FYP Term 1 Presentation

KY1701
Chord Identification

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Objective

1. Focus on chord identification
2. Pieces for orchestra (Symphony)
3. Handling dissonance

Preparation works & Research

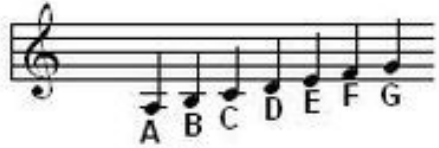
1. Notes and Intervals
2. Beat in Time Signature
3. Chords
4. Melodic Decorations

1. Notes and Intervals

- Note: The pitch and duration of a sound. Represented by {C,D,E,F,G,A,B} in English.

- The five accidentals: ♭ ♮ ♯ 𝄪 𝄫

- Interval: the word used in music to describe the distance between notes.



Seven Notes on Staff

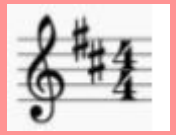
Interval Name	Short Hand	Semitone Difference*	Note Difference*
Union	P1	0	0
Minor 2nd	m2	1	1
Major 2nd	M2	2	1
Minor 3rd	m3	3	2
Major 3rd	M3	4	2
Perfect 4th	P4	5	3
Augmented 4th	A4	6	3
Perfect 5th	P5	7	4
Minor 6th	m6	8	5
Major 6th	M6	9	5
Minor 7th	m7	10	6
Major 7th	M7	11	6

Musical Intervals

2. Beat in Time Signature

- Beat: Basic unit of time, the pulse, of the mensural level. Related concepts: tempo, meter, specific rhythms, and groove.

- Time signature: Consisted of two numbers
- Upper: denotes number of beats per measure
- Lower: defines the unit of each beats



A standard 4/4 time signature. This means 4 beats per measure (the upper 4), and ¼ note per beat (the lower 4).

On-beat and Off-beat

- In a 4/4 time, the 1st beat is sounded the loudest and then the 3rd beat.
- If any of these is the strongest beat, the tune is said to be "On-beat."
- If 2nd or the 4th note is sounded the loudest and the 1st or 3rd is not, then the tune is said to be "Off-beat".

Example1:

```
  #         #
| 1  2  3 | 1  2  3|
```

stress on 1st beat for 3/4 = on-beat

Example2:

```
  #     #     #     #
| 1  2  3  4 | 1  2  3  4 |
```

stress on 1st and / or 3rd beat for 4/4 = on-beat

Example3:

```
  #        #        #        #
| 1  2  3  4  5  6 | 1  2  3  4  5  6|
```

stress on 1st and / or 4th beat for 6/4 = on-beat

stress anywhere else = off-beat

3. Chords

What is chord?

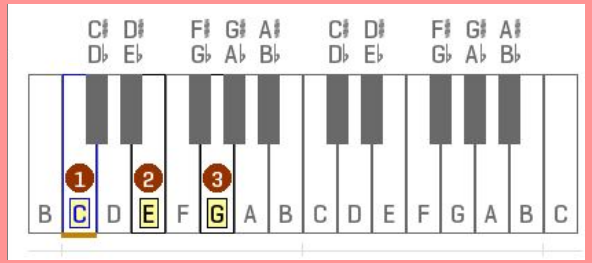
Two or more notes sounded simultaneously are known as a chord. (Ottó, 1991) Chords are formed by adding two or more distinct frequency to produce harmonic effects.

I (major triad)	C E G (C major)
II (minor triad)	D A F (D minor)
III (minor triad)	E G B (E minor)
IV (major triad)	F A C (F major)
V (major triad)	G B D (G major)
VI (minor triad)	A C E (A minor)
VII (diminished triad)	B D F (B diminished)

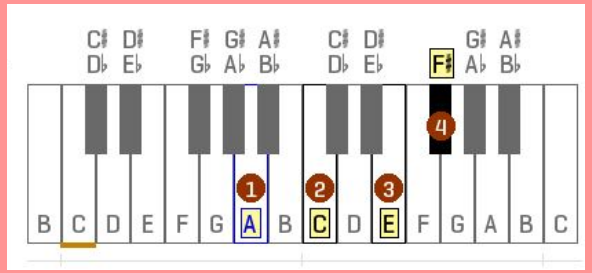
Chord Table for C Major in Roman Numeral Form

Chord Types:

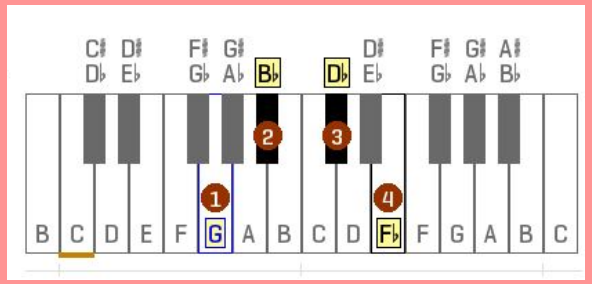
- Major chord: root, M3, P5
- Minor chord: root, m3, P5
- diminish chord: root, m3, A4
- 7th chord: adding the seventh note to the original chord (depends on the type of original chord)



C Major Chord I



A Minor Chord VI



G Major Diminished 7th Chord

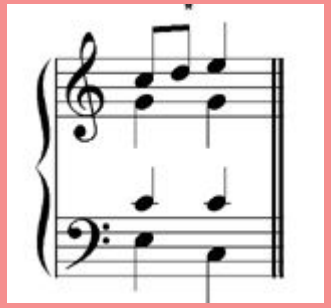
List of Chords we used in the program

Chords in Major Scale		Chords in Minor Scale	
I	VI b	I	VI b
I 7	VI German	I +	VI German
II b	VI French	II b	VI French
II	VI Italian	II	VI Italian
II 7	VI	II 7	VII
III	VI 7	III	VII dimnish
III 7	VII	IV	VII dimnish7
IV	VII 7	IV +	
IV 7	VII dimnish7	V	
V		V +	
V 7		V +7	

4. Melodic Decorations

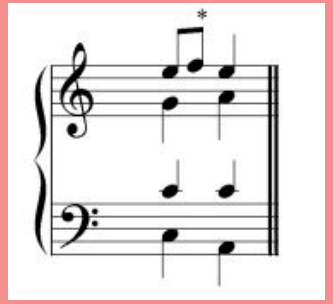
Passing Notes:

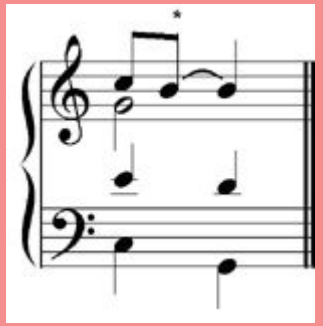
falls in between two different notes a third apart.



Neighbour Notes:

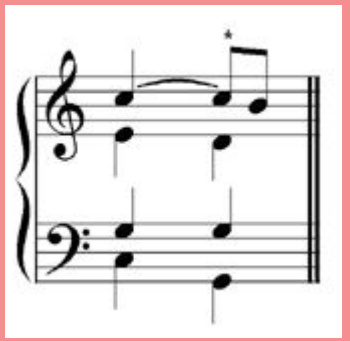
falls between two identical chord notes, can be lower or higher than the chord note.





Anticipation:

Note in the beat before the rest of the chord sounds.

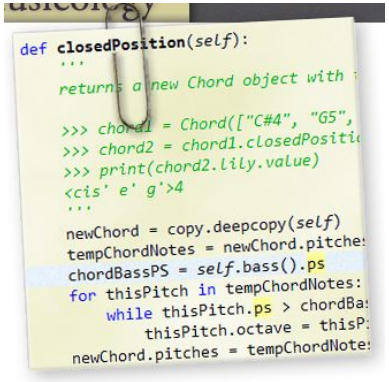


Suspension:

Note in the beat after the rest of the chord sounds.

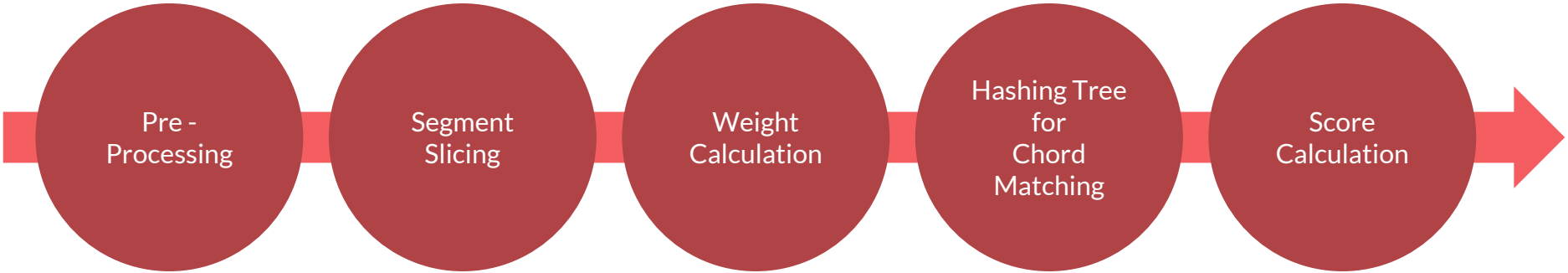
Technical Supports

- Python: main programming language
- music21: a toolkit developed by MIT for computer-aided musicology, used for parsing and retrieving music information of files in MusicXML format
- MuseScore: open source music composition and notation software for viewing and editing music files



Overall System

Overall System

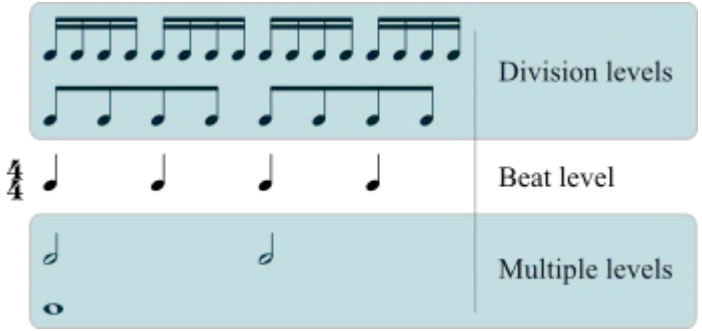


1. Pre-Processing

1. Voice to Part
2. Slicing notes by the beat of the time signature

2. Segment slicing

Assume chord change occurs once in every measure, at most one in every stressed beat.
Slice segment into sub-segments by stressed beats.



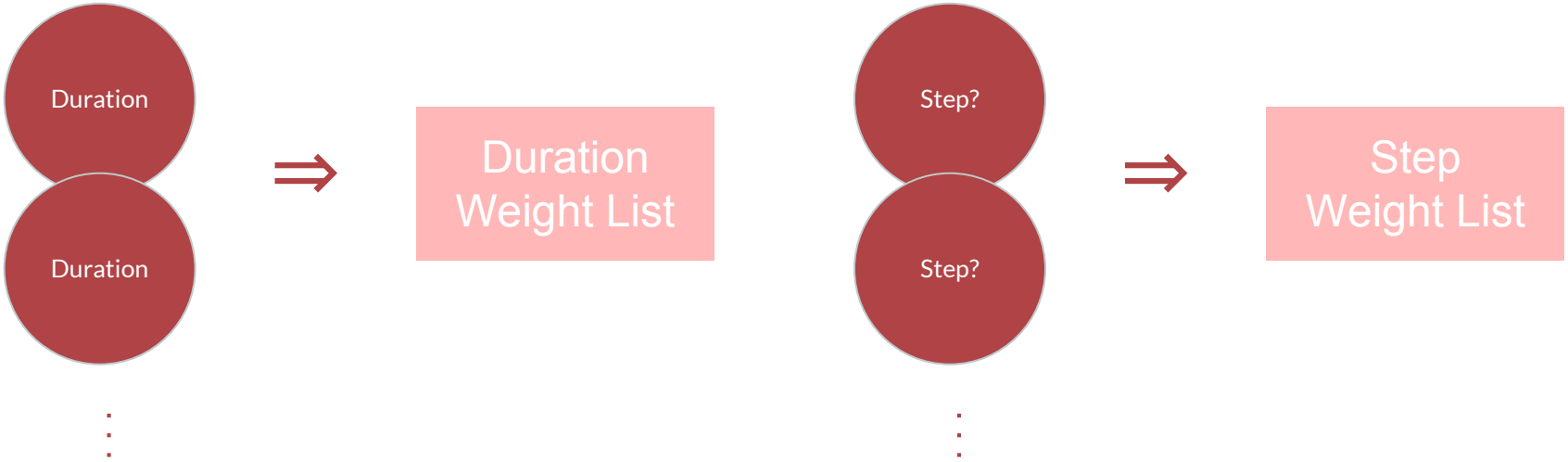
3. Weight Calculation

For every note:

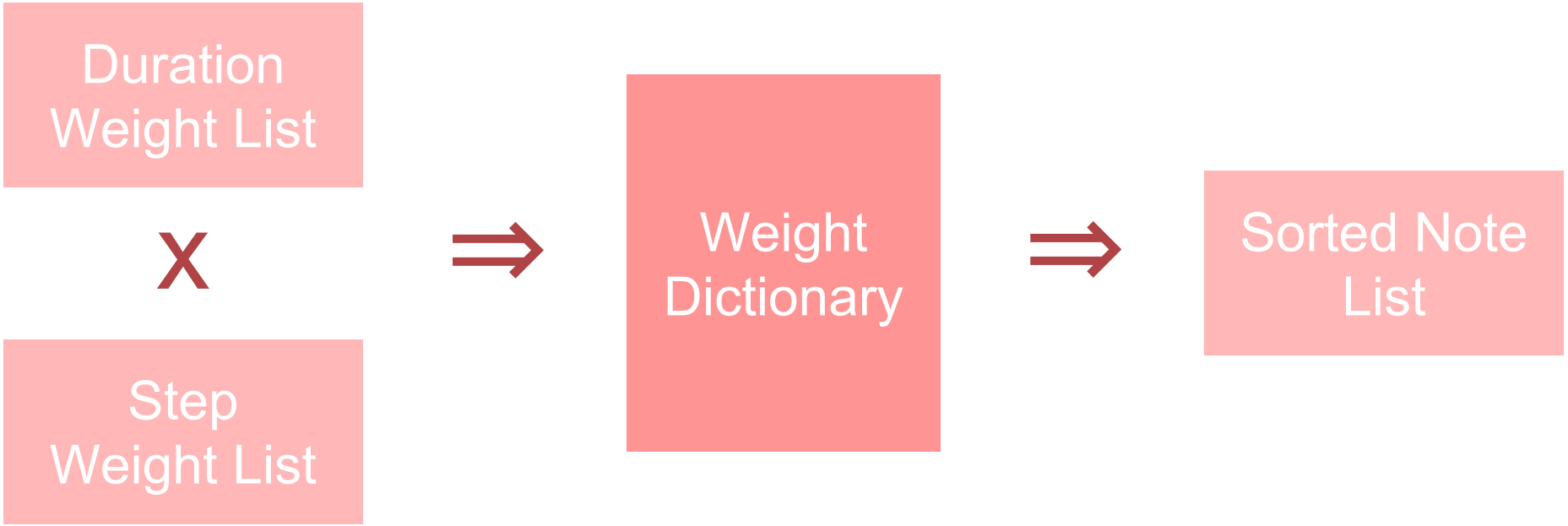
Possibility of being melodic decoration / running notes

3. Weight Calculation

For every part in Segments and Sub-segments:



3. Weight Calculation



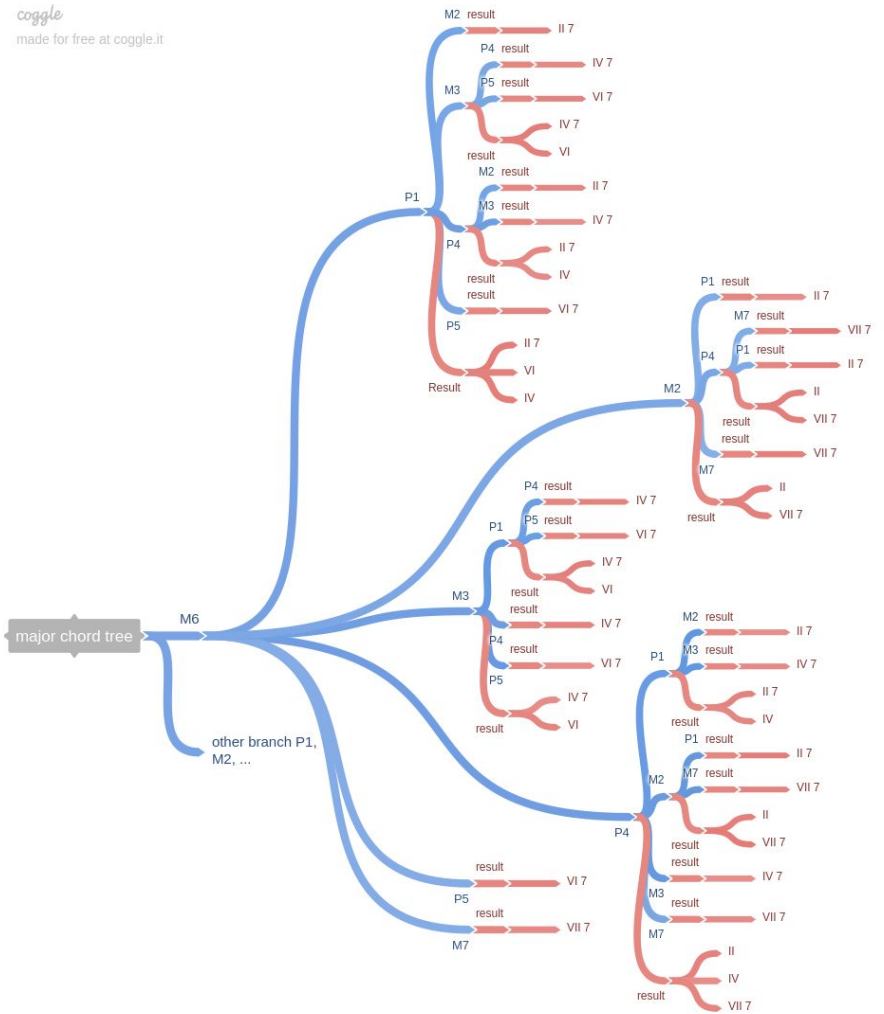
4. Hashing Tree for Chord Matching

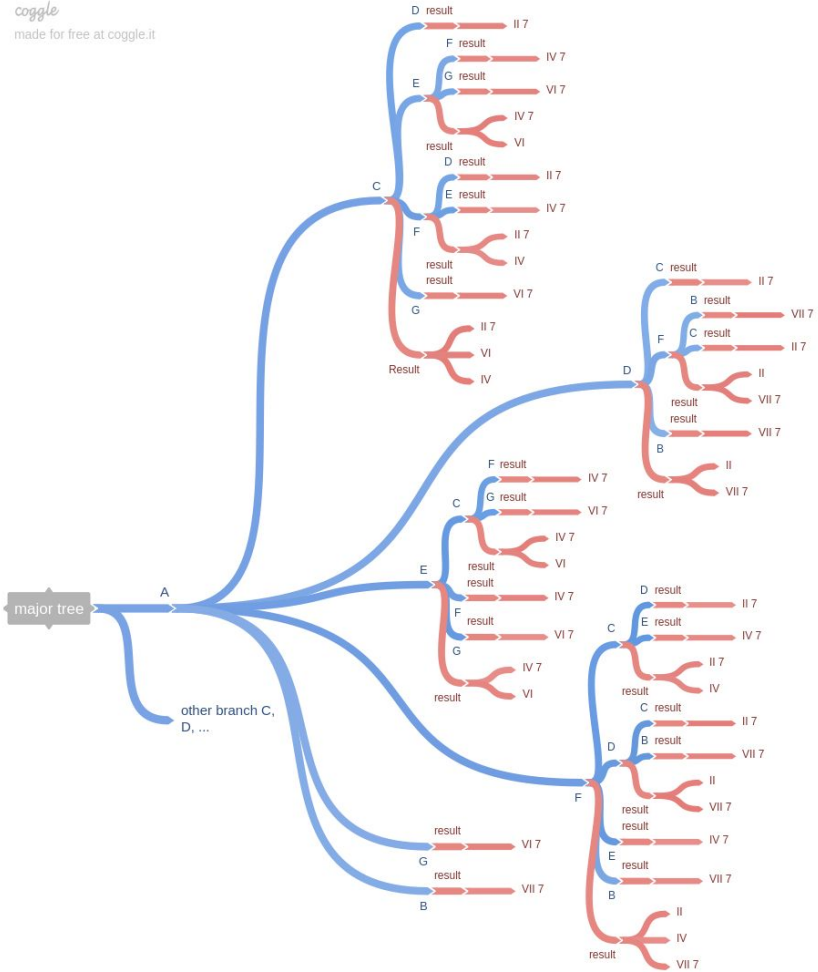
Hash is pre-generated from the Chords List shown in previous section

Special Rules:

1. At least two note of the chord exist
2. For 7th chords, the 7th note must exist

   similar rules for German, French, Italian 6th





5. Score Calculation

Calculate the following for every possible chord match

1. Percentage of notes in a segment which are included in the chord
2. Percentage of notes in a chord which are included in the segment

$$Score_1 = \frac{\sum_{n \in N} W(n)}{\sum_{n \in N_S} W(n)}, \; N = N_C \cap N_S \qquad Score_2 = \frac{\sum_{n \in N} 1}{\sum_{n \in N_C} 1}, \; N = N_C \cap N_S$$

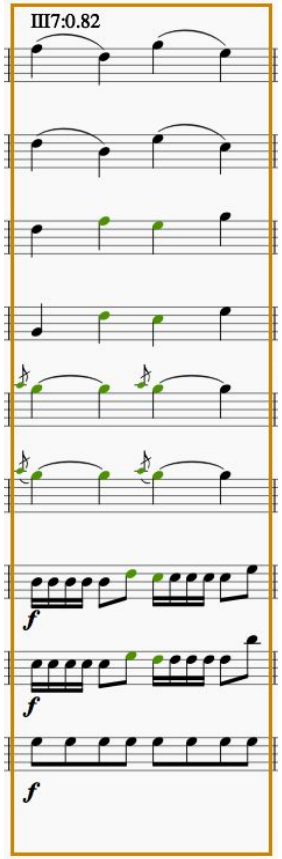
Scores are returned as a tuple ($Score_1$, $Score_2$) for comparison

5. Score Calculation

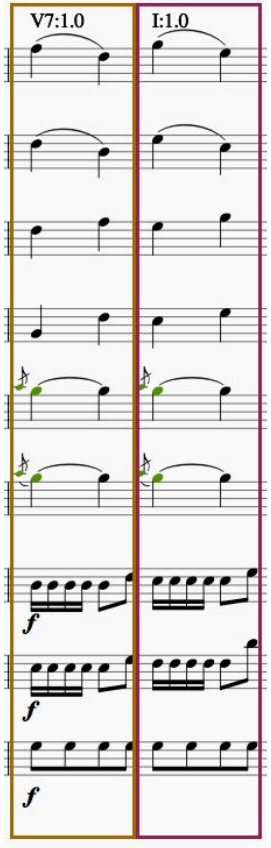
Comparsion is done for

1. Possible chord choices for segments
2. Segment vs Sub-segments

Example 1



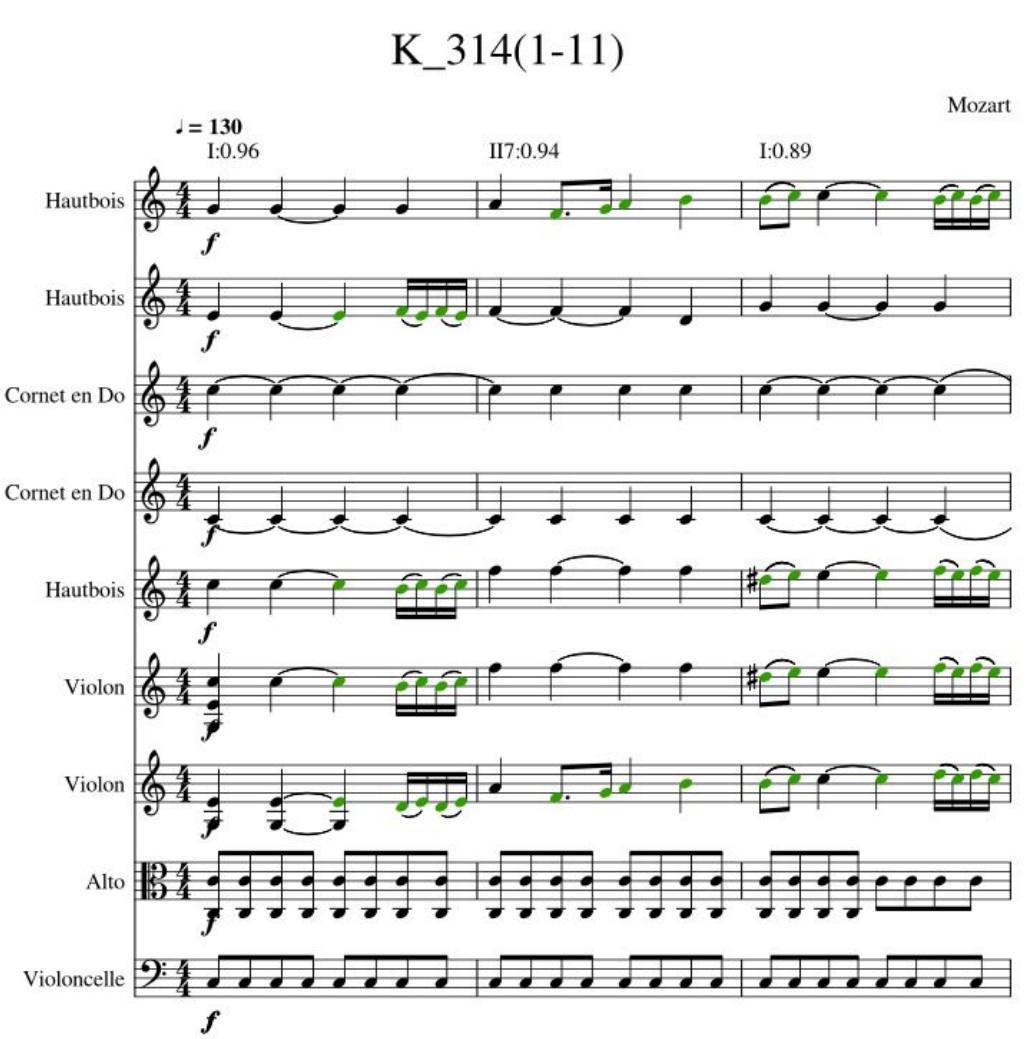
Example 2



Testing Results

1. W. A. Mozart, Oboe Concerto in C major, K. 314
2. Beethoven Ludwig van, Symphony No.5, Op.67

Example


K_314(1-11)
Mozart
♩ = 130
I:0.96
II7:0.94
I:0.89
Hautbois
Hautbois
Cornet en Do
Cornet en Do
Hautbois
Violon
Violon
Alto
Violoncelle
f

Testing Results

W. A. Mozart, Oboe Concerto in C major, K. 314

Testing measure	1-9
No. of chords	10 (with 1 sub segments)
No. of mismatches	3

Beethoven Ludwig van, Symphony No.5, Op.67

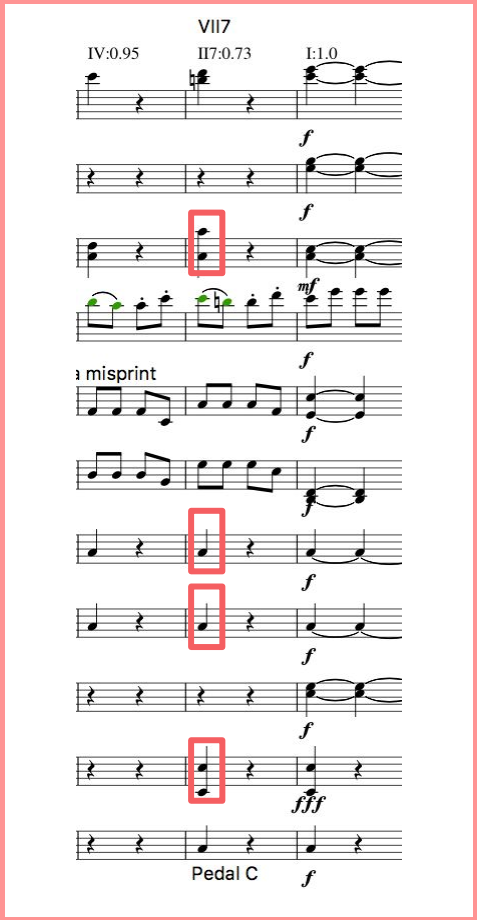
Testing measure	1-57
No. of chord Identified	42 (with 2 sub segments)
No. of mismatches	3 + 1 (1 for lack of Information)

Future Work

1. More on Melodic Analysis

- Pedalling (Example 1 from Symphony no.5)
- Bassline

Example 1

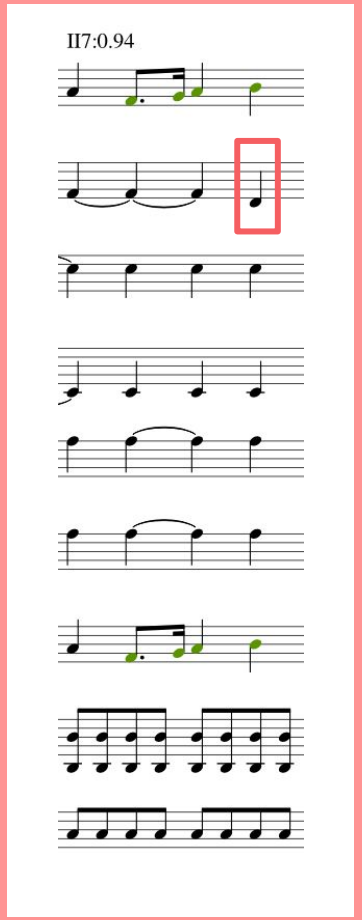


2. Prevent overfitting

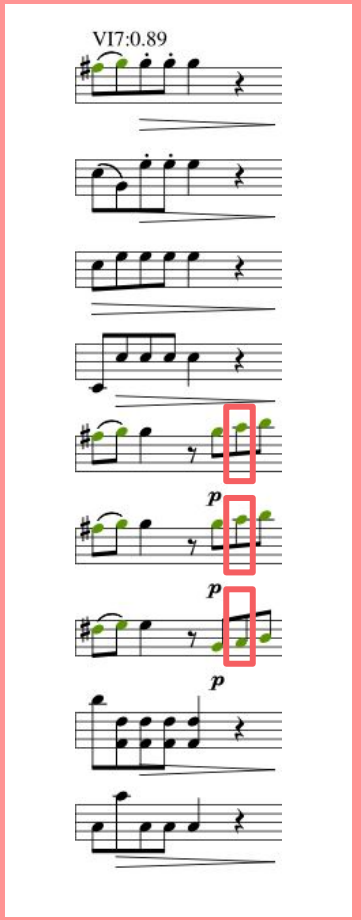
7th chord mismatching

Failure in Chord matching	Failure in Score calculation
Example 1: Weight Dict = {'C': 20.0, 'F': 11.0, 'A': 2.0, 'D': 1.0} Sorted Note List = [‘C’, ‘F’, ‘A’, ‘D’] Correct chord is IV	Example 2: Sorted Note List = [‘E’,’G’,’C’] Score = {'I': (0.74, 1.0), 'VI 7': (0.87, 1.0)} Correct chord is I

Example 1



Example 2



3. Key Change

- Chords from Relative Keys
- Common-chord modulation (from KY1601)

	D	A	D	A	D	G
D Major	I	V	I	V	I	
G Major					V	I

Table 1.9: Example of a modulation from D major to G major

4. Transposition of instruments

Alto Horn in Beethoven Symphony No.5, Op.67

Other examples: Clarinet...

5. Chord Progression

Use the probability of progression as a factor in score calculation

Q&A