CS5001 Final Project V2 Report

Shang Xiao

March 30, 2022

1 Project Background Description

I will be designing a new program for my final project because we have covered the Tower of Hanoi game in Module 7 related to recursion.

Chord diagrams for beginners is a mini-program that can teach beginners how to play basic chords of a specific song on their guitar. The end goal is to get everybody playing on their guitar regardless of their musical backgrounds.

2 Required Element Planning

Each guitar chord diagram is unique to that specific chord itself. When looking at the chord diagram, players can play the chord on their guitar by a single strum from string six to one, given the correct finger positions placed on each fret and string of their guitar.

To start, we need to understand how a guitar works. Below is a fretboard of the guitar which are very commonly seen in real life:

Figure 1: Guitar fretboards

Python has a built-in library called Matplotlib, which we have experienced in a previous project, Lottery Simulation. A sample Matplotlib version of a guitar fretboard is shown below:

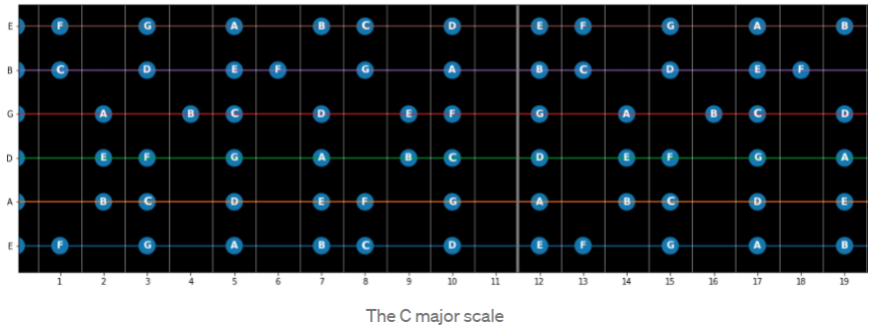

Figure 2: Advanced guitar fretboard visualization using Matplotlib

Figure 2 is a relatively complex version of the fretboard. In our project, we will only be focusing on the first couple of frets; hence the program is for guitar beginners.

2.1 Classes/Objects

1. Class Chord. All beginner chords will be stored in it. And we can easily extract a chord with particular key and level.

First, we need some music knowledge to get us started. Figure 3 shows a table of all common guitar chords. In fact, you can almost play any song by just using these chords:

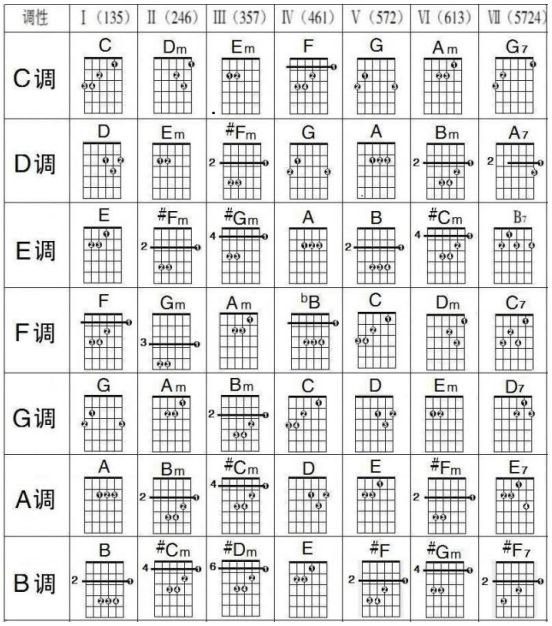

Figure 3: Beginner chords

As you can see in Figure 3 above, on the first column, we have seven keys, represented by letter C, D, E, F, G, A, B, which:

C representing the note 'Do'

D representing the note 'Re'

E representing the note 'Mi'

F representing the note 'Fa'

G representing the note 'So'

A representing the note 'La'

B representing the note 'Si'

On the first row, for each key, we have seven levels of chords, represented by numbers from 1 to 7, which:

I representing the first level of chord in C major

II representing the first level of chord in D major

III representing the first level of chord in E major

IV representing the first level of chord in F major

V representing the first level of chord in G major

VI representing the first level of chord in A major

VII representing the first level of chord in B major

2. Class FretboardPainter. This class is for guitar fretboard visualization using Matplotlib, so some basic parameters of visualization of Matplotlib will be stored in it.

Next, we want to understand another musical term called 'chord progression'. Chord progression is foundation to Western music styles. For every song that has been produced, there can be found at least one chord progression in it.

You may often hear music professionals say a set of four numbers, such as '1564' or '1645' while describing the composition of a song. Now you understand that they are referring to the chord progression of a particular song.

Figure 4 shows an example of the chord progression of a song called 'Shut Up and Dance' produced by the band 'Walk the Moon':

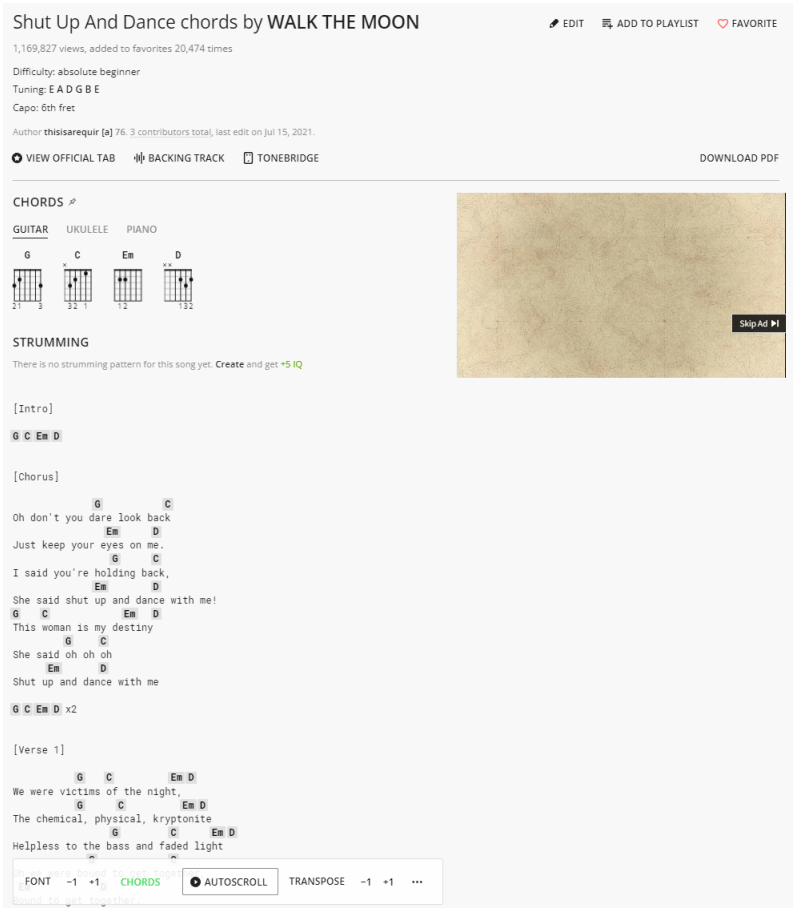

Figure 4: 'Shut Up and Dance' chord progression (Source: Ultimate Guitar)

The chord progression for this song is '1467' because the song follows a 'G', 'C', 'Em', 'G' strumming pattern in G major. Now you might be wondering why '1467' is important here. If we want to change the key to C major, we can directly apply '1467' to the C major scale above to get 'C', 'F', 'Am', 'G7'.

The program will prompt the user to enter three inputs:

1. The key that they are current using
2. The level of the chord that they want to know
3. The key that they want the chord to be converted to

The program will output the following:

1. The corresponding chord for a particular key and level, both description and diagram using Matplotlib

2. The corresponding chord and its equivalent chord in another key, both description and diagram using Matplotlib

2.2 Data Structures

1. List. For a particular chord, I will use a list of length 7 to store it. The first six elements are pairs, which represent the position of the finger and which finger is used for each of the strings one through six. The last element is also a pair, representing which fret will be whole pressed and which finger is used. We call it "finger list".

2. Dictionary. I will store all chords, which are represented by a list for each. If a particular key and level are given, I can access the "finger list" of the corresponding chord. For example, if you give me key C and level I, I can first calculate the corresponding chord "C Chord" and then use "C" to access the "finger list" in the dictionary.

A chord contains finger positions for the string (horizontal) and fret (vertical), for example, a C major level 1 chord can be described as the following:

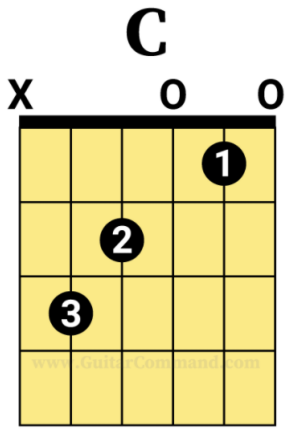

Figure 5: C major level 1, aka the C chord

Open Position C Chord Guitar Photo

How to play a C chord on guitar

> *The "C" chord symbol is just a shortened way of telling you to play a C major chord. Further down the page we explain what a C major chord is and examine the notes it contains.*

- First, position your third finger (ring finger) on the 3rd fret of the A string. This is a C note, and it will be the bass note of your chord.
- Next, position your second (middle) finger at the second fret of the D string.
- Finally, position your first (index) finger at the 1st fret of the B string.

Figure 6: Description for C major level 1, aka the C chord (Source: Guitar-Command.com)

From figure 6, we can re-arrange our description for the C chord like this:
(If use Figure 5, from left to right are string 6 to 1, from top to bottom are fret 0 to 4)
Finger 1 on fret 1 string 2
Finger 2 on fret 2 string 4
Finger 3 on fret 3 string 5

Or even more simple:
(If use figure 5, from left to right are string 6 to 1, from top to bottom are fret 0 to 4)
Fret 1 string 2
Fret 2 string 4
Fret 3 string 5

2.3 Basic Programming Skills

My initial design for this comprehensive project is to ensure to cover almost everything we have covered so far. This means conditionals, loops, lists, and tuples. Since my previous proposal emphasized recursion heavily, I wish to apply more class/object, dictionaries, and data visualizations in this project.

Next term, I will be moving forward to CS5004 on Java, which is about object-oriented programming. I firmly believe the second half of this course is key to our success in CS5004, and it is also vital that we apply these knowledge learned as much as possible in our final project.

The knowledge we learned from module 8 to the end is fundamental to later programming courses. These modules shape our habits for future program design. Good code organization and detailed commenting in files reflect our ability to solve real-life problems and build better software in our future careers.

3 Testing Plan

I will test it by inputting some information and checking if the program's result is correct. There are $7 \times 7 = 49$ cases in total, and there are no edge cases as of now.

The input will be a key (string) from "C" to "G" and a level (integer).

The result will be presented in a fretboard picture using Matplotlib.

4 Lingering Questions

There could be possible variations on the output of the key-change feature of this program.

Since we introduced the concept of 'chord progression', we need to be careful that they do not always come with four-digit arrangements. Instead, chord progressions can be anything such as '165', which contains three-digit arrangements, or '13654', which contains five-digit arrangements.

Every time we prompt the user to enter another key that they wish to change, do we print out every chord with a description and diagram one by one, or do we want to develop a feature that fully supports chord progression that prints out a series of chord altogether? If we were to print out each chord one by one, it might be easier to write the code, but it might be time-consuming for the user.

If we were to develop the chord progression feature, I am thinking about prompting the user to enter their chord level combinations, in which there can be so many combinations and will be much harder to code.

5 Resources

5.1 https://www.ultimate-guitar.com/ - Guitar tab for songs

https://www.fachords.com/guitar-alternate-tunings/ - Knowledge on Guitar tuning

https://betterprogramming.pub/how-to-learn-guitar-with-python-978a1896a47 - A much-advanced version of this project, my inspiration for this project comes directly from here. This project records each note when the user plays the note on their guitar once and recognizes it using the AAC recording Format to match the corresponding frequency (Hertz) of the note and convert them into the note on the guitar's fretboard. Super cool and interesting.

All other resources used has already been cited under each figure within this report.