Pitch Perfect

TEAM: D7

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Application Area

Problem Area:

High cost and inaccessibility of singing lessons taught by vocal coaches for people interested in introductory training in singing

Solution:

A web application that provides novice singers with free vocal lessons focused on improving pitch and timing
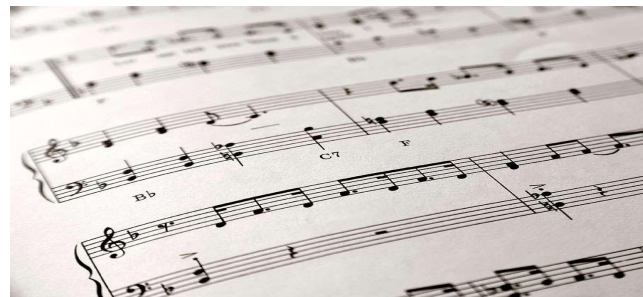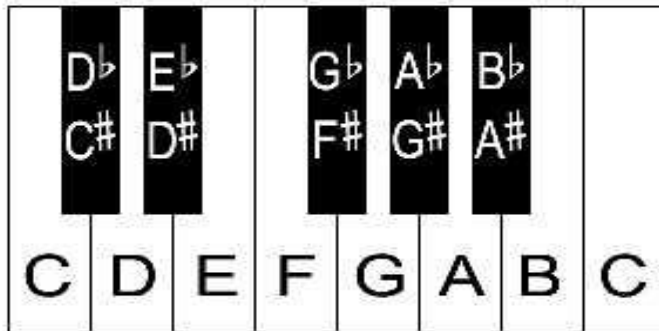
Solution Approach

Pitch:

Scales + Note + Listening

Rhythm:

Clapping Exercises

Music Theory:

Identifying music terminology important to singing

System Specification

- **Django Framework running an MVC architectural pattern**

- **Yin pitch detection algorithm (PDA) based on the autocorrelation method with post-processing steps to increase accuracy**

- **Note strain characterization derived from analysis of pitch intensity and intonation**

- **Peak finding based clap detection algorithm (CDA)**

- **Metronome generation to guide rhythm tempo**

Web App Implementation

USER Authentication
- Login
- Register

User Dashboard
- Exercises
- Past Feedback
- External Resources

Pitch
- Single Note
- Scale

Rhythm
- Clap Beats

Music Theory (Sheet Music)
- Identify Beats
- Identify Pitch

- Fill in User Info
- Voice Range Evaluation

- Low Range: C2 → C4
- High Range: C4 → C6

- Pitch Accuracy (%)
- Note Transition Strain (%)
- User's rhythm representation
- Music Theory Quiz Results
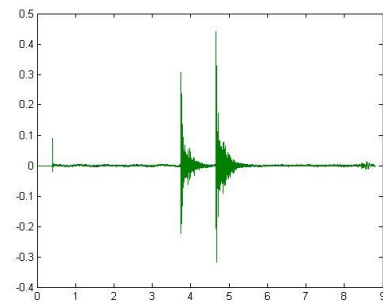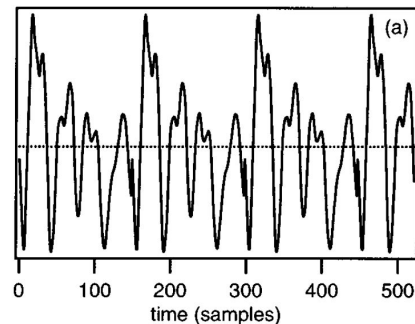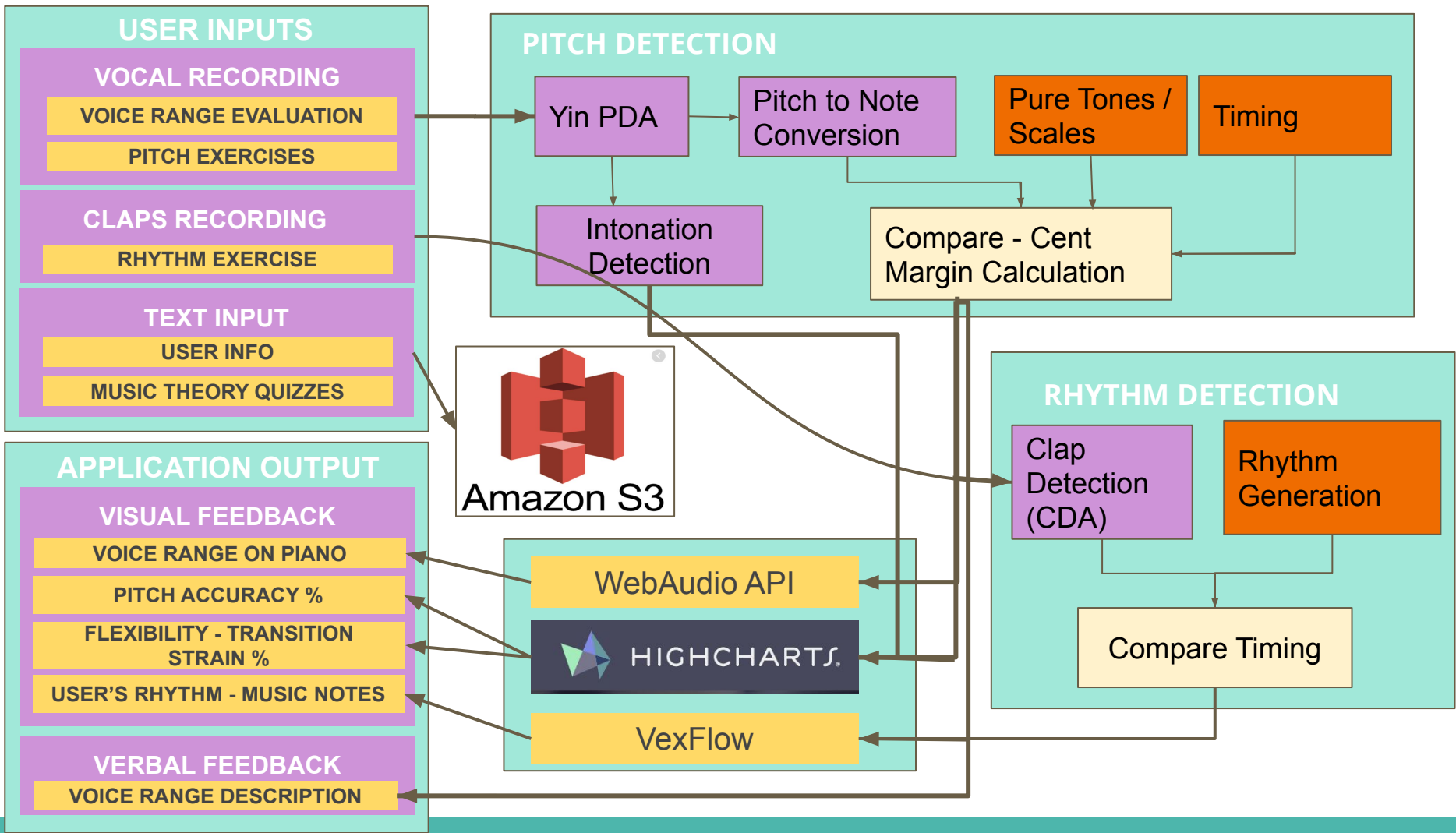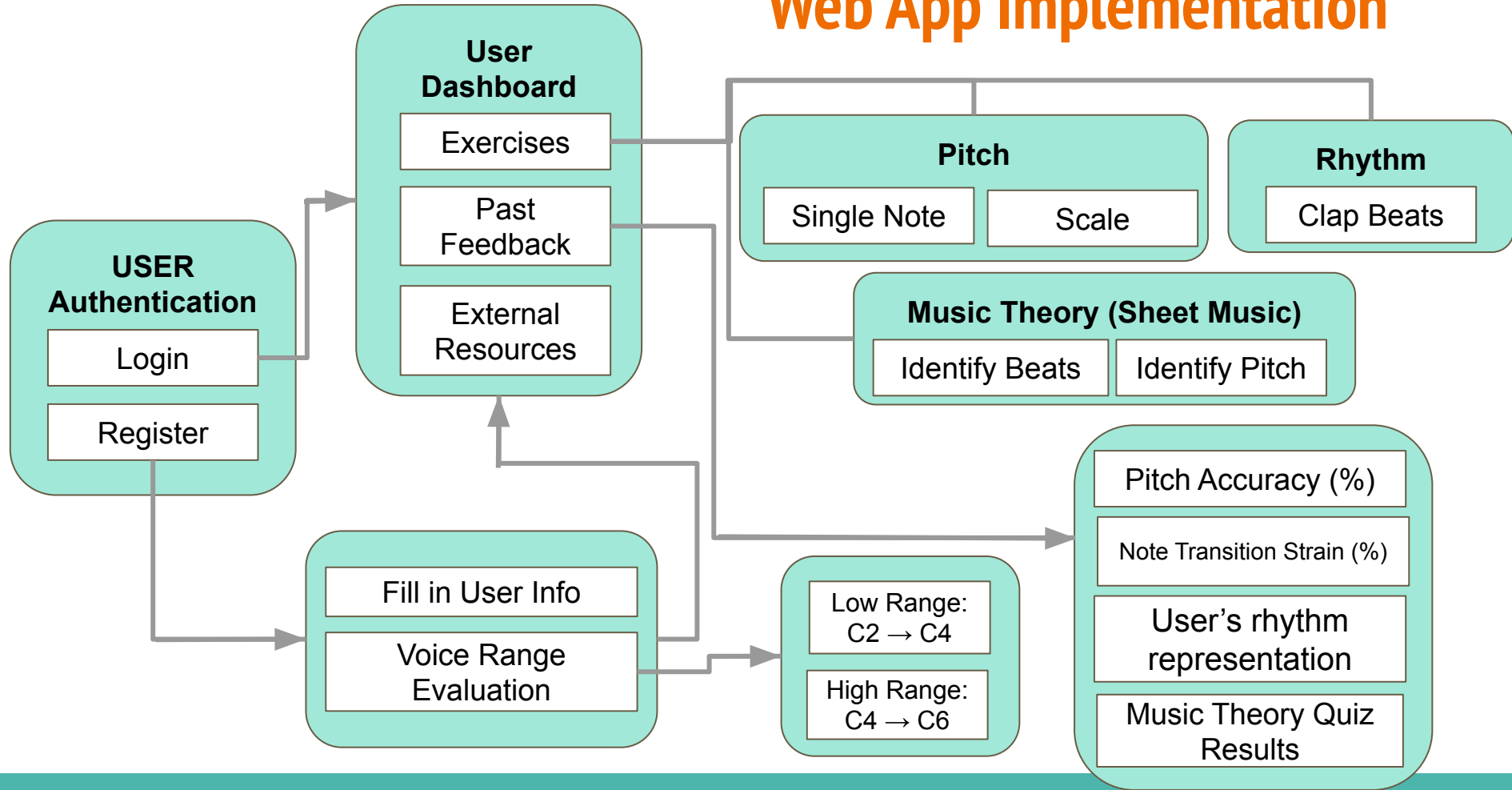
System Specification

Buying: Shure BRH440M Broadcast Headset + Microphone

Amazon Web Services (AWS)

Downloading: Web Audio API, MediaStream Recording API, Django Highcharts, VexFlow, Yin PDA, Music Theory Lessons

Designing/Developing: CDA, Feedback generation, Metronome, Pitch strain calculation

Feedback

Pitch Feedback → Unit of measurement (cents) Margin of error allowed is the Just Noticeable Difference (jnd) = 5 cents.

Strain Feedback → Analyze intonation and pitch intensity

Timing Feedback → Calculate time difference between the user's clap sound and the expected time of clap, with a margin of error considered.

Music Theory Feedback → Graded on answers to quizzes with solutions to answers they got wrong
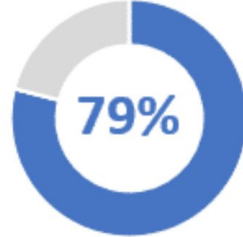
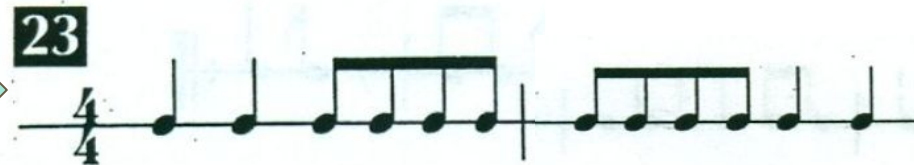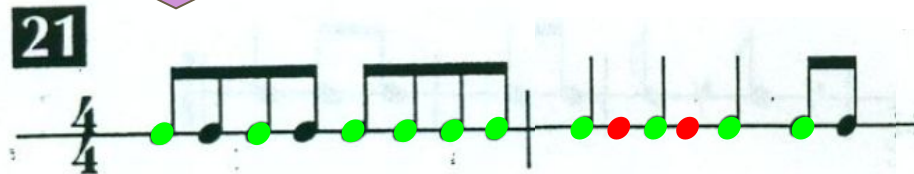$$Cents = 1200 \times log_2 \left(\frac{f}{f_{desired}} \right)$$

PITCH ACCURACY NOTE: C

97%

STRAIN NOTE: C

79%

RHYTHM: CLAP

EXPECTED

21
$\frac{4}{4}$

User Claps

23
$\frac{4}{4}$

Metrics & Validation

Requirement	Test Input	Testing/Validation	Passing Test Output
95% PDA accuracy per note	10,000 randomly generated pure tones with added white noise	Calculate pitch using PDA and compare to generated pure tone	PDA able to accurately classify 95% pitch to notes on test set
95% clap detection accuracy	Audio clips of a single person clapping	Detect claps in audio clip using clap detector	Clap detector able to accurately detect 95% of claps in clip
Intuitive and User-friendly Interface	Time user takes to navigate to exercises/Overall satisfaction	Focus Group Survey their experience	5-10 seconds to navigate to each exercise 5/5 Satisfaction Rating
Useful and concise feedback	Recordings of lesson responses for analysis	Run recordings through feedback algorithms	Response should be easily understood

Risk Factors/Unknowns

Risk	Mitigation
External Noise in Vocal Recording/Clap Recording	Noise-cancelling microphone
Using a third-party implementation of the Yin PDA	We will be thoroughly testing this module as described earlier, and tune parameters accordingly
Poor compatibility of Web App with other browsers	Build scalable UI/Django code to suit any browser

Schedule

SCHEDULE								
Tasks	Phase 1			Phase 2			Phase 3	
	3/8 - 3/14	3/15 - 3/21	3/22 - 3/28	3/29 - 4/3	4/4 - 4/10	4/11 - 4/17	4/18 - 4/24	4/25 - 5/1
Pitch Detection and Testing								
Clap Detection								
Pitch to key mapping								
Strain Detection								
Feedback Generation								
Pitch Matching (single notes)								
Scale lesson (includes flexibility) piano								
Login and registration								
Home page (user account)								
Lessons Page - Category 1								
Feedback Page - UI								
Recording Functionality								
Piano Note Generation								
Voice Range Evaluation								
Database relationship								
Training your ear lesson								
Interval Lesson								
Metronome clap along rhythm generation								
Resources Page (Information)								
Resources Page (UI)								
Lessons Page - Category 2								
Feedback Page - Information								
Cloud Deployment								
Design Report								
Phase 1 Integration								
Phase 2 Interim Demo Integration								
Final System Integration								
Testing								

Key

Funmbi	(blue)
Carlos	(red)
Sai	(green)
General	(gray)