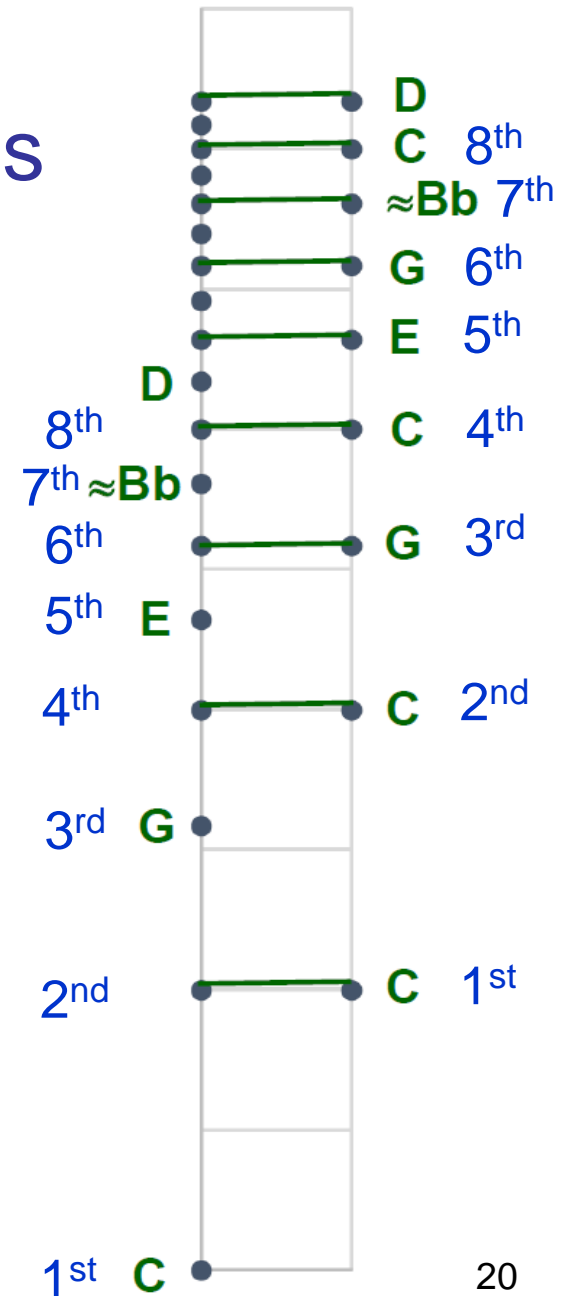
[Audio file](#)

C with harmonics G with harmonics C + G with harmonics

Harmonious Intervals

- It is easy to recognize intervals whose frequencies have simple ratios.
 - They have many harmonics in common.
 - For example, an **octave**...

Harmonics of C and C octave,
which have frequency ratio 1:2



Harmonious Intervals

- Example
 - Octave C-C

[Audio file](#)

The image displays three musical examples on a single staff with a treble clef. The first example, labeled '15', shows a C note on the first line with a series of six harmonics above it. The second example shows a C note on the first line with a series of three harmonics above it. The third example shows a C note on the first line with a series of six harmonics above it, and a C note on the first line with a series of six harmonics below it. Blue arrows point from the labels below to the corresponding notes in each example.

C with harmonics

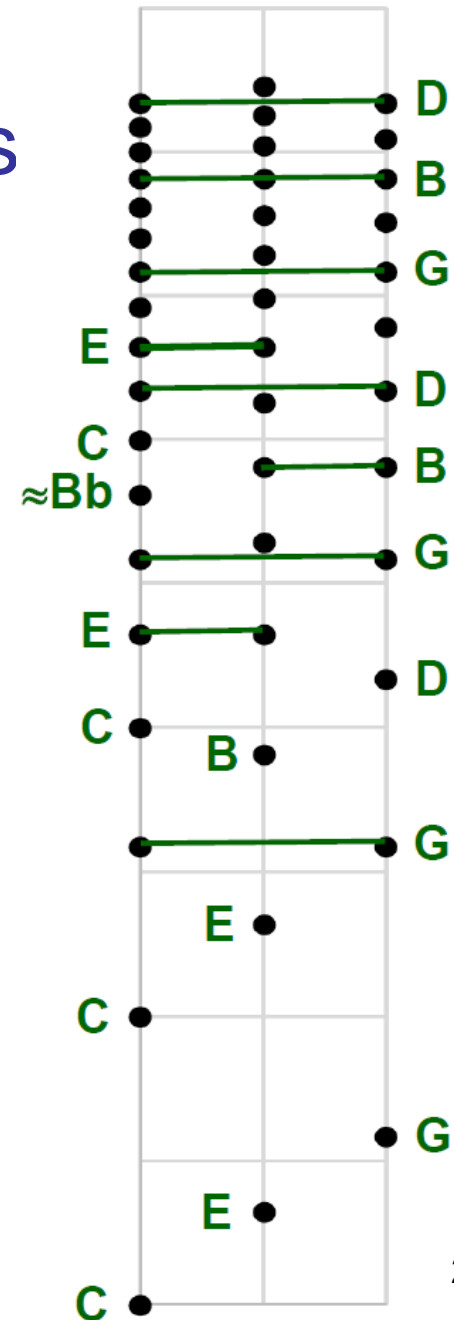
C octave with harmonics

C + octave with harmonics

Harmonious Intervals

- It is easy to recognize intervals whose frequencies have simple ratios.
 - They have many harmonics in common.
 - For example, a **major triad**...

Harmonics of C, E and G,
which have frequency ratios 3:4:5



Harmonious Intervals

- Example
 - Major triad C-E-G

[Audio file](#)

The image displays a musical staff with a treble clef and a key signature of one sharp (F#). The staff is divided into four measures. The first measure shows a single note C (middle C) with its harmonics (C2, C3, C4, C5, C6, C7) represented by circles on the staff. The second measure shows a single note E (E4) with its harmonics (E2, E3, E4, E5, E6, E7). The third measure shows a single note G (G4) with its harmonics (G2, G3, G4, G5, G6, G7). The fourth measure shows the combined harmonics of the C-E-G triad, with a key signature change to two sharps (F# and C#) indicated by a double sharp sign. Blue arrows point from the labels below to the notes in the first three measures.

23

C with harmonics

E with harmonics

G with harmonics

C+E+G with harmonics

Intervals

Ratios with smaller numbers indicate greater consonance

[Audio file](#)

The image displays two staves of musical notation in 4/4 time, illustrating various intervals and their corresponding frequency ratios. The first staff shows intervals from the second to the fifth, and the second staff shows intervals from the minor sixth to the octave. Each interval is represented by a pair of notes on a staff, with the interval name and ratio written above it. The ratios are: Second (8:9), Minor third (5:6), Major third (4:5), Fourth (3:4), Tritone (32:45), and Fifth (2:3) on the first staff; and Minor sixth (5:8), Major sixth (3:5), Minor seventh (9:16), Major seventh (8:15), and Octave (1:2) on the second staff. A small number '4' is placed above the Fourth interval, and a small number '7' is placed above the Minor sixth interval.

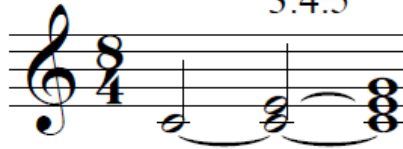
Interval	Ratio
Second	8:9
Minor third	5:6
Major third	4:5
Fourth	3:4
Tritone	32:45
Fifth	2:3
Minor sixth	5:8
Major sixth	3:5
Minor seventh	9:16
Major seventh	8:15
Octave	1:2

Common chords

Ratios with smaller numbers indicate greater consonance

[Audio file](#)

Major triad
3:4:5



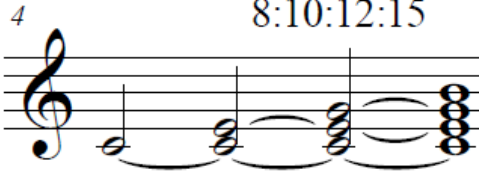
Major sixth chord
12:15:18:20



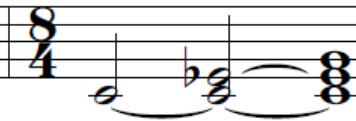
Dominant seventh chord
36:45:54:64



Major seventh chord
8:10:12:15



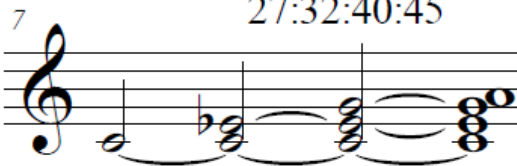
Minor triad
10:12:15



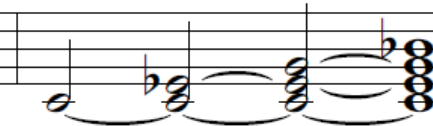
Diminished chord
125:150:180:216



Minor sixth chord
27:32:40:45



Minor seventh chord
10:12:15:18



Augmented triad
16:20:25



Chords

Example: "Blue Moon" (1933)

Richard Rogers (music) and Lorenz Hart (lyrics)

[Audio file from *Manhattan Melodrama* \(1934\) 0:06](#)

[Audio file of the excerpt below](#)

The image displays two systems of piano accompaniment for the song "Blue Moon". Each system consists of a grand staff with a treble and bass clef. Above the first system, six chord types are labeled: Major triad, Minor triad, Minor 7th, Dominant 7th, Major triad, and Minor triad. Above the second system, seven chord types are labeled: Minor 7th+9th, Dominant 7th + 6th, Major triad, Minor triad, Minor 7th, Dominant 7th+4th, 9th, and Major triad. Below the staves, a series of figured bass notations are provided, including symbols like "Leo." and asterisks. The first system covers measures 1 through 6, and the second system covers measures 7 through 12.

Chords

Example: Diminished chord

J. S. Bach

TOCCATA II.

Adagio.

Diminished chord

[Audio file \(0:11\)](#)

Manuale.

Pedale.

The first system of the score is for the 'Adagio' section. It consists of three staves: the top staff is the right hand (Manuale), the middle staff is the left hand (Pedale), and the bottom staff is the right hand (Manuale) again. A red box highlights a diminished chord in the right hand, consisting of the notes G4, B4, and D5.

Prestissimo.

The second system of the score is for the 'Prestissimo' section. It consists of three staves: the top staff is the right hand (Manuale), the middle staff is the left hand (Pedale), and the bottom staff is the right hand (Manuale) again. The music is characterized by rapid sixteenth-note passages in both hands.

Chords

Example: Minor 6 chord

Most popular sound for US freight trains

[Audio file \(0:08\)](#)



Chords

Example: "Five Minutes More" (1946)
Jule Styne (music) and Sammy Cahn (lyrics)

[Audio file](#)

The image displays a musical score for the song "Five Minutes More". It features a vocal line and a piano accompaniment. The score is annotated with chord diagrams and labels. The lyrics are: "Give me Five Min - utes More on - ly Five Min - utes More. Let me stay, let me stay."

Chord diagrams and labels are provided for the piano accompaniment:

- Major 6th (Red boxes):** C6, Db7, C6, E7, F6
- Minor 7th (Blue boxes):** A7, Dm7, D7, G7, Dm7

Handwritten annotations include fingerings (e.g., 3 4 2, 3 5 3 2 1) and circled notes in the piano part.

Chords

Example: "Five Minutes More" (1946)

The image shows a musical score for the song "Five Minutes More" (1946). The score is written in treble and bass clefs. The lyrics are: "in your arms Here am I beg - ging for on - ly Five Min - utes More, On - ly Five Min - utes More of your charms." The score includes chord diagrams for various chords: G7, C6, G11, D♭7, E7, F6, A7, Dm7, D7, G7, and F7. The C6 chords are highlighted with red boxes, and the Dm7 chords are highlighted with blue boxes. Handwritten annotations in red and blue ink are present, including the words "Major 6th" and "Minor 7th".

Major 6th

Minor 7th

Chord diagrams shown: G7, C6, G11, D♭7, E7, F6, A7, Dm7, D7, G7, C6, F7.

Chords

Example: "A Man and a Woman" (1946)
Francis Lai (music) and Pierre Barouh (lyrics)

[Audio file](#)

Moderately

Dmaj7

Major 7th

When hearts are pass-ing in the night, In the lone-ly night.
si-lence of the mist, Of the morn-ing mist.

mp - mf

Detailed description: This block shows the first system of the musical score. It features a vocal line and a piano accompaniment. The tempo is marked 'Moderately'. A guitar chord diagram for Dmaj7 is shown above the vocal line. An orange box highlights a section of the piano accompaniment, with the text 'Major 7th' written above it. The lyrics are: 'When hearts are pass-ing in the night, In the lone-ly night. si-lence of the mist, Of the morn-ing mist.' The dynamic marking is *mp - mf*.

C#7

Then they must hold each oth-er tight, Oh so ver-y tight—
When lips are wait-ing to be kissed, Long-ing to be kissed,—

Detailed description: This block shows the second system of the musical score. It features a guitar chord diagram for C#7 above the vocal line. The lyrics are: 'Then they must hold each oth-er tight, Oh so ver-y tight— When lips are wait-ing to be kissed, Long-ing to be kissed,—'

Chords

Example: "A Man and a Woman" (1946)

The image displays two systems of musical notation for the song "A Man and a Woman" (1946). Each system includes a vocal line, a piano accompaniment, and guitar chord diagrams. The first system features a Cmaj7 chord diagram and the text "Major 7th" in orange. The second system features F#m7, B7, and Ema7 chord diagrams. Orange boxes highlight the piano accompaniment for the first system and the piano accompaniment for the second system, specifically the section corresponding to the Ema7 chord.

System 1:

Chord: Cmaj7

Major 7th

Lyrics: — And take a chance that in the light In to - mor - row's light
— Where is the rea - son to re - sist And de - ny a kiss.

System 2:

Chords: F#m7, B7, Ema7

Lyrics: — They'll stay to - geth - er — So much in love. And in the
— That holds a prom - ise — Of hap - pi - ness.

1. Tacet

Chords

Example: "A Man and a Woman" (1946)

Skipping to the end of the song...

Major 7th

fraid to take the chance, Real-ly take a chance Let your heart be-gin to dance,
mu-sic of a glance Of a fleet-ing glance to the mu-sic of ro-mance,

1. 2.

Let it sing and dance to the take a chance.
Of a new ro-mance

Keys

- One can start a scale on any one of the 12 chromatic notes.
 - This produces the 12 **keys**.
- Some keys are more **distant** from the **tonic** key
 - Tonic key = the one we start the music in.
 - More distant keys have **fewer notes in common**.



Keys

Some closely related keys

[Audio file](#)

C major scale = tonic = I G major = dominant = V

Piano

The image shows two musical staves for piano in 4/4 time. The first staff is for the C major scale, labeled 'C major scale = tonic = I'. It consists of eight measures: four ascending (C4, D4, E4, F4, G4, A4, B4, C5) and four descending (C5, B4, A4, G4, F4, E4, D4, C4). The second staff is for the G major scale, labeled 'G major = dominant = V'. It also consists of eight measures: four ascending (G4, A4, B4, C5, B4, A4, G4, F4) and four descending (G4, F4, E4, D4, C4, B3, A3, G3). The G major scale includes a sharp sign for the F#4 note.

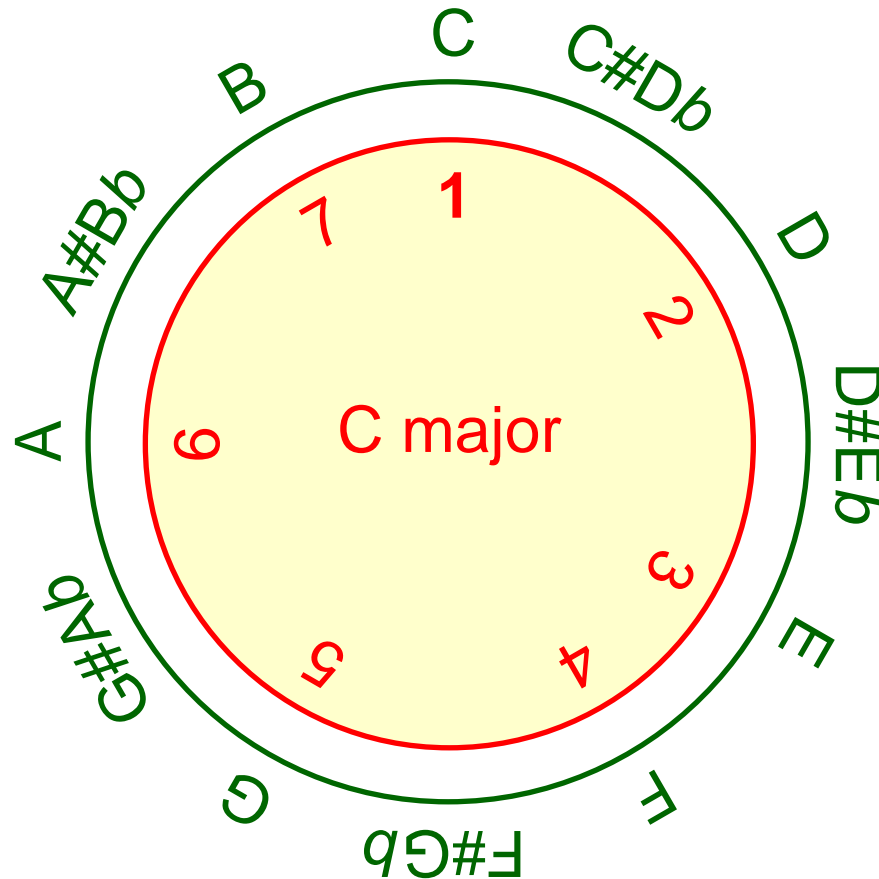
7 F major = subdominant = IV A minor = relative minor = vi

Pno.

The image shows two musical staves for piano in 4/4 time. The first staff is for the F major scale, labeled 'F major = subdominant = IV'. It starts at measure 7 and consists of eight measures: four ascending (F4, G4, A4, Bb4, C5, Bb4, A4, G4) and four descending (F4, E4, D4, C4, B3, A3, G3, F3). The second staff is for the A minor scale, labeled 'A minor = relative minor = vi'. It also consists of eight measures: four ascending (A3, B3, C4, D4, E4, F4, G4, A4) and four descending (A4, G4, F4, E4, D4, C4, B3, A3). The A minor scale includes a flat sign for the Bb4 note.

Keys

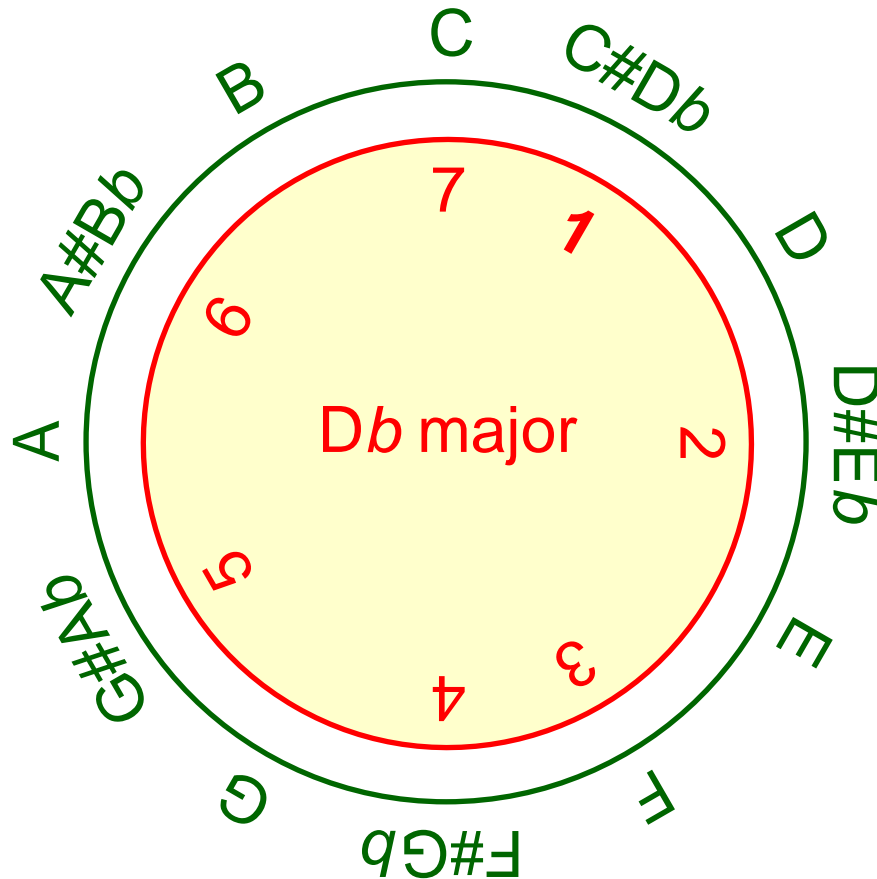
Let C major be
the tonic key



0 notes
not in C major
I = Tonic

Keys

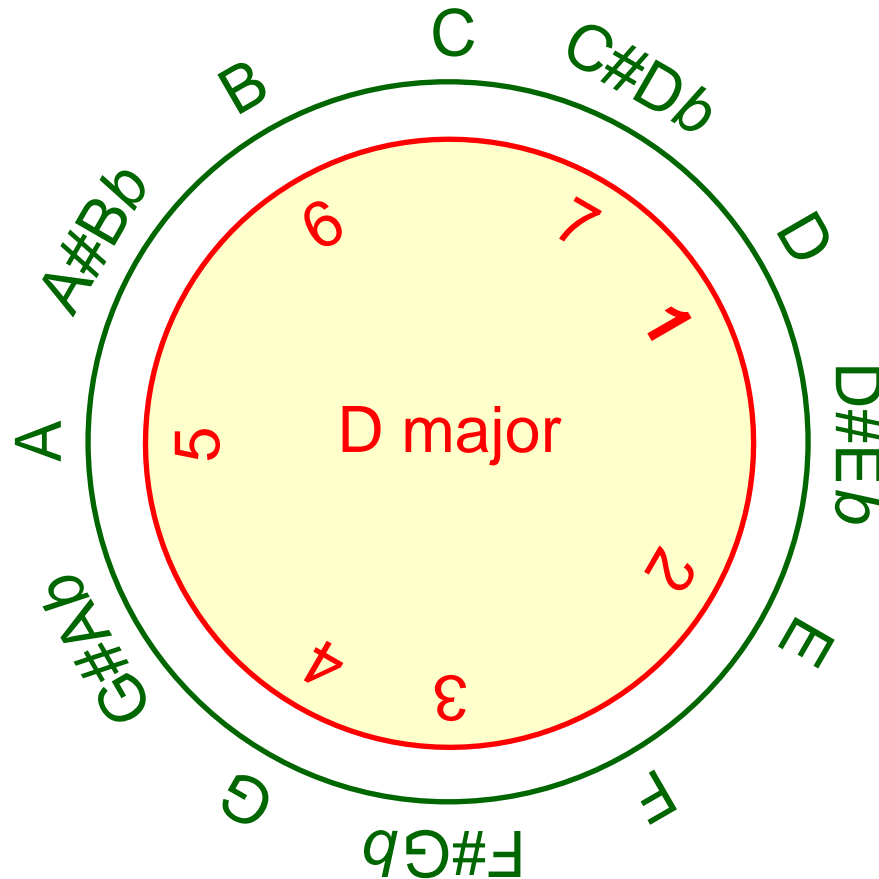
Let C major be
the tonic key



5 notes
not in C major

Keys

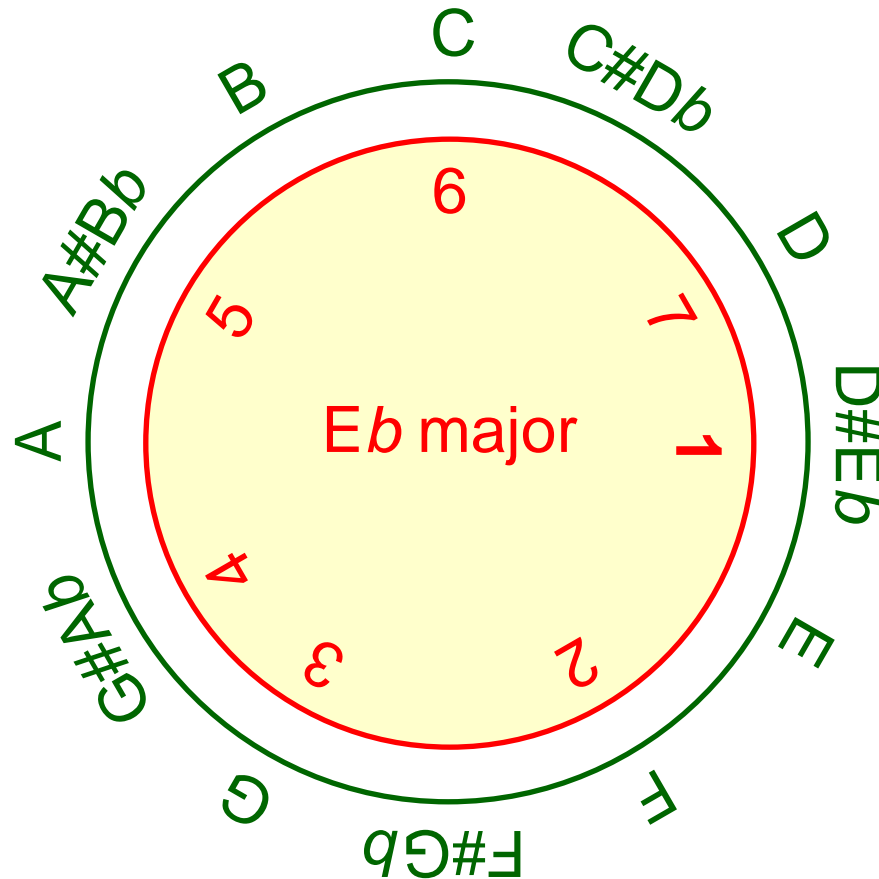
Let C major be
the tonic key



2 notes
not in C major
II

Keys

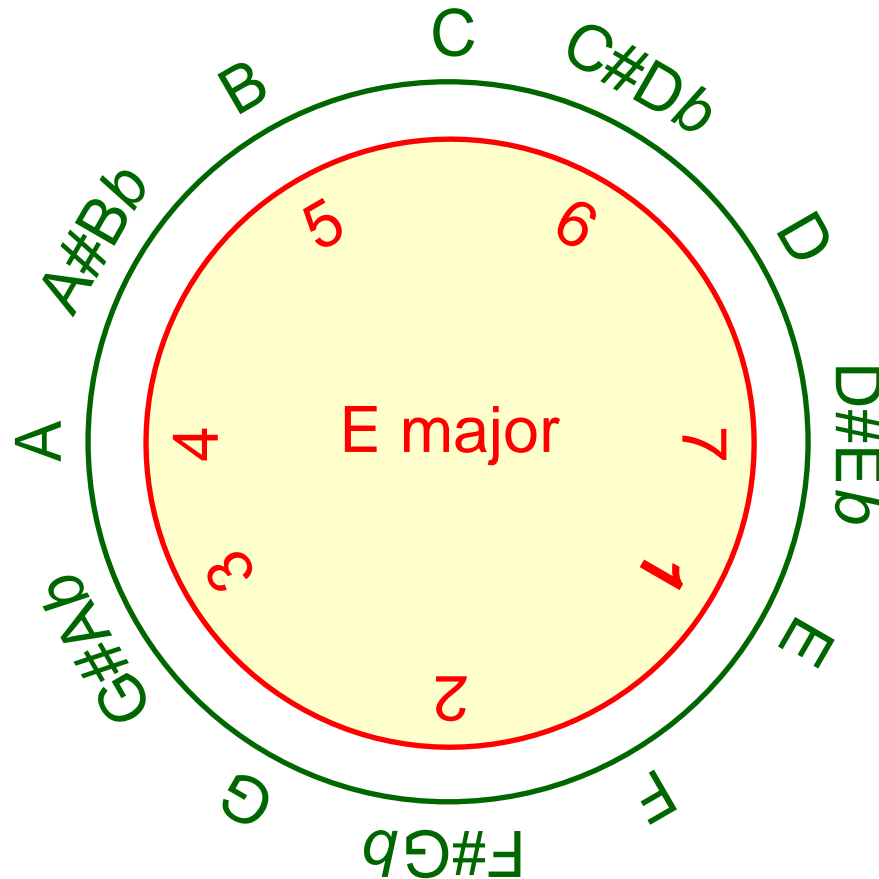
Let C major be
the tonic key



3 notes
not in C major

Keys

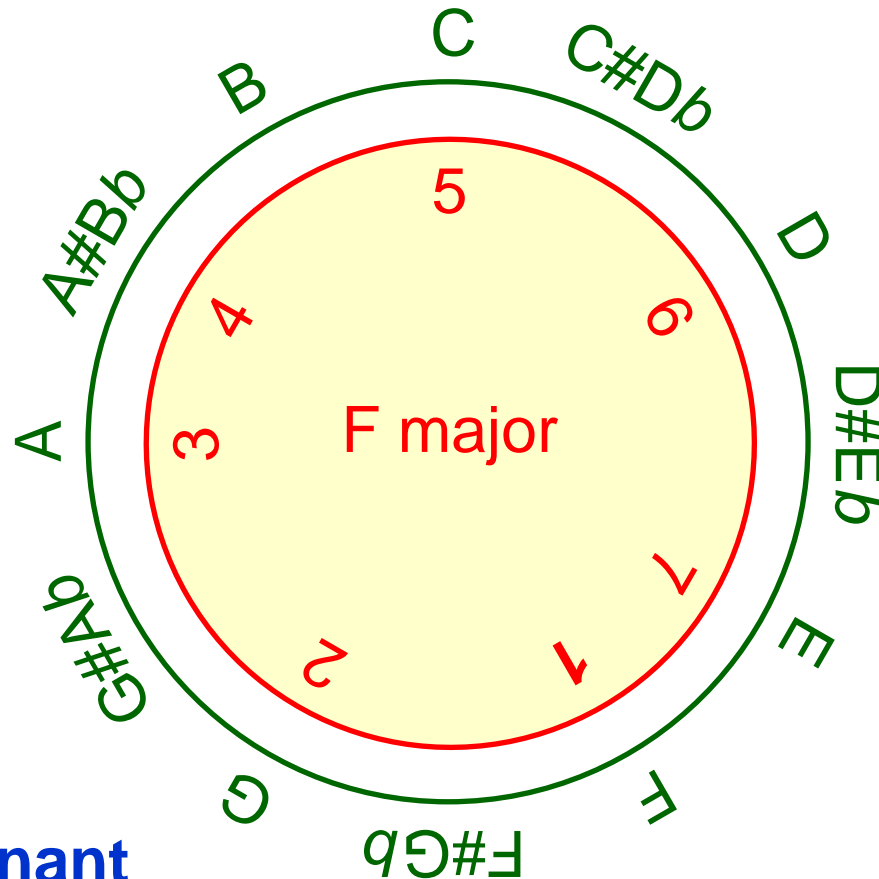
Let C major be
the tonic key



4 notes
not in C major
III = Mediant

Keys

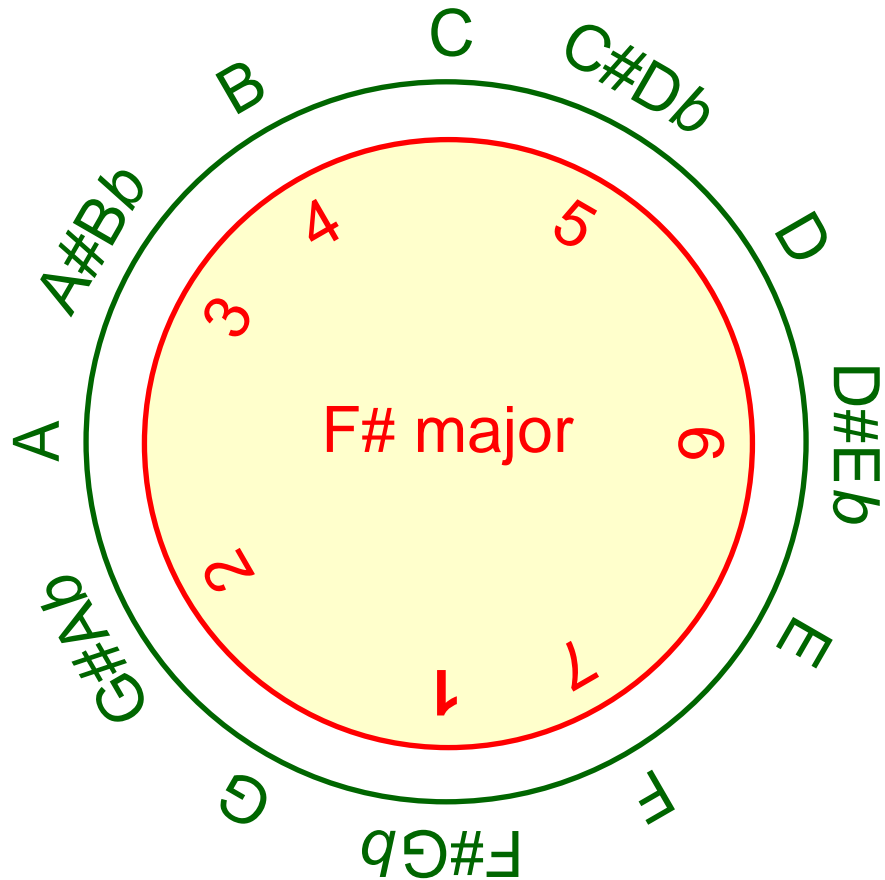
Let C major be
the tonic key



1 note
not in C major
IV = Subdominant

Keys

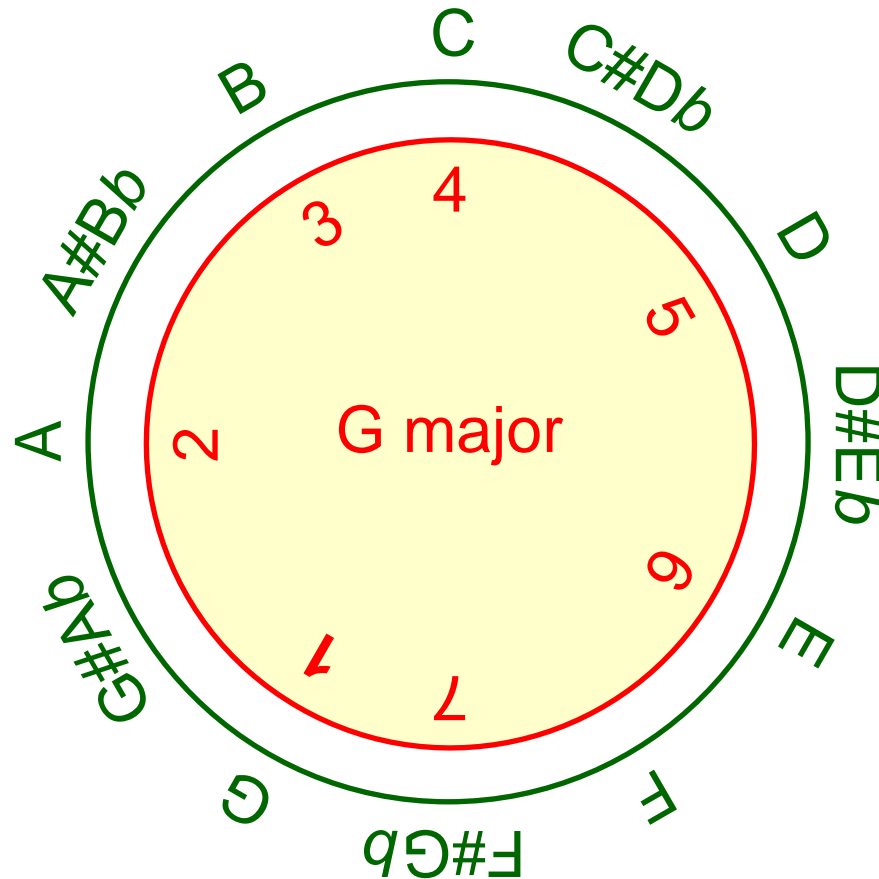
Let C major be
the tonic key



6 notes
not in C major

Keys

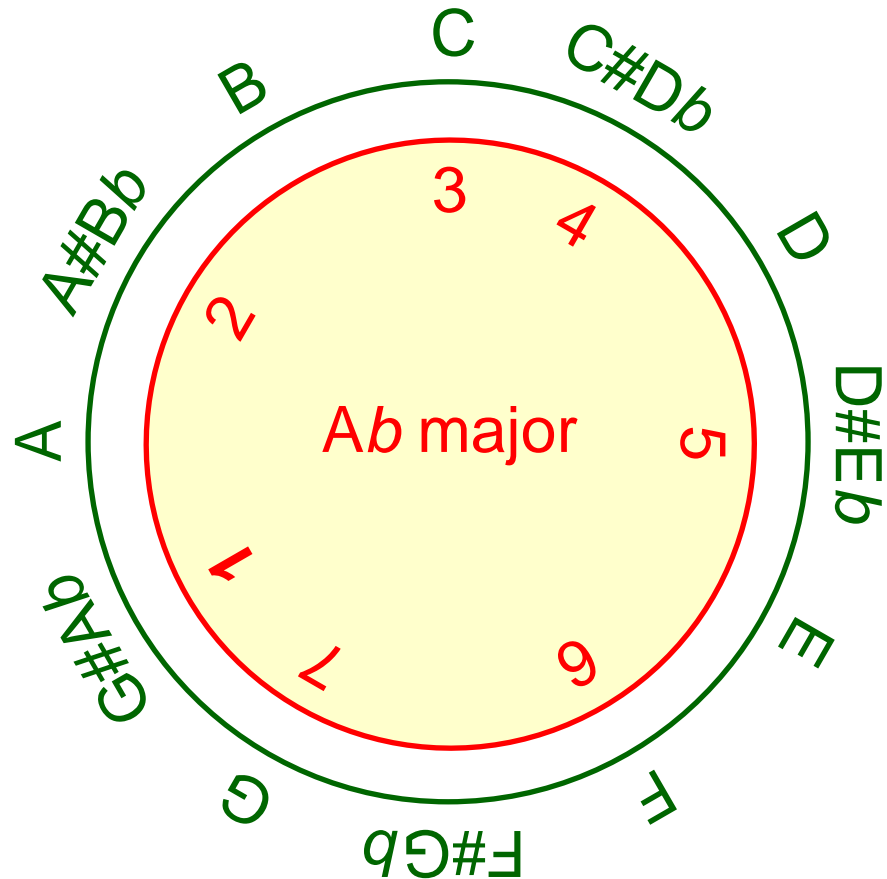
Let C major be
the tonic key



1 note
not in C major
V = dominant

Keys

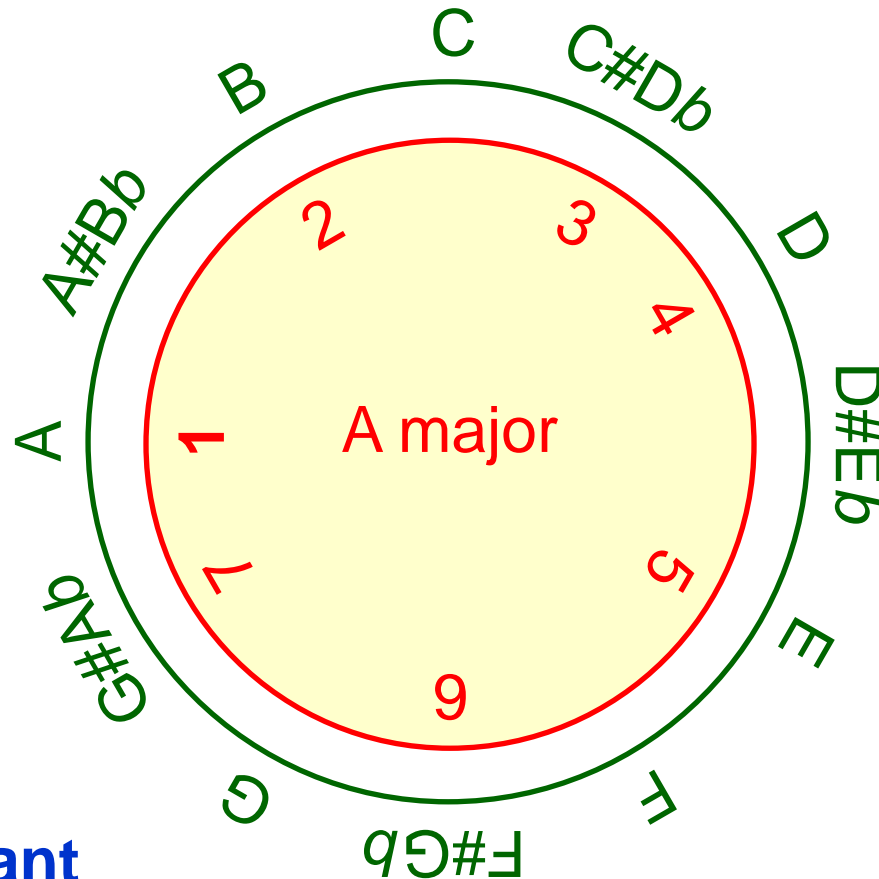
Let C major be
the tonic key



4 notes
not in C major

Keys

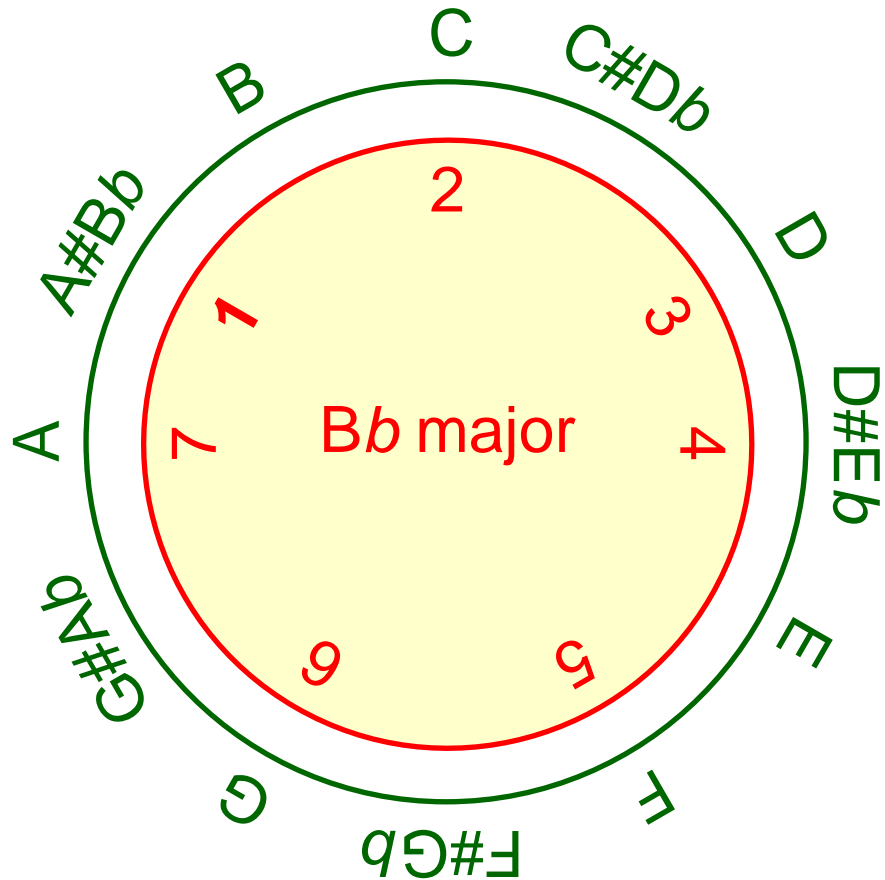
Let C major be
the tonic key



3 notes
not in C major
VI = submediant

Keys

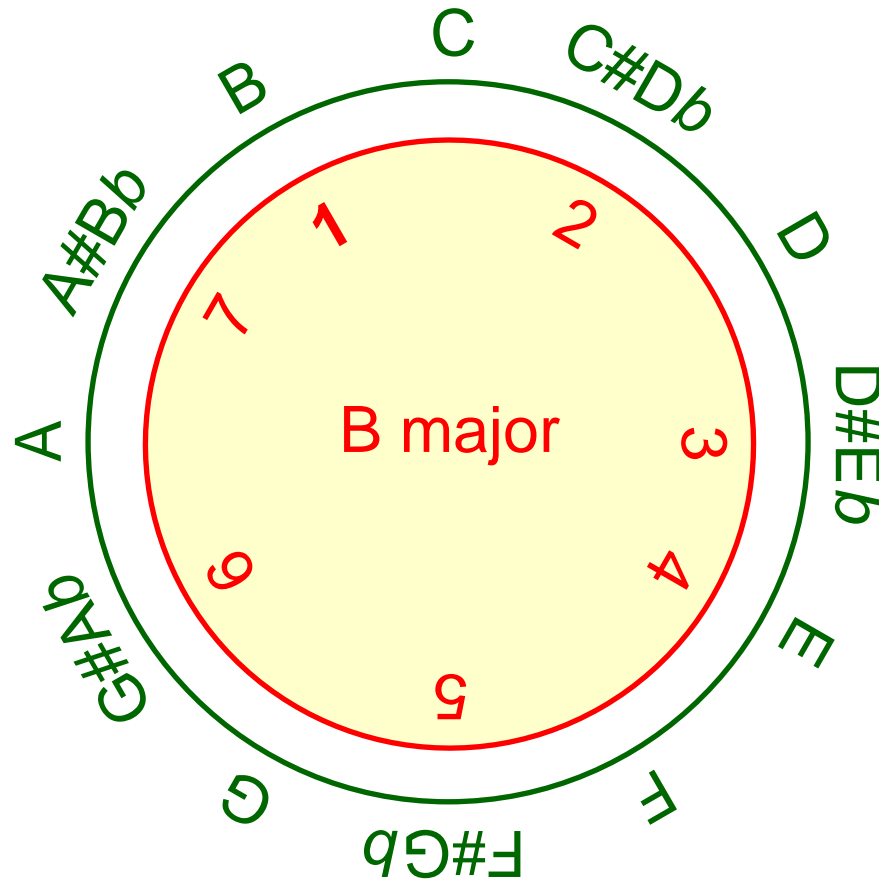
Let C major be
the tonic key



2 notes
not in C major

Keys

Let C major be
the tonic key



5 notes
not in C major
VII

Keys

- Western music likes travel & adventure...
 - Start at home (tonic)
 - Travel to other lands (other keys)
 - Return home (tonic)
- Much music moves from tonic to dominant to tonic (I-V-I)
 - The return to the tonic is a **cadence**.

Cadences

[Audio file](#)

Cadence with passing tone

Cadence with suspension

1 I V I V⁷ I I V I

Piano

Cadence with appoggiatura

Plagal cadence (amen)

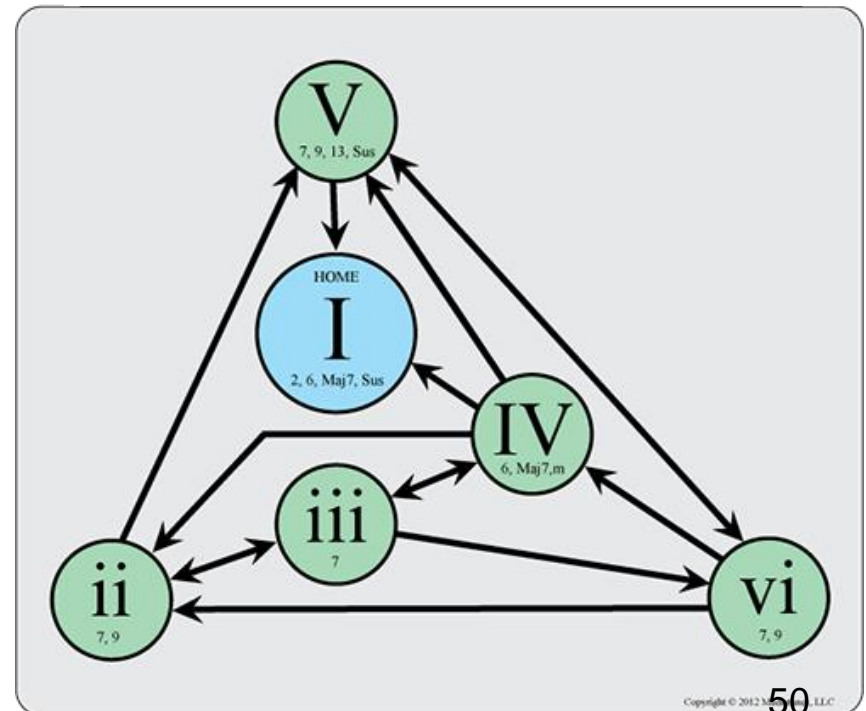
Deceptive cadence

8 I V I I IV I I V VI^b

Pno.

Cadences

- Dominant 7th chord is from V-I cadence
 - Passing tone creates 7th chord
 - Dominant 7th chord does not “lead to” tonic
- Harmony should flow organically from the music
 - Not be imposed from outside as a “standard” chord progression.



Cadences

Example: Adagio Cantabile from Pathétique Sonata L. van Beethoven (1798)

[Audio file \(performance\)](#)

[Audio file
\(excerpt\)](#)

$\text{♩} = 60$ I. Ab major - - - - - Bb⁷ V. Eb major - -

Piano

----- I. Ab - - - F⁷ ii. Bb - - - V. Eb - - - I. Ab major (appoggiatura)

5

Pno.

Temperament

- There is a problem with playing all the keys with only 12 different notes.
 - The harmonic intervals are not exactly right.
- The pitches are adjusted so that every key is slightly out of tune.
 - The errors are the same in every key
 - **This is equal temperament.**



Temperament

Interval	Error
C-D (second)	Slightly flat
C-E (major third)	Sharp
C-F (fourth)	Slightly sharp
C-G (fifth)	Slightly flat
C-A (sixth)	Sharp
C-B (seventh)	Sharp

Alternative Scales

- Are the traditional scales the best choice?
 - They are the **second best** choice!

Alternative Scales

- Are the traditional scales the best choice?
 - They are the **second best** choice!
- The 19-tone chromatic is a better choice.
 - Based on a complete [combinatorial search](#).
 - Provides a larger set of consonant chords.
 - Basis for many interesting scales.

Alternative Scales

- Are the traditional scales the best choice?
 - They are the **second best** choice!
- The 19-tone chromatic is a better choice.
 - Based on a complete [combinatorial search](#).
 - Provides a larger set of consonant chords.
 - Basis for many interesting scales.
- Why didn't someone discover the 19-note chromatic?

Alternative Scales

- Are the traditional scales the best choice?
 - They are the **second best** choice!
- The 19-tone chromatic is a better choice.
 - Based on a complete [combinatorial search](#).
 - Provides a larger set of consonant chords.
 - Basis for many interesting scales.
- Why didn't someone discover the 19-note chromatic?
 - **Someone did!**

Alternative Scales

- Advantages of 19-note chromatic were discovered during the Renaissance.
 - By Spanish organist and music theorist **Francisco de Salinas** (1530-1590).



An 11-note scale on 19-note chromatic

[Audio file](#)

- For comparison, chords from the classic major scale.
 - Major scale
 - Major triad 4:5:6
 - Major 7th 8:10:12:15
 - Minor triad 10:12:15
 - Minor 7th 10:12:15:18
 - Dominant 7th 36:45:54:64
 - Jazz chords (tensions)

An 11-note scale on 19-note chromatic

[Audio file](#)

- Chords from an 11-note scale.
 - The scale
 - Major triad 4:5:6
 - Minor triad 10:12:15
 - Minor 7th 10:12:15:18
 - New chord 5:6:7:9
 - New chord 6:7:8:10
 - New chord 7:8:10:12
 - New chord 4:5:6:7
 - Tensions



Just Tuning

- Voices, violins, etc. don't have a problem with temperament.
 - They can produce perfect intervals with “just tuning.”
 - This can lead to striking harmonic effects.



Just Tuning

Example: “Earth Song” for SATB Frank Ticheli (2006)

[Audio file \(choral performance\)](#)

[Audio file \(excerpt below\)](#)

$\text{♩} = 50$

The image shows a musical score for SATB voices in 4/4 time. The tempo is marked as quarter note = 50. The score consists of four staves: Soprano, Alto, Tenor, and Bass. Each staff has a treble clef (except for the Bass staff which has a bass clef) and a key signature of one flat (B-flat). The lyrics are: Sing, Be, Live, See. The music features a mix of quarter and eighth notes, with some notes beamed together. There are also some rests and fermatas. The lyrics are written below the notes, with lines indicating where the notes should be placed.

Soprano
Sing, Be, Live, See.

Alto
Sing, Be, Live, See.

Tenor
Sing, Be, Live, See.

Bass
Sing, Be, Live, See.

Just Tuning

Example: “Earth Song” for SATB
Frank Ticheli (2006)

Ticheli's chord



[Audio file](#)

	Soprano/alto clash	Expand to maj 7th now consonant 4:6:10:15:16	Lower the 3rd still consonant 4:6:9:15:16	Drop root 6:9:15:16
Piano				

- The chord is **consonant** when performed with just tuning.
- Also, the A-B \flat clash produces a **beat note** that is exactly 2 octaves below the root B \flat .

Just Tuning

Example: “Alleluia” for SATB
Randall Thompson (1940)

Audio file

- Entire text consists of 2 words from Hebrew – *Alleluia, Amen*
- Performed by Octarium.
- Written for opening of Berkshire Music Center (Tanglewood)
- An example of how beautiful harmonious voices can be.
- Note major 6th chords (3 different inversions) just after climax.

Ozawa Hall, Tanglewood

