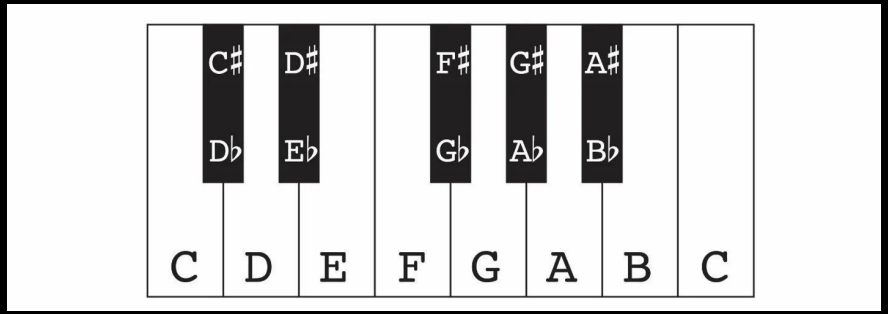
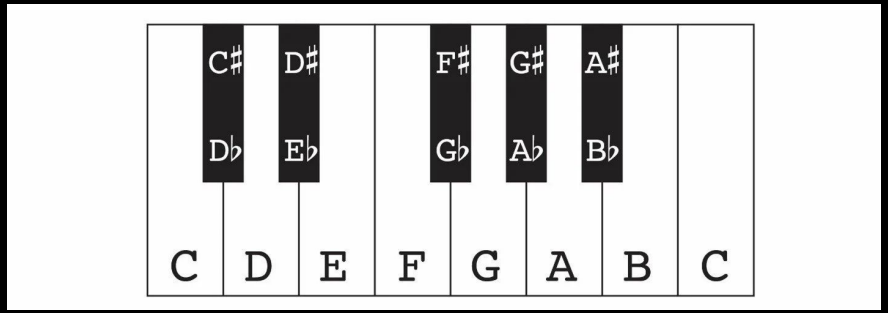
Secondary Dominant Detection within Chord Progressions

Andy Huynh



Music Theory Background

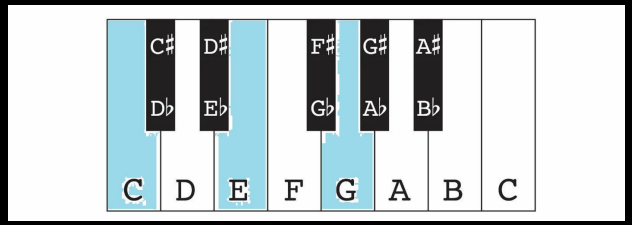
- In classical western music theory, there are twelve distinct notes
- Notes are named by their letter and the accidental
  - Letter goes is in the range A-G
  - Accidental can be natural (no accidental), sharp (denoted by #), flat (denoted by b)



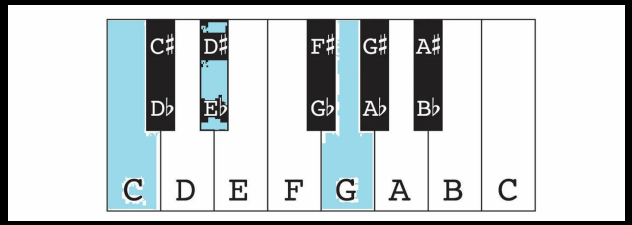
What is a chord?

- A chord is a combination of three or more notes played together to create harmony
- Chords have a quality associated with them
  - Major
  - Minor
  - Dominant

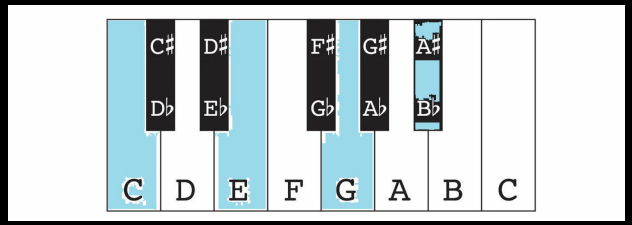
What is a chord?



C Major: C E G



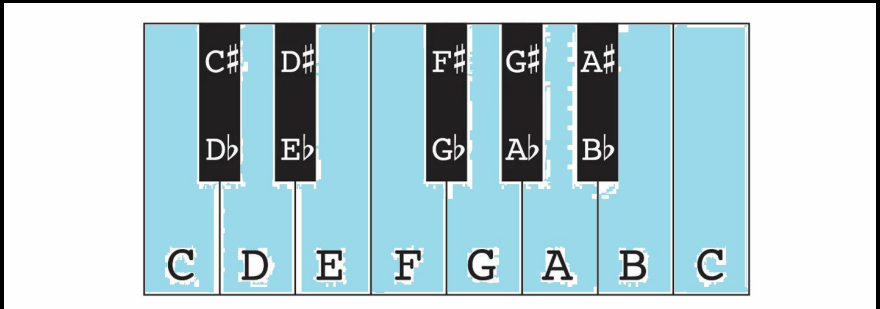
C Minor: C Eb G



C Dominant: C E G Bb

What is a scale?

- A series of notes collected together that can be used to form harmonies and melodies
- C Major scale
  - Consists of all the natural notes (white keys on the keyboard)

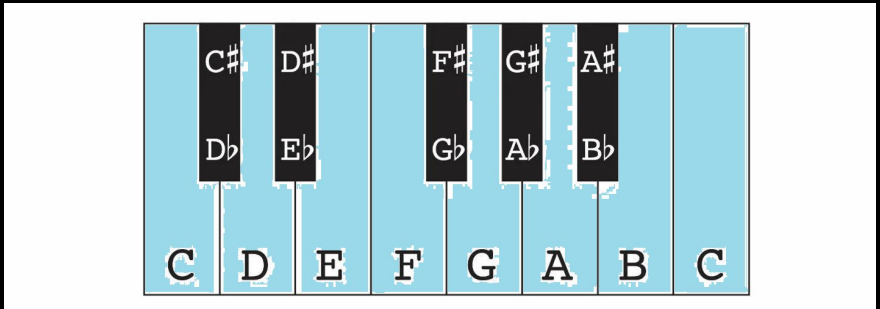


What chords can be formed in the C Major scale?

For every note in the scale, we can build a chord based off of it

Basic rule for forming chords in a scale is to start on note in the scale and skip every other note in the scale

- C E G
- D F A



What chords can be formed in the C Major scale?

Based off a note's relative position in the scale (the degree), we assign it a roman numeral

Degree relative position in the scale

- C E G - I
- D F A - ii
- E G B - iii
- F A C - IV
- G B D - V
- A C E - vi
- B D F - vii°

Chord Functions

Depending on the degree of the chord, each chord has its own function in the scale

Three functions

- Tonic (feel at rest/homely)
- Dominant (high tension, wanting to resolve to the tonic)
- Subdominant (chord that sets up a dominant chord)

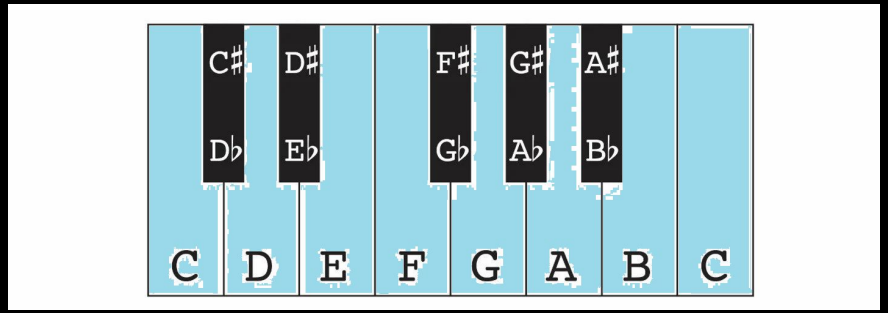
- C E G - I Tonic
- D F A - ii Subdominant
- E G B - iii Tonic
- F A C - IV Subdominant
- G B D - V Dominant
- A C E - vi Tonic
- B D F - vii° Dominant

Dominant Chords

- Let’s focus on two chords in the C major scale:
  - I - C E G C Major Chord
  - V - G B A G Major Chord
- G Major is the V chord in the key of C Major
- This means that it is a dominant chord with respect to C
- G Major resolves nicely to C

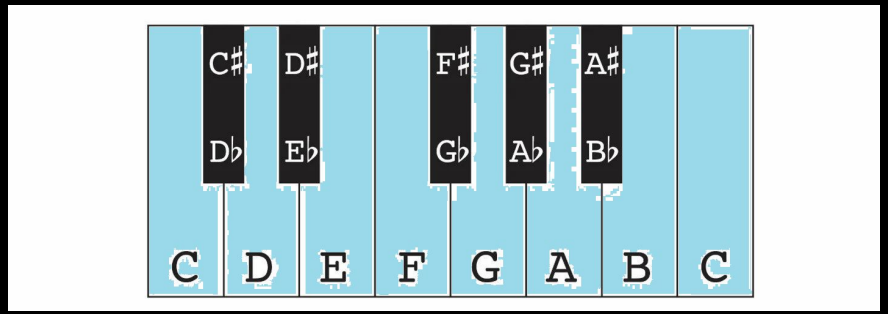
Secondary Dominant Chords

- We know that G Major can resolve us to C Major
- What if we want to resolve to some other chord
- Let's say in our chord progression is in C Major, but we wish to temporarily resolve to G Major
- We would need to use the dominant chord with respect to G Major



Secondary Dominant Chords

- Using the same rules as earlier, this would be the V Chord in the G Major scale
- To skip to the answer: We would need to use the chord
  - D F# A
- An issue immediately becomes apparent
- That chord does not exist in our key of C Major



What is a Secondary Dominant

- A secondary dominant is when you temporarily use notes from outside your current key to form a dominant chord
- That dominant chord then resolves to something that is not the tonic note

Dataset collection

- Programmatically generate chord progressions that are 8 chords long
- Use a python library called midiutil to turn these chord progressions into a midi file
  - Each chord is played for a length of 2 seconds
- Use a cli tool called Fluidsynth to render the midi into a wave using a soundfont
  - Soundfonts are essentially virtual instruments
  - Turns the midi from just music data into real audio with various instruments
- Generate 1000 data points for each category

Features

- Harmonic Pitch Class Profile (HPCP)
- For every frame of the music HPCP gives you a vector of length 12
- Each vector represents the intensity of a given pitch in that particular frame
- However, there is one issue with this...

Features

- HPCP gives you this information for every frame of the audio
- Models we learned in class aren't sufficient enough to compute data across a time span like this
- I know the generated dataset contains 8 chords, each 2 seconds long
- I divide the audio samples into 8 segments representing the eight chords
- For each of these segments
    - Compute the HPCP for all frames within the segment
    - Compute the mean and standard deviation of intensity for each note
    - 24 features per each segment
- Concatenate the features for all the segments together
- End result of 24 * 8 =192 features