Digital Image Processing

Team Name: skynet

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Title: Sheet Music Reader

Mentor TA: Manasvi Vaidyula

Repo link: [LINK]

PPT Link: [LINK]

Contents

Overview

Preprocessing

Clef Note Detection

Quarter Note Detection

Key Note Detection

Dots and Ties Detection

Rest Note Detection

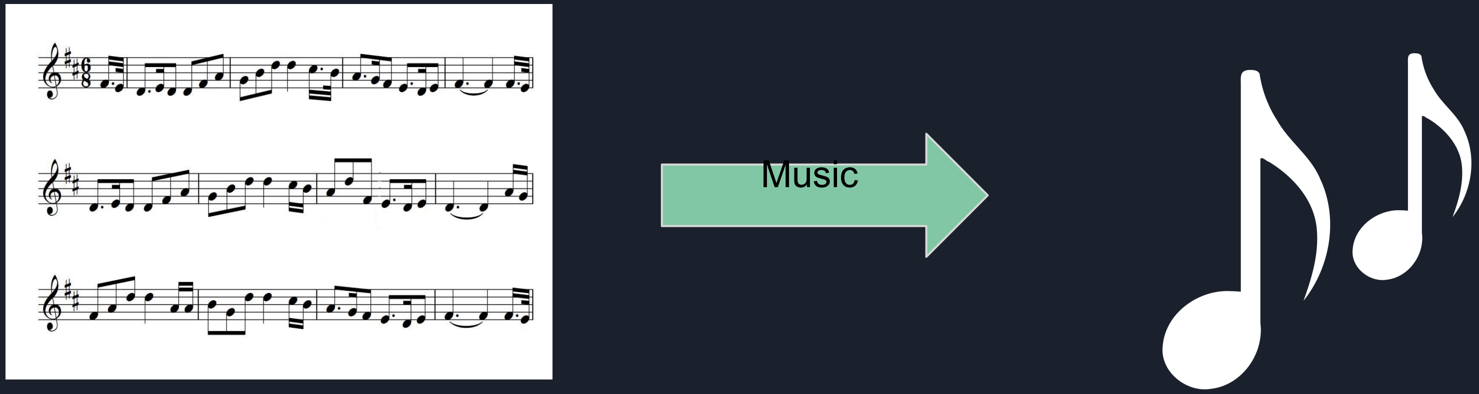
Half Note and Whole Note Detection

1/8th Notes Detection

Timeline

Overview

1. Our Research Problem deals with reading sheet music and synthesizing music from it.
2. The paper presents techniques(In General) on how to preprocess it but does not explicitly mention on how to proceed.
3. So by the ideas mentioned in the paper we came up with a preprocessing and segmentation technique following which we synthesize the audio



Preprocessing

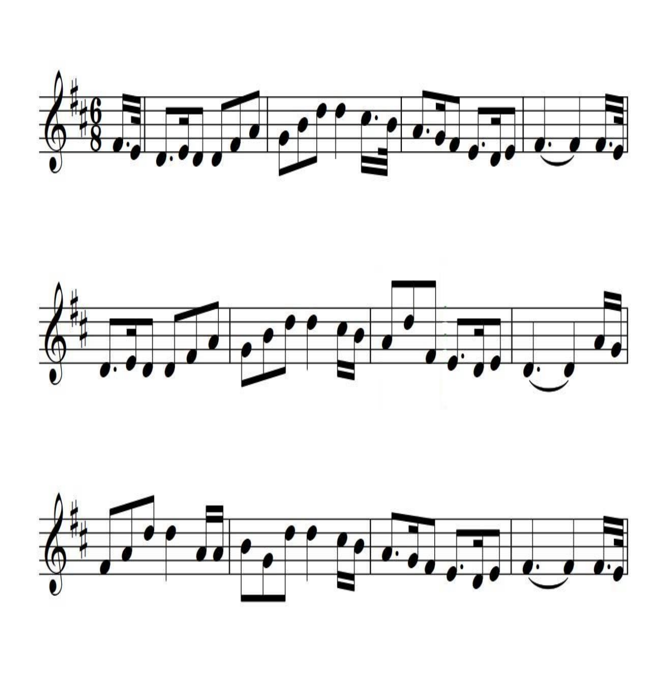
01 First Up is Thresholding, we use OTSU’s Thresholding method for this

02 Once, Thresholded it is now easy to work on. We Next move on to detect the staff lines in the given image

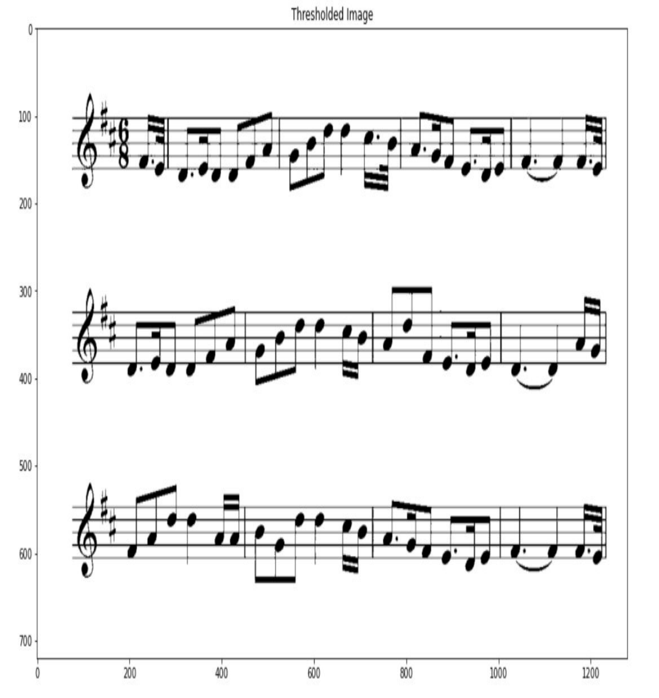
03 Detecting Staff lines help, as once detected these can be removed from the original image. And with Appropriate closing operation we can get an image comprising only of notes.

04 After Staff line Detection, we segment the image into multiple parts comprising of each row of staff row music notation

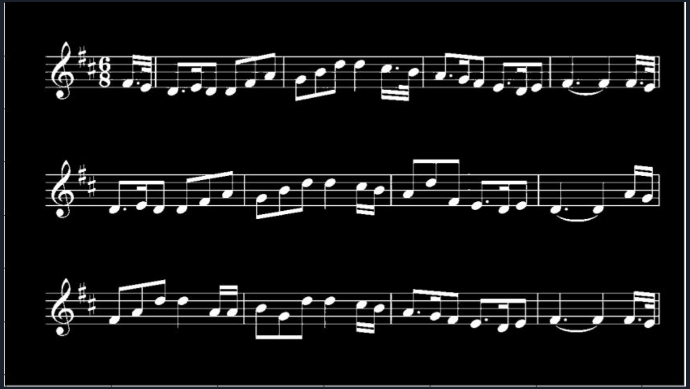
Preprocessing (Continued)
Step 1 Demonstration



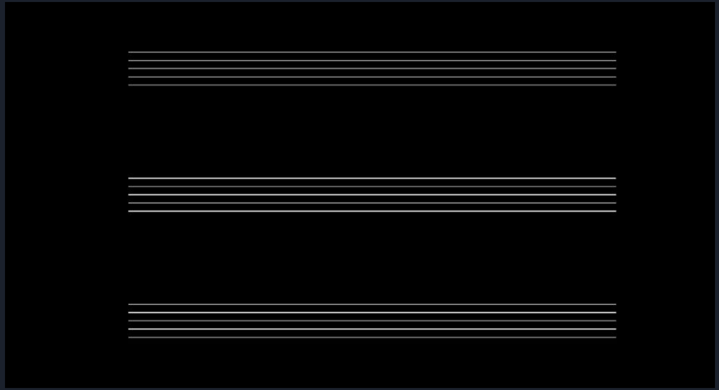
Otsu’s Threshold



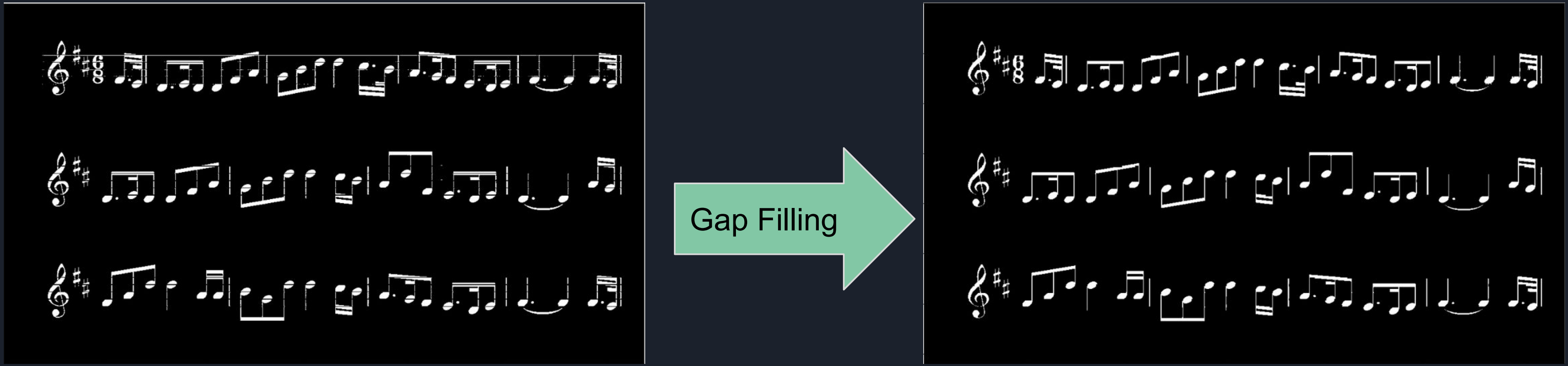
Preprocessing (Continued)
Step 2 Demonstration



Erosion to detect staves

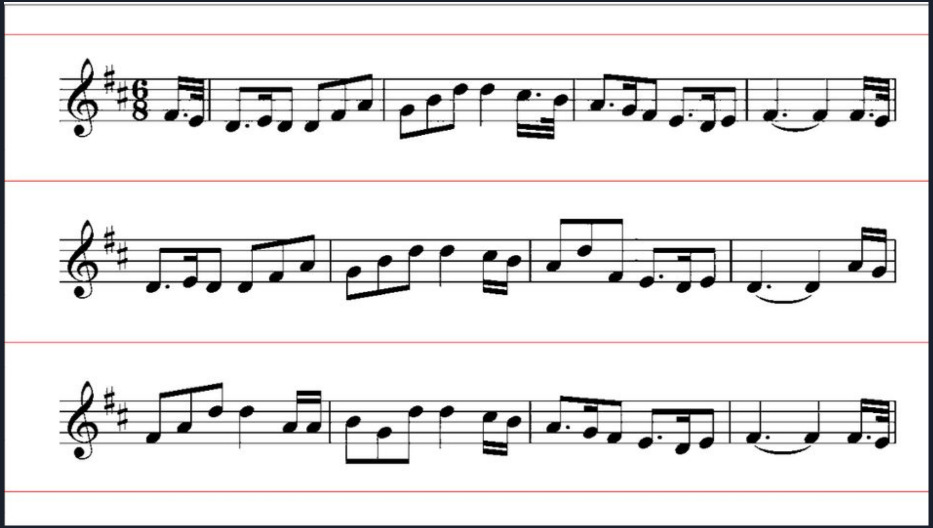


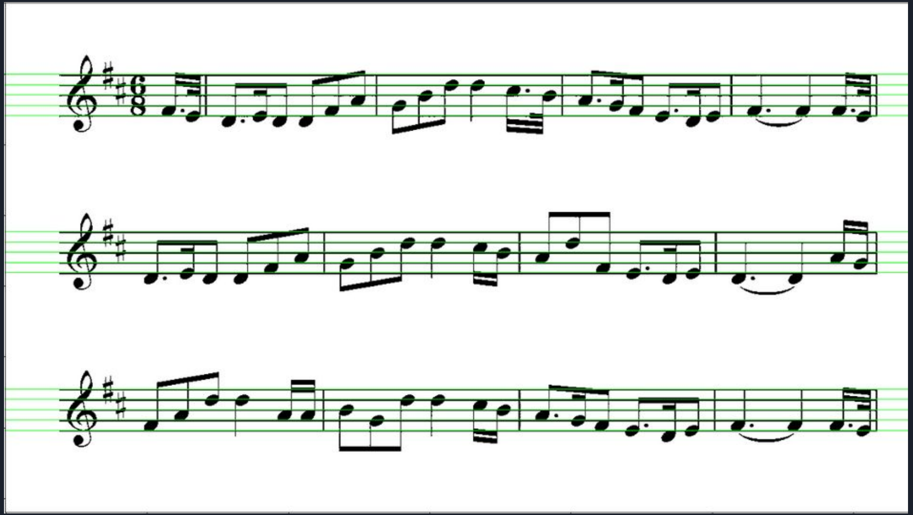
Preprocessing (Continued)
Step 3 Demonstration



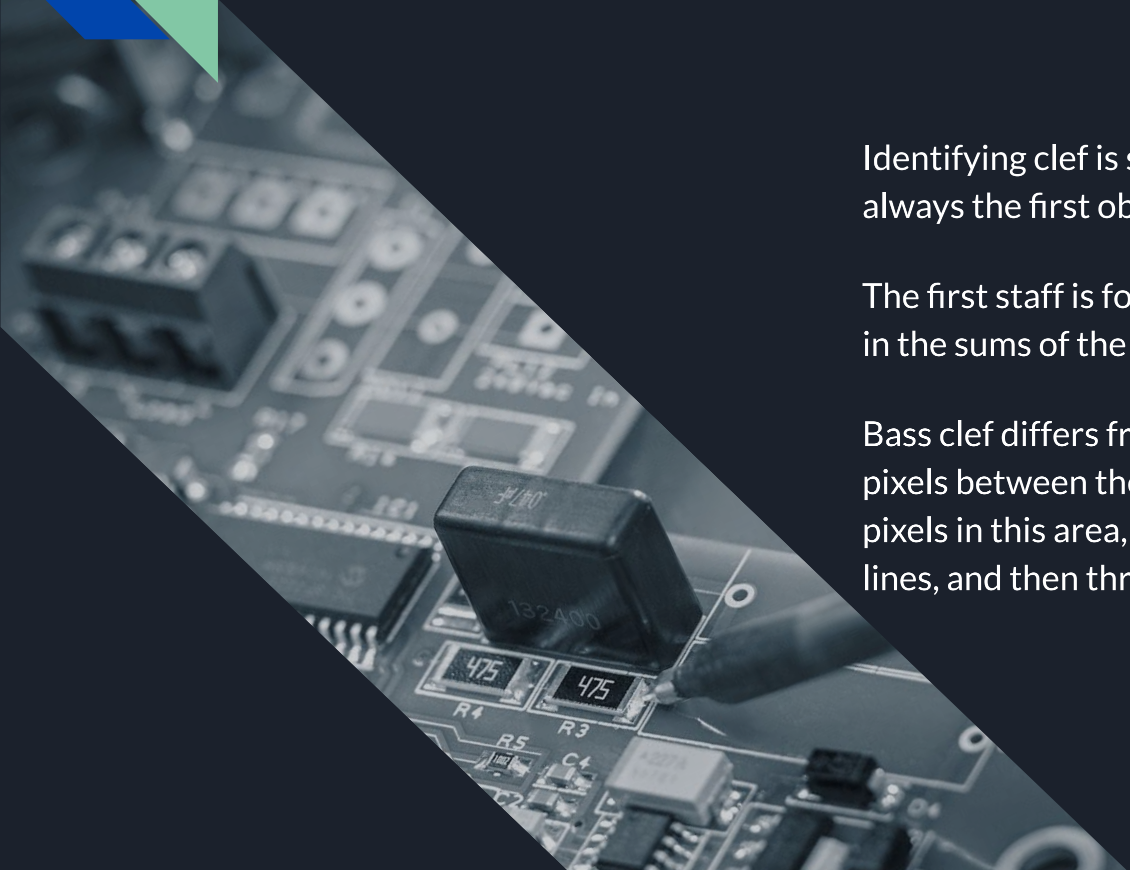
Gap Filling

Preprocessing (Continued)
Step 4 Demonstration





Clef Note Detection

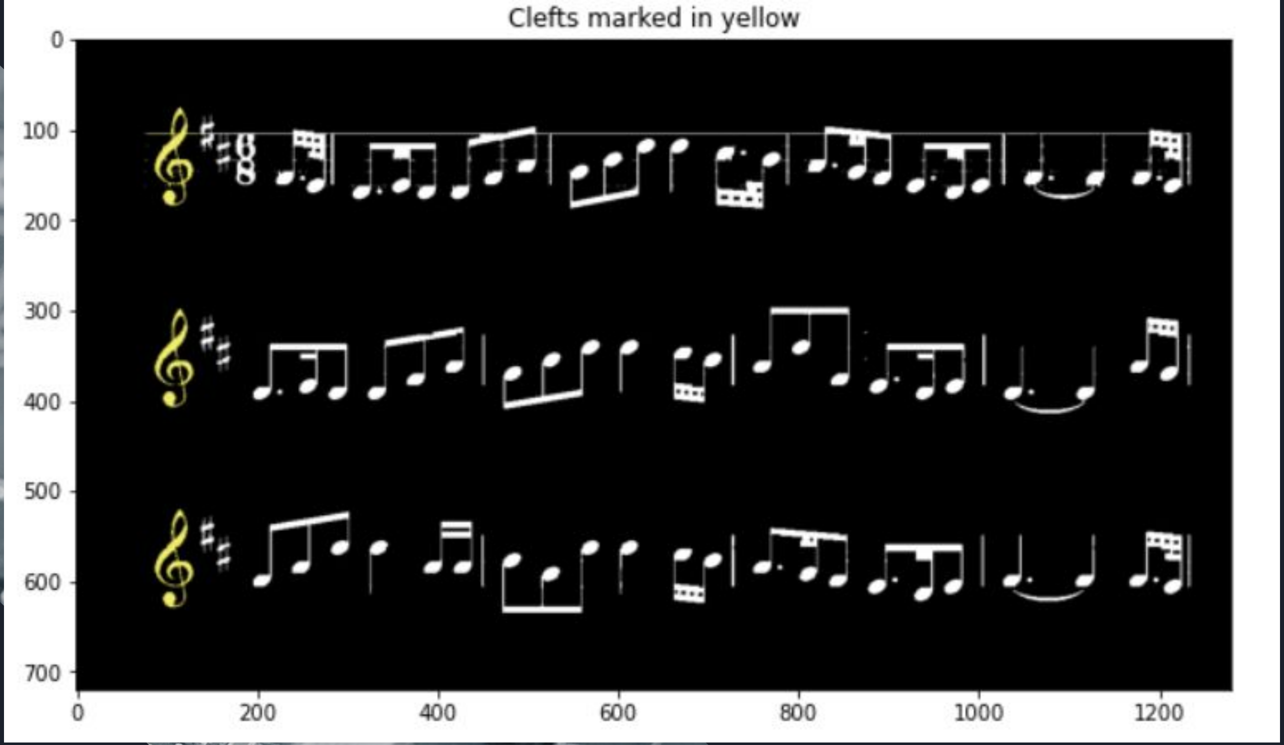


Identifying clef is simplified by the fact that the clef is always the first object drawn on the left side of the staff.

The first staff is found by looking for the first major peak in the sums of the vertical columns.

Bass clef differs from treble clef in that it has almost no pixels between the bottom two staff lines, so we sum the pixels in this area, normalize by the spacing between staff lines, and then threshold to get the classification.

Clef Note Detection (Continued)



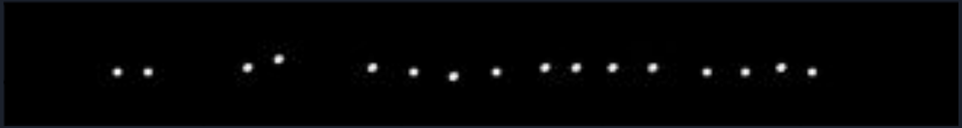
Quarter Note Detection

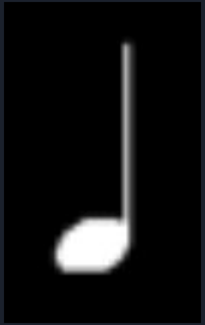
Detecting Quarter note is equivalent to detecting a white filled circle

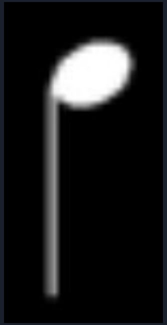
We used opening with a circular structuring element of suitable radius to detect these white circles.

(Very similar to Assignment-3 Q1 on OMR scanning)

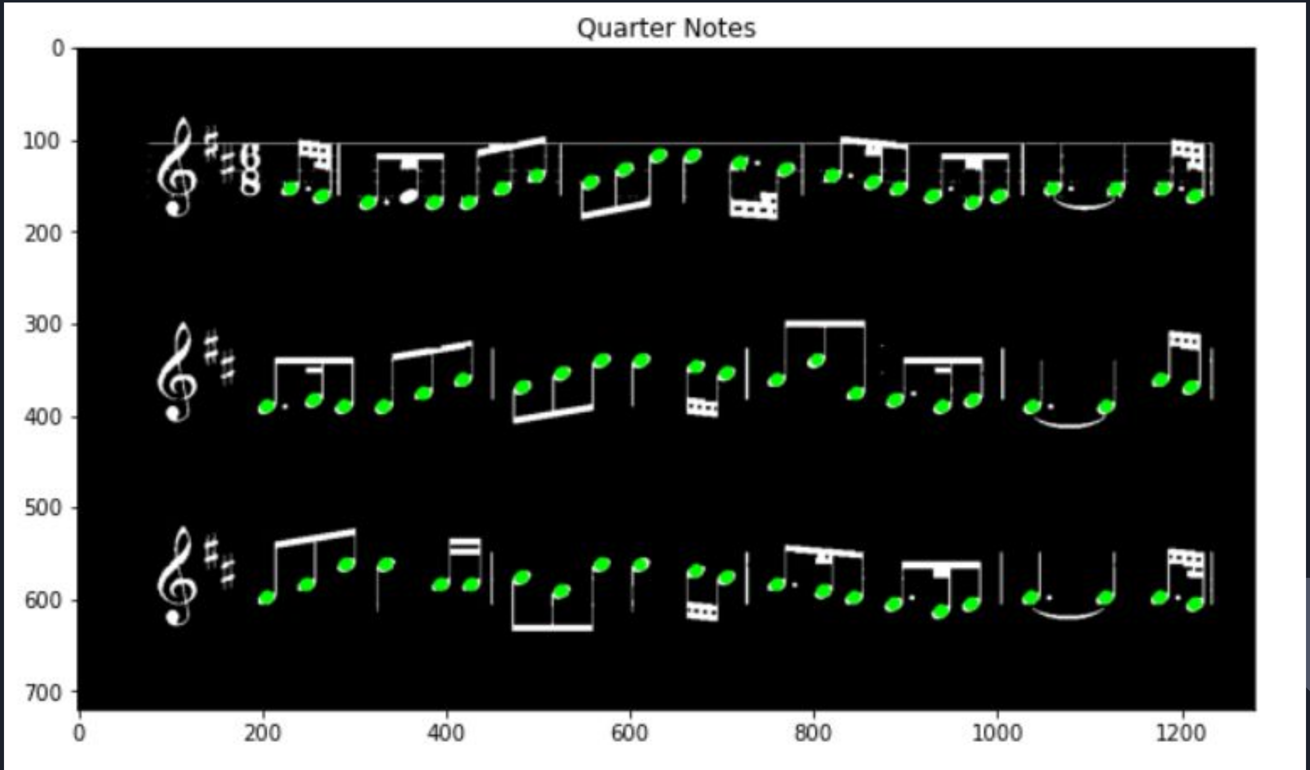
Output after opening on single row :







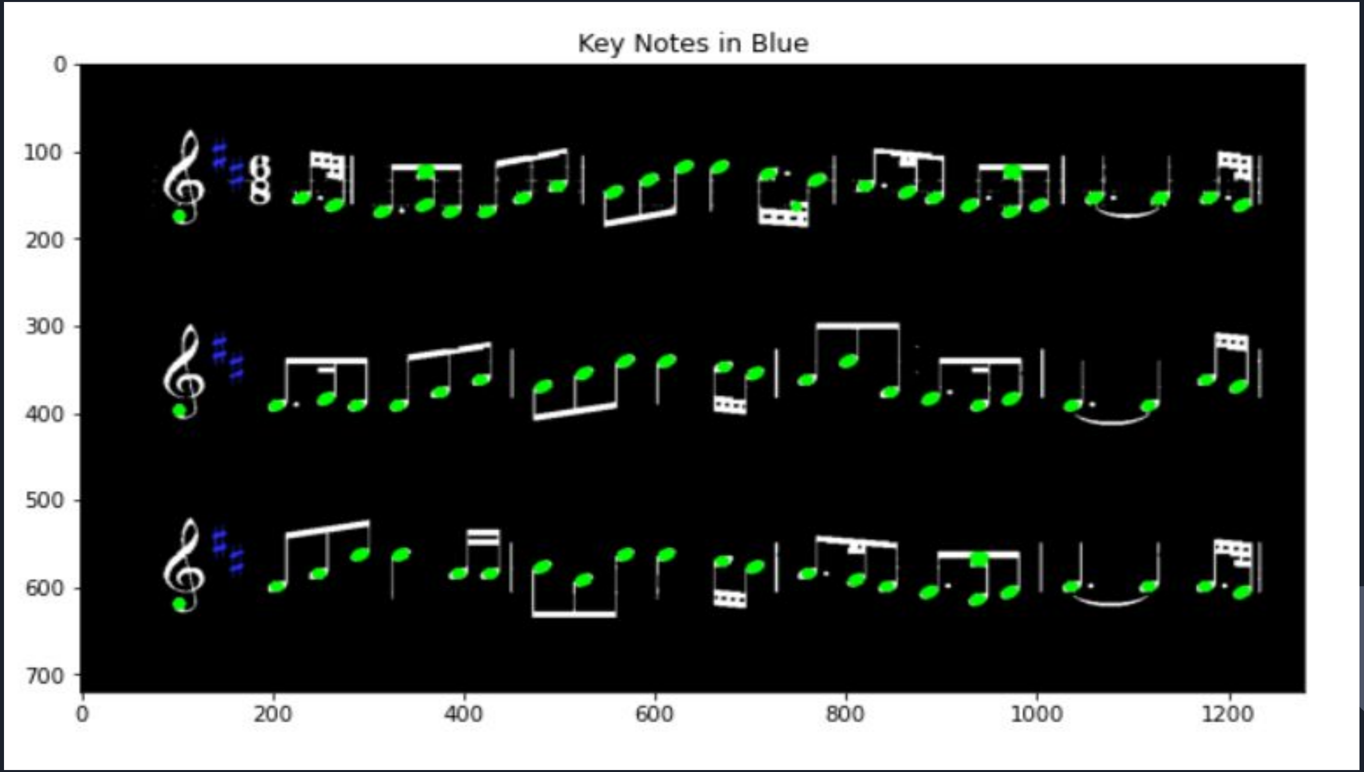
Quarter Note Detection (Continued)



Key Note Detection

1. Key Notes are none but the Sharps and Flats in the Sheet Music
2. We Notice a Key Distinguishing Feature of Sharps that is it has two vertical parallel lines such as the second parallel line is extremely close to the first one
3. In Flats, the key feature is it only has a single vertical line
4. We Use these KEY FEATURES of them to detect them in the images
5. This is the key Idea but Some other conditions were also added so as to make it function more appropriately

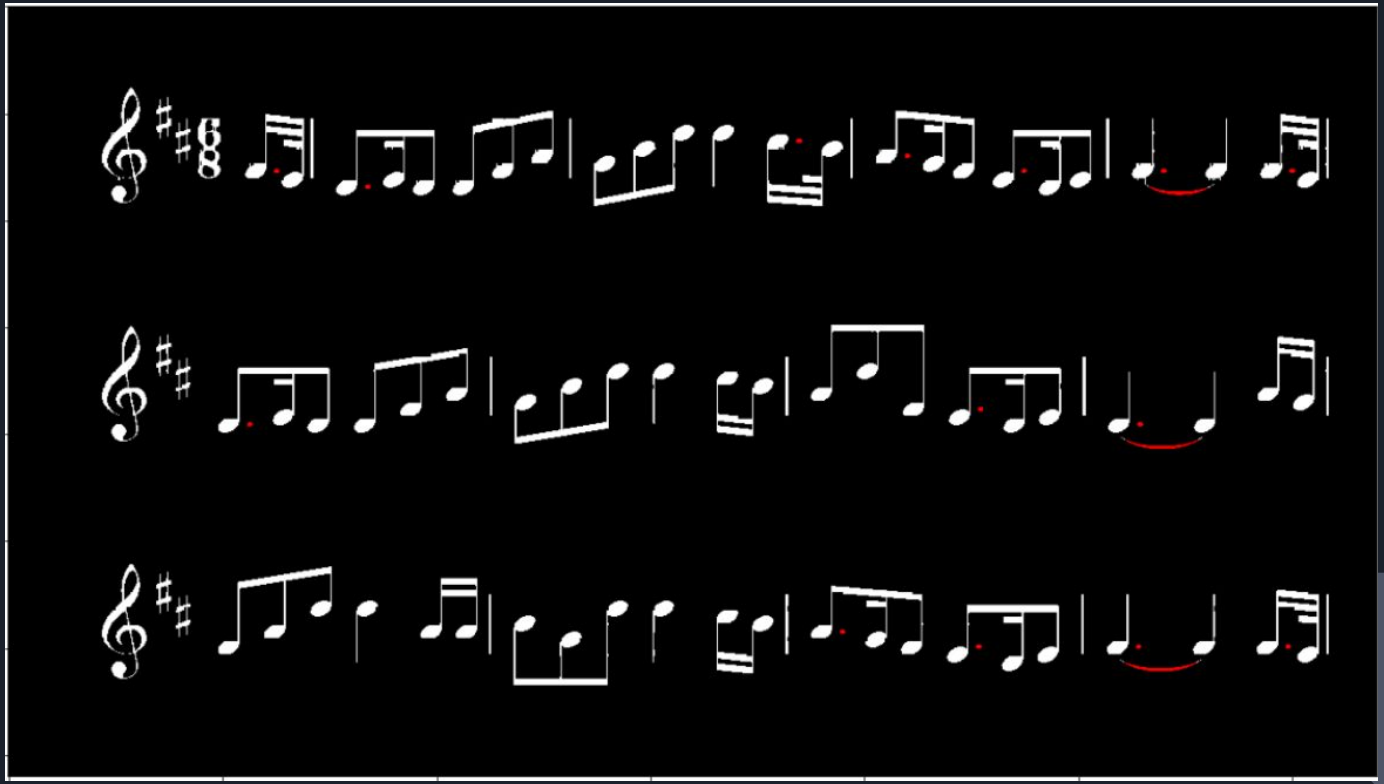
Key Note Detection (Continued)



“Dots” and “Ties” Detection

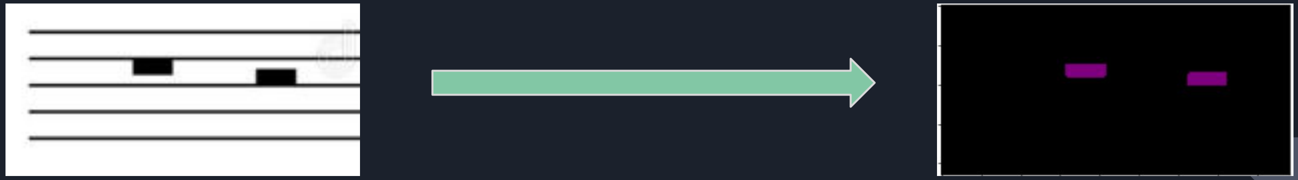
1. For both these Detections, we used Connected Components (Sort of like 2 Pass Algorithm)
2. For the Detection of Dots, we look for Connected components with low number of pixels
    a. This approach works because other type of Notes are much larger when compared to Dots
3. For Detection of Ties, we now look connected components with a certain shape. We try to exploit the physical features of the shape of Ties

“Dots” and “Ties” Detection (Continued)



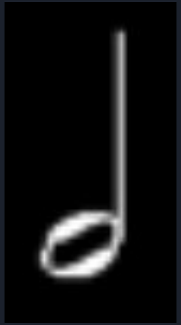
Rest Note Detection

1. For Detection of Rests,
2. We Intend to detect the rectangles
   a. We find areas of zero variance (Mentioned in the paper)
   b. We can not use Morphology because there are other elements in the image(why ?)



Half Note and Whole Note Detection

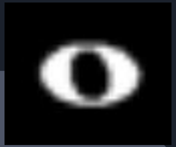
This is similar to detecting a white ring in the image. But how to distinguish the two ? - Trial and Error



Half-Note:

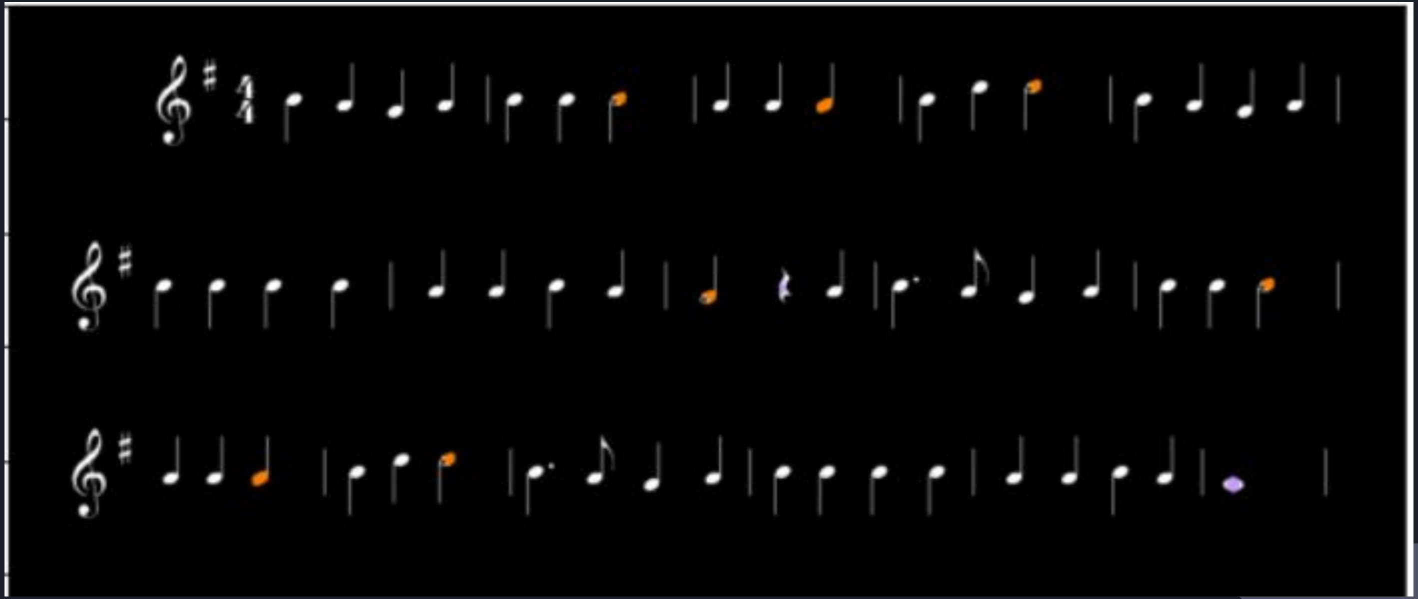
1. Apply closing with a circular structuring element of suitable radius
2. Subtract the original image from the closed image (other notes are removed)
3. Apply opening with a circular structuring element (removes whole notes)

Whole-Note:



1. Apply closing with 2 different radii
2. Subtract the 2 outputs (this removed the half notes)

Half Note and Whole Note Detection(Continued)



1/8th Notes Detection

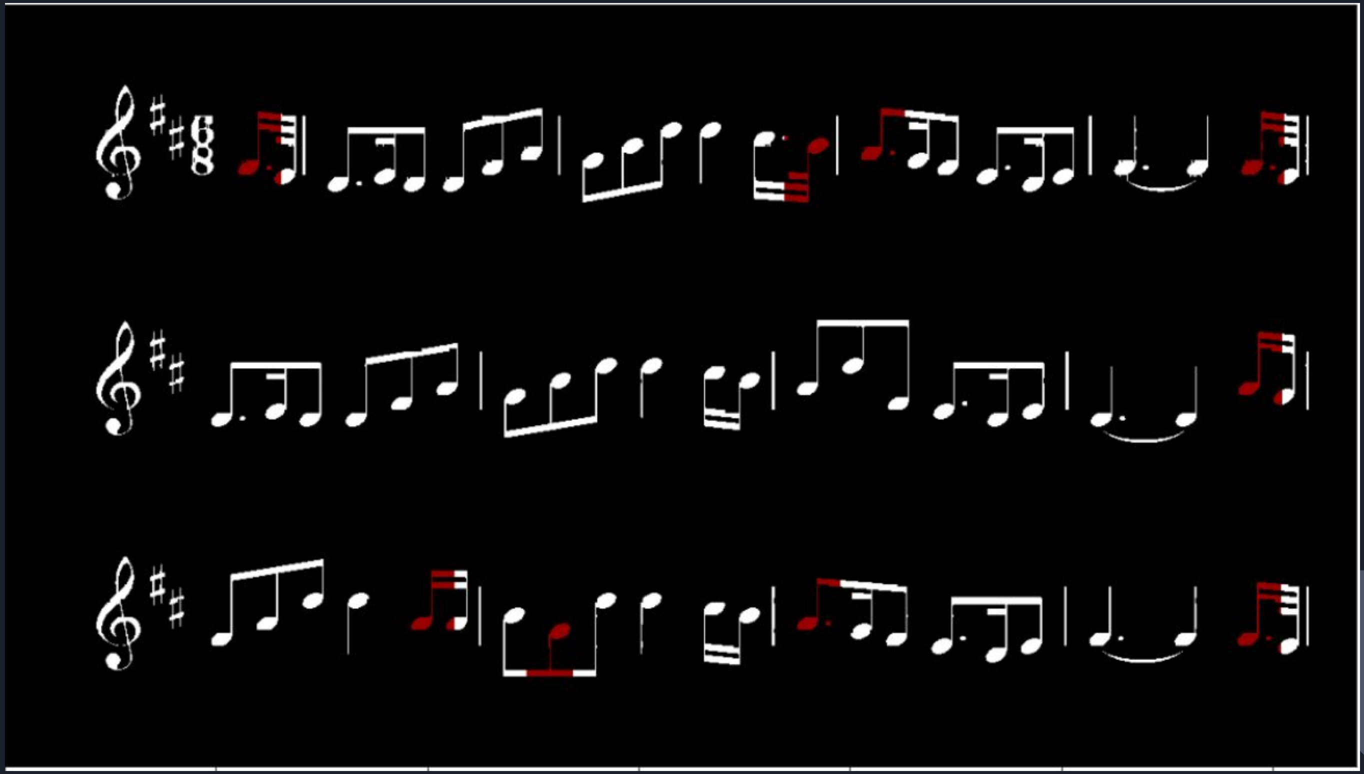
As the name suggest they are 1/8th of a note but unlike their name their shape is very different. They have filled black circles.

We used a structuring element which is shaped like a disk similar to the eighth note shape. Also made a inverted structuring element to detect inverted notes.

After doing this we got the morphed row from which we got the indices (by checking whether == 255 or not)

Then we fill the notes with color red

1/8th Note Detection (Continued)

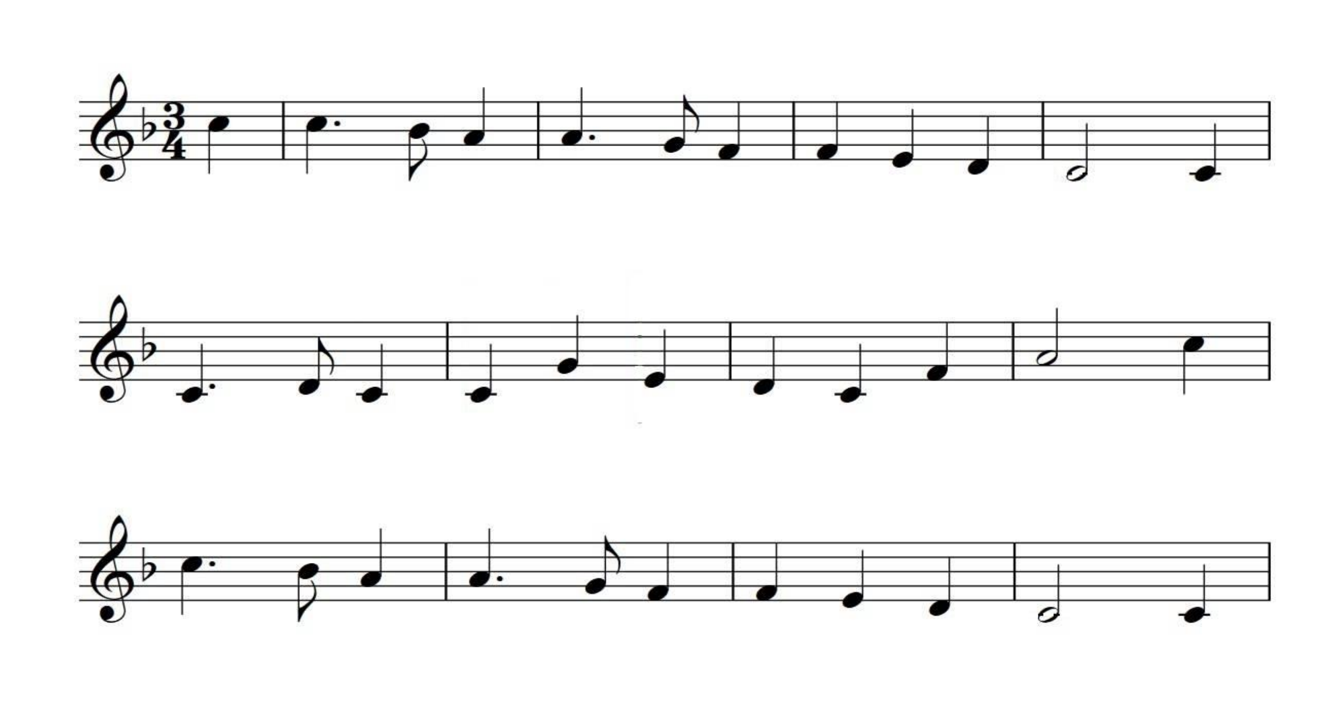


Audio Synthesis

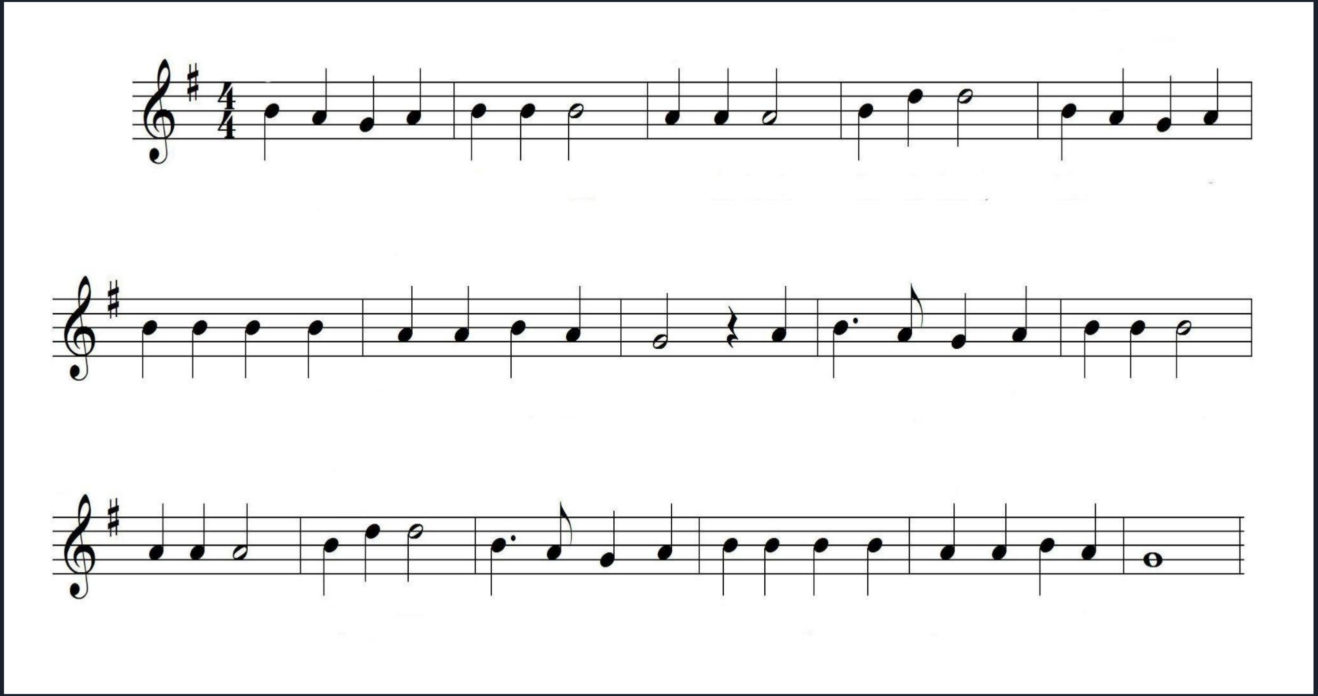
This part converts ABC notation to WAV file using tomita library's PySynth module.

- Detect color labels of centroids of the connected components
- Find nearest neighbour staff line
- If two staves are at similar distance then its in the space between the staves
- List of frequencies from the staves and duration from the type of notes is given to the library

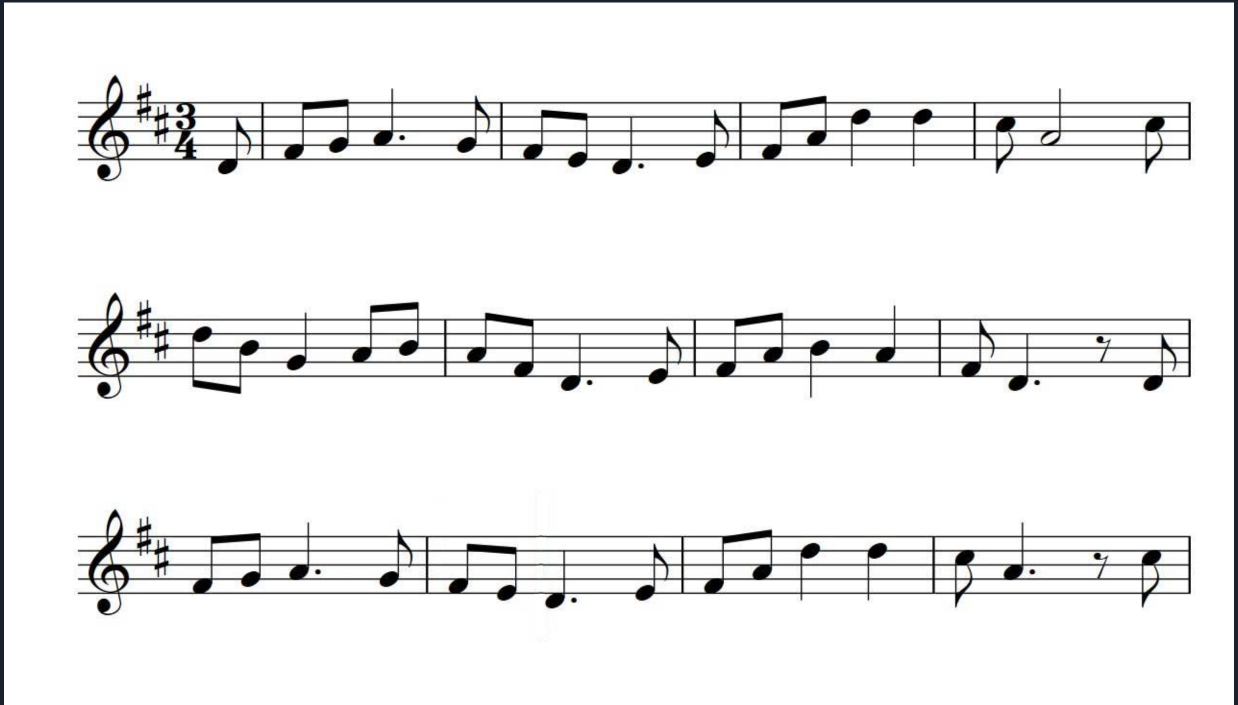
First Output



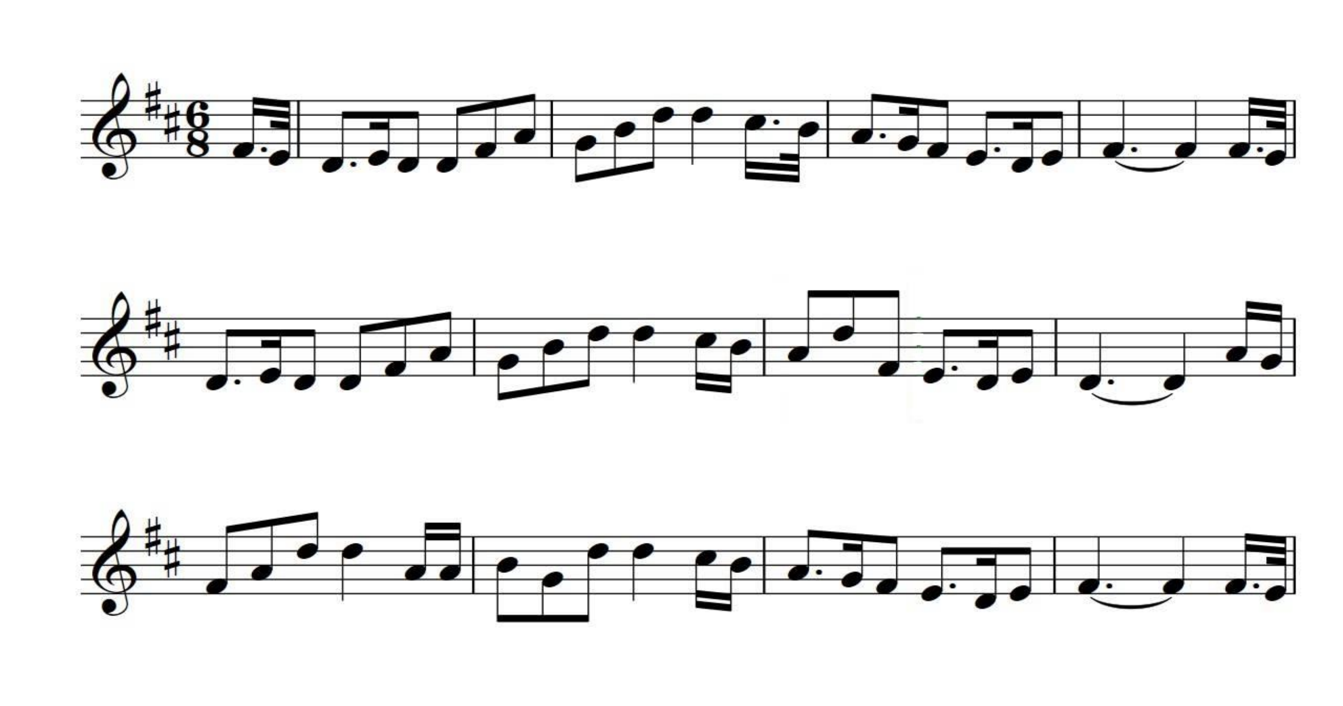
Second Output



Third Output



Fourth Output



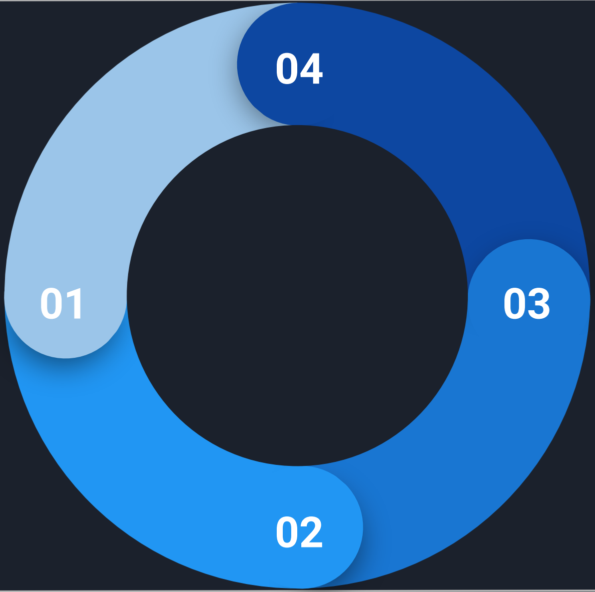
Timeline diagram

Mid Eval Progress

Preprocessing

Note Detection (0.5)

Key Note, Quarter Note, Clef



After Mid Eval Progress

Remaining Note Detection

1/8th , Dot and Tie(New), Rest Detection, Half and Full Note Detection, REST Detection

Audio Synthesis

Work Division

1. Aaditya Sharma
   a. 1/8th note detection
   b. Rest Detection
2. Kartik Garg
   a. Preprocessing
   b. Key note detection + Rest Detection + Dots and Ties Detection
3. Samyak Jain
   a. Preprocessing
   b. Quarter note detection + Half and Whole note detection
4. Tushar Choudhary
   a. Clef Detection
   b. Audio Synthesis

Thank you!