



INVESTIGATION REPORT

Music Recognition and Genre Classification System (MRGCS)

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A report submitted in partial fulfillment of the requirements for the degree of

B.Sc. (Hons) Computer Science Specialism Intelligent Systems

at Asia Pacific University of Technology and Innovation.

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9-December-2022

Acknowledgement

I would like to appreciate to my project supervisor, Assoc. Prof. Dr. Imran Medi for guiding me for the entire period for completing this investigation report. Assoc. Prof. Dr. Imran Medi provide assist and correcting me professionally on works including project proposal form (PPF) and project specification form (PSF) which are the fundamental for this investigation report (IR), clear and accurate information are given based on his experience when I am having any question related to this project with kindness and patient which is very helpful for me where I can fulfil the requirements for this report and able to deliver a reliable system idea.

Besides that, I would like to express gratitude to my friends and family members who supporting me emotionally throughout the investigation progress when I lost my direction and motivation.

Last but not least, I would like to thank to everyone that supporting me during the process of completing this project else I am not able to deliver the project on time.

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Chapter 1: Introduction to The Study

The required knowledge and specification related to the project will be clearly stated in Chapter 1 for the purpose of an overview of the proposed project and field of study.

1.1 Background to the project

In this current era, people are more favour to listen to their dearest music via digital album from various music player platform. This is because a digital music album allows them to listen to it from anywhere at all time, while physical album disc will require a CD player in order to listen to it. This technology has brought quite a few advantages to the people including people do not have to queue up for so long or fighting each other for a famous artist album anymore. Besides that, the genre of music on those platforms are more than enough to fulfil everyone taste such as pop, funk, classical, techno, country and rock and many other more. Moreover, the users can also browse all the related artist's work and find the title of particular music from music recognition. To accomplish the user satisfaction, most of the artists are developing their work on digital album.

In a digital music album, there are a few of digital music. Digital music or digital audio file is a method of representing sound as numerical values and is identical to MP3 music since that is the most widely used file format that digital music exists in. Digital audio file is created by converting analog data into digital data while using various encoding formats to store the audio information (Harris, 2021). As example, a music can be downloaded from the internet and listen to it from the computer or mobile device. That way, the artist can easily promote their work and the audience can have their convenience.

However, the widely used of digital music also has some down side to it. It has caused too many music created by the artist to the platform due to the easement, the main problems come from it are the unbalanced for every work exposure and the difficulty of user to search for a particular music. Therefore, the project will be implementing music recognition and genre classification to overcome the existing problems and improve all the users' experience.

Music recognition is a concept that can be accomplish by using the query-by-example (QBE) music search service to let users find out the identity of audible pre-recorded music by sampling a few second of audio using an audio recording device. There are some other methods of music recognition but QBE recognition technique has been sought by many organisations around the world because of the flexibility on music recognition (Wang A. , 2006). By implementing

music recognition into the system, the difficulty for users to identify a particular music will be overcome because the users can get the result as long as there is a sample audio for that target. Genre classification is a concept to enable machine to automatically categorize and structure the large collections of music available on the internet. The automation of genre classification can assist or replace the manual work from human in this process and would be a valuable addition to music information retrieval systems. Besides that, genre classification establishes a framework for creating and assessing features for any type of content-based analysis of musical signals (Tzanetakis & Cook, 2002). With the use of genre classification, the users can easily find the desired genre based on the genre category.

In this project, the concept of music recognition and genre classification will be analysed in depth for a better understanding to develop a better technique or improve the current existing model. The result produced from this project should be meeting the expected accuracy and reliability. So that, a web application can be developed while applying the introduced concepts to overcome the current problem facing by all type of users.

1.2 Problem context

In this section, the problem context of the project will be listed out to make sure that the proposed system can overcome the problem stated below efficiently and effectively.

1. Noise and distortion of music recognition sample audio

The process of acquiring sample audio for the music recognition to conduct the comparison may exist noise and distortion. It has been proven to be one of the challenges facing by the music recognition from the paper (Wang A. , 2006). The user is expected to be anywhere when using the microphone of the device to recording the sample audio, the background noise such as traffic noise, ambient sound and human speech noise might be appearing in the sample. Therefore, the problem of identify and extract the actual music audio from the signal will be facing by the system. Besides that, the distortion of audio created by the equipment either from source or microphone are also needed to be identify by the system. With the solution for this problem, the music recognition function for the system will be more accurate and providing high reliability for the users.

2. Lyrics meaning extraction for genre classification

Most of the genre classification are classifying the music based on the typical features extracted from the music including timbre, melody or harmony and rhythm (Zoia, Nicolas, & Mlynek, 2006). Besides that, the automatic genre classification seems to be only classifying the typical music which is too little and restricting the flexibility for users to search their desired genre. Therefore, a lyric meaning extraction algorithm should be applied by using natural language processing to let the machine not only understanding the rhythm but also combining the meaning with the lyric, with that, the accuracy of the genre classification should be highly increased. In addition, the genre should not be only restricted to the main music type, instead, some emotion keyword such as happy, exciting and sad can be added as a genre during the machine learning phase.

3. Key and tempo changes for the sample audio

Key and tempo of the sample audio can be significantly affecting the music recognition result which is proven from the paper (FLORA & XIAO, 2019). The same music with different key can be easily notice and identify by a human hearing. However, it is not the case for the music recognition algorithm as it not designed for the particular case. From the same paper

stated that modification for the algorithm can be made to overcome the issue and recognize the music even when the key and tempo of the sample are incorrect. The study is needed for the modification and product a reliable music recognition algorithm that ready to face key and tempo changes from the sample while ensuring the accuracy of the result is meeting the requirement.

1.3 Rationale

To overcome the problems stated in section 1.2, the project proposed a music recognition and genre classification system “MRGCS” which will be reliable and promoting for a greener environment. The system will be a web application that recognize the music with a sample audio provided and classify the music existing in the database. Many types of users can access to the system via their devices which are able to run a web browser with available internet connection such as mobile phone, tablet, personal desktop computer and laptop. It will promote the use of digital album which will significantly reduce the use of CD or DVD followed by the reduction of waste created to the environment.

Besides that, the system will provide the solution to overcome the difficulty for users to identify a particular music name which is a problem caused by too many digital music existing, with the use of the system the user can get the result as long as there is a sample audio of the target music provided to the system. The system will acquire the sample audio and go through a signal processing to capture the uniqueness of the audio in order to search it with similar music within the database.

Moreover, the system will also provide the functionality of genre classification which help not only the audience can easily find the desired genre based on the genre category but also ease the artist to label their music uploaded to the system with a constant genre classification algorithm. The system learned the labelled genre from the database and use the knowledge to classify any new music sent to the system database with their similarity.

1.4 Potential benefits

There are many benefits which will be provided by the project result and they are the main motivation to carry out the project. The benefits of the project will be listed in this section in two categories which are intangible and tangible benefits, intangible benefits are those which are measurable and quantifiable while tangible benefits are those which are subjective and qualitative.

1.4.1 Tangible benefits

- Reduce the cost of time, unrenewable energy such as electricity for the audience needed to search for a music they heard or only having a small portion of the full music.
- The action of artist using physical album disc to promote and distribute their music work will be reduced significantly to have a greener environment since the digital music is also reliable on the organised system.
- There will be no need for audience to store their disc in their storage of shelf rack, instead they can store lot of their music into a single hard disk if they want to download the music to their device.
- Music market analyser can predict or obtain the information of which genre of music is popular among the audience to produce a work that is expected to be liked by the audience.

1.4.3 Intangible benefits

- Artist who uploads work to the system can enjoy the convenience from genre classification system identifying their work's genre to the audience.
- Audience can easily explore for music that have similar genre with their favourite music with the use of genre classification.
- Artist can easily know how many people had viewed their own work from the system.

1.5 Target users

The system will have many types of target users including system administrators, managerial staff, music artist, music audience and music market analyser where music audience will be the main target on utilising the music recognition and genre classification function of the system.

1.6 Scope and objectives

In this section, the aim and objectives of the project are listed to effectively plan for deliverables that can achieve the project scope while facing the nature of challenges for the project stated.

1.6.1 Aims

The aim of this project is to improve the accuracy and reliability of music recognition and develop a stable genre classification for the web application system. Therefore, the exposure for every artist's work can be balanced and the difficulty for user to search for a particular music can be ease.

1.6.2 Objectives

The objectives of this project are:

1. To study the existing machine learning model for music recognition and genre classification.
2. To identify the advantages and disadvantages of the model and improve it with modification or introducing a new technique.
3. To acquire the require and suitable datasets to train the model for the expected result from the machine when testing.
4. To acquire the data of the result produced by the modified model for the record and prove of the improvement.
5. To develop a web application that having account authentication for each role while implementing the model to the system.
6. To identify the weakness and possible future improvement for the final product developed in this project.

1.6.3 Deliverables

The final product of the project is a web application that having account authentication for every type of user. The web application is acting as a music platform for artist to upload their work and audience to listen to it. The developed music recognition and genre classification algorithm will be utilized and implemented to improve the user experience and overcome the problem brought by the introduction of digital music. However, the main feature of the web application would be the music recognition and genre classification, other features will be considered as extra and will only be completed if there is sufficient time for them.

Main Features:

MRGCS allows every user type

- Browse music from the database while using the genre category
- Perform music recognition
- Prioritised extra feature (if there is extra time):
 - Able to identify the popular genre of the music in the database
 - Able to look for music that have similar genre with their favourite music
- Highlighting Features:
 - Music recognition that only need a part of the audio
 - Music recognition that recognises not only song with lyrics but also instrumental music
 - Acquiring sample audio not only from microphone but also accept speaker as input
 - Fast boot up speed and straight-forward design to perform music recognition immediately
 - Consistent genre classification

Extra Features:

MRGCS allows system administrators

- Login to the system
- Add or remove account for every type of role in the system
- Able to modify or access to all the database in the system

MRGCS allows managerial staff

- Register an account
- Login to the system
- Produce a report of the accuracy of the result
- Add or restrict account of music artist, music audience and music market analyser for inappropriate actions.

MRGCS allows music artist

- Register an account
- Login to the system
- Upload music work to the system while the genre will be classified
- Observe own work viewed count and exposure rate to the audience from the system
- Obtain the information of similar percentage of other music compare to own music
- Identify the popular genre of the music in the database

MRGCS allows music audience

- Register an account
- Login to the system

MRGCS allows music market analyser

- Register an account
- Login to the system
- Produce a graph showing the history of user listen to a particular music
- Identify the popular genre of the music in the database

1.6.4 Nature of Challenges

First and foremost, the user interface is one of the challenges in this project since the final product will be a web application that can be access by user from every type of device that able to run a browser with internet connection, different type of device will have a different resolution for the display screen which will cause the elements of the interface appear at a not desired place. Therefore, the design of dynamic interface which will adapt to the resolution of the device will be a challenge to the web application.

Besides that, the security of the web application is also very important to this project in order to protect personal information for every user of the system and also prevent any malicious

modification to the database such as via SQL injection causing the trained model to produce a wrong answer to music recognition and genre classification system.

Moreover, the skills and techniques for signal processing and the filtering for the noise and distortion to the music audio file is the most crucial challenge to the project since it will directly affect to the project functionalities result.

Last but not least, the constant project coding file structure is also a challenge part where all the naming contention and coding technique must be oriented and constant throughout the whole project.

1.7 Overview of this Investigation report

The entire investigation report will have total of 7 chapters in order to provide a detailed documentary of the proposed title and every chapter are showing the required knowledge and information for the project to execute the development phase smoothly without any critical issue and fulfilling the expectation of developer and the requirement of the users.

Chapter 1 will be describing the fundamental of the project, the background of the study, the problem context with analysis and how will the project overcoming them, the potential benefits that will brought by the project, the target user of the project, the project scope including aim, objectives, deliverables and nature of challenges that will be faced by the developer in the development phase of the project.

Chapter 2 will be conducting literature reviews by studying from existing similar works that done by other researchers through resources that can be found online including journal papers and related materials. Domain research areas of the project such as how signal processing work, the importance of music recognition and genre classification system and the algorithms used for machine learning. Research on similar system compared with the proposed system will be conducted to innovate idea from them. This chapter will be useful on helping the developer to achieve succession on the project.

Chapter 3 will be conducting technical research for the project by comparing the current available on trend resources in the aspects of their advantages and disadvantages to find out the best suits tools for the developer to use to complete the project. This chapter will identify and make decision on the best resource that will be used by the developer to develop the project.

Chapter 4 will be talking about system development methodologies for the project. The developer will be comparing methodologies in various aspects and chose the most suitable methodology among them with appropriate justification given. The developer will also mention how the chosen methodology will be implemented in the project.

Chapter 5 will be mentioning the data gathering methods that will be used by the developer to identify the user requirements for the project, each selected method will be given their question design and followed by an explanation of purpose for each question.

Chapter 6 will be analysing and evaluate the responses collected from the respondents for every selected data gathering methods to obtain knowledge from the data and create insights on the requirements of the project.

Chapter 7 is the last chapter of the project which will be concluding the project and reflection of the developer based on the conducted investigation report of the project.

1.8 Project Plan

The breakdown of the investigation report that need to be completed on a planned date and duration are shown on the table below in order to ensure that the report is progressing in scheduled timeline.

Final Year Project - Investigation Report (MRGCS)				
Task	Duration	Start Date	End Date	Status
Project Proposal Form (PPF)	5 days	12/9/2022	16/9/2022	Submitted
Project Specification Form (PSF)	8 days	23/10/2022	30/10/2022	Submitted
Fast-Track Ethics Form	3 days	14/11/2022	16/11/2022	Completed
Questionnaire Questions	1 day	20/11/2022	20/11/2022	Completed
Interview Questions	1 day	20/11/2022	20/11/2022	Completed
Project Log Sheet – 1	1 day	28/9/2022	28/9/2022	Completed
Project Log Sheet – 2	1 day	6/12/2022	6/12/2022	Completed
Project Log Sheet – 3	1 day	9/12/2022	9/12/2022	Completed
Chapter 1: Introduction	5 days	1/11/2022	5/11/2022	Completed
1.1 Background of the Project	5 days	1/11/2022	5/11/2022	Completed
1.2 Problem Context	1 day	1/11/2022	1/11/2022	Completed
1.3 Rationale	1 day	1/11/2022	1/11/2022	Completed
1.4 Potential Benefits	1 day	1/11/2022	1/11/2022	Completed
1.4.1 Tangible Benefits	1 day	1/11/2022	1/11/2022	Completed
1.4.2 Intangible Benefits	1 day	1/11/2022	1/11/2022	Completed
1.5 Target Users	1 day	1/11/2022	1/11/2022	Completed
1.6 Scope and Objectives	1 day	2/11/2022	2/11/2022	Completed
1.6.1 Aims	1 day	2/11/2022	2/11/2022	Completed
1.6.2 Objectives	1 day	2/11/2022	2/11/2022	Completed
1.6.3 Deliverables	3 days	2/11/2022	4/11/2022	Completed
1.6.4 Nature of Challenges	3 days	2/11/2022	4/11/2022	Completed
1.7 Overview of the Investigation Report	3 days	3/11/2022	5/11/2022	Completed
Chapter 2: Literature Review	3 days	4/11/2022	6/11/2022	Completed
2.1 Introduction	2 days	4/11/2022	5/11/2022	Completed

2.2 Domain Research	2 days	4/11/2022	5/11/2022	Completed
2.2.1 The Importance of Music Recognition and Genre Classification	2 days	4/11/2022	5/11/2022	Completed
2.2.2 Algorithms for Music Recognition	2 days	4/11/2022	5/11/2022	Completed
2.2.3 Algorithms for Genre Classification	2 days	4/11/2022	5/11/2022	Completed
2.3 Similar System	1 day	6/11/2022	6/11/2022	Completed
2.4 Additional Insights	1 day	6/11/2022	6/11/2022	Completed
2.5 Summary	1 day	6/11/2022	6/11/2022	Completed
Chapter 3: Technical Research	3 days	24/11/2022	26/11/2022	Completed
3.1 Programming Language	1 day	24/11/2022	24/11/2022	Completed
3.2 Interactive Development Environment (IDE)	2 days	25/11/2022	26/11/2022	Completed
3.3 Libraries and Tools	1 day	26/11/2022	26/11/2022	Completed
3.3.1 NumPy	1 day	26/11/2022	26/11/2022	Completed
3.3.2 SciPy	1 day	26/11/2022	26/11/2022	Completed
3.3.3 Pandas	1 day	26/11/2022	26/11/2022	Completed
3.3.4 PyTorch	1 day	26/11/2022	26/11/2022	Completed
3.4 Database Management	1 day	26/11/2022	26/11/2022	Completed
3.5 Operating System	1 day	26/11/2022	26/11/2022	Completed
3.6 Summary	1 day	26/11/2022	26/11/2022	Completed
Chapter 4: System Development Methodology	1 day	27/11/2022	27/11/2022	Completed
4.1 Comparison of Methodology	1 day	27/11/2022	27/11/2022	Completed
4.2 Justification of Chosen Methodology	1 day	27/11/2022	27/11/2022	Completed
4.3 Details of Chosen Methodology	1 day	27/11/2022	27/11/2022	Completed
4.4 Overview of Project Progression	1 day	27/11/2022	27/11/2022	Completed
Chapter 5: Research Methods	1 day	28/11/2022	28/11/2022	Completed

5.1 Introduction	1 day	28/11/2022	28/11/2022	Completed
5.1.1 Questionnaire	1 day	28/11/2022	28/11/2022	Completed
5.1.2 Interview	1 day	28/11/2022	28/11/2022	Completed
5.2 Design	1 day	28/11/2022	28/11/2022	Completed
5.2.1 Questionnaire	1 day	28/11/2022	28/11/2022	Completed
5.2.2 Interview	1 day	28/11/2022	28/11/2022	Completed
5.3 Summary	1 day	28/11/2022	28/11/2022	Completed
Chapter 6: Requirement Validation	2 days	6/12/2022	7/12/2022	Completed
6.1 Analysis Data of Questionnaire	1 day	6/12/2022	6/12/2022	Completed
6.2 Analysis Data of Interview (Participant 1)	1 day	6/12/2022	6/12/2022	Completed
6.3 Analysis Data of Interview (Participant 2)	1 day	6/12/2022	6/12/2022	Completed
6.4 Summary	1 day	7/12/2022	7/12/2022	Completed
Chapter 7: Conclusion and Reflection	1 day	7/12/2022	7/12/2022	Completed
References	1 day	7/12/2022	7/12/2022	Completed
Appendix	1 day	7/12/2022	7/12/2022	Completed

Chapter 2: Literature Review

In this chapter, the developer will conduct literature review based on the domain field and existing system that are similar to the proposed project to make sure the final product of the project is reliable and reasonable.

2.1 Introduction

In this early phase of the project, study on relevant topic and report is conducted to provide a review based on the fact investigation and backing up the project topic. The literature on music recognition and genre classification are mostly describing the process of improvement or implementation to the existing system. Along with that, the information such as limitation and significant improvement from those reports are to be collected as a fact. Due to that, this project can renovate some new ideas that can overcome the limitation while maximize the improvement for the system.

2.2 Domain research

In this section, the findings from existing works from other researchers will be described including topic related to the importance of music recognition and genre classification as well as the algorithms for both music recognition and genre classification.

2.2.1 The Importance of Music Recognition and Genre Classification

According to the study from (Scaringella, Zoia, & Mlynek, 2006), music artists and librarians primarily utilise genre as the descriptor when organising their music collections. Genres are quite interesting as descriptions of some similar features in musical pieces, even though they could be a simplification of one artist's musical discourse. In the current era, the distribution of electronic music has been rising throughout the world cause the number of music categories become huge where genre become the important tool to help users on finding what the users wish to look for. However, the promoted use of digital music has provided efficient way to browse, organise and update music collections which mean the genre become more and more important. Therefore, the genre classification which provide a consistent genre answer has been further emphasises to be important on overcoming the issue while improving the user experience for the proposed system.

Based on the study titled A Behavioural Model of Digital Music Piracy has been conducted by (Gopal, Sanders, Bhattacharjee, Agrawal, & Wagner, 2004). Digital music piracy

has undergone a significant transformation as a result of the rise use of the internet, broadband connections, and the development of digital compression technologies. The paper mentioned that digital music file is the best and perfect economic good that is easy to be duplication and to be transported anywhere which causing the behaviour of illegally copying of this digital music file is increasing rapidly. Therefore, the importance of music recognition system is emphasized with the ability to recognise any music that has copyright and being used on commercial purpose almost immediately. With that, the copyright for the music author can be assured and reducing the privacy behaviour on music work.

2.2.2 Algorithms for Music Recognition

In the paper (Gutiérrez & García, 2016), an optimisation process of music recognition system using the CHC Generic Algorithm (GA) has been proposed where first C stands for Cross-generational elitist selection strategy, H stands for a Heterogeneous recombination and the second C stands for Cataclysmic mutation, this is one of the best GA. The paper starts from discussing about the implementation of landmark-based approach which have the purpose to robustness that allows reasonable level of noise exist in the audio query, an exposed method that calculates the fitness of a collection of parameters by counting the matching landmarks between the original song and the audio sample capture from the microphone is used to evaluate chromosome that is used by GA. To prove the optimization process is success, the parameter values obtained from the process get executed in testing and gone through analysis where a successful recognition from CHC GA achieved 1.84 second earlier than the original algorithm. Besides that, the consistency of CHC GA were also tested and proved by comparing the result with hill-climbing approach.

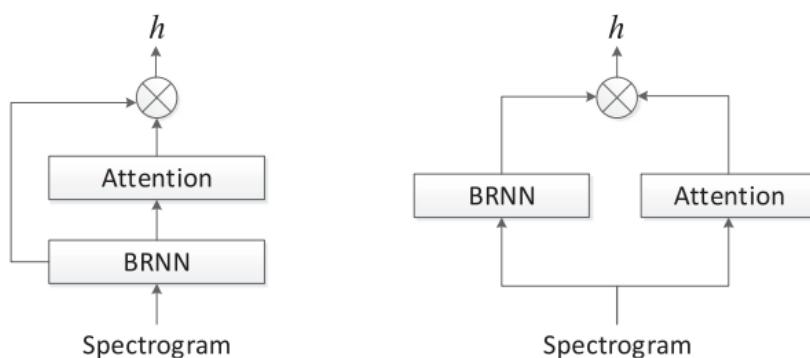
CHC Generic Algorithm (GA)	
Advantages	Disadvantages
One of the best GA	High complexity
High suitability on the level of consistency	
Proven to be very effective in problems of high complexity	Slow in term of speed

In the paper (Wang & Fang, 2022), Feedforward Neural Network (FNN) has been used by the researcher as a music recognition and classification algorithm while considering the audio emotion while the Gradient descent learning algorithm will be used to train audio emotion features. FNN algorithm is used in this paper to extract the musical emotion features to identify and classify them based on the intensity, melody and rhythm density from the features. Based on the result shown in the paper, the FNN model has been proven to be high value of use, high accuracy for recognising the emotional features from music and important significance for music emotion recognition classification.

Feedforward Neural Network (FNN)	
Advantages	Disadvantages
Process for non-linear data can be done easily	
With a minimal intermediary to provide moderation, a number of Feedforward networks can operate independently.	Require good hardware to train the model

2.2.3 Algorithms for Genre Classification

Based on the research (Yang, et al., 2020) conducted, there are two types of Bidirectional Recurrent Neural Network (BRNN) proposed in the paper for the purpose of genre classification which each of the BRNN incorporating their respective attention mechanisms which are serial attention and parallelized attention. The paper stated that the model that apply serial attention rely on BRNN too much causing it have lower performance compared to the parallelized attention model (PAM) which have the better performance. Besides that, the paper mentioned that the PAM is so flexible that can accept different attention forms to be implemented into it such as linear transformation and Convolutional Neural Network. To conclude the result in the paper, BRRN that implement attention mechanism had achieved better result and even better than related previous work especially BRRN with parallelized CCN attention.



Architecture of serial and parallelized attention models (Yang, et al., 2020)

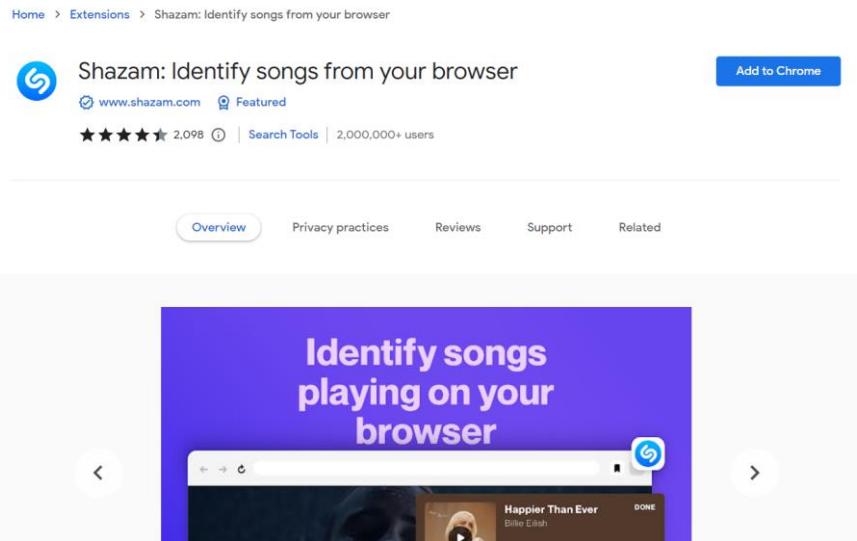
Bidirectional Recurrent Neural Network (BRNN) + parallelized Convolutional Neural Network (PRNN) attention	
Advantages	Disadvantages
Incredibly high accuracy that succeed the previous work	High complexity
Flexible to implement with different type of attention	

According to the research (Lidy, Schindler, & Rauber, 2016), Shallow and Deep Neural Network Architectures has been compared on the topic of automatic music genre classification. Some testing has been done to both of the type of Convolutional Neural Network (CNN) with many different sizes of dataset to perform genre classification task and obtain the performance result. To conclude the result shown in the paper, shallow CNN model proved to be more suitable for small size of dataset because of deep CNN model do not show any significant improve to the specific case. On the other side, deep CNN model can perform better if the larger dataset is used for performance testing. Besides that, it has been proved that the use of data augmentation by applying time stretching and pitch shifting has improved the performance for the deep CNN model while it cannot be applied to shallow CNN on the small datasets because it showed negative effect. Hence, deep CNN model should be implemented if data augmentation is applied for better performance.

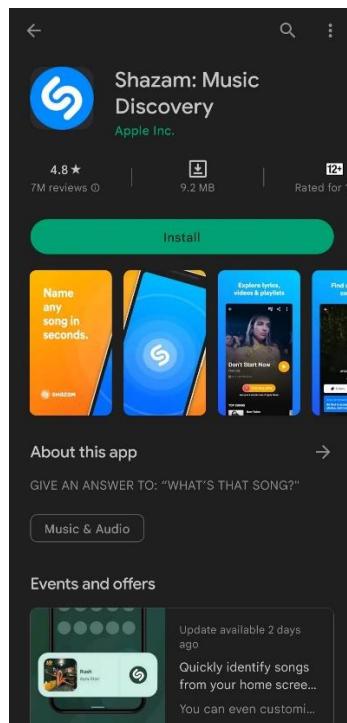
Deep Convolutional Neural Network (CNN)	
Advantages	Disadvantages
Advanced visibility	Do not encode the position and orientation of object.
No more bottlenecks	Lack of ability to be spatially invariant to the input data.
A higher level of control	Huge training data is required.

2.3 Similar System

2.3.1 Shazam



Screenshotted from Chrome Extension Store

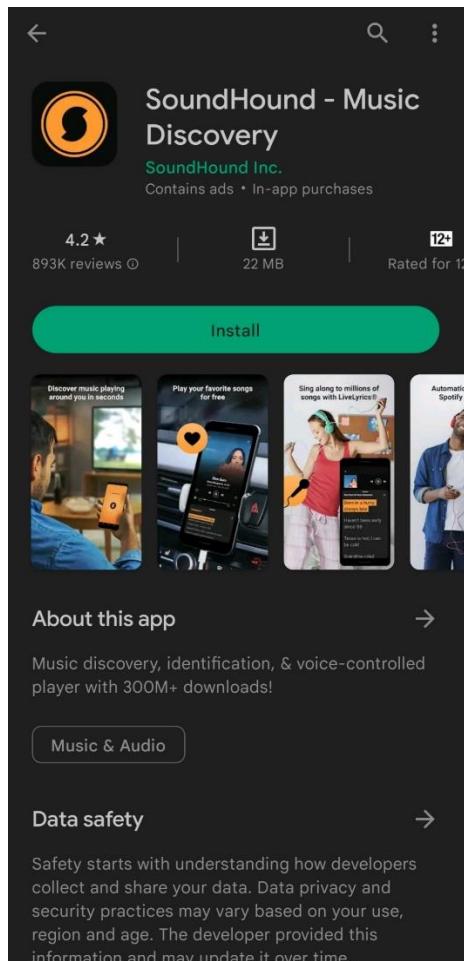


Screenshotted from Google Play Store

Shazam is one of the most popular mobile applications that people used to identify music or performing music recognition which can also be install on chrome, it is reliable that can recognise the exact song successfully without having many failed attempts. The Shazam application is available to install on operating system of Android and iOS without issue, in fact,

the famous assistant that exist in iOS, Siri, uses the Shazam database to help user who ask for recognising songs. Hence, people utilise Shazam which can easily help to recognise the music, find a song and get the lyrics of the song so the user can sing along with the song. Besides that, Shazam can also store the recognised song in the past to the user personal library which can then be displayed as a list to the user when searching for history. Moreover, Shazam can even work without internet connection where it is first recorded the audio sample if there is no internet connection at the meantime, then the recognition process will begin after the device get a stable internet connection. Last but not least, the Shazam also introduce the function called “Pop Pu Shazam” which will recognise songs that are currently playing on the mobile phone since it is impossible to capture audio sample from the same device that run Shazam, this function will be useful when browsing social media platform where it has many interesting music (Sha, 2022).

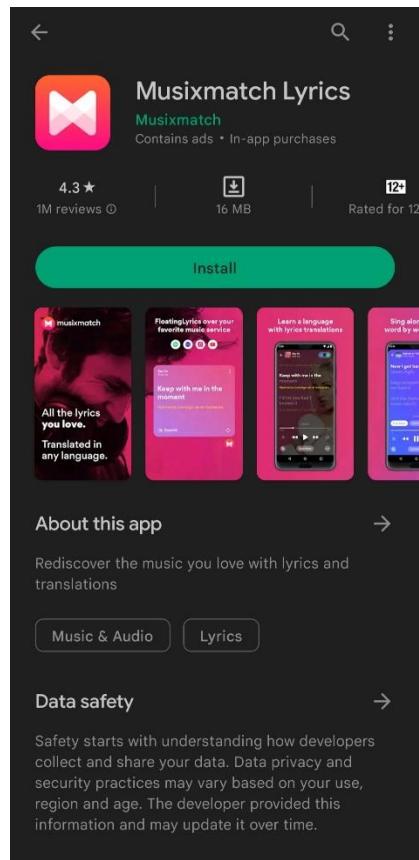
2.3.2 SoundHound



Screenshotted from Google Play Store

SoundHound is also one of the famous applications that can be used to recognise the name of the song, it is an application that allows to operate in the operating system of Android, iOS and Windows. One of the areas that SoundHound is proud of and able to compete with Shazam is that it can perform music recognition from human humming the tunes of the song which is very incredible. This function is so helpful when the user does not remember any single lyrics of the song but is able to hum the tune of it. Besides that, SoundHound is also able to recognise music but not only recognise song while the speed of the recognition can be said as fast as Shazam. Moreover, it can get user the lyrics of the song so the user can sing along with the song while keeping all of the history song or music discoveries in a personal library presenting with a clean user interface. Last but not least, SoundHound can perform the recognition but saying the fixed instructions without having any physical interaction with the device (Sha, 2022).

2.3.3 Musixmatch



Screenshotted from Google Play Store

Musixmatch is an application that can be used to quickly recognise music that is playing around the user surrounding with in-line lyrics, it is an application that allow to operate in the operating system of Android iOS and Windows. This application is not only focusing on the music recognition function, but it is a music player with lyrics support. Musixmatch will look for a song that fits the audio fingerprint and attempt to identify the music that is currently playing. ACRCLOUD supports Musixmatch's song recognition function, which performs very well. Musixmatch's attempt to sync the music and words in real-time is unusual and frequently successful. In addition, it provides song lyrics translations into a variety of national and regional languages (Sha, 2022).

2.4 Additional Insights

Based on the report produced by Avery Wang, QBE technique is one of the ways to achieve music recognition but it must overcome some technical challenges to produce a good result including dealing with the ambient or environment sound mixing with the target music audio, the distortion such as reverberation and absorption caused by the source equipment and the database management which adding millions of music do not decrease the probability of finding the correct target (Wang A. , 2006). Although these challenges are discovered from QBE technique, these challenges should still be given attention to in order to improve the music recognition.

In the project conducted by Blaise Agüera y Arcas team, they stated that all the existing music recognition applications require a connection to a server that perform the actual recognition which is causing the high battery consumption during the process. Therefore, the team install a small music detector to the digital signal processor to wake it up only when it is confident that music is present, then the music fingerprint will then use to compare with the fingerprint database on the device. The conclusion prove that the battery consumption is decreased significantly while alleviating the need for users to query a server and thereby preserving the user's privacy (Arcas, et al., 2017). This project result has reminded that the importance of battery and time consumption for the music recognition since they are both well related.

Fangjian Flora and Xiao conducted some experiments with the famous Shazam Music application for the identification algorithm. In the conclusion of the experiments, the music can be easily recognised despite the background noise because the algorithm is not fundamentally built to recognize musical structure. However, difference in key and tempo of the sample can confuse the result produced by the application but there are some ways to modify the algorithm for recognising them (FLORA & XIAO, 2019). This study finds out the key changing in the sample audio can affect the result of music recognition significantly. Hence, this can be a problem for the project to overcome to identify the target music even when the key or tempo change exist in the sample.

According to the report from George Tzanetakis and Perry Cook, musical genre classification can be performed automatically with the result which significantly better than human genre classification in term of chance and performance despite of the fuzzy nature of genre boundaries. Besides that, the paper stated that the result can testify to their potential as basis for other type of technique including similarity retrieval, segmentation and audio thumbnailing which are describing the musical content by extracting the features (Tzanetakis & Cook, 2002).

From this study, the genre classification is proven to be useful for categorising the music by genre and many other techniques are introduced and may be useful for this project.

On the other report conducted, Scaringella Nicolas, Giorgio Zoia, and Daniel Mlynek review the automatic genre classification and present new directions in automatic organization of music collections. Expert system, unsupervised clustering and supervised classification technique were used in that review and identified their advantages and drawbacks for each of them. Besides that, the paper listed out three typical features used to characterize music content which are timbre, melody or harmony and rhythm (Zoia, Nicolas, & Mlynek, 2006). From that, the common element act as parameter needed to perform genre classification are identified while idea of other way to classify music is innovated.

Based on the report conducted by Cory McKay and Ichiro Fujinaga, the paper stated that automatic genre classification is a difficult and problematic task that nonetheless has important value in terms of both pure research and commercial application. Therefore, they come out with some further improvement for the genre classification on a list to get genre classification concept out of local maximum (McKay & Fujinaga, 2006). There are some improvements can be referred to from the paper to be implement on the project for better genre classification to be truly useful for the users.

Although some paper can be slightly unrelated to the music recognition and genre classification, most of them are still quite useful for the project research. The papers show the common way of achieving the functionalities which can be used or introduce a different way of recognition or classification to the music.

2.5 Summary

For the summary on Chapter 2, the developer has innovated a few of insights and ideas for the proposed project after the research related to the study field of the proposed project has been conducted by the developer. The literature review parts are making the developer have a better understanding on the importance of music recognition and genre classification system, algorithms for music recognition, algorithms for genre classification. This part let the developer to further understand the background of the proposed project as well as the available and useful algorithms which can be apply to the music recognition and genre classification function. Besides that, research on total of 3 similar system has been conducted to study the common function of existing similar system in the market and possibly innovate idea from them. Moreover, some additional insights have been done to related topic of the proposed project. In short, the literature review is one of the most important parts for any software development process as it will deepen the understanding of developer toward the study field of the proposed project.

Chapter 3: Technical Research

In this chapter, the developer conducted technical research on the current available on trend resource based on the project and list all of the findings out in the sections including programming language, interactive development environment (IDE), libraries and tools, database, operating system, web server and web browser which are best suited for the development phase of the project.

3.1 Programming language

The decision of programming language is very important for any software development project as it is a core element which will be used to effectively utilise the capabilities it provided. With the grow of technology nowadays, there are various available selection of programming language in the market and the selection is the first step for software development to begin. Different programming language have different purpose and main focus where the syntax of code is different and the data processing time will also be different, these aspects will affect the progress of developing the project if a not suitable programming language is chosen. Since the project is a type of signal processing and Artificial Intelligence-Based project, the comparison between Python and C++ based on (GeeksForGeeks, 2022) and (Prasanna, 2022) will be conducted and shown below.

Aspects	Python	C++
Code	Fewer lines of code for achieving the same purpose.	Longer lines of code for achieving the same purpose.
Garbage Collection	Support garbage collection.	Do not support garbage collection but can be implemented.
Syntax	Python features a large number of short-hand structural iterators and employs short-hand syntax. Any class instance method must have the parameter "self" as an argument. Although some of the short-	Due to the large number of predefined syntaxes and structures, C++ has a challenging learning curve. Instances of classes are implicitly referred to as "this" in C++. C++ has a few

	hand syntax, such "rkwargs," can be perplexing, Python is rarely entirely esoteric.	exceedingly esoteric syntaxes.
Compilation	Python is interpreted.	C++ is precompiled.
Speed	Python is slower because it employs an interpreter and chooses the data type at run time.	C++ is faster once the source code is compiled.
Rapid Prototyping	Rapid Prototyping is possible with easy project setup and live interpreter	Rapid Prototyping is possible but project setup can be complicated while live interpreter can be through IRC bot
Efficiency	Specialized formatting not common in other languages, script-like language, OOP features, code reuse through libraries	C-like syntax, powerful OOP features and operator overloading, best compile-time optimizer
Nature	Python is dynamically typed.	C++ is statically typed.
Extension	Python programs are saved with .py extension.	C++ programs are saved with .cpp extension.
Popularity	Python has a huge community support. Beginner and novice programmers frequently choose Python due to its popularity.	C++ has a devoted following online as well. However, only those with some prior knowledge in the field exhibit a high level of interest in C++.
Functions	Python Functions do not have restrictions on the type of the argument and the type of its return value.	In C++, the function can only accept and return the type of value which is already defined.
Scope of Variable	Variables are accessible even outside the loop.	The scope of variables is limited within the loops.

Advantages	<ol style="list-style-type: none"> 1. Easy to use and learn 2. Increased productivity 3. Flexibility 4. Extensive library 5. Supportive community 	<ol style="list-style-type: none"> 1. Portability 2. Object-oriented 3. Memory Management 4. Low-level Manipulation
Disadvantages	<ol style="list-style-type: none"> 1. Execution speed 2. Memory consumption 3. Weak mobile development 	<ol style="list-style-type: none"> 1. Use of Pointers 2. Security Issue 3. Absence of Garbage Collector 4. Absence of Built-in Thread

After the comparison between Python and C++ programming language has been conducted, the decision of choosing Python programming language as the main language for the development process of the project is clear.

Aside from the difference stated above as advantages of Python programming language, it is proven being popular for any Artificial Intelligence (AI) or machine learning related project because it offers straightforward and flexible tools which are very friendly for novice programmer, not only that, the high simplicity of syntax and the keyword use in Python resembling daily use of English word, it will significantly reduce the use of time the developer need to learn and fully understand the syntax in order to utilise it properly, the use of brackets and indentation are also not involved in Python (Turing, n.d.).

Besides that, there are many libraries provided that ease the development process for AI and machine learning such as TensorFlow and PyTorch which are very famous among the AI community while NumPy and Pandas library will be helping the system to process the data (Turing, n.d.).

Moreover, the flexibility of Python programming language is also the big advantage of it, the Python do not require to recompile the source code every time, instead, developer can immediately make change and see the result whether there is an error or not (Turing, n.d.).

Last but not least, there should have many obstacles and challenges faced during the development process but the programmer can seek for help easily due to the large community of Python programming language (Turing, n.d.).

3.2 IDE (Interactive Development Environment)

An integrated development environment (IDE) is a software application that provides assistance and tools for software developers to accelerate the process of developing a software application including web application. It is an environment that consists of multiple useful tools such as code editor, Local build automation, debugger, unit testing, intelligent code checking and graphic user interface design tool (Red Hat, 2019). Not to mention, different IDE will support different programming languages but some IDEs are able to support multiple programming languages. In this section, the developer will be describing the justification of why the IDE of PyCharm will be chosen for the project. PyCharm is one of the most popular Python IDEs due to multiple reason including the fast that it is developed by JetBeans which is the developer that developed the popular IntelliJ IDEA IDE used for Java software development and WebStorm for JavaScript development, PyCharm also having the support for web development by leveraging Django (Arora, 2022).

First and foremost. PyCharm is an IDE that is mainly for Python programming while allowing it to operate across multiple platforms including Windows, Linux and macOS. The IDE include the useful tools such as code analysis tools, debugger, testing tools, and also version control options. PyCharm also provide various APIs that will help developer to build Python plugins easily which will ease the process of development phase. Besides that. It allows the system to work with several databases directly without having the help or need to integrate with external tools. It also allows the creation of HTML, CSS and JavaScript file which will let the developer to develop a web application and customizing the user interface with or without plugins. Hence, these features of this IDE are very suitable for the proposed project (Arora, 2022).

Besides that, PyCharm is designed to come with a smart code editor that will give suggestion on writing appropriate and high-level Python code. It is the main reason for the IDE readability of code because its distinct color schemes for keywords, classes and functions while also highlighting the syntax error of the code. Not only that, the intelligent of this helper will also generate suggestions for the current code to complete which will make the whole process of programming more comfortable with quick fixes (Arora, 2022).

Moreover, knowing that the existing tools of PyCharm might not sufficient for data science related projects due to the high complexity, the IDE also allow for integration with a huge range of tools that are useful for this situation which include Anaconda, a free and open-source Python distribution geared towards scientific computing, Pylint which is a checker to identify

bug and quality from source code provided as well as Pytest which is a framework to conduct unit testing or small tests for Python Code (Arora, 2022).

Last but not least, the tool of project navigation and refactoring are also the reason which significantly reduce the time consumption of project development process. The use of project navigation will help the developer to quickly navigate to class that having bug to have a quick fix while refactoring helps the developer to make changes of reference name quickly and with follow up on other source code file (Arora, 2022).

In addition, the IDE will be used for dataset features study and model training is colab, a cloud-based platform offers a free and practical way to write and run Python applications. It offers consumers access to potent computing resources including CPUs, GPUs, and TPUs and is hosted by Google. Colab is made for research in machine learning, artificial intelligence, and data analysis. It enables users to produce and distribute Jupyter notebooks, interactive documents with real-time code, visuals, and text. Jupyter notebooks offer a simple approach to prototype, experiment, and document as well as share research findings which make it more suitable for the model training of the proposed system.

3.3 Libraries and Tools

In this section, the libraries and tools are chosen by the developer in order to successfully develop the proposed project, they are very useful and mostly available in the current system development environment which will provide AI project in term of functionalities, effectiveness, and capabilities. Hence, there are several chosen libraries and tools including NumPy and Pandas are listed in the sections below describing how will they be useful to create a high satisfaction system upon integrating them into the project.

3.3.1 NumPy

NumPy is a famous library provided by Python Programming language which have the usage of processing multi-dimensional array and matrix due to the capability of NumPy can be used to perform various of mathematical operations. Based on that, NumPy have the capability to handle algorithm such as linear algebra, Fourier transform and many more complex algorithms that involve a high mathematical calculation which making NumPy be the best library for projects related to Artificial Intelligence and machine learning. For example, the system can manipulate matrix easily by using the library to improve the machine learning performance effortlessly. Not to mention, NumPy is faster and easier to use among other Python libraries (Coursera , 2022).

3.3.2 Pandas

Pandas is also one of the libraries provided by Python programming language which can on par with NumPy library, it is responsible for preparing and structuring the suitable high level data sets for machine to learn and trained. There are two main data structure in this library which are one-dimensional named series and two-dimensional named data frame. These structures allow Pandas to be useful on processing data from many types of industries including finance, engineering, and statistics. Not only that, Pandas library is always quick, compliant and flexible for its processing speed and method (Coursera , 2022).

3.4 Database Management System

Database Management System (DBMS) is a software tool that used to create and manage multiple databases by providing the functionalities of create table, update row data, retrieve information, all of the process will be preventing conflicts due to the rule of the DBMS. Although DBMS is a system that will only be seen by the developer and never be same display as front-end, most organisation and system will still implement DBMS to themselves because of the benefits it provides including improve data sharing and data security where DBMS able to manage data effectively and quick which can speed up the data communication process and ensure the accuracy of the data. Besides that, DBMS ensure consistent and reliable data where matching data stored in different place will be always accurate without inconsistent (Pizzo, n.d.). In this section, comparison between SQLite and MySQL based on (Edward , 2022) will be conducted by the developer with the aspects of supporting data type, storage, portability, authentication, scalability, security, ease of setup, advantages and disadvantages shown at table below.

Aspects	SQLite	MySQL
Supporting Data Type	Few - Blob, Integer, Null, Text, Real	A lot and more flexible - Tinyint, Smallint, Mediumint, Int, Bigint, Double, Float, Real, Decimal, Double precision, Numeric, Timestamp, Date, Datetime, Char, Varchar, Year, Tinytext, Tinyblob, Blob, Text, MediumBlob, MediumText, Enum, Set, Longblob, Longtext
Storage	about 250 KB in size	about 600 MB
Portability	Information is straightforward to copy since it is stored in a single file. There are no setups needed,	The action of consolidate MySQL into a single file is needed before copying or exporting it. This will be a

	and the process only needs basic assistance.	time-consuming task for larger databases.
Authentication	Since SQLite lacks any specific user management features, it is not appropriate for multiple user access.	The user management mechanism in MySQL is well-designed and capable of managing many users and granting different levels of authorization.
Scalability	Smaller databases work well with SQLite. When using SQLite, the memory required increases as the database expands. When utilising SQLite, performance optimization is more difficult.	Due to MySQL is easily scalable, a larger database can be handled with less effort.
Security	There is no built-in authentication system for SQLite. Anyone with access can view the database files.	There are numerous built-in security mechanisms in MySQL. This entails authentication via SSH and username and password.
Ease of Setup	It's simple to set up and doesn't require many setups to use SQLite.	Compared to SQLite, MySQL requires additional setup. Additionally, MySQL offers more setup instructions.
Advantages	<ol style="list-style-type: none"> 1. File-based, simple to install and use 2. Appropriate for fundamental development and testing 3. Portable 	<ol style="list-style-type: none"> 1. Simple to use 2. Offers numerous database-related features 3. Strong security components

	<p>4. uses a modified version of the normal SQL syntax.</p> <p>5. Simple to use</p>	<p>4. It is appropriate for large databases and is easily scalable.</p> <p>5. Gives off good performance and quickness.</p> <p>6. Provides numerous access controls and effective user management</p>
Disadvantages	<p>1. Features for user administration and security are absent.</p> <p>2. Impossible to scale</p> <p>3. Is not appropriate for large databases.</p> <p>4. Unable to be modified</p>	<p>1. Setup calls for certain technological know-how</p> <p>2. A little bit different syntax than standard SQL</p>

After the comparison between SQLite and MySQL conducted, the developer had made a decision on the Data Management System (DBMS) which will be going to implement to the proposed project, the final decision turned out to be MySQL will be the DBMS for the system to store and manage the data because MySQL is one of the databases that supported by Python programming language API, there are other more justification for the decision.

First and foremost, MySQL is one of the DBMS famous in its data protection due to the security and dependability it provides. For the prove of that, it has been used by various kind of web application which are top number of users in the world including Twitter, Facebook, Joomla, Drupal, and WordPress. MySQL will be reliable if the DBMS is for transactional processing particularly in the e-commerce industry (Derek, 2022).

Besides that, the scalability of MySQL provided can help with the management of the application effectively. Even if there is an incredibly large warehouse filled with a tonne of data, this statement is still true. In fact, the system's ability to adjust on-demand is one of its key features. The scalability of MySQL come from it is allowing customisation which developer can adjust the DBMS to best suited the system usage (Derek, 2022).

Moreover, MySQL has a unique storage engine that make developer easier to administer the system. Addition to that, MySQL database allow configuration from the

developer to achieve peak and desired performance which mean the more data the system receive per day the more the benefits get from the DBMS (Derek, 2022).

Last but not least, the uptime of MySQL DBMS is also the reason of choosing it, it is having 24/7 uptime which assures continuous uptime, in addition, it offers a wide range of options, including master/slave replication settings and unique cluster servers (Derek, 2022).

3.5 Operating System

An operating system (OS) is the program that controls all other application programs in a computer after being installed and loaded into the system first by a boot program, it is the core software that make the computer to operate. The application programs will require defined application program interface (API) to make request for services from the operating system. However, users can communicate directly with the operating system by using a user interface, such as a graphical user interface (UI) or a command-line interface (CLI) (GUI) (Bigelow, n.d.). Therefore, the operating system that will be used for the project will be Windows 10 Home due to several reason but first it is chosen mainly because of it is reliable and trustable based on the famous firm named Microsoft and it is able to support various types of application and programming or scripting language, these factors making Windows 10 the best choice for the project operating system. Besides that, Windows 10 provides a high flexibility on customisation and compatibility compared to previous version of Windows, it also has a huge improvement on the speed such as the boot time and shutdown time is much lesser compared with before. Moreover, the security of Windows 10 provided is much more promising including the authentication methods are significantly improved and the introduction of encryption type of protection. In addition. The protection provided by Windows Defender Antivirus cooperate with Windows 10 will ensure the information on the PC more secure making the PC could not easily infected by a virus causing cybercrime such as information theft (Roomi , 2022).

3.6 Summary

To conclude the technical research for the project development phase conducted by the developer, all of the chosen tools which are going to implement to the project will be summarised in a table as shown below with a specific version given. However, the chosen tools may be adjusted or additional tools may be added when the project actually starting into development phase with appropriate justification given for the purpose of project completion.

Category	Decision	Version
Programming Language	Python	3.10
Interactive Development Environment (IDE)	<ul style="list-style-type: none">• PyCharm• Colab	Professional Edition for PyCharm
Libraries and Tools	<ul style="list-style-type: none">• NumPy• Pandas	<ul style="list-style-type: none">• 1.23.5• 1.5.0
Database Management System (DBMS)	MySQL	8.0.31
Operating System	Windows	10 Home

Chapter 4: System Development Methodology

This chapter will be talking about the system development methodology that will be chosen from comparison and implement the methodology for the project to effectively develop the system following the phases for a good quality and reliable web application system that meet the requirements of the users. The decision of the system development methodology should be made in the early phase of the project and it is very critical as the whole project schedule need to always refer to the methodology principles. There are two type of system development methodology which are traditional and agile methodology where traditional method will be more fixed to the flow while agile method can be more flexible and adaptive to any urgent or unexpected changes during the development phases after the planning (Whee Yen, Kim Yeow, & Chan Wai, 2013). The developer has chosen waterfall methodology and Rapid Application Development (RAD) methodology to be implemented to the project, the comparison and the result will be showing in section below with the justification of reason Scrum has been chosen and details of how the Scrum will be apply to the project.

4.1 Comparison of Methodologies

In this section, the developer has studied research conducted by (KissFlow, 2022) which is related to the differences between waterfall methodology and RAD methodology, the result is summarised and shown in table below.

Aspects	Waterfall	RAD
Aim	To develop software of high assurance	To quickly develop software
Time	follows a set schedule; if there are any significant alterations, the development need to start back from the beginning	The project will be open-ended project where it will end as soon as the client is happy
Suitable Size of the Project	Very small and very large projects	Small and medium-sized projects
Developer Team Size	Small to large size	Stay small size

Developer Experience Level	Junior developer is allowed as long as the specs is clearly stated	A multi-talented, seasoned, and adaptable individual
Suitable Project Type	Desktop application	Web-based and mobile application
Suitable Client	fully detached and very clear in mind of what they want from the start	Good communicator, receptive to ideas, sees the big picture, and readily available
Not Suitable Client	Changing their minds regularly, constantly wants to be involved, and scope creep	Inaccessible, indecisive and uninterested
Risk	There is accounting for the risk determined at the beginning but not for risk determined at the middle of project phases.	Constantly prepare for risks and react to them
Approach to Change	Change is not welcome for waterfall	Change is always accepted by the methodology
Best time for Changes	At the very beginning	Anytime
Project Management Style	Keep to the planned schedule and deadlines	Adaptive
Use of new technologies	After specifications are established, no implementation of technology is changed.	Anytime new changes can be implemented
Feature Management	Every feature in the spec is built	Only functionalities that show to be helpful are developed
Updates and Versions	Planned and systematic	Ad-hoc and quick

Costs	Fixed costs and assuming no changes	Not fixed and depending on the number of iterations until the project complete
Prototype	Only will be delivered after everything is complete	Working prototype will be delivered as soon as it is ready
Advantages	<ul style="list-style-type: none"> 1. It is simple to translate and align objectives. 2. Enforces rules and permits stringent timeline adherence 3. Planning is given top priority to enable predictability. 4. Testing requirements are predetermined. 5. Early problems identification 	<ul style="list-style-type: none"> 1. Drastically shortened development times 2. The division of system components makes customization simple. 3. Since the client is actively involved in the development process, it is simpler to reach consensus. 4. Parts can be reused 5. Numerous changes in criteria, objectives, and goals are accommodated
Disadvantages	<ul style="list-style-type: none"> 1. Delivery times are longer 2. very inflexible, possibly preventing the ability to change course 3. if there are considerable modifications, a hard restart will be necessary. 4. excludes the customer or end user from the development process 	<ul style="list-style-type: none"> 1. Strongly depends on a talented group of developers and testers 2. Possibly not the greatest choice for tasks requiring a high level of expertise 3. Requires strong communication between clients and developers 4. Only able to be used to construct modularized systems

4.2 Justification of Chosen Methodology

After the comparison between waterfall and RAD methodology conducted, the developer had made a decision on the system development methodology that will be implemented for the project which is RAD methodology because of it is one of the agile methodologies that are able to adapt to changes to the project scope midway since changes are inevitable during the development lifecycle cause by various reasons according to (Computer World, 2008). Those changes are very important as it will produce an even better system and avoid any possible project failures which is the reason why an adaptive methodology is chosen instead of prevent changes for the project. RAD methodology also having multiple competitive advantages that become the reason for the decision.

First and foremost, RAD have an advantage of measurable progress and reduced development time, the process of going through multiple time of iterations, components and prototypes make the developer easier to measure the current progress of the project which is helpful to maintain the schedule and budget. The advantage of quicker time to deployment and implementation within the organisation also come out followed by that (FNTS, 2017).

Besides that, RAD can reduce the effort needed to manual coding due to the code generators and code reuse leading to faster code generation. It can decrease the time consumed to coding and scripting because of deliverables can be easily transferred as scripts, while it also reduces the time it takes to produce a working prototype and working code for iterative which are work normally would take weeks or months for other methodologies (FNTS, 2017).

Moreover, RAD make developer easy on modification through compartmentalisation of system components as the iteration process of RAD is designed specifically for developer to develop components that will function independently which will finally combine to make up the application. Since every component is compartmentalized, they can be easily modified according to the needs of the system, it makes it possible for several individual and collective advantages in terms of cost, quality, and shortened application development lifecycles (FNTS, 2017).

In addition, RAD methodology accepts rapid and constant feedback from user which mean the project development will not only involving developer but also internal and external stakeholders which will feedback their satisfactory progress. These feedbacks collected from the stakeholder can lead to a successful project development because the constant feedbacks getting from iterative process can be used by the developer to incorporate them into later

iterations to improve the final product which fulfil requirements from everyone (FNTS, 2017).

Last but not least, RAD methodology will have early system integration compared to other traditional methodologies which they will wait until the end of lifecycle to begin the integrations with other system and services. On the other side, RAD can integrate almost immediately, the early integrations happened in prototype will be very useful on identifying errors and complications and immediately resolve the issue (FNTS, 2017).

4.3 Details of Chosen Methodology

In this section, the details for every phase that involved in RAD methodology will be described clearly which are requirements planning, user design, rapid construction and cutover.

Phase 1: Requirements Planning

This is the very first phase of RAD methodology which is similar to a project scoping meeting. Even though the planning phase is shorter than other project development methodologies, the planning phase is still nevertheless essential to the project's success. During this phase of RAD methodology, group including developers, clients and team members require a good communication to determine the goals for developers and expectations for client to the project while potential issues that will be facing during the development process should also be addressed in this phase. Therefore, there is a basic tasks breakdown for this phase which are study and research on the current problem, identify the requirements for the project and finalizing the requirements by getting approval from respective stakeholders. It is crucial that every related group involved in this project will have the chance to propose and evaluate goals as well as expectations for the projects. The importance to get approval from stakeholder and developer is to avoid possible miscommunication and misunderstanding which might cause the cost of the project significantly increase for the change throughout the whole development process (Lucid Content Team, n.d.).

Phase 2: User Design

This phase will start once the project scope is defined and confirmed from previous phase of RAD methodology, it is one of the development phases involved in the iterations and focusing on building out the user design through prototyping which is also where the RAD methodology unique and set it apart from other system development methodologies. During this phase, the interaction and communication between clients and developers are crucial to ensure that their requirements can be met at every step in the design process. It is similar to a customizable software development where the client can test prototype for any product at every phase in the purpose of make sure the product is following their expectations. All bugs and exceptions will be solved in an iterative process where developer design a prototype then the client will test it and finally communicate on which part is working and which part is not. This gives the developers chances to modify the model during the entire development process until everyone reach their expectation and satisfaction, while both client and developer will be

making sure there is no possibility for something to slip through the cracks from the experience (Lucid Content Team, n.d.).

Phase 3: Rapid Construction

In this phase of RAD methodology, the prototypes and beta systems from the design phase will be taken to converts them into a working model. Since majority of the issues and changes were identified during the iterations of design phase, it makes the developers can build the final working model more quickly and effective compared to other methodologies especially traditional system development methodologies. Hence, the phase is breaking down to several steps which are, preparation for rapid construction, program and application development, coding as well as unit, integration and system testing. In this phase, the programmers, coders, testers and developers in the software development team must work together to ensure that the progress is working smoothly and the final result will satisfy every expectation and the project objectives. The third phase of RAD methodology is important because client is still able to give input during the process of this phase, they can suggest any changes and ideas that can overcome issues if any arise (Lucid Content Team, n.d.).

Phase 4: Cutover

This is the final phase for RAD methodology which is the implementation phase where the final product will go to launch. In this phase, there are few steps that need to be achieved including, data conversion, testing, change over to the new system and user training. In this point of time, all of the changes should be made and they are requiring to always look for any bugs existing in the system for now (Lucid Content Team, n.d.).

4.4 Overview of Project Progression

In this section, the developer will explain the way of implementing all of the four phases described on section 4.3 for the entire web application development process for the proposed project.

Phase 1: Requirements Planning

In the beginning of the project development process, the developer will first be defining a brief project requirement for the proposed system by conducting a meeting with the project supervisor while two data gathering methods which care questionnaires and interview will be carried out to the target respondent. The target respondent involved in the data gathering method is students from APU. The project requirement that needs to be defined including the deliverables, functions and recommendation from the target respondent. The developer will ask for approval from the target user to ensure that everyone is involving in the process of defining the project scope. Besides that, research on domain area related to proposed topic will be conducted in this phase to motivate the developer to achieve the potential benefits that will be fulfilled by the proposed project while also innovate idea from them. Not to mention, the project requirement could be changed any time throughout the development process of the project depending on the opinions and expectations from the target users in order to make sure that the final product of the project can satisfy all of the requirements given.

Phase 2: User Design

With the defined project scope, the developer will then move on to the next development phase which will be building the system prototype that will be showed to the target user to make sure it is their expectation and needs which mean the involvement of the target user will be very important in this phase as the feedback from them can be used to identify that which of the functionalities are not working as expected. Besides that, test including user acceptance testing, usability testing will be conducted in this phase. If any problems with the prototypes are found, the developer can quickly accept the changes requested by the target user and make improvements to the prototypes themselves by creating a second prototype to make sure the problem has been solved. The process will be done in iterations until the target user is satisfying and there are minimal bugs existing within the system. All of these steps done in this phase will enhance the quality of the final product of the project in term of fulfilling the requirements.

Phase 3: Rapid Construction

With the end of user design phase, the developer will be able to develop a working system very quick because of the prototype and beta systems provided from previous phase while this phase will also able to repeat to accept any changes from the target user. Not only that, most of the bugs and issues are identified and solved in previous phase which make the developer can easily build the final system. Hence the system will be gone through test including unit testing, integration testing and system testing for final confirmation that it is working properly and fulfilling the requirements of the project. The satisfaction of the target user will still be very important as if the feedback is negative, then the developer will be required to start from phase 2 again while the developer can move to the final phase if the feedback from the target user is positive.

Phase 4: Cutover

In the final phase of development process, the developer will conduct one full testing for the final system, so that there will be no any error and exception will be happening after the system delivered. The main goal of the Music Recognition and Genre Classification system will be focusing on the main feature which are the accuracy of music recognition and a constant genre classification feature. In order to prove these two features are functioning as the project needs, 5 students from APU will be chosen to conduct a testing to the system. So that, the project can finally be considered as a success project.

Chapter 5: Research Methods

In this chapter, the developer will explain the research methods for the data related for the project to be used to collect different opinion, expectation and agreement from the target participants. Therefore, the developer decided to collect both quantitative and qualitative data by using questionnaire and interview data gathering method, the data will then be analysed and evaluated in chapter 6. The section below will be introducing the method of questionnaire and interview with their respective advantages and disadvantages.

5.1 Introduction

Research methods are differed from research methodologies because they are the method which researcher chose to get the data for the research purpose. The topic of the project, the type of data the research looking for, and the subjects or attributes the research seek from the collected data will all play a significant role in determining the ideal method (Pfeiffer Library, n.d.). In the end of data gathering process, there will be two types of data collected in total which are quantitative data and qualitative data. Quantitative data is information that is expressed as counts or numbers, each of which has a specific numerical value. This data is any quantifiable information that may be used by researchers for statistical analysis and mathematical computations so that they can make decision based on them (QuestionPro, n.d.). On the other hand, qualitative data is described as data that approximates and characterizes, it is able to be observed and recorded although the data is non-numerical in nature. Qualitative data is also known as categorical data due to the data can be arranged into categories based on the attributes and properties of it (QuestionPro, n.d.). The techniques and tools which are used to collect quantitative data including surveys or questionnaires, observation, document screening and experiments while technique and tools for qualitative data are interviews, focus groups, observations, document analysis and oral history or life stories. Based on the research by (Anpar Research, 2020) the advantages and disadvantages for both qualitative and quantitative data will be shown at the table below.

Aspects	Quantitative Research	Qualitative Research
Advantages	<ul style="list-style-type: none"> 1. Able to collect large sample size which allow generalisation to work. 2. Impartiality and accuracy of data. 3. Fast and simple to conduct 4. Anonymity provided for the participant 5. Able to offers reliable and continuous information by repeating the research method on certain period again to address issues. 	<ul style="list-style-type: none"> 1. Able to explore the attitudes and behaviour of the target user in depth. 2. Discussion is encouraged as it will be in more unstructured way of asking question instead of following a fixed set of questions. 3. Provide good flexibility where interviewer can ask any questions related to the subject and change the setting if needed.
Disadvantages	<ul style="list-style-type: none"> 1. Limited by the set answers on a survey. 2. Research is not carried out in their normal environment which means the answer given might not be their actual behaviour in real situation. 3. Unable to have follow-up question based on the answer given by the participant. 	<ul style="list-style-type: none"> 1. Hard to generalise the opinion due to the sample size issue. 2. May have bias for the sample selection because the participants are not having mixed views to the subject. 3. Lack of privacy for the participants and may let them feel uncomfortable during the data gathering section. 4. A skilled moderator is needed to manage the conversations smoothly and asking relevant questions which are never thought of.

5.1.1 Questionnaire

To acquire both quantitative and qualitative data, a questionnaire was first selected as the data collection method. The questionnaire's primary goal is to gather feedback and suggestions from MRGCS users along with any useful personal data. Since the questionnaire will be conducted using the free platform Microsoft Form, it can be a very cost-efficient way to collect a lot of data in a short amount of time with a relatively simple way to send the questionnaire to respondents. Questionnaires have an advantage over other existing methods in that they are less expensive. In addition, the respondent anonymity is another benefit offered by the questionnaire technique, as it protects the respondent's privacy and allows them to answer the question without the host knowing who they really are. As a result, the respondent feels more at ease when responding to the question and is more likely to express their honest and genuine thoughts. Additionally, using an online survey platform makes it easier to analyse and visualise data because a suitable graph is automatically generated for both discrete and continuous data, eliminating the need for any additional processing. If necessary, however, the data can also be downloaded and processed manually. Last but not least, the advantages and disadvantages of questionnaire research method based on the research (Prasanna, 2022) is shown as table below.

No.	Advantages	Disadvantages
1.	Economical which require low cost to conduct.	May have less and poor responses depend on the targeted participant such as ignorant or semi-educated people.
2.	Easy to obtain data rapidly due to the convenience of free platforms provided.	Lacks of personal interaction where no one can explain terms that the respondent does not understand.
3.	Adaptability where the questionnaire and answer can be come in various structures.	Unreliability due to respondent might misjudge the questions while the researcher does not aware about that.
4.	High accuracy of information due to the obscurity given to the respondent making them answer honestly.	It allows respondents to change their previous answer if it contradicts the after answers.

5.1.2 Interview

Interviews are the second method of data collection that has been selected in order to gather primarily qualitative data. The goal of this interview is the same as that of the questionnaire method: to improve the MRGCS system. When compared to other methods, the interview methodology has the flexibility to allow for a follow-up question to be raised in response to the respondent's response. This is extremely important to gather more data and better understand user opinions. Additionally, since the interview will be done face-to-face, it prevents the respondent from giving fake information and producing misleading analysis for the system. The high accuracy of the respondent's demographic information is another benefit of the interview technique. Additionally, compared to other techniques, the interview technique has the smallest sample size; only a small number of interviewees are required to generate data that is generally of good quality. Last but not least, the advantages and disadvantages of interview research method based on the research (Prasanna, 2022) is shown as table below.

No.	Advantages	Disadvantages
1.	Able to look for the right candidate according to the characteristics.	Time consuming for both process of looking for candidate and interviewing section.
2.	Provide great source of reliable and value information which is important for decision making.	Not only inefficient, but it can lead to further issues with passing judgement on applicants during interviews.
3.	Have a better understanding on the stakeholders of the project.	Hard to verify the truth for what the interviewee answered.
4.	Possibility of obtaining additional information since it allows the interviewer to ask extra question related to the study field.	Interviews do not offer any predictive validity making it not as reliable or valid as tests,

5.2 Design

5.2.1 Questionnaire

Music Recognition and Genre Classification System (MRGCS)

My name is Sia De Long. I am a student from Asia Pacific University of Technology and Innovation (APU) pursuing my degree in Bachelor of Computer Science (Hons) (Intelligent Systems). I am currently working on my final year project titled "Music Recognition and Genre Classification System (MRGCS)". The aim of this project is to improve the accuracy and reliability of music recognition and develop a stable genre classification for the web application system. Therefore, the exposure for every artist's work can be balanced and the difficulty for user to search for a particular music can be ease.

The questionnaires is conducted for gathering data about the opinion on related question on problem context and requirements of the system. It will only take less than 5 minutes of your time to be completed. Your participation is voluntary and may withdraw from it anytime throughout the questionnaires. All the collected data from your response will be strictly confidential. If you have problems or concerns regarding this questionnaires, please fell free to contact me through the contact information as provided below.

Thank you for your corporation.

Sincerely,
Sia De Long TP060810
TP06010@mail.apu.edu.my

* Required

Participation Note

1. Your participant is completely voluntary and you are considered to be read the study description.*

Understood

Objective: The developer is able to determine that the participants are understanding the purpose of this questionnaire and volunteer to provide data.

Demographic Profile

2. What is your gender? *

- Male
- Female

Objective: The developer is able to determine the gender of participants who had participated to the questionnaire and to ensure that the data collected is not bias to one gender.

3. What is your age group? *

- Under 25
- 26 - 35
- 36 - 45
- 46 - 55
- 56 and above

Objective: The developer is able to determine the age group of participants who had participated to the questionnaire and to ensure that the participants are either full-time studying, part-time studying or working in the institution.

4. What is your main language? *

- Malay
- Mandarin
- English
- Other

Objective: The developer is able to determine the main language used by the participants who had participated to the questionnaire and to determine that which language will be mainly implemented to the Natural Language Processing for the system if available.

Music Recognition

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
I had experience listening to a song but do not know the name	<input type="radio"/>					

Objective: The developer is able to understand how the participants agreement on experience listening to a song but do not know the name. This enables the developer to emphasise the importance of music recognition function.

I want to know the name of the music when the music is play on public places (shopping mall, club)	<input type="radio"/>					
--	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	--

Objective: The developer is able to understand how the participants agreement on desire of wanting to know the name of a music at public places. This enables the developer to emphasise the importance of denoise processing on music recognition function.

I have the experience of getting the wrong result from existing music recognition system	<input type="radio"/>					
--	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	--

Objective: The developer is able to understand how the participants agreement on bad experience from existing music recognition system. This enables the developer to further improve the accuracy of music recognition system.

I want to know the name of the music when I only have a part of the audio	<input type="radio"/>					
---	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	--

Objective: The developer is able to understand how the participants agreement on desire of wanting to know the name of a music when only have a part of the audio. This enables the developer to implement the music recognition system that only require a part of the audio.

I want to know the name of the music even though it is only instrumental	<input type="radio"/>					
--	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	--

Objective: The developer is able to understand how the participants agreement on desire of wanting to know the name of an instrumental music. This enables the developer to implement the music recognition not only to song but also pure instrumental music.

I want the music recognition
not only accept audio from
microphone but also from
files (MP3, WAV)

Objective: The developer is able to understand how the participants agreement on convenience of music recognition system. This enables the developer to implement another way for the music recognition system to acquire the sample audio.

I want the music recognition startup as soon as possible

Objective: The developer is able to understand how the participants agreement on start up speed of music recognition system. This enables the developer to implement fast boot up speed or alternative way to start the music recognition system as soon as possible.

I can remember all the name
of the music that I heard
before

Objective: The developer is able to understand how the participants agreement on whether they remember every name of the music they heard before. This enables the developer to further emphasise the importance of the music recognition system.

Genre Classification

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I can classify genre for the music myself consistently	<input type="radio"/>				

Objective: The developer is able to understand how the participants agreement on whether they can have consistent genre classification themselves. This enables the developer to emphasise the important of consistent genre classification system.

I feel confuse when the classification is too many and detail

Objective: The developer is able to understand how the participants agreement on detailed genre classification. This enables the developer to determine the number of genres should be given to the system.

I look for music through the selection of genre first

Objective: The developer is able to understand how the participants agreement on the usage of genre. This enables the developer to emphasise the importance of genre to the user.

I can easily remember genre for everyone music I have

Objective: The developer is able to understand how the participants agreement on whether they can remember genre for every music they have. This enables the developer to emphasise the importance of genre label on the music to the user.

I want to know the most popular genre of the current trend

Objective: The developer is able to understand how the participants agreement on whether they can know which genre is on trend. This enables the developer to implement the function to display the on-trend genre after go through analyse with visualisation.

I want to look for music that have similar genre with my favorite music

Objective: The developer is able to understand how the participants agreement on whether they want to look for music with similar genre to their favourite music. This enables the developer to implement the function to search for similar genre.

Extra Features

7. I would like the web application to have following extra features: *

Please select at most 2 options.

- Able to observe your music work's viewed count and exposure rate to the audience from the system
- Able to obtain the information of similar percentage of other music compare to your own work
- Able to identify the popular genre of the music in the database
- Able to produce a graph showing the history of user listen to a particular music

Objective: The developer is able to understand which extra features that the participants desired the most. This enables the developer to further improve the overall system by implement the extra features to the system.

Project Focus

8. I am more focus on *

- The accuracy of music recognition
- The consistency of genre classification
- The user friendliness of the web application

Objective: The developer is able to understand which aspects of the system that the participants care the most. This enables the developer to focus on improving the part of the system to further satisfying the user requirement.

5.2.2 Interview

1. What is the main factor for music recognition that will make you think it is reliable?

A:

Objective: The developer is able to understand which factors is the most important for music recognition system to be reliable for the user. This enables the developer to focus on the factor to further improve the music recognition system.

2. What is music data acquisition method (microphone, audio file) you prefer for the music recognition?

A:

Objective: The developer is able to understand which method of providing sample audio is the most favourable for the user. This enables the developer to implement the suggested audio acquire method to the music recognition system.

3. What is your opinion in term of number and consistency on genre?

A:

Objective: The developer is able to understand the opinion of user in term of the number and consistency of genre. This enables the developer to determine the genre classification system based on the opinion.

4. What is the way that you choose for a music at any time?

A:

Objective: The developer is able to understand how the user behaviour to choose for a music. This enables the developer to further improve the system on making user easier to find music on the system.

5. What extra features that you desired the most?

A:

Objective: The developer is able to understand which extra feature that the user wants the most. This enables the developer to further improve the system by implementing the suggested extra features into the system.

6. What is your main expectation for that web application of music recognition and genre classification?

A:

Objective: The developer is able to understand the minimum expectation from the user related to the music recognition and genre classification. This enables the developer to further improve the system by implementing the suggested expectation into the system.

5.3 Summary

For a summary to chapter 5, the research method of questionnaire and interview will be conducted to the student in APU and lecturer if they are available. The participant is not targeting the system user is because the main focus of this project is music audience where everyone should have heard music at least once in their life, so the students in APU can be the participant for this research method. In order to understand their opinion and expectation from the target user, number of participants for questionnaire should be 40 while interview will be 2, then the data will be analysed and evaluated in the next chapter.

Chapter 6: Requirements Validation

In this chapter, the developer will be analysing and evaluating the data collected from chosen research method mentioned on previous chapter which are questionnaire and interview. The developer has obtained a total of 40 responses from questionnaire and 2 responses from the interview. The sections below will be summarising the requirements of the system based on the responses received from the target participants.

6.1 Analysis of data collected through Questionnaire

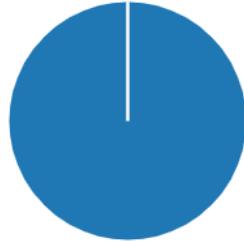
The responses for the questionnaire were gathered from students of APU and lecturers if they are available.

1. Your participant is completely voluntary and you are considered to be read the study description.

[More Details](#)

Understood

40



Analysis	Based on the analysis above, all the of the participants are understood that their participant is completely voluntary and they are considered to be fully understood about the study description stated in the questionnaire.
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Demographic Profile

2. What is your gender?

[More Details](#)

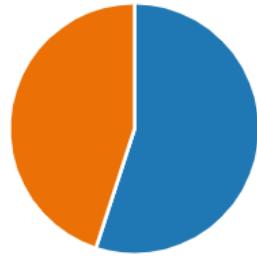
 Insights

 Male

22

 Female

18



Analysis

Based on the analysis above, the majority of the participants are male which have the total percentage of 55% among all the participants who participate for the questionnaire, the remaining 45% of the participants are female.

3. What is your age group?

[More Details](#)

 Insights

 Under 25

37

 26 - 35

3

 36 - 45

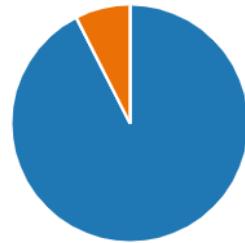
0

 46 - 55

0

 56 and above

0



Analysis

Based on the analysis above, the majority of the participants are in the age group of under age of 25 which have the total percentage of 93% among all the participants who participate for the questionnaire, the remaining 8% belong to the age group of age between 26 to 35, meaning that most of the participants are student.

4. What is your main language?

[More Details](#)[Insights](#)

Malay	2
Mandarin	3
English	35
Other	0



Analysis

Based on the analysis above, the majority of the participants are using the main language of English which have the total percentage of 88% among all the participants who participate for the questionnaire, the following main language is Mandarin with percentage of 8% and lastly Malay with the percentage of 5%. This data will be useful that the developer can choose to implement Natural Language Processing that get the meaning from English song lyric since majority of them are using English as their main language.

5. Music Recognition

[More Details](#)

■ Strongly Disagree ■ Disagree ■ Neutral ■ Agree ■ Strongly Agree

I had experience listening to a song but do not know the name



I want to know the name of the music when the music is play on public places (shopping mall, club)



I have the experience of getting the wrong result from existing music recognition system



I want to know the name of the music when I only have a part of the audio



I want to know the name of the music even though it is only instrumental



I want the music recognition not only accept audio from microphone but also from files (MP3, WAV)



I want the music recognition startup as soon as possible



I can remember all the name of the music that I heard before

100% 0% 100%

100%

0%

100%

Analysis	<p>The analysis to these statements will be related to the requirements of music recognition system implemented to the proposed system.</p>
	<p>First and foremost, the first statement “I had experience listening to a song but do not know the name” have the majority of participants feel agree to it with total 55%, followed by 40% of the participants feel strongly agree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that the importance of music recognition system is in presence and could help them to solve this issue which emphasising the purpose of this project.</p>
	<p>The second statement “I want to know the name of the music when the music is play on public places (shopping mall, club)” have the majority of participants feel agree to it with total 52.5%, followed by 40% of the participants feel strongly agree to the statement and 7.5% feel neutral to it. From this analysis, the developer can confirm that there are significant number of users will want to use music recognition system in places that have noises exist aside from the target audio, which mean the important of implementing denoising module is emphasising from this.</p>
	<p>The third statement “I have the experience of getting the wrong result from existing music recognition system” have the majority of participants feel agree to it with total 47.5%, followed by 37.5% of the participants feel strongly agree to the statement, 7.5% feel neutral to it while 5% and 2.5% feel disagree and strongly disagree to the statement respectively. From this analysis, the developer can determine the importance of the accuracy for music recognition while there are also some reliable existing systems that make some of the participants feel disagree to this statement can be used for getting insights.</p>
	<p>The fourth statement “I want to know the name of the music when I only have a part of the audio” have the majority of participants feel agree to it with total 55%, followed by 40% of the participants feel strongly agree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that most of the time users will only have a part of the audio but they want to perform music recognition with it, which the proposed system should fulfil this requirement.</p>

The fifth statement “I want to know the name of the music even though it is only instrumental” have the majority of participants feel agree to it with total 55%, followed by 40% of the participants feel strongly agree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that the music recognition system should not only be able to recognise song with lyrics but also pure instrumental music.

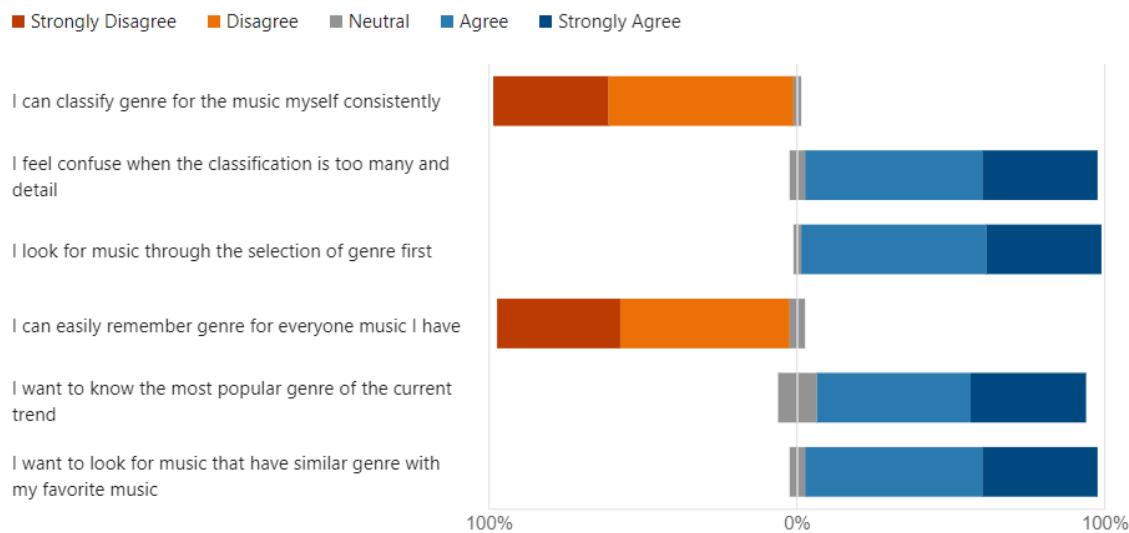
The sixth statement “I want the music recognition not only accept audio from microphone but also from files (MP3, WAV)” have the majority of participants feel agree to it with total 52.5%, followed by 40% of the participants feel strongly agree to the statement and 7.5% feel neutral to it. From this analysis, the developer can determine that the alternative way of music recognition system acquire the sample audio can be implemented such as upload the audio file instead of from device’s microphone.

The seventh statement “I want the music recognition startup as soon as possible” have the majority of participants feel agree to it with total 52.5%, followed by 42.5% of the participants feel strongly agree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that the boot up speed of the music recognition is important and straight forward should be used to start the recognition process as soon as possible.

The final statement “I can remember all the name of the music that I heard before” have the majority of participants feel disagree to it with total 55%, followed by 40% of the participants feel strongly disagree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that a system that can help them to remember the name of the music is important which also emphasising the importance of music recognition system.

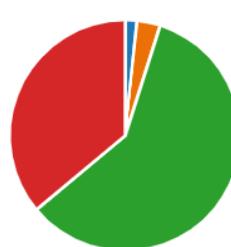
6. Genre Classification

[More Details](#)



Analysis	<p>The analysis to these statements will be related to the requirements of genre classification system implemented to the proposed system.</p> <p>First and foremost, the first statement “I can classify genre for the music myself consistently” have the majority of participants feel disagree to it with total 60%, followed by 37.5% of the participants feel strongly disagree to the statement and 2.5% feel neutral to it. From this analysis, the developer can determine that human could not do genre classification consistently which emphasise the importance of genre classification in the project.</p> <p>The second statement “I feel confuse when the classification is too many and detail” have the majority of participants feel agree to it with total 57.5%, followed by 37.5% of the participants feel strongly agree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that too many genres are not suitable for the system instead only main and useful genre should be labelled to the music.</p> <p>The third statement “I look for music through the selection of genre first” have the majority of participants feel agree to it with total 60%, followed by 37.5% of the participants feel strongly agree to the statement and 2.5% feel neutral to it. From this analysis, the developer can determine the</p>
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	<p>importance of having genre category for user to select when they looking for a music to listen.</p> <p>The fourth statement “I can easily remember genre for everyone music I have” have the majority of participants feel disagree to it with total 55%, followed by 40% of the participants feel strongly disagree to the statement and 5% feel neutral to it. From this analysis, the developer can determine the importance of genre label for every music for the user of the system which can be achieved by the genre classification system.</p> <p>The fifth statement “I want to know the most popular genre of the current trend” have the majority of participants feel agree to it with total 50%, followed by 37.5% of the participants feel strongly agree to the statement and 12.5% feel neutral to it. From this analysis, the developer can determine that the user would like to obtain the information about the current popular genre on-trend which is a functionality that can be implemented to the system.</p> <p>The final statement “I want to look for music that have similar genre with my favourite music” have the majority of participants feel agree to it with total 57.5%, followed by 37.5% of the participants feel strongly agree to the statement and 5% feel neutral to it. From this analysis, the developer can determine that the user would like to look for music that have similar genre with their favourite music which is a functionality that can be implemented to the system.</p>
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	<p>7. I would like the web application to have following extra features:</p> <p>More Details</p> <ul style="list-style-type: none"> ● Able to observe your music wor... 1 ● Able to obtain the information ... 2 ● Able to identify the popular gen... 36 ● Able to produce a graph showin... 22 
Analysis	Based on the analysis above, the majority of the participants pick for the extra feature of being able to identify the popular genre of the music in the database which have the total percentage of 59% among all the participants

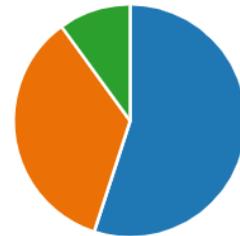
who participate for the questionnaire, followed by the participants who pick for being able to produce a graph showing the history of user listen to a particular music which have the percentage of 36%, participants who pick for being able to obtain the information of similar percentage of other music compare to your own work have the percentage of 3% and lastly the single participant who pick for being able to observe your music work's viewed count and exposure rate to the audience from the system have the percentage of 2%. This data will be very helpful that it can help developer to determine the priority of extra features to implemented to the project system, in this case, user would like to have the information of on trend music while the need of functionalities focus on music artist are not so on demand, hence it should be listed as extra feature in deliverables that only will be achieved if there is extra time and other important extra features has completed.

8. I am more focus on

[More Details](#)

 Insights

- The accuracy of music recogniti... 22
- The consistency of genre classifi... 14
- The user friendliness of the web... 4



Analysis

Based on the analysis above, the majority of the participants are more focus on the accuracy of music recognition which have the total percentage of 55% among all the participants who participate for the questionnaire, following by participants focus on the consistency of genre classification with percentage of 35% and lastly participants who focus on the user friendliness of the web application consist percentage of 10%. From the analysis of this data, the developer conclude that the main feature of the system would be a music recognition system with high accuracy which need to give attention to based on the demand from the user, not only that, a genre classification with high consistency is also contributing a high demand for the project requirement. To summarise, the accuracy of music

recognition and the consistency of genre classification should be given higher priority compared to the user friendliness of the web application during the development process of the project.

6.2 Analysis of data collected through Interview (Participant 1)

Age: 21

Date: 22nd November 2022

Main Language: English

Interviewer: Sia De Long

Interview Platform: Microsoft Teams (Online)

1. What is the main factor for music recognition that will make you think it is reliable?	
Answer	First of all, I think that the accuracy of the result that provided by the music recognition system is very important since it is the main reason that make me use it. Besides that, I think the response time of the system is also important which will make me think it is reliable because I would like to know the answer for the name of the song using as short as possible of time.
Analysis	Based on the responses from the interviewee, the accuracy and response time of the music recognition system get highlighted as the main factor that will make user think it is a reliable tool. The accuracy of music recognition is one of the goals of the project while response time can be achieved through various aspects including data communication method, straight-forward design and boot up time.

2. What is music data acquisition method (microphone, audio file) you prefer for the music recognition?	
Answer	It is hard to make choice but I think both of the suggested method should be available for music recognition because I face an inconvenience before which is one time, I only have the audio file in the same device that I use to perform music recognition but it is not working due to the output audio will not be input back to the same device. Then microphone as the data acquisition should be the common and basic way in my opinion.
Analysis	Based on the responses from the interviewee, the data acquisition method for music recognition is very important as it affect the user experience especially the method of using audio file should be implemented to overcome the issue of the interviewee addressed.

3. What is your opinion in term of number and consistency on genre?	
Answer	I don't like if there are too many types of genres, they classify them in too detailed which make me feel confused and unnecessary, useful genre is more than enough for the system. Genre classification that produces consistent answer should always be the best because it will not cause mixing genre into a same category.
Analysis	Based on the responses from the interviewee, the genre category of the proposed project should be controlled and be useful for the user to differentiate genre at the same time while the consistency is also very important for the system as it will affect the experience for the user to look for music from genre category.

4. What is the way that you choose for a music at any time?	
Answer	Most of the time, I choose for music based on the rhythm sudden pop up from my mind, then I will try to think what is the name of the song and start listen to it. Sometimes I will try to discover some new music by choosing the genre that I like and hopefully find something that I like.
Analysis	Based on the responses from the interviewee, it highlighted that genre is a very important element that need to be implemented to the system including the genre label to every music from genre classification system and also the genre category to group similar music.

5. What extra features that you desired the most?	
Answer	I would say check for the current trend of genre in the system, with visualisation such as graph would be perfect. This choice is chosen because I am not very interested to the functionalities related to music artist to be honest.
Analysis	Based on the responses from the interviewee, the extra feature of being able to produce a graph showing the history of user listen to a particular music fitted the interviewee requirement which will be given priority to implement if there is extra time.

6. What is your main expectation for that web application of music recognition and genre classification?	
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Answer	I will expect the web application should have a good reliability in term of useful of the main features. I will also expect for a good design of the web application so it attracts us user to use the system.
Analysis	Based on the responses from the interviewee, the goal of the project on the main feature should be reach which are accuracy and consistency for both music recognition and genre classification system respectively while the design of the system also get highlighted which can also be conducted if there is extra time to decorate the web application.

6.3 Analysis of data collected through Interview (Participant 2)

Age: 22

Date: 24th November 2022

Main Language: English

Interviewer: Sia De Long

Interview Platform: Microsoft Teams (Online)

1. What is the main factor for music recognition that will make you think it is reliable?	
Answer	<p>It is very important that whether the music recognition can answer the correct and exact song name for the user, and also, I think it is important that the database have as much as knowledge or music name in it because I had experience that the music recognition could not give me an answer although I provide a clear audio of that music.</p>
Analysis	<p>Based on the responses from the interviewee, the accuracy and knowledge base of the music recognition system get highlighted. The accuracy of music recognition is one of the goals of the project while the knowledge base issue might not be overcome due to the copyright issue for music.</p>

2. What is music data acquisition method (microphone, audio file) you prefer for the music recognition?	
Answer	<p>I think microphone itself is sufficient for the music recognition function because as for me, I use related system a lot on my mobile phone and it is working without any issue until now.</p>
Analysis	<p>Based on the responses from the interviewee, data acquisition of music recognition by using microphone is considered as the basic and a must for it to operate, any other method that implemented to it will be considered as extra feature of the system.</p>

3. What is your opinion in term of number and consistency on genre?

Answer	I don't think huge variety of genre is good for the user because there are too many categories and don't know which one to pick. However, I think the consistency of genre is very important, I personally do not want to hear the wrong genre music under the genre category that I expected.
Analysis	Based on the responses from the interviewee, a maintained genre category is very important for the system to reduce confusion as well as the consistency of genre is also very important to the system to improve user experience.

4. What is the way that you choose for a music at any time?

Answer	I will always look for the genre category that I like the most, it is easier for me to discover music that have the rhythm I like under the chosen category, so it won't take a long time to find one music.
Analysis	Based on the responses from the interviewee, the genre category is a very important element for user which promote the existence of genre within the proposed system while implementing genre classification system to ensure that.

5. What extra features that you desired the most?

Answer	I want feature that let me know the current famous music that everyone listens to, so I can keep up with the trend and enjoy a good music without the effort to look for one myself.
Analysis	Based on the responses from the interviewee, the extra feature of being able to produce a graph showing the history of user listen to a particular music fitted the interviewee requirement which will be given priority to implement if there is extra time.

6. What is your main expectation for that web application of music recognition and genre classification?

Answer	I want them to be accurate and convenience, and I also expect that the web application will simple to use.
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Analysis	Based on the responses from the interviewee, the user friendliness of the web application get highlighted which will the ease the user to learn and understand how to interact with system, while the goals of the project should be fulfilling the requirement of accurate and convenience to the user.
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6.4 Summary

After the process of analysing and evaluating the responses gathered from the questionnaire and interview, different kind of opinion and recommendation are given toward the proposed project. Related to that, the developer has a better understanding on the objectives and the requirements from the users due to the conduct of research method. With that, a more satisfaction and reliable system will be developed by the developer while reviewing the data collected and gone through analysis and evaluation in this chapter.

Chapter 7 System Architecture

7.1 Introduction

The act of identifying a piece of music involves examining its auditory signal, which is known as music recognition. Trained musicians can perform this manually, but it is more frequently carried out by computer algorithms that automatically identify and categorise music using machine learning and digital signal processing techniques. In this system, there is music recognition function implemented to it where it will be using the famous music recognition Shazam API to do the recognition process. A good music recognition allows us to recognise and find new music since keeping track of all the songs we hear and wish to remember might be challenging given the abundance of music that is readily available online. Even if we do not know the song's name or artist, music recognition technology makes it simple for us to recognise a song and find new music that we otherwise might not have heard.

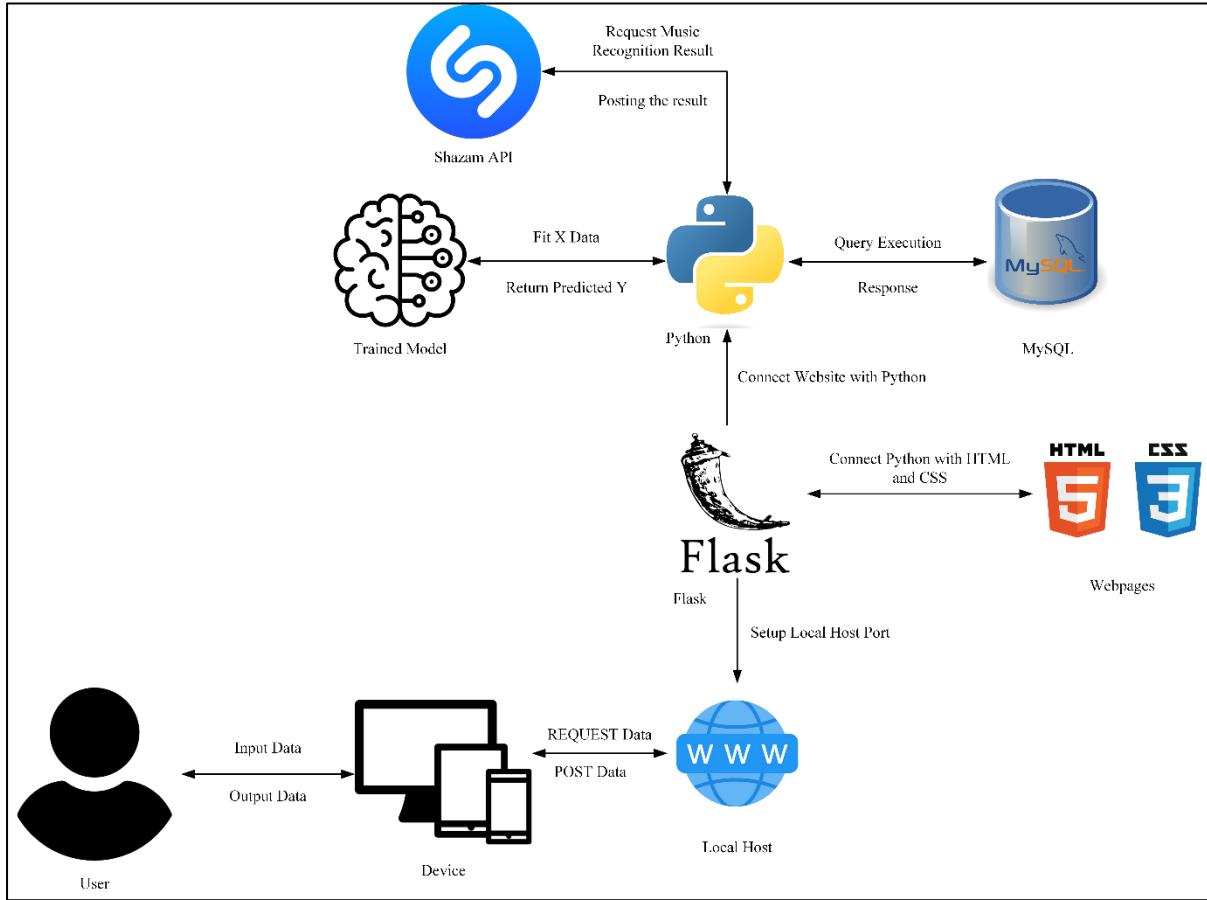
Besides that, the technique of classifying music into several genres based on their musical traits and characteristics is known as genre classification. Machine learning algorithms are typically used for this, which analyse audio data and extract pertinent elements including pace, rhythm, harmony, melody, and instrumentation which is true for this project since many types of machine learning algorithm were used to compare the result with each other and find out the best performance out of them. The model is then being exported and imported to the project directory to achieve accurate and consistent genre classification for the proposed system.

Moreover, the system which verifying a user's identity when they want to access a secure account or service is known as account authentication. Typically, this process entails providing some kind of credentials, like a login and password, to a system or service, which then verifies the authenticity of those credentials before authorising access to the account. In this system, there is also account authentication system implemented which is mainly to use to organise the data produced by the music recognition and genre classification function, so that every user can have an individual space to interact and play around with the system and have the unique history only for themselves.

Last but not least, a web application is a piece of software that can be accessed online using a web browser or other web-enabled device. Web applications are made to have an intuitive user interface that allows users to interact with them and enjoy their features without having to download and install any software on their devices. Hence, the architecture of web

application is being implemented for the proposed system to integrated all of those three functions mentioned above.

7.2 Abstract Architecture

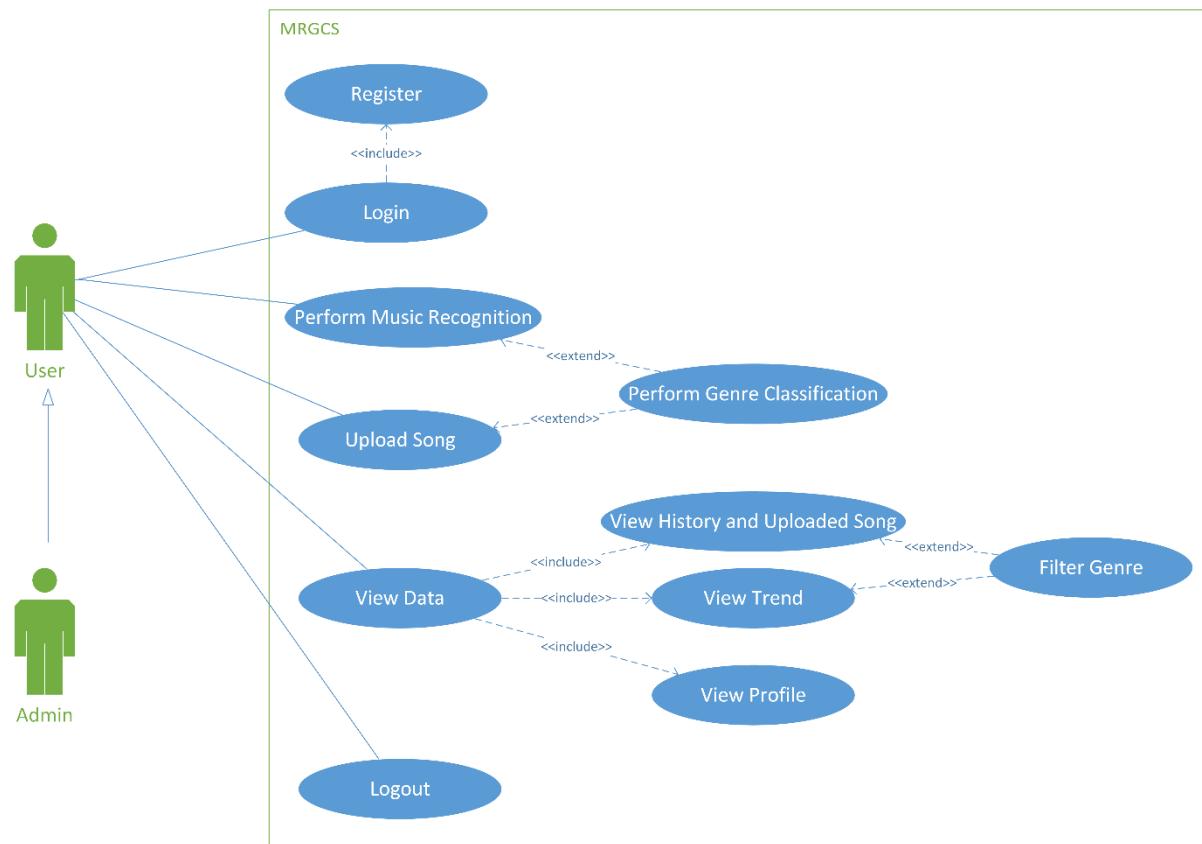


The MRGCS uses Flask framework to implement the final system on the platform provided by PyCharm. Python-based Flask is a web application framework that enables quick and simple web application development. Developers may create scalable, modular, and simple-to-maintain web applications with the aid of the libraries and tools offered by Flask. Besides that, Static files, templates, and a collection of Python files make up the majority of Flask applications. The application code, which outlines the routes, views, and other features of the application, is found in the Python files. The templates are HTML files that provide the organisation and design of the user interface for the programme. The user interface is styled and improved using static files including pictures, CSS, and JavaScript. With so many components existing, to process requests and render templates, Flask utilises the Werkzeug WSGI toolkit and the Jinja2 template engine. Along with other features, Flask supports sessions, cookies, and authentication. So that the Python can be used in a web application system and with the help of Python code, Shazam API, trained model and MYSQL can be all integrated to the system without any issue and working perfectly fine as expected. In the development process, developer often begins by specifying the routes that the Flask application will handle. A route is a URL that a user can access to communicate with the app. Hence. the

developer can create a view function for each route that processes the request and produces the response.

7.2.1 System design

7.2.1.1 Use Case Diagram



7.2.1.2 Use Case Specification

Function Name	Login
Description	User can login to their personal account on the web application system.
Actor	User and Admin

Function Name	Register
Description	User can register an account that does not exist in the database for the use of accessing the web application system
Actor	User

Function Name	Logout
Description	User can logout from their account after login to end their session.
Actor	User and Admin

Function Name	Perform Music Recognition
Description	User can select the audio input method including speaker and microphone to capture audio data and perform music recognition upon pressing a button.
Actor	User and Admin

Function Name	Upload Song
Description	User can upload a wav format audio file to the web application system.
Actor	User and Admin

Function Name	Perform Genre Classification
Description	Both recognised music and uploaded song will be automatically performed genre classification and label the genre on them.

Actor	User and Admin
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Function Name	View Data
Description	User can view the data from the database of the web application system where admin can view all user data.
Actor	User and Admin

Function Name	View History and Uploaded Song
Description	User can view history and uploaded song as well as their classified genre in an organised form.
Actor	User and Admin

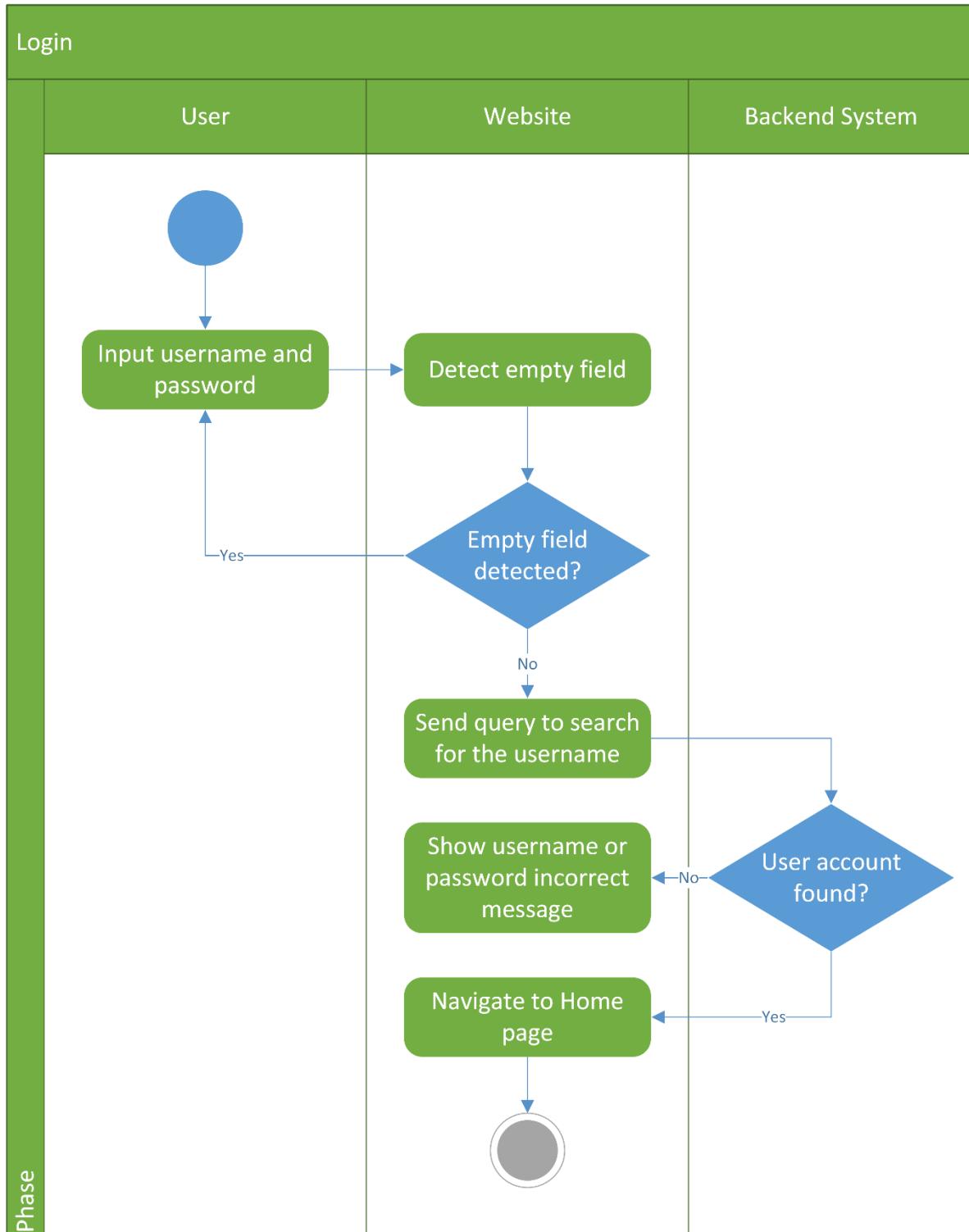
Function Name	View Trend
Description	User can view the current trend of recognised song where the most recognised count song will be on the top.
Actor	User and Admin

Function Name	View Profile
Description	User can view their own account information.
Actor	User and Admin

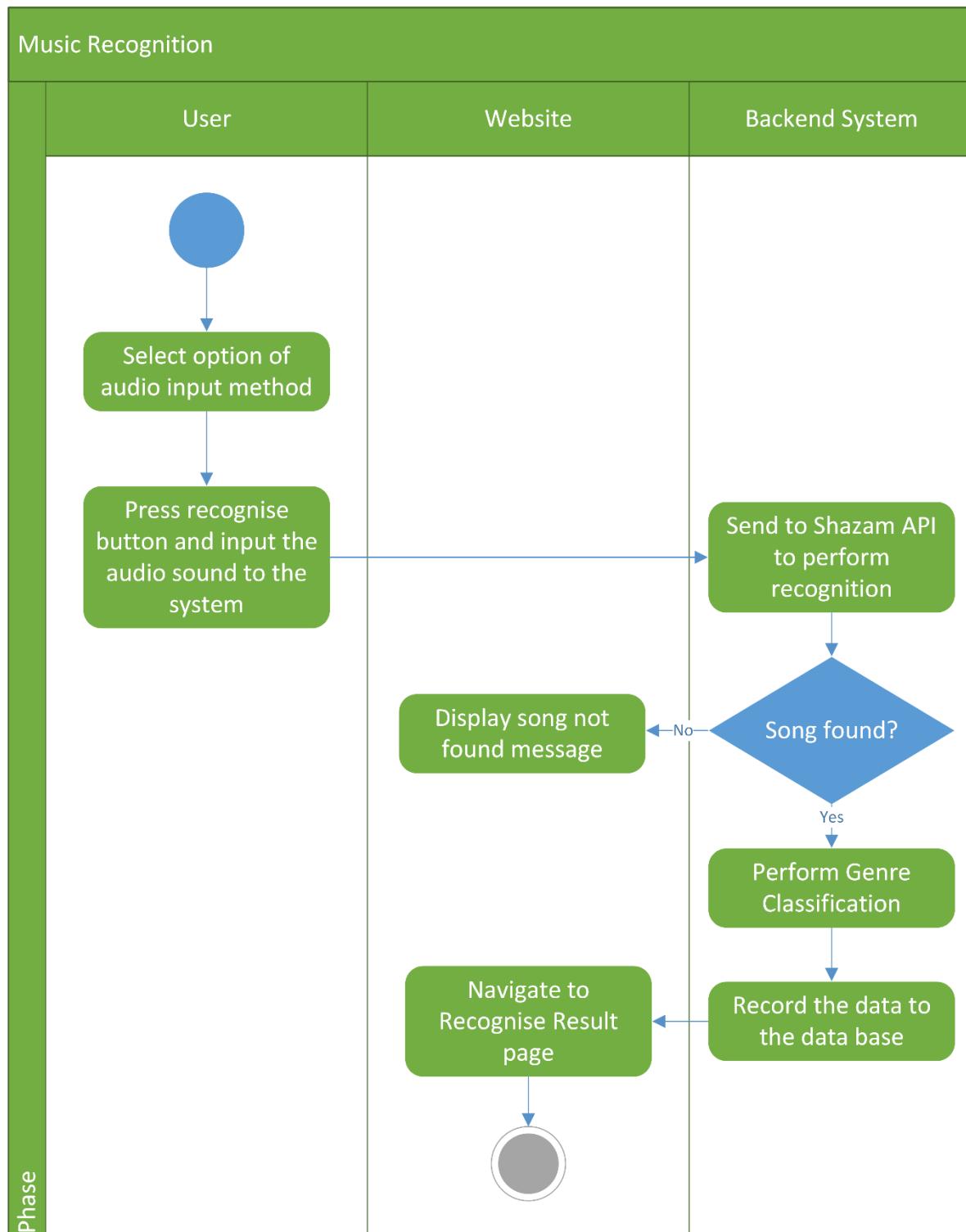
Function Name	Filter Genre
Description	User can filter the data displayed by selecting a genre.
Actor	User and Admin

7.2.1.3 Activity Diagram

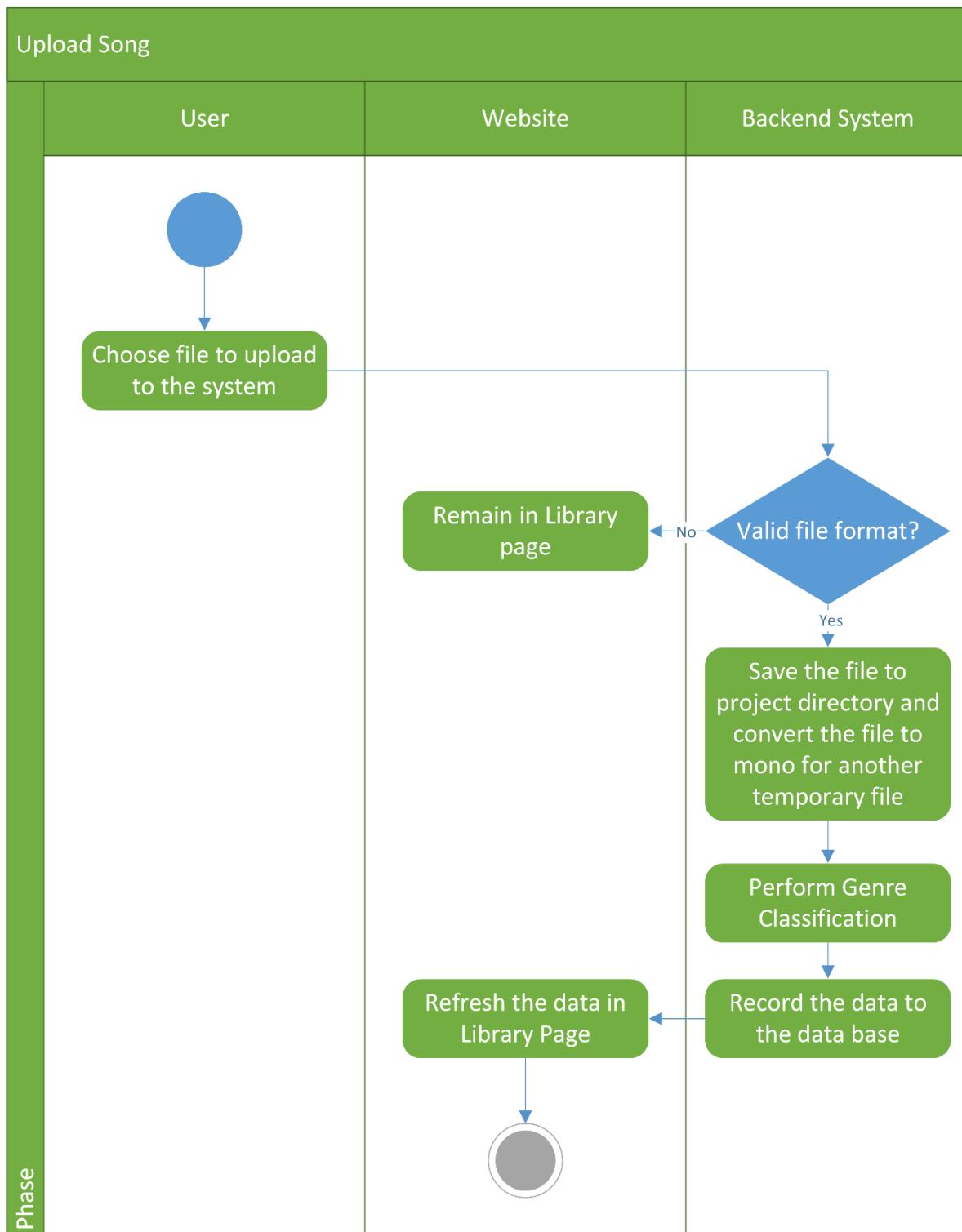
Login Activity Diagram



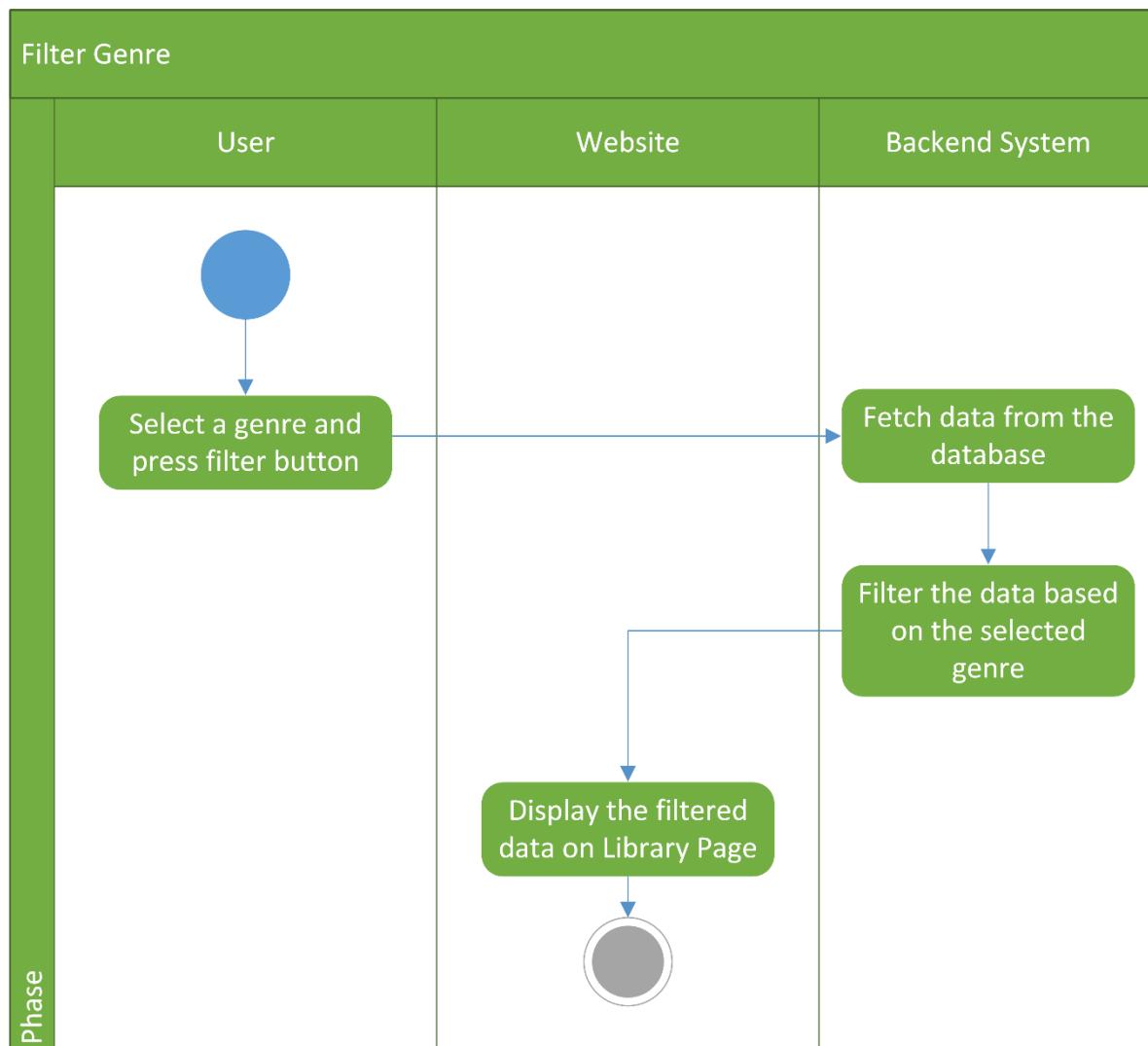
Music Recognition Activity Diagram



Upload Song Activity Diagram



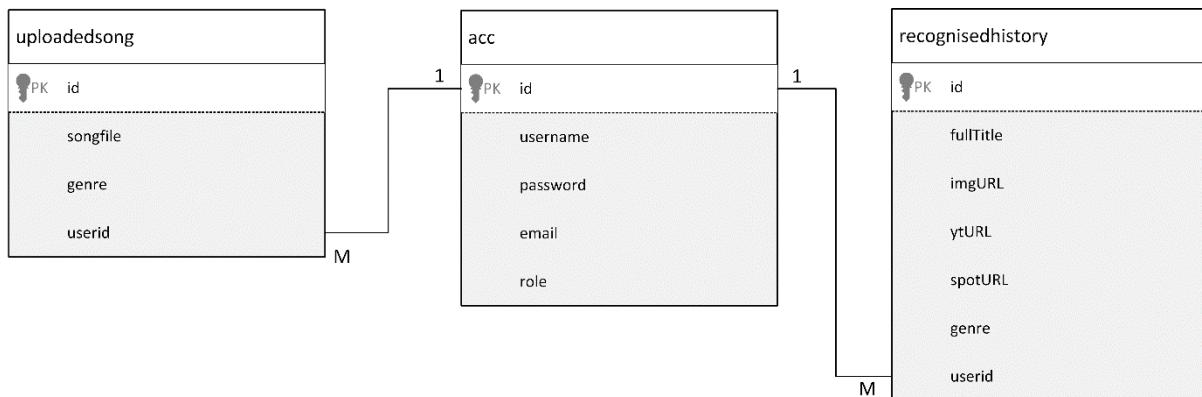
Filter Genre Activity Diagram



7.2.2 Database design

7.2.2.1 Entity relationship diagram (ERD)

Entity-Relationship Diagrams are graphical depictions of the connections between various database elements. An entity is anything that is significant to the system being modelled, such as a person, place, thing, or concept. In the diagram, the connections between the entities are indicated by lines. Besides that, ERDs are helpful for planning and describing a database system's structure. They can facilitate communication between developers and stakeholders, aid in the detection of potential design problems, and act as a guide for execution. Hence, the ERD for MRGCS is shown as figure below.



7.2.2.2 Database table structure

Table Name: acc

Column Name	Column Type	Description	Key
id	Integer	id will be unique and auto increment by adding a new roll meaning that the value can be inserted as NULL and the database will automatically assign the integer number for the id.	Primary Key
username	String	username is the data which be added when registering and will be fetched for account login function and display welcome message.	-
password	String	password is the data which be added when registering and fetched for account login function and when visit profile page.	-
email	String	email is the data which be added when registering and fetched when visit profile page.	-

role	String	role is the data which be added when registering, fetched when visit profile page and also differentiate functionalities availability between user and admin.	-
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Table Name: recognisedsong

Column Name	Column Type	Description	Key
id	Integer	Id will be unique and auto increment by adding a new roll meaning that the value can be inserted as NULL and the database will automatically assign the integer number for the id.	Primary Key
fullTitle	String	fullTitle is the data which be added after recognised a song and fetched during displaying data.	-
imgURL	String	imgURL is the data which be added after recognised a song.	-
ytURL	String	ytURL is the data which be added after recognised a song.	-

spotURL	String	spotURL is the data which be added after recognised a song.	-
genre	String	genre is the data which be added after recognised a song and it come from the genre classification system, it will be fetched during displaying data.	-
userid	String	userid is the data that linking this table with the acc table, the account information can be access with the use of this userid.	Foreign Key

Table Name: uploadedsong

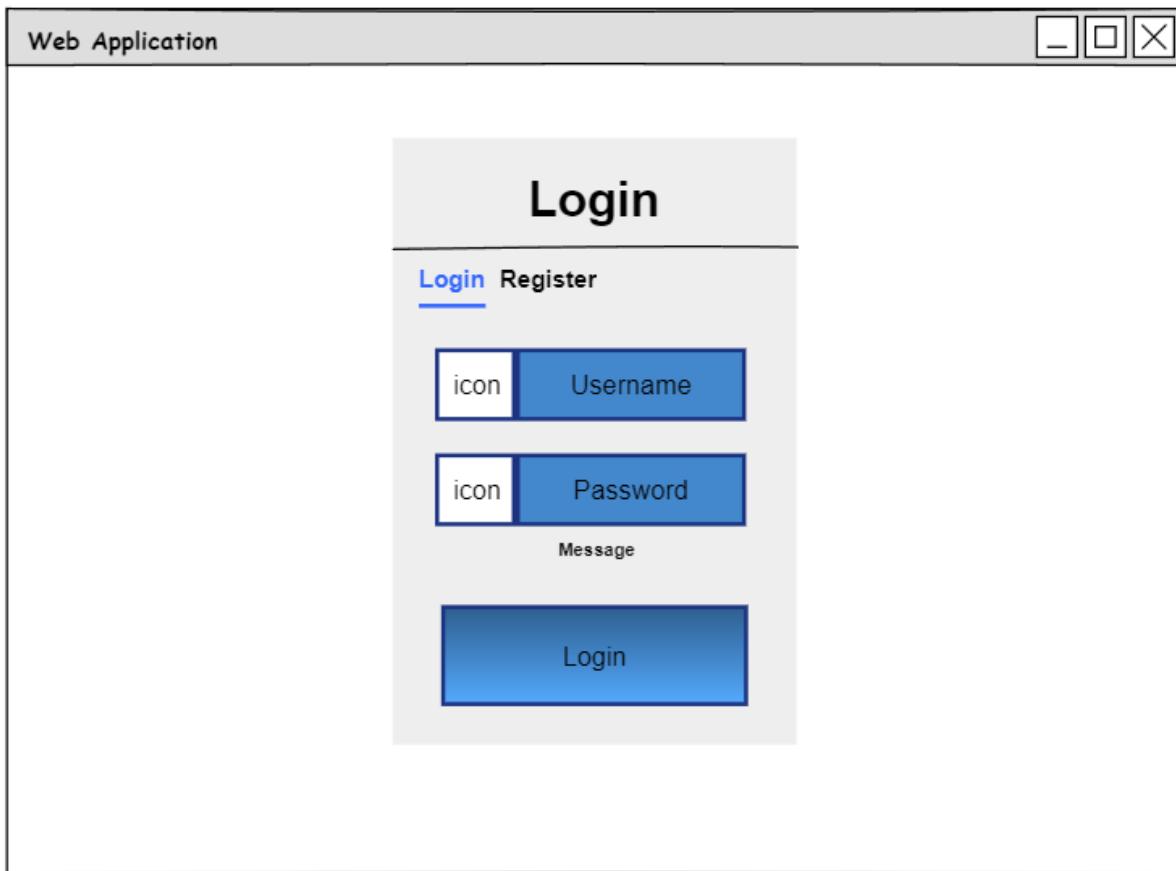
Column Name	Column Type	Description	Key
id	Integer	Id will be unique and auto increment by adding a new roll meaning that the value can be inserted as NULL and the database will automatically assign the integer number for the id.	Primary Key
songfile	String	songfile is the data which be added after	-

		uploaded a song and it will be fetched during displaying data.	
genre	String	genre is the data which be added after uploaded a song and it come from the genre classification system, it will be fetched during displaying data.	-
userid	String	userid is the data that linking this table with the acc table, the account information can be access with the use of this userid.	Foreign Key

7.2.3 Interface design

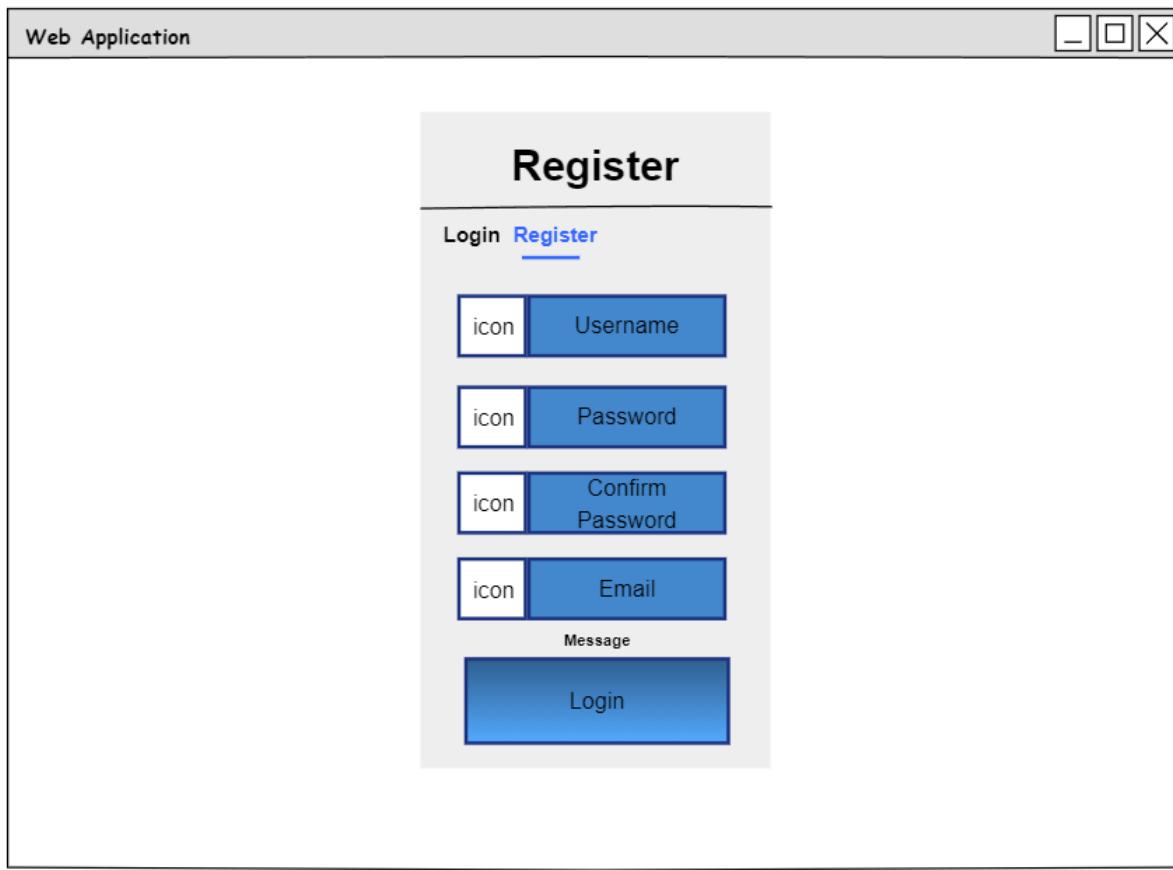
Interface design, commonly referred to as user interface design or UI design, is the process of creating the graphical interfaces and interactive features for a website or software programme. In order to give users a favourable experience, interface design aims to build interfaces that are intuitive, simple to use, and visually appealing. In this section, the designs of the pages will be shown with description for the element on the MRGCS pages while the interface design was done by using Pencil.

7.2.3.1 Interface for login & logout page



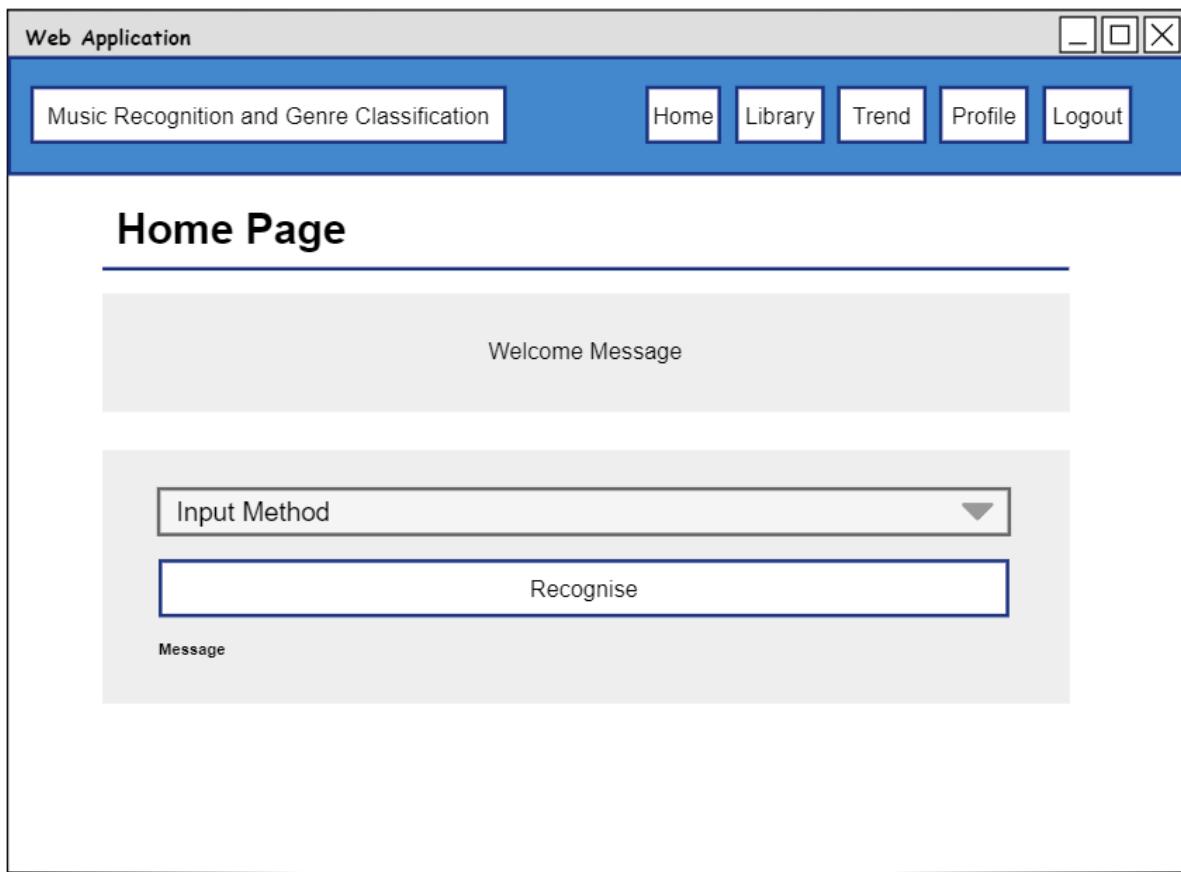
The design for login and logout pages where it will have two text input for both username and password to be filled, the user can then click the login button as a submit input to login to the system, any message such as account not found and logout message will be displayed under the second text input. Besides that, there is also a register page that can be accessed by pressing the register word.

7.2.3.2 Interface for register page



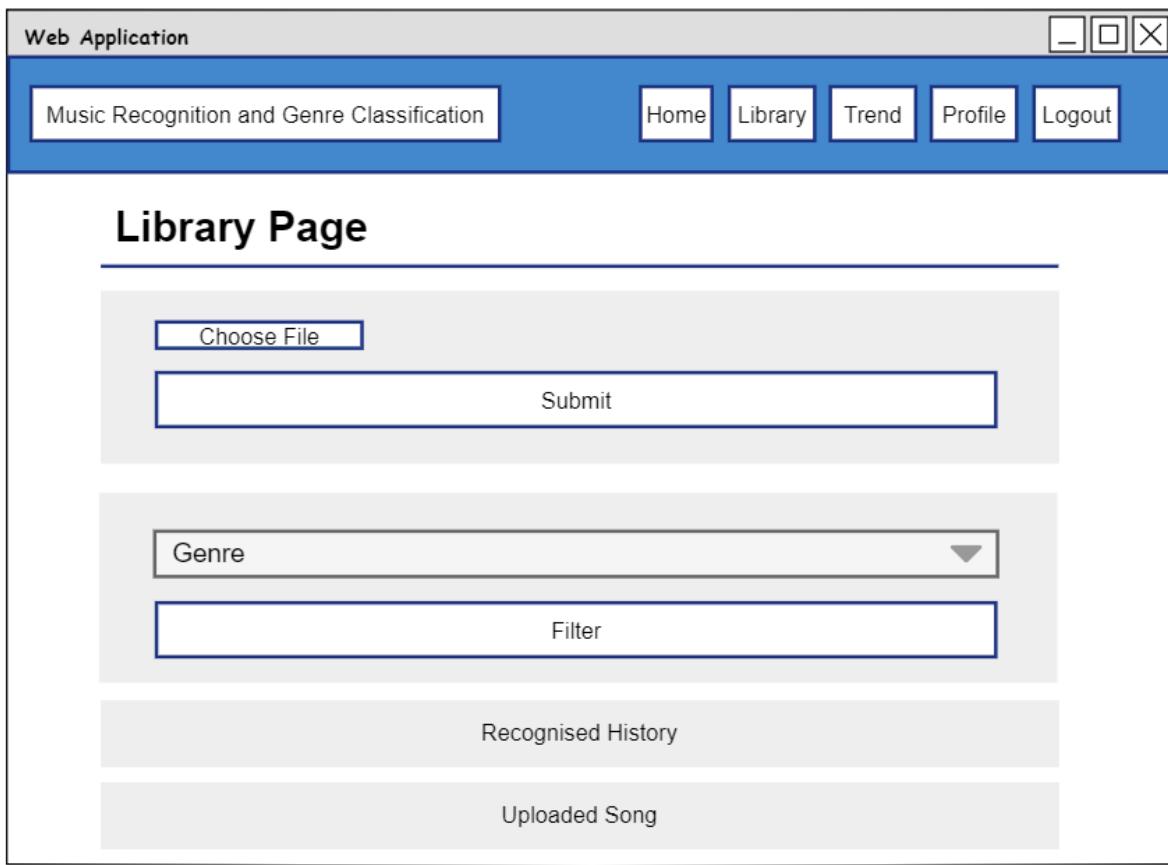
The design for register page where it will have four text input for the user to fill including username, password, confirm password and email, the user can then press the register button to submit those data to the system to register an account, any message such invalid input and account exists message will be displayed under the second text input. Besides that, there is also a login page that can be accessed by pressing the login word upon register.

7.2.3.3 Interface for home page



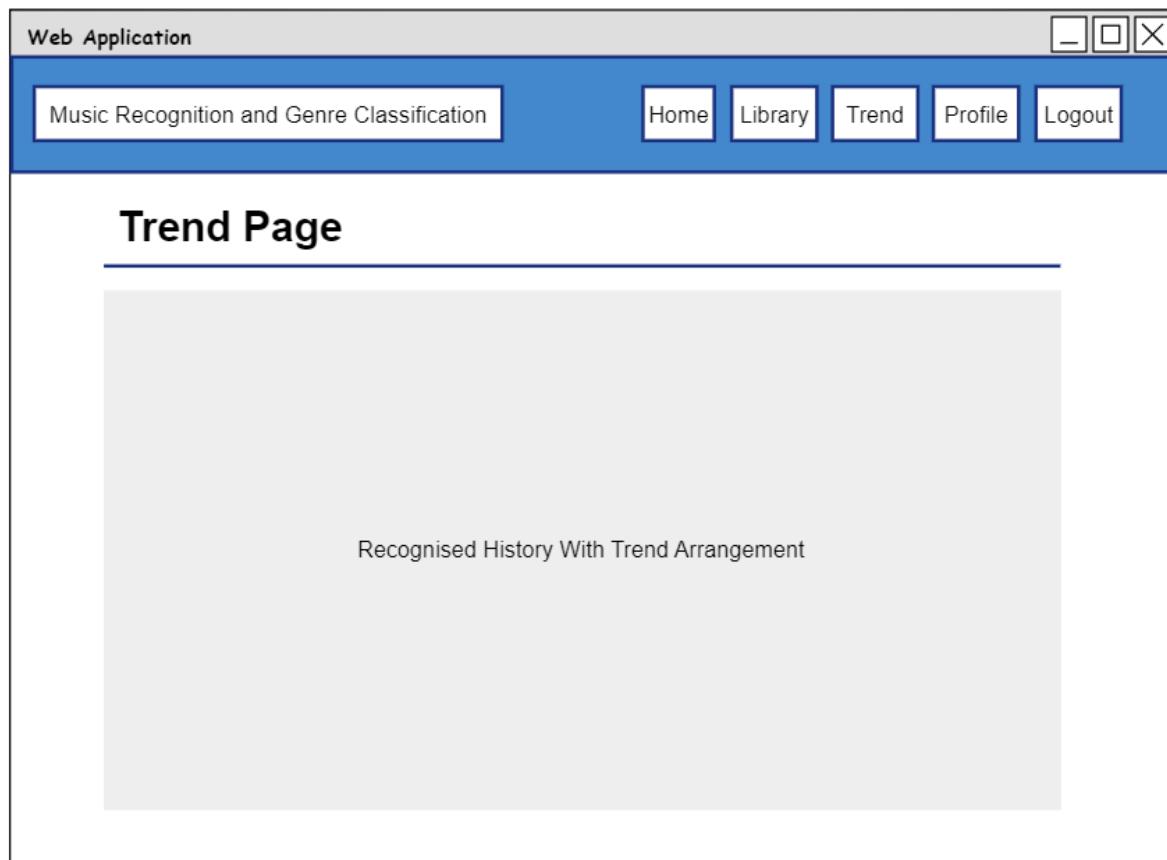
This is a page that will be displayed upon login to an account, navigation bar on top can be used to navigate between every page of the system. Home page will have a button for the user to press after choosing the input method to capture the audio data. User will need to wait usually 15 to 30 seconds after pressing the button to wait for the system to recognise the music and redirect the user to the result page or display a message when no song found from the audio.

7.2.3.4 Interface for library page



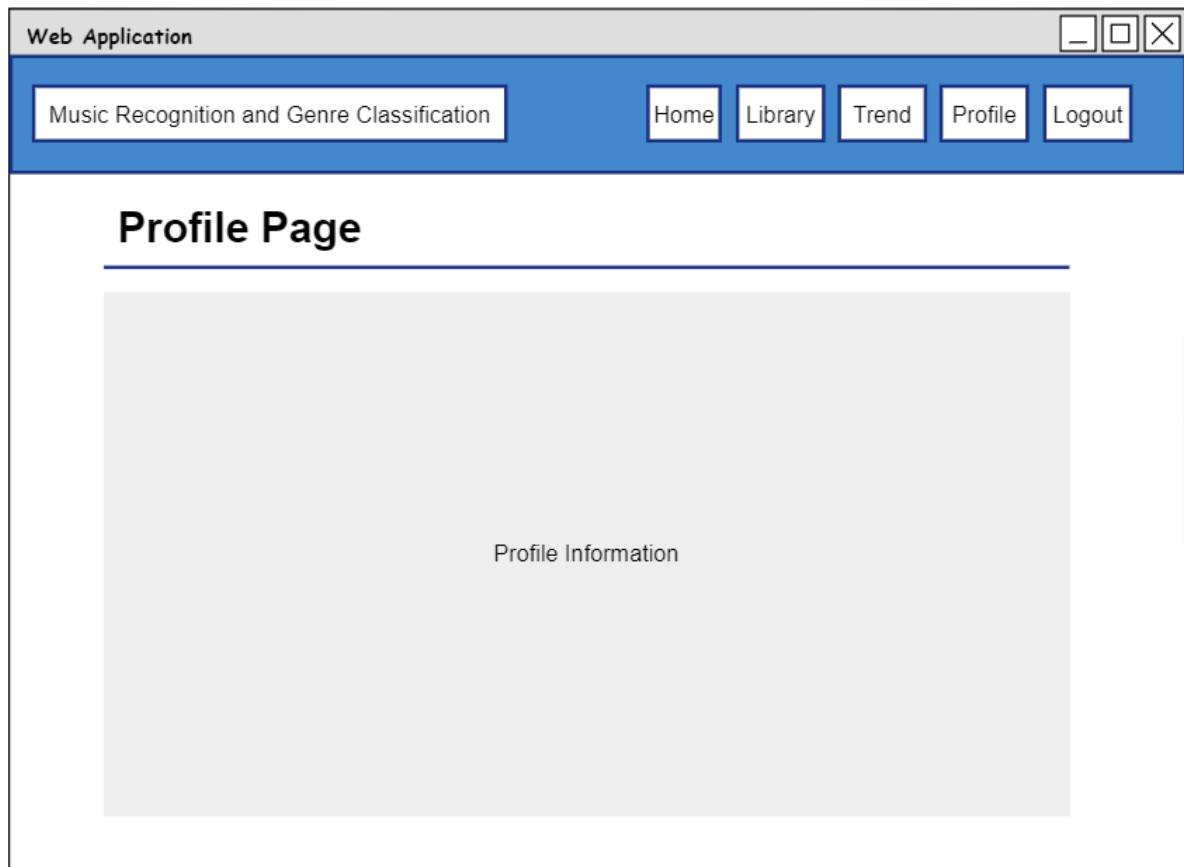
The library page is a page for the user to see the recognised history and uploaded song to the system, user can also upload song from the local device to the system on this page to perform genre classification for the song. The history information can also be filtered by selected genre by choosing an option from the combo list and press the filter button.

7.2.3.5 Interface for trend page

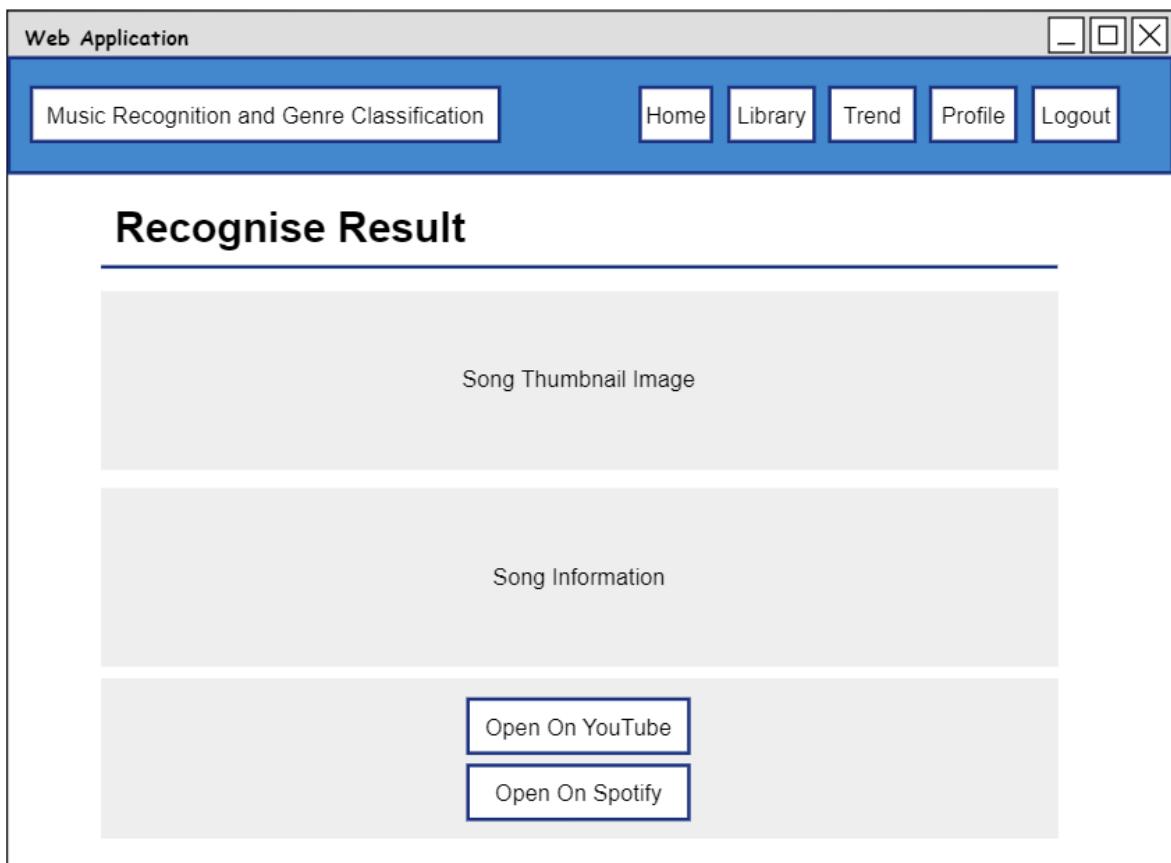


This page will be displaying the popular recognised song which means that the most recognised count song will be arranged in ascending order to let the user have the information for which song and its genre is trending at the moment.

7.2.3.6 Interface for profile page



7.2.3.7 Interface for recognise page



This page will be displaying the result of recognised song in an organised way where the image of the song will be displayed and other information including song tile, author, classified genre, and Shazam URL. Besides that, there will have two buttons in the bottom which can redirect user to search the user on both YouTube and Spotify platform respectively.

Chapter 8 Project Plan

In this section, the developer will go over the proposed system's release schedule. This proposed system consists of three parts: music recognition, genre classification, and web application. However, a comprehensive project schedule will be provided in the appendix section as a Gantt chart.

8.1 Details of the release plan

The developer will describe the many release versions in this section. Starting with the prototyping phase, the system was intended to be published a few times until the final demo release for the testers.

8.1.1 Version 1.0 of MRGCS

The first version of MRGCS was planned to release at the first week of April 2023. Lot of the audio reading and processing techniques had been studied for the developers on which libraries will do the job for them. Hence, this version of the system can execute music recognition by able to capture input from speaker and microphone and feed the data to Shazam API without any issue. Although there is still without account authentication functionality in this version, the music recognition function is completed with a simple design of result output displayed to the user on the web application.

8.2.2 Version 2.0 of MRGCS

The second version of MRGCS will be released in the second week of April 2023. The genre classification function has been introduced to the system after the complete development of the machine learning model for it. The accuracy result produced from the test data is satisfying the objectives requirement and need to further improvement on it for the mean time. Although both function for music recognition and genre classification are not integrated with each other yet, user can still upload a song to the system to classify the genre.

8.2.3 Beta Version of MRGCS

The third version of MRGCS will be the Beta version released in the third week of April 2023. Both of the music recognition function and genre classification has been integrated together where recognised music will also be classified a genre without any issue. The result will be stored and displayed in an organised form whenever it is needed.

8.2.3 Demo Version of MRGCS

The final release of MRGCS which is the demo will be in the last week of April 2023. In this version, the developer was focus on the final clean interface design as well as the user authentication function where it allows user to register an account to login to the system to

interact with it, the interface will be reorganised to be simple and easy to understand with more organised data displayed. Lastly, this version will be considered to be the final version that will be showcased in this documentation.

8.2 Test Plan

The strategy, goals, scope, and procedure for testing a software application or system are described in a test plan, which is a written document. Details like test case, test condition, expected result and actual result are frequently included. A test plan is crucial because it ensures that the testing procedure is well-structured, methodical, and effective. It guarantees that the testing is carried out in a systematic and uniform manner and that all components of the testing process are carefully planned and carried out. From that, the possibility of faults being found late in the development cycle can be decreased with the use of a well-defined test plan that can assist in identifying potential issues or risks early in the testing process. Additionally, it can ensure that the testing is concentrated on the application's or system's most important features which are music recognition and genre classification while the testing activities are in line with the overall project's goals and objectives. Hence, the test plan is designed in this section to plan out what are need to be tested to prove the system is working as expected in required units and also a form for testers to evaluate the system after the use of the demo system.

8.2.1 Test plan for Unit Testing

A software testing technique known as unit testing involves testing individual software application modules or components separately from the rest of the system. Unit testing checks that each part or component of the software such as login, registering as well as music recognition and uploading music for genre classification are working properly and performing as it should. Hence, this test will be conducted by the developer himself after the development of demo version for the system.

Case No	Test Case	Test Condition	Expected Result	Actual Result	Status
1	1. Leave any field in Login page empty 2. Click Login button	Username: empty Password: empty	Empty field warning		
2	1. Input existing username and password in Login page 2. Click Login button	Username: admin Password: admin	Login successfully and go to Home page		
3	1. Leave any field in Register page empty 2. Click Register button	Username: empty Password: empty Confirm Password: empty Email: empty	Empty field warning		
4	1. Fill in the all the fields in Register page 2. Click Register button	Username: Sia De Long Password: sia Confirm Password: sia Email: sia@outlook.com	Account registered successfully and display a message		
5	1. Select speaker option in Home page 2. Click Recognise button	Open a song on YouTube of the device running the web application	Song recognised successfully with genre		

			classified and go to result display page		
6	1. Select microphone option in Home page 2. Click Recognise button	Open a song on YouTube from a mobile phone and play it to the microphone of the device running the web application	Song recognised successfully with genre classified and go to result display page		
7	Upload a mp3 format file on Library page	A mp3 file	File upload fail and stay at the same page		
8	Upload a wav format file on Library page	A wav file	File upload successfully and genre classified with message display		
9	1. Select classical option in Library page 2. Click Filter button	-	Data in the library page get filtered by the selected genre		
10	Navigate to trend Page	-	Go to the trend page with data displayed		

11	Navigate to Profile Page	-	Go to the profile page with profile information displayed		
12	Navigate to Log out page	-	Profile log out successfully and go back to login page with message displayed		

8.2.2 Test plan for User Acceptance Testing

A representative group of end users will test the web application system of MRGCS as part of the user acceptance testing methodology to see if it satisfies their needs and expectations as well as to check whether the system meet the aim and objectives for the project. User acceptance test is done to make sure the system or software is usable by the intended audience and is prepared for release. Hence, this test will be conducted by three student study in APU by letting them test the system on the developer device.

Name						
Date of Testing						
No	Criteria	Test Rating				
		1	2	3	4	5
1	User Interface <ul style="list-style-type: none">- Interaction with the web application- Information is clearly displayed and organised- Easy to use and learn- Overall experience					
2	Model Evaluation <ul style="list-style-type: none">- Music recognition accuracy is high- Consistent genre classification and suitable genre classified					
3	Website Design <ul style="list-style-type: none">- Theme consistent for all the pages- Suitable colour combination used					
4	Functionalities <ul style="list-style-type: none">- Free of bugs- Error and validation message is displayed					

Feedbacks and Suggestions:

Chapter 9 Implementation

9.1 Model Development

In this project development, there will be only genre classification model training since music recognition will be accomplished by the use of Shazam API. Hence, this section will show the process of produce a model that meet the requirement.

```
[1] # Usual Libraries
    import pandas as pd
    import numpy as np
    import seaborn as sns
    import matplotlib.pyplot as plt
    %matplotlib inline
    import sklearn

    # Librosa (the mother of audio files)
    import librosa
    import librosa.display
    import IPython.display as ipd
    import warnings
    warnings.filterwarnings('ignore')
```

Figure above shows the first step of the process which is libraries importing, these libraries will be use to read and manipulate audio data for studying the meaning and correlation between the audio features.

```
[2] from google.colab import drive
    drive.mount('/content/drive')
```

The dataset will be uploaded to the drive for the Colab platform to access to the dataset by executing source code show on the figure above.

```
[3] import os
    general_path = '../content/drive/MyDrive/Data'
    print(list(os.listdir(f'{general_path}/genres_original/')))

['hiphop', 'blues', 'metal', 'classical', 'reggae', 'rock', 'pop', 'jazz', 'disco', 'country']
```

To ensure the dataset is imported to the platform successfully, source code above has been executed and print out all the genre to prove that the data can be extracted out from the dataset.

9.1.1 Feature Study

First and foremost, audio file can have many features and each of them might or might not determine the genre of one song. Hence, this section will be focusing on study the meaning and way to extract the features from the audio based on the attributes existing in the dataset.

```
[4] # Importing 1 file
y, sr = librosa.load(f'{general_path}/genres_original/reggae/reggae.00036.wav')

print('y:', y, '\n')
print('y shape:', np.shape(y), '\n')
print('Sample Rate (KHz):', sr, '\n')

# Verify length of the audio
print('Check Len of Audio:', 661794/22050)

y: [0.02072144 0.04492188 0.05422974 ... 0.06912231 0.08303833 0.08572388]

y shape: (661794,)

Sample Rate (KHz): 22050

Check Len of Audio: 30.013333333333332
```

To understand more on the audio, one of the audio file have been chosen shown as figure above while librosa library has been use to extract signal wave(y) and sample rate(sr) of the audio. These two elements are very important to represent data of an audio file which can be used to train a model.

```
[5] # Trim leading and trailing silence from an audio signal (silence before and after the actual audio)
audio_file, _ = librosa.effects.trim(y)

# the result is an numpy ndarray
print('Audio File:', audio_file, '\n')
print('Audio File shape:', np.shape(audio_file))

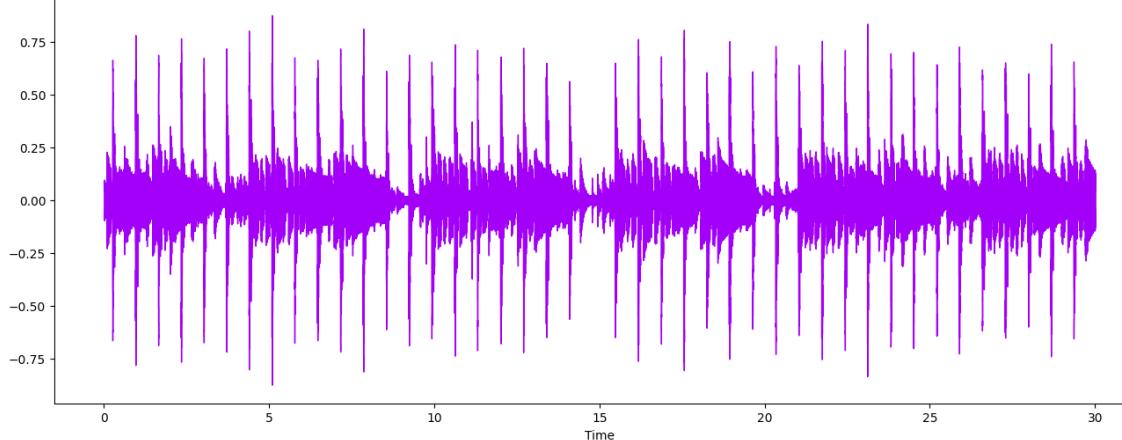
Audio File: [0.02072144 0.04492188 0.05422974 ... 0.06912231 0.08303833 0.08572388]

Audio File shape: (661794,)
```

Besides that, the way to abstracting only the actual audio part was also discovered where trim function from librosa library will be used. So that, the audio data can be focusing on where the actual audio start.

```
[6] plt.figure(figsize = (16, 6))
librosa.display.waveform(y = audio_file, sr = sr, color = "#A300F9");
plt.title("Sound Waves in Reggae 36", fontsize = 23);
```

Sound Waves in Reggae 36



To further study on the sound wave, y and sr value has been used to plot a figure to have a better understanding on what these two values represent.

▼ Fourier Transform

- Function that gets a signal in the time domain as input, and outputs its decomposition into frequencies
- Transform both the y-axis (frequency) to log scale, and the "color" axis (amplitude) to Decibels, which is approx. the log scale of amplitudes.

```
✓ 0s [7] # Default FFT window size
n_fft = 2048 # FFT window size
hop_length = 512 # number audio of frames between STFT columns (looks like a good default)

# Short-time Fourier transform (STFT)
D = np.abs(librosa.stft(audio_file, n_fft = n_fft, hop_length = hop_length))

print('Shape of D object:', np.shape(D))
```

Shape of D object: (1025, 1293)

One mathematical method for analysing and converting data, such sound waves, from the time domain to the frequency domain is the Fourier Transform. A Fourier Transform can be used to break down a complex waveform into its component frequencies when discussing sound waves which mean that Fourier Transform is a powerful tool for analysing and understanding sound waves, and can be used to extract valuable information from complex audio signals. Figure above shows how the shape of Fourier Transform plot can be calculated by combining NumPy and librosa library.

```
[8] plt.figure(figsize = (16, 6))
plt.plot(D);
```

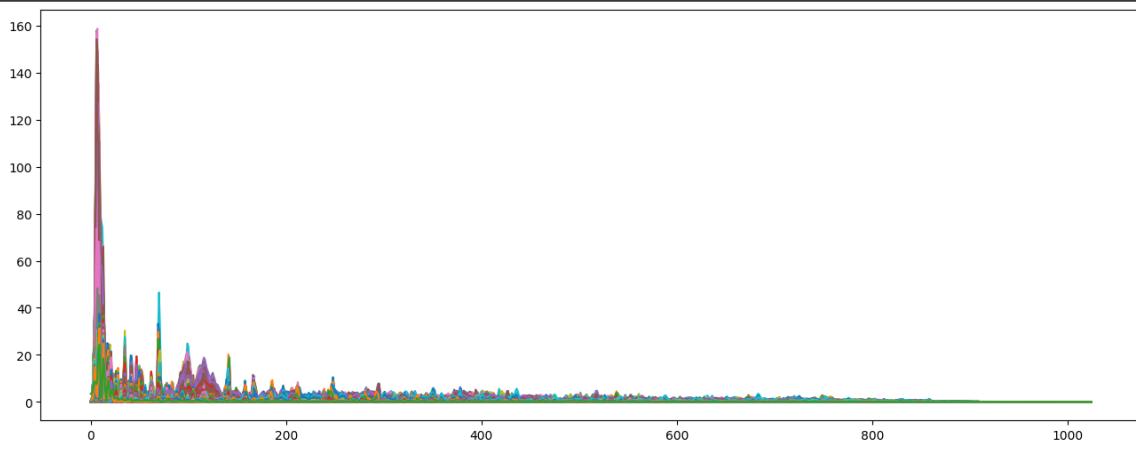


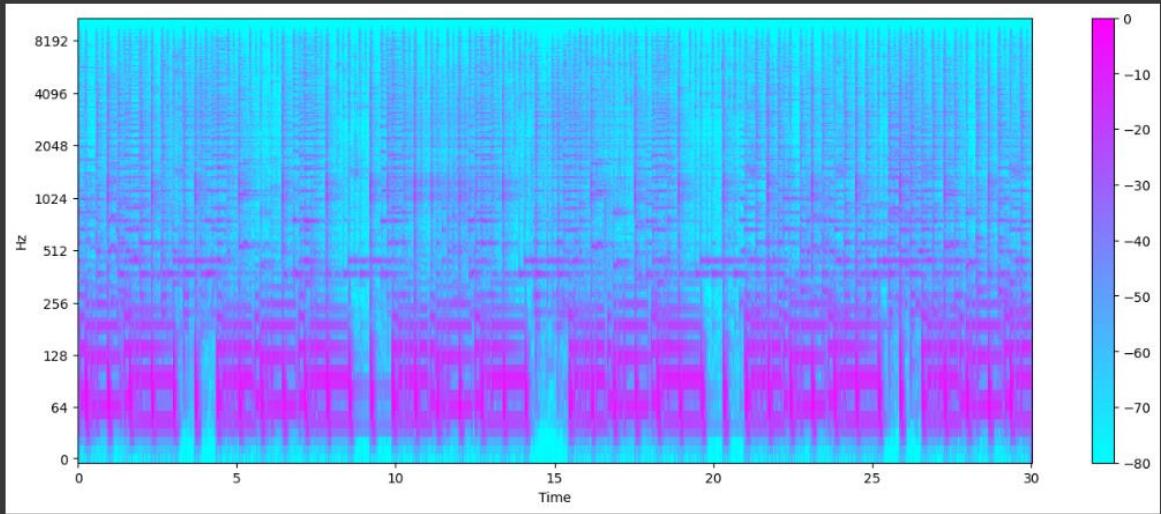
Figure above shows how the shape data be used to plot out the Fourier Transform figure and also the figure itself.

The Spectrogram

- What is a spectrogram? A spectrogram is a visual representation of the spectrum of frequencies of a signal as it varies with time. When applied to an audio signal, spectrograms are sometimes called sonographs, voiceprints, or voicegrams.
- Here we convert the frequency axis to a logarithmic one.

```
[9] # Convert an amplitude spectrogram to Decibels-scaled spectrogram.
DB = librosa.amplitude_to_db(D, ref = np.max)
```

```
# Creating the Spectrogram
plt.figure(figsize = (16, 6))
librosa.display.specshow(DB, sr = sr, hop_length = hop_length, x_axis = 'time', y_axis = 'log',
                      cmap = 'cool')
plt.colorbar();
```



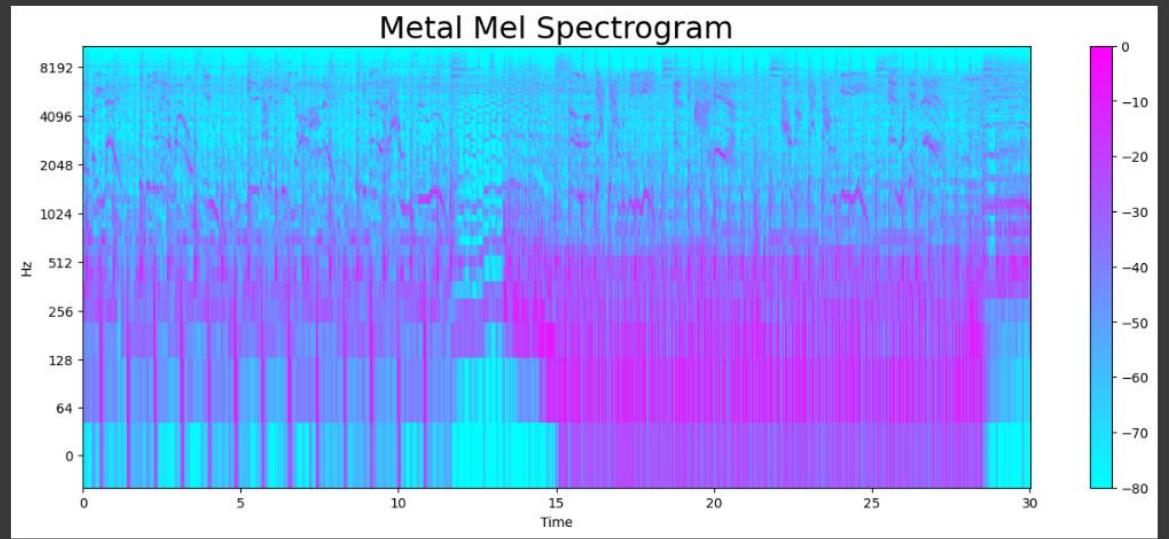
A spectrogram is a graphic representation of a signal's changing frequency spectrum over time. The x-axis indicates time, the y-axis represents frequency, and the colour or intensity reflects the amplitude or power of the frequency at each point in time meaning that this is a 2D representation of a 3D graph. With that data, it can be useful in locating sonic characteristics like harmonics, overtones, and formants. Hence, figure above shows the way to plot and display a spectrogram.

Mel Spectrogram

- The Mel Scale, mathematically speaking, is the result of some non-linear transformation of the frequency scale. The Mel Spectrogram is a normal Spectrogram, but with a Mel Scale on the y axis.

```
[10] y, sr = librosa.load('genres_original/metal/metal.00036.wav')
y, _ = librosa.effects.trim(y)
```

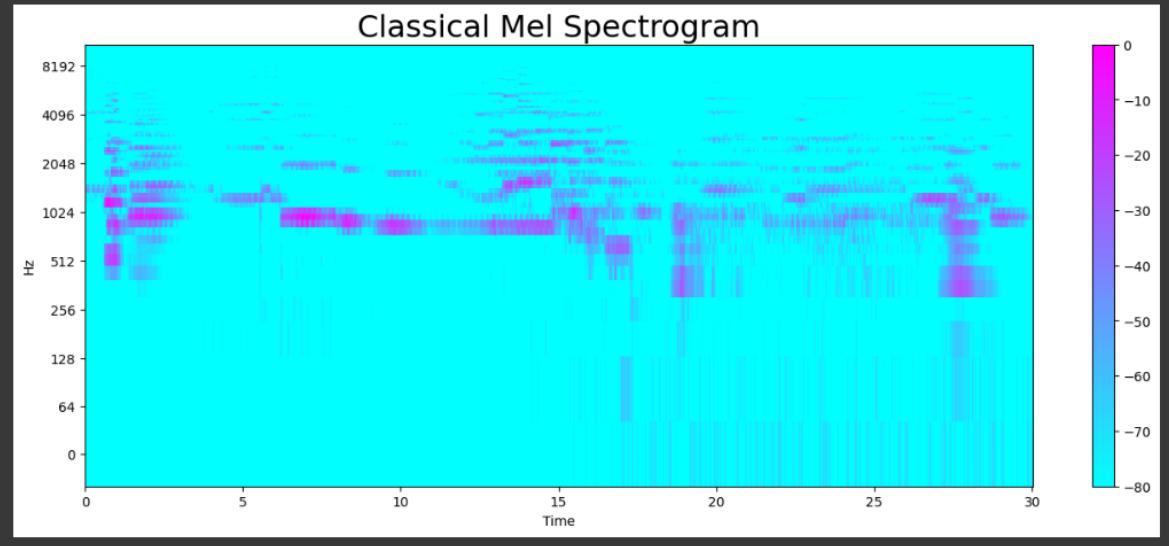
```
S = librosa.feature.melspectrogram(y=y, sr=sr)
S_DB = librosa.amplitude_to_db(S, ref=np.max)
plt.figure(figsize=(16, 6))
librosa.display.specshow(S_DB, sr=sr, hop_length=hop_length, x_axis='time', y_axis='log',
                        cmap='cool');
plt.colorbar();
plt.title("Metal Mel Spectrogram", fontsize=23);
```



Similar to the spectrogram, the frequency content of an audio stream is represented using a spectrogram called a Mel spectrogram, which is more in line with how people hear sound. It is frequently applied to the study of speech and music as well as to the creation of speech and music recognition systems. The difference of spectrogram and mel spectrogram is that it is having mel scale on the y axis. Hence, figure above shows the way to plot and display a mel spectrogram for a metal genre audio file.

```
[11] y, sr = librosa.load('general_path/genres_original/classical/classical.00036.wav')
y, _ = librosa.effects.trim(y)

S = librosa.feature.melspectrogram(y=y, sr=sr)
S_DB = librosa.amplitude_to_db(S, ref=np.max)
plt.figure(figsize = (16, 6))
librosa.display.specshow(S_DB, sr=sr, hop_length=hop_length, x_axis = 'time', y_axis = 'log',
                        cmap = 'cool');
plt.colorbar();
plt.title("Classical Mel Spectrogram", fontsize = 23);
```



To study the mel spectrogram furthermore, figure above shows the way to plot and display a mel spectrogram for a classical genre audio file. The figure shows that there is a significant change on the mel spectrogram compare between both of the genre meaning that mel spectrogram can be one of the significant features that can be used to differentiate between genre.

Audio Features

Zero Crossing Rate

- the rate at which the signal changes from positive to negative or back.

```
[12] # Total zero_crossings in our 1 song
zero_crossings = librosa.zero_crossings(audio_file, pad=False)
print(sum(zero_crossings))

39232
```

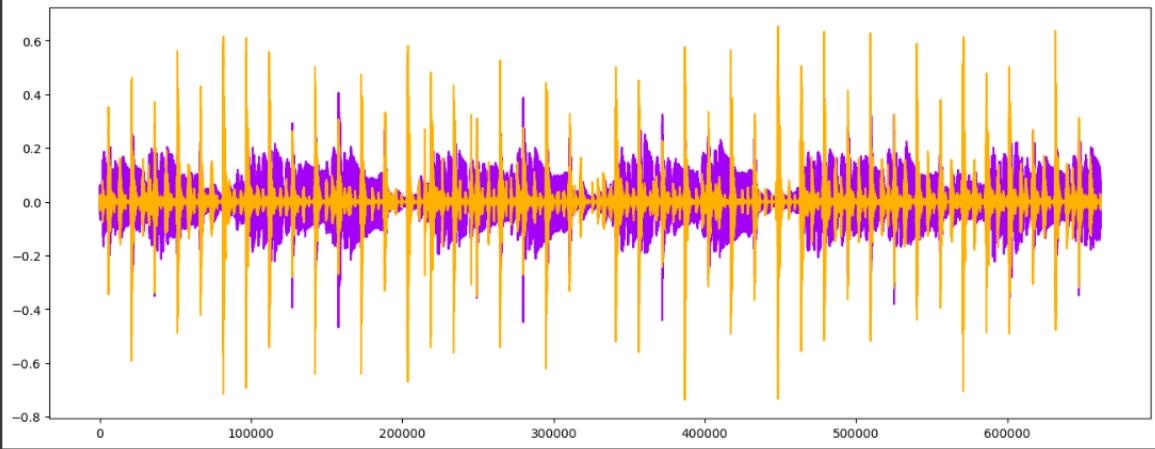
The number of times a signal crosses the horizontal axis, or zero, in a predetermined amount of time is known as the Zero Crossing Rate. it is a characteristic that is frequently used in audio processing to define a sound signal's frequency content and rhythmic pattern. Hence, figure above shows the way to extract this feature from an audio file.

Harmonics and Perceptual

- Harmonics are characteristic that human ears can't distinguish (represents the sound color)
- Perceptual understanding shock wave represents the sound rhythm and emotion

```
[13] y_harm, y_perc = librosa.effects.hpss(audio_file)

plt.figure(figsize = (16, 6))
plt.plot(y_harm, color = '#A300F9');
plt.plot(y_perc, color = '#FFB100');
```



The partials or overtones that are present in a sound wave along with the fundamental frequency are referred to as harmonics. A complex waveform made up of a basic frequency and several harmonics is often produced when a musical instrument or a human voice makes a sound. These harmonics have amplitudes that are smaller than the fundamental frequency and multiples of the fundamental frequency. While human hearing perception is referred to be perceptual. Loudness, pitch, timbre, and duration are some of the elements that affect how we perceive sound. Perceptual models are employed in audio processing to rate the perceived quality of sound signals. This two information are important for audio processing and the model itself, so the figure above shows the way to extract these features from an audio file and display it on a plot.

Tempo BMP (beats per minute)

Dynamic programming beat tracker.

```
[14] tempo, _ = librosa.beat.beat_track(y=y, sr = sr)
      tempo
```

```
107.666015625
```

The rate or speed at which a musical work is performed is referred to as tempo. The number of beats in one minute, or beats per minute (BPM), is the standard unit of measurement. As a result, tempo has a significant impact on the entire mood and feel of a piece of music. While a slower tempo can suggest relaxation or sadness, a faster tempo can evoke feelings of

excitement and energy. In another word, tempo can represent the genre of a music, so the way to extract tempo feature from an audio file is show as figure above.

Spectral Centroid

- indicates where the "centre of mass" for a sound is located and is calculated as the weighted mean of the frequencies present in the sound.

```
[15] # Calculate the Spectral Centroids
spectral_centroids = librosa.feature.spectral_centroid(y=audio_file, sr=sr)[0]

# Shape is a vector
print('Centroids:', spectral_centroids, '\n')
print('Shape of Spectral Centroids:', spectral_centroids.shape, '\n')

# Computing the time variable for visualization
frames = range(len(spectral_centroids))

# Converts frame counts to time (seconds)
t = librosa.frames_to_time(frames)

print('frames:', frames, '\n')
print('t:', t)

# Function that normalizes the Sound Data
def normalize(x, axis=0):
    return sklearn.preprocessing.minmax_scale(x, axis=axis)

Centroids: [1758.29476432 1946.74243678 2038.8113414 ... 766.50416352 1041.07728901
1391.05145642]

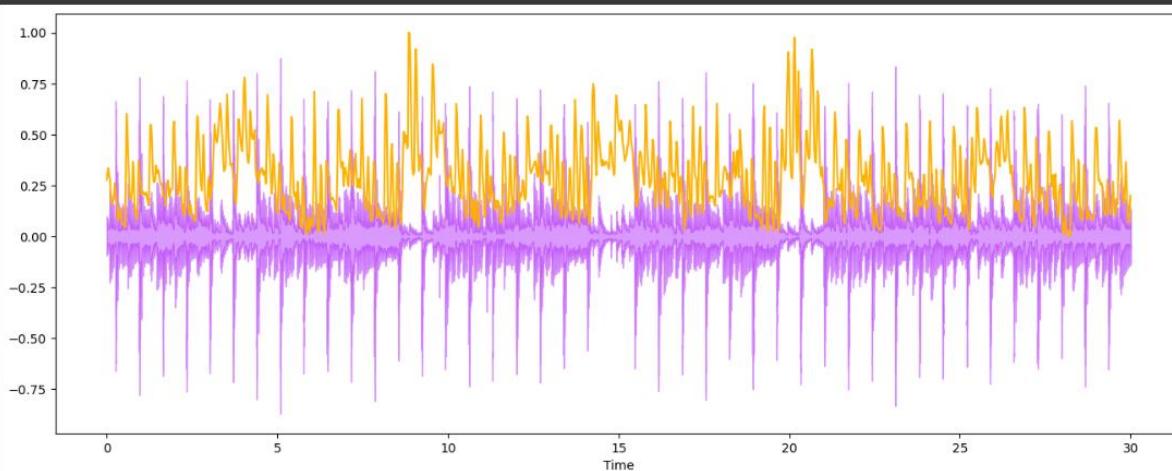
Shape of Spectral Centroids: (1293,)

frames: range(0, 1293)

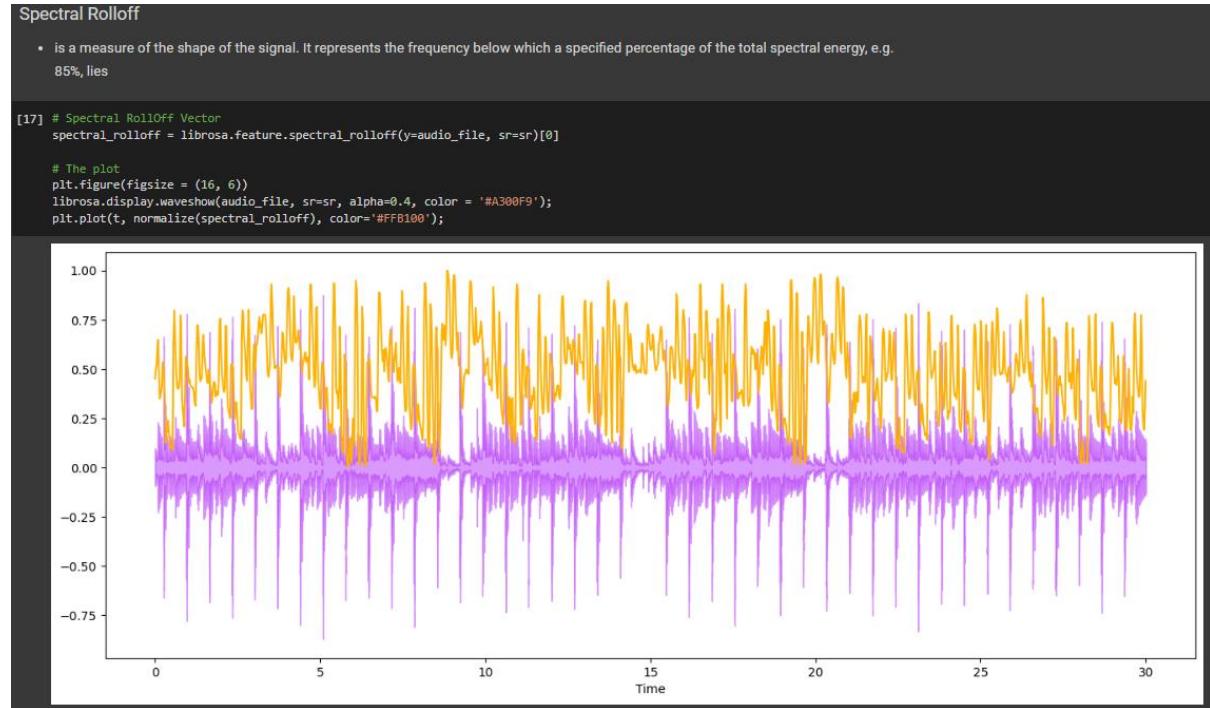
t: [0.00000000e+00 3.2199546e-02 4.64399093e-02 ... 2.99537415e+01
2.99769615e+01 3.00001814e+01]
```

The weighted average of the frequencies presents in a sound stream, where the weighting factor is the strength or magnitude of each frequency component, is known as the spectral centroid. It serves as the spectrum's centre frequency and is an important characteristic for determining the brightness and timbre of a sound while it is often used in music information retrieval to classify music by genre, mood, or other characteristics. Hence, the figure above shows the way to extract this feature from an audio file.

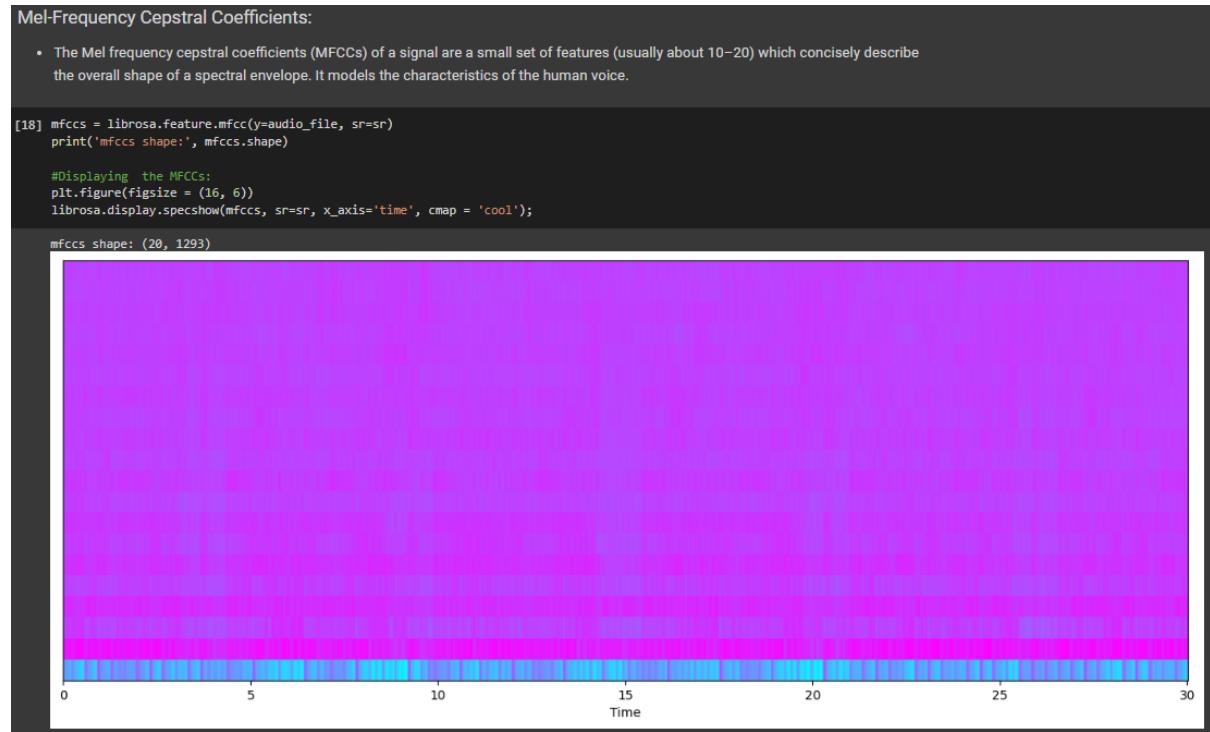
```
#Plotting the Spectral Centroid along the waveform
plt.figure(figsize = (16, 6))
librosa.display.waveform(audio_file, sr=sr, alpha=0.4, color = '#A300F9');
plt.plot(t, normalize(spectral_centroids), color='#FFB100');
```



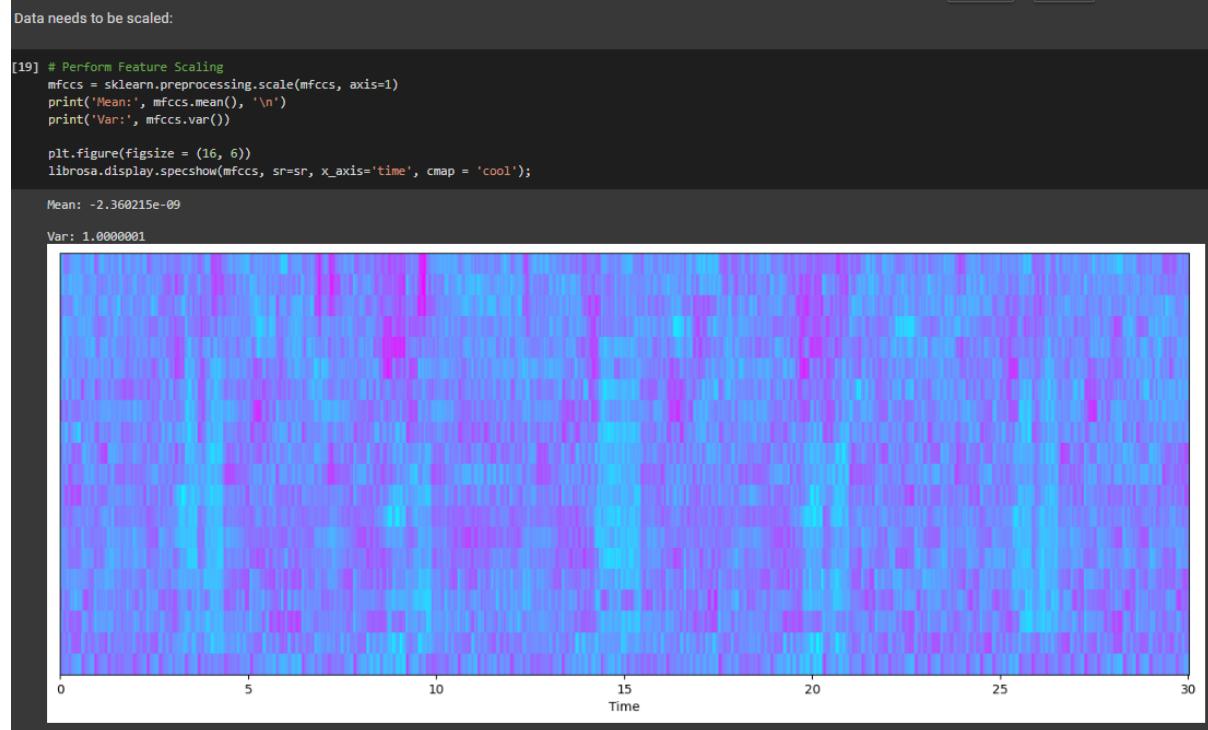
The data is then displayed on a plot shown as figure above for better understanding on the spectral centroid represent for an audio file.



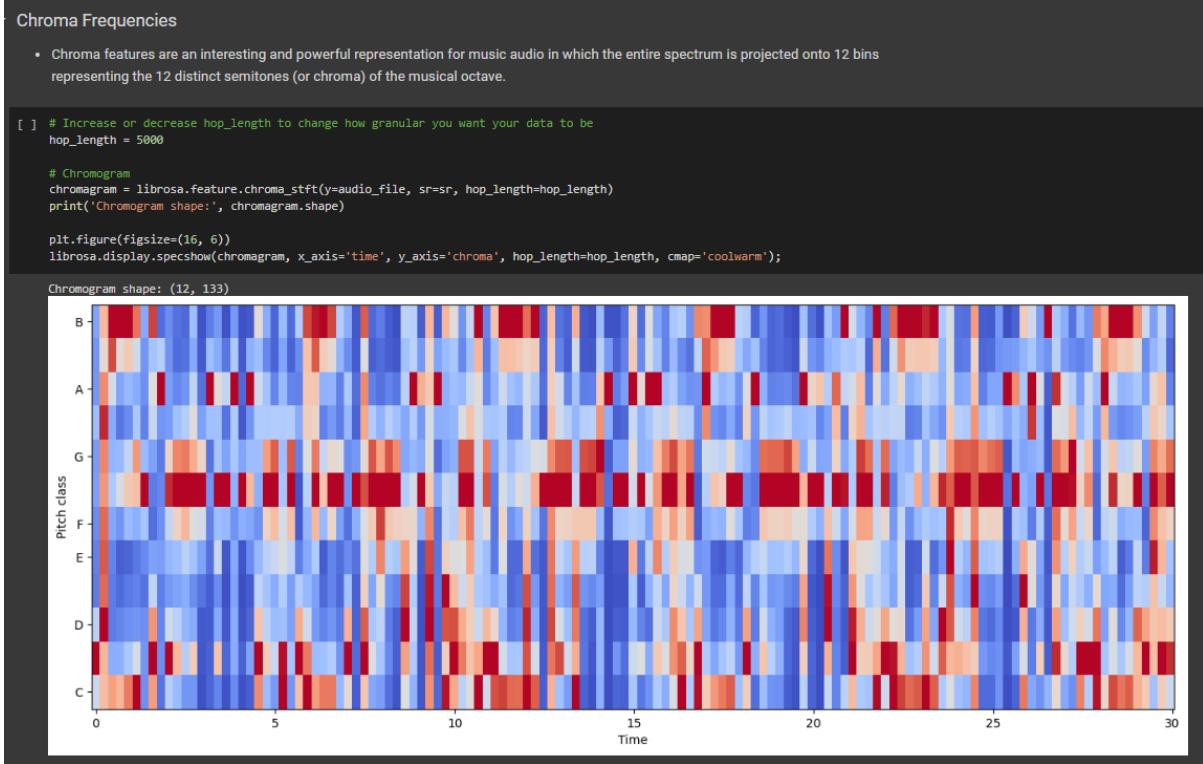
The frequency below which a specific portion of the total energy in the power spectrum of a sound source is concentrated is known as the Spectral Rolloff. It might be compared to the region of the frequency spectrum where energy levels start to decline and is a useful feature for characterizing the spectral shape of a sound signal. Hence, the figure above shows the way to extract this feature from an audio file and display it on a plot.



Mel-Frequency Cepstral Coefficients are a popular feature extraction method in voice recognition and digital signal processing. They are based on the Mel scale, which, in comparison to the linear frequency scale, is a perceptual scale of frequency that is more closely tied to how people perceive sound. Hence, the figure above shows the way to extract this feature from an audio file and display it on a plot.



Obviously, the first figure for Mel-Frequency Cepstral Coefficients is not showing any thing that significant to study because there is no specific axis that chosen to be displayed on the plot. Hence, the figure above shows the way to extract axis 1 Mel-Frequency Cepstral Coefficients of from an audio file and display it on a plot as well as the mean and var of the data.



Chroma Frequencies are a group of features used in music information retrieval and audio processing to accurately and musically represent the pitch content of a sound stream. They are built around the concept of projecting the 12 notes of the Western musical scale onto a circular chromatic scale, which is arranged like a piano keyboard. Hence, the figure above shows this feature from an audio file and display it on a plot.

EDA

EDA is going to be performed on the `features_30_sec.csv`. This file contains the mean and variance for each audio file to the features analysed above.

So, the table has a final of 1000 rows (10 genres x 100 audio files) and 60 features (dimensionalities).

```
[21]: data = pd.read_csv('general_pdb/features_30_sec.csv')
data.head()
```

	filename	length	chroma_stft_mean	chroma_stft_var	rms_mean	rms_var	spectral_centroid_mean	spectral_centroid_var	spectral_bandwidth_mean	spectral_bandwidth_var	...	mfcc11_mean	mfcc11_var	mfcc12_mean	mfcc12_var	mfcc13_mean	mfcc13_var	mfcc14_mean	mfcc14_var	mfcc15_mean	mfcc15_var	mfcc16_mean	mfcc16_var	mfcc17_mean	mfcc17_var	mfcc18_mean	mfcc18_var	mfcc19_mean	mfcc19_var	mfcc20_mean	mfcc20_var
0	blues_00000.wav	661794	0.350088	0.088757	0.102028	0.002327	1784.168590	129774.064525	2002.449060	35882.761315	...	52.420910	-1.690215	36.524071	-0.488979	41.597103	-2.303523	55.962623	1.22121	46											
1	blues_00001.wav	661794	0.340914	0.084980	0.095948	0.002373	1530.178679	375850.073649	2039.036516	213843.755497	...	55.364003	-0.731125	60.314529	0.295073	48.120598	-0.283518	51.106190	0.53121	45											
2	blues_00002.wav	661794	0.363637	0.085275	0.175570	0.002746	1552.811995	156467.043368	1747.702312	76254.192257	...	40.980766	-7.729993	47.839427	-1.816407	52.382141	-3.439720	46.639660	-2.231250	30											
3	blues_00003.wav	661794	0.404785	0.083999	0.141093	0.006346	1070.106615	184355.942417	1560.412872	166441.494769	...	44.427753	-3.319597	50.206673	0.636965	37.319130	-0.619121	37.299739	-0.407448	31											
4	blues_00004.wav	661794	0.388526	0.087841	0.091529	0.002303	1835.004266	343399.939274	1748.172116	88445.209036	...	86.099236	-5.454034	75.269707	-0.816874	53.613918	-4.404827	62.910812	-11.703234	55											

5 rows × 80 columns

In order to obtain insights and find patterns, anomalies, correlations, and potential problems, a technique known as Exploratory Data Analysis analyses and summarises data sets. Usually, it is carried out prior to more formal statistical or machine learning analysis. Hence, figure above shows that the excel file of 30 seconds of audio feature from the dataset was chosen to explore the dataset.

Correlation Heatmap for feature means

```
[22] # Computing the Correlation Matrix
spike_cols = [col for col in data.columns if 'mean' in col]
corr = data[spike_cols].corr()

# Generate a mask for the upper triangle
mask = np.triu(np.ones_like(corr, dtype=np.bool))

# Set up the matplotlib figure
f, ax = plt.subplots(figsize=(16, 11));

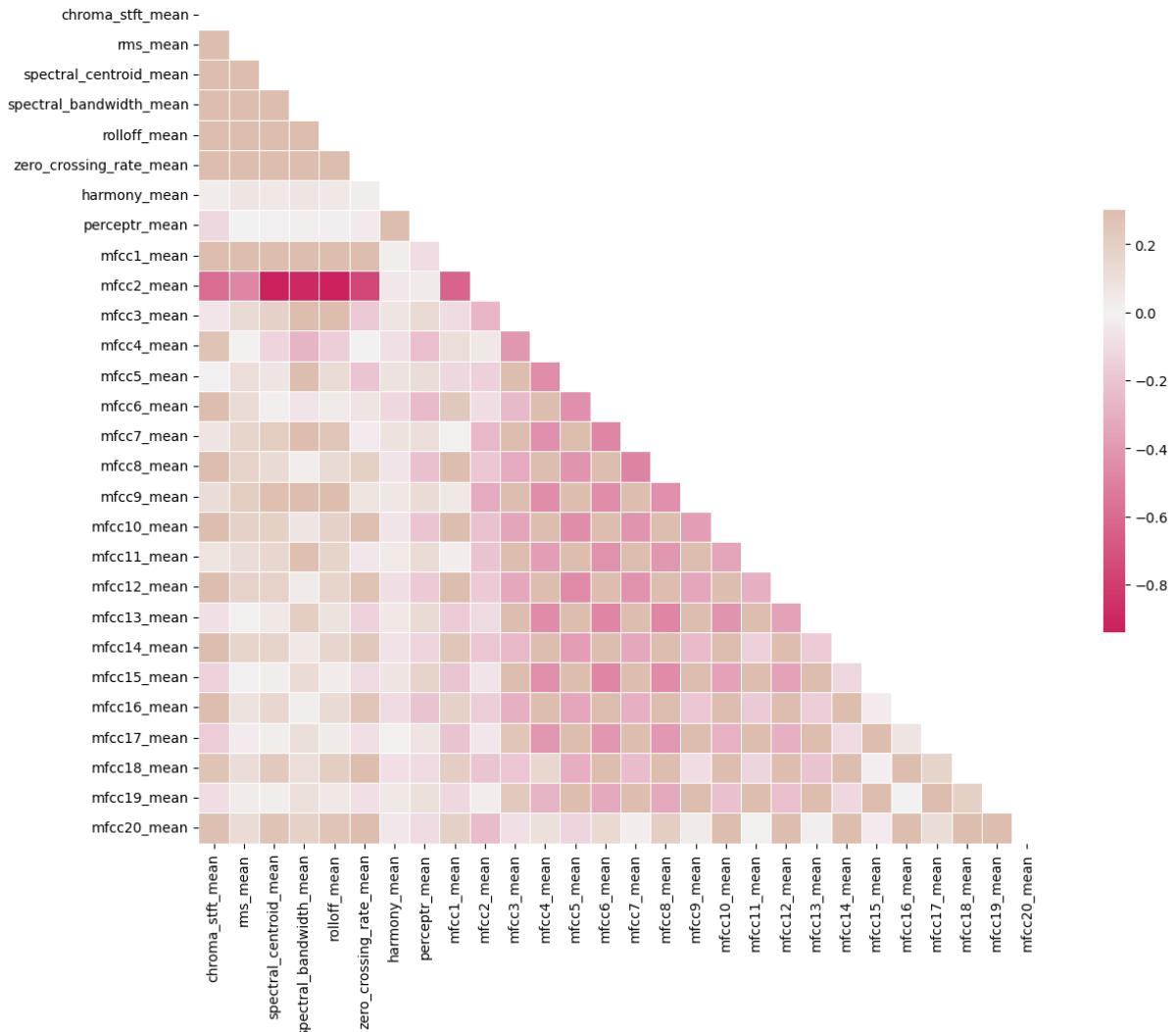
# Generate a custom diverging colormap
cmap = sns.diverging_palette(0, 25, as_cmap=True, s = 90, l = 45, n = 5)

# Draw the heatmap with the mask and correct aspect ratio
sns.heatmap(corr, mask=mask, cmap=cmap, vmax=.3, center=0,
            square=True, linewidths=.5, cbar_kws={"shrink": .5})

plt.title('Correlation Heatmap (for the MEAN variables)', fontsize = 25)
plt.xticks(fontsize = 10)
plt.yticks(fontsize = 10);
plt.savefig("Corr Heatmap.jpg")
```

A correlation heatmap shows the relationships between variables in a dataset graphically. It is frequently used to see the relationships between variables' strengths and directions, as well as to spot patterns and dependencies. Hence, figure above shows the way to plot a correlation heatmap, the axis 2 of Mel-Frequency Cepstral Coefficient shows that it has strong corelation to few other features from the heatmap while other features seem to have low corelation between each other. The heatmap is shown as figure below.

Correlation Heatmap (for the MEAN variables)



Box Plot for Genres Distributions

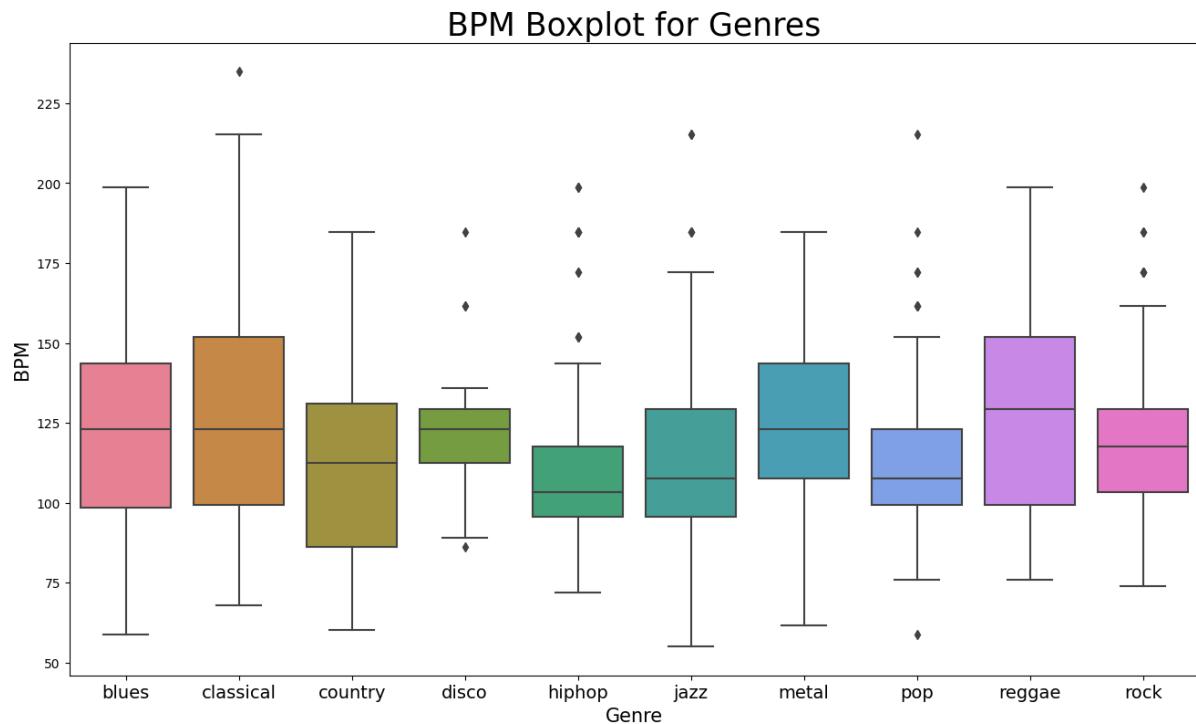
```
[23] x = data[["label", "tempo"]]

f, ax = plt.subplots(figsize=(16, 9));
sns.boxplot(x = "label", y = "tempo", data = x, palette = 'husl');

plt.title('BPM Boxplot for Genres', fontsize = 25)
plt.xticks(fontsize = 14)
plt.yticks(fontsize = 10);
plt.xlabel("Genre", fontsize = 15)
plt.ylabel("BPM", fontsize = 15)
plt.savefig("BPM_Boxplot.jpg")
```

As mentioned just now in this section, tempo can be significant to differentiate between genres. Therefore, to prove it and further study the relation between them, the boxplot method

has been use which shows as figure above to plot the boxplot out while figure below show the plot itself.



Principal Component Analysis - to visualize possible groups of genres

1. Normalization
2. PCA
3. The Scatter Plot

```
[24] from sklearn import preprocessing

data = data.iloc[:, 1:]
y = data['label']
X = data.loc[:, data.columns != 'label']

#### NORMALIZE X ####
cols = X.columns
min_max_scaler = preprocessing.MinMaxScaler()
np_scaled = min_max_scaler.fit_transform(X)
X = pd.DataFrame(np_scaled, columns = cols)

#### PCA 2 COMPONENTS ####
from sklearn.decomposition import PCA

pca = PCA(n_components=2)
principalComponents = pca.fit_transform(X)
principalDf = pd.DataFrame(data = principalComponents, columns = ['principal component 1', 'principal component 2'])

# concatenate with target label
finalDf = pd.concat([principalDf, y], axis = 1)

pca.explained_variance_ratio_

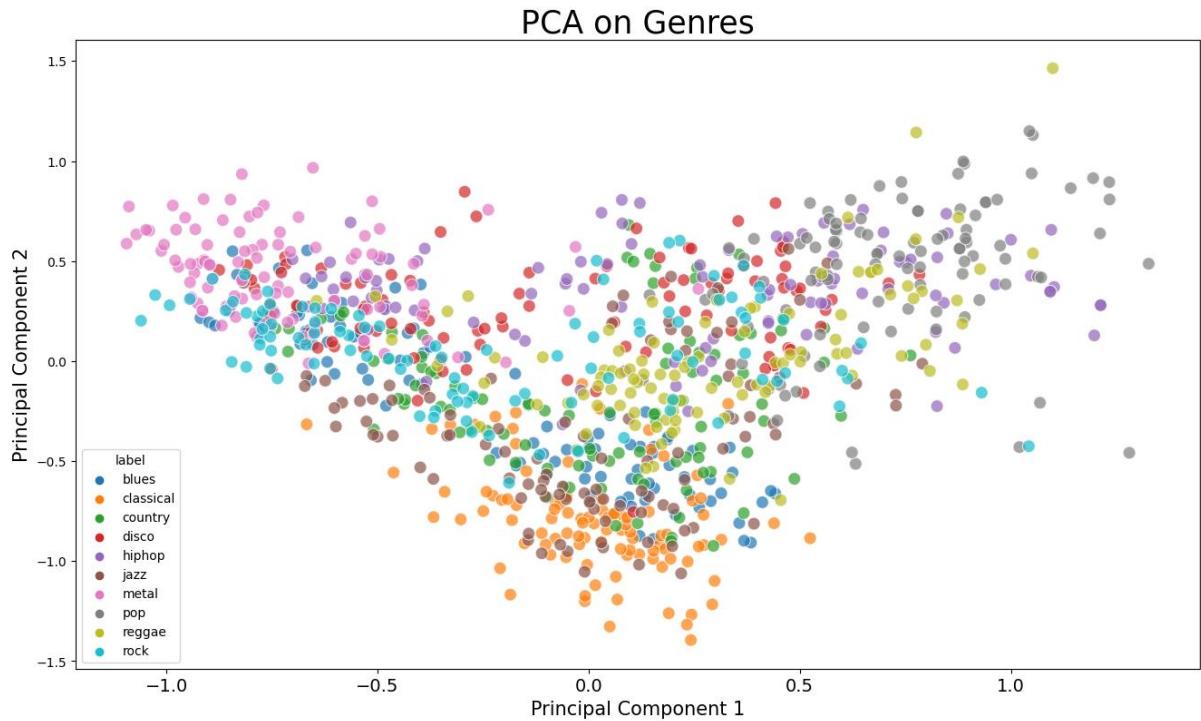
# 44.93 variance explained

array([0.2439355 , 0.21781804])
```

A statistical method called Principal Component Analysis reduces the dimensionality of a dataset by converting the original variables into a new collection of uncorrelated variables that are referred to as principal components, plotting the data points along the first two or three principal components allows one to see high-dimensional data in two or three dimensions. Hence, the way to get the data of Principal Component Analysis plot is shows as figure above while figure below shows the way to plot the graph and display out.

```
[25] plt.figure(figsize = (16, 9))
sns.scatterplot(x = "principal component 1", y = "principal component 2", data = finalDf, hue = "label", alpha = 0.7,
                 s = 100);

plt.title('PCA on Genres', fontsize = 25)
plt.xticks(fontsize = 14)
plt.yticks(fontsize = 10);
plt.xlabel("Principal Component 1", fontsize = 15)
plt.ylabel("Principal Component 2", fontsize = 15)
plt.savefig("PCA Scattert.jpg")
```



The plot shows that there are some groups that are significantly grouping together but some of the groups might have outliers that closer to another group making it might be confusing for the model when classifying.

9.1.2 Data Splitting

In this section, data splitting process will be explained with the screenshots of source code. It is a process to prepare data for train and test ready for the model training phase.

```
[26] from sklearn.naive_bayes import GaussianNB
    from sklearn.linear_model import SGDClassifier, LogisticRegression
    from sklearn.neighbors import KNeighborsClassifier
    from sklearn.tree import DecisionTreeClassifier
    from sklearn.ensemble import RandomForestClassifier
    from sklearn.svm import SVC
    from sklearn.neural_network import MLPClassifier
    from xgboost import XGBClassifier, XGBRFClassifier
    from xgboost import plot_tree, plot_importance

    from sklearn.metrics import confusion_matrix, accuracy_score, roc_auc_score, roc_curve
    from sklearn import preprocessing
    from sklearn.model_selection import train_test_split
    from sklearn.feature_selection import RFE
```

Firstly, libraries for the models that will be used in the model training process and also function that need to be used for data splitting will be imported.

Features and Target variable

- creates the target and feature variables
- normalizes the data

```
[28] y = data['label'] # genre variable.
    X = data.loc[:, data.columns != 'label'] #select all columns but not the labels

    ##### NORMALIZE X #####
    # Normalize so everything is on the same scale.

    cols = X.columns
    min_max_scaler = preprocessing.MinMaxScaler()
    np_scaled = min_max_scaler.fit_transform(X)

    # new data frame with the new scaled data.
    X = pd.DataFrame(np_scaled, columns = cols)
```

Figure above shows the process of getting the x(audio feature) and y(genre label) from the dataset and normalise the features to a same scale to be ready for training and testing usage.

```
[29] X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)
```

Figure above shows the source code for splitting x and y to train and test data in the ratio of 70% train data and 30% test data, a random state is given to the function to always get the same way of splitting for consistent result each time executing the source code.

```
[30] def model_assess(model, title = "Default"):
        model.fit(X_train, y_train)
        preds = model.predict(X_test)
        #print(confusion_matrix(y_test, preds))
        print('Accuracy', title, ':', round(accuracy_score(y_test, preds), 5), '\n')
```

Figure above shows the declaration of a function that can be used by every type of machine learning algorithm to predict a genre for the test data and print out the score for the accuracy. This function will be used on the model training process.

9.1.3 Model Training and Selection

In model training process, the dataset of 3 seconds features will be used by multiple machine learning algorithm to be compared by the developer to select out the best model out of them by the score of the accuracy.

	length	chroma_stft_mean	chroma_stft_var	rms_mean	rms_var	spectral_centroid_mean	spectral_centroid_var	spectral_bandwidth_mean	spectral_bandwidth_var	rolloff_mean	...	mfcc6_mean	mfcc7_mean	mfcc17_var	mfcc18_mean	mfcc19_var	mfcc19_mean
0	66149	0.335406	0.091048	0.130405	0.003521	1773.065032	167541.630869	1972.744388	117335.771563	3714.560359	...	39.687145	-3.241280	36.488243	0.722209	38.099152	-5.9503
1	66149	0.343065	0.086147	0.112699	0.001450	1816.693777	90525.690866	2010.051501	65671.875673	3069.682242	...	64.748276	-6.055294	40.677654	0.159615	51.264091	-2.8376
2	66149	0.346815	0.092243	0.132003	0.004620	1788.539719	111407.437613	2084.565132	75124.921746	3997.639160	...	67.336563	-1.768610	28.348579	2.378768	45.717648	-1.9384
3	66149	0.363639	0.086856	0.132565	0.002448	1655.289045	111952.284517	1960.039968	82913.639269	3568.300218	...	47.739452	-3.841155	28.337118	1.218588	34.770935	-3.5803
4	66149	0.335579	0.088129	0.143289	0.001701	1630.656199	79667.267654	1948.503884	60204.020268	3469.992864	...	30.336359	0.664582	45.880913	1.689446	51.363583	-3.3924

5 rows × 59 columns

Figure above shows the import of the dataset and display it out.

```
[ ] # Naive Bayes
nb = GaussianNB()
model_assess(nb, "Naive Bayes")

# Stochastic Gradient Descent
sgd = SGDClassifier(max_iter=5000, random_state=0)
model_assess(sgd, "Stochastic Gradient Descent")

# KNN
knn = KNeighborsClassifier(n_neighbors=19)
model_assess(knn, "KNN")

# Decision trees
tree = DecisionTreeClassifier()
model_assess(tree, "Decision trees")

# Random Forest
rforest = RandomForestClassifier(n_estimators=1000, max_depth=10, random_state=0)
model_assess(rforest, "Random Forest")

# Support Vector Machine
svm = SVC(decision_function_shape="ovo")
model_assess(svm, "Support Vector Machine")

# Logistic Regression
lg = LogisticRegression(random_state=0, solver='lbfgs', multi_class='multinomial')
model_assess(lg, "Logistic Regression")

# Neural Nets
nn = MLPClassifier(solver='lbfgs', alpha=1e-5, hidden_layer_sizes=(5000, 10), random_state=1)
model_assess(nn, "Neural Nets")

from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y_train_le = le.fit_transform(y_train)
y_test_le = le.fit_transform(y_test)

# Cross Gradient Booster
xgb = XGBClassifier(n_estimators=1000, learning_rate=0.05)
xgb.fit(X_train, y_train_le)
preds = xgb.predict(X_test)
#print(confusion_matrix(y_test, preds))
print('Accuracy', "Cross Gradient Booster", ':', round(accuracy_score(y_test_le, preds), 5), '\n')

# Cross Gradient Booster (Random Forest)
xgbrf = XGBRFClassifier(objective= 'multi:softmax')
xgbrf.fit(X_train, y_train_le)
preds = xgbrf.predict(X_test)
#print(confusion_matrix(y_test, preds))
print('Accuracy', "Cross Gradient Booster (Random Forest)", ':', round(accuracy_score(y_test_le, preds), 5), '\n')
```

Figure above shows the model training and testing for every algorithm. Label is encoded for the Cross Gradient Booster model for encoding properly for the y data.

```

    □ Accuracy Naive Bayes : 0.51952
    Accuracy Stochastic Gradient Descent : 0.65532
    Accuracy KNN : 0.80581
    Accuracy Decission trees : 0.63964
    Accuracy Random Forest : 0.81415
    Accuracy Support Vector Machine : 0.75409
    Accuracy Logistic Regression : 0.6977
    Accuracy Neural Nets : 0.67835
    Accuracy Cross Gradient Booster : 0.9009
    Accuracy Cross Gradient Booster (Random Forest) : 0.74575

```

Figure above shows the accuracy result output for all the model and the highest accuracy score is by the Cross Gradient Booster which is 90.09%. Hence, the model will be chosen for the genre classification function in the system.

```

[31] # Final model
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y_train_le = le.fit_transform(y_train)
y_test_le = le.fit_transform(y_test)

xgb = XGBClassifier(n_estimators=1000, learning_rate=0.05)
xgb.fit(X_train, y_train_le)
preds = xgb.predict(X_test)
#print(confusion_matrix(y_test, preds))
print('Accuracy', ':', round(accuracy_score(y_test_le, preds), 5), '\n')

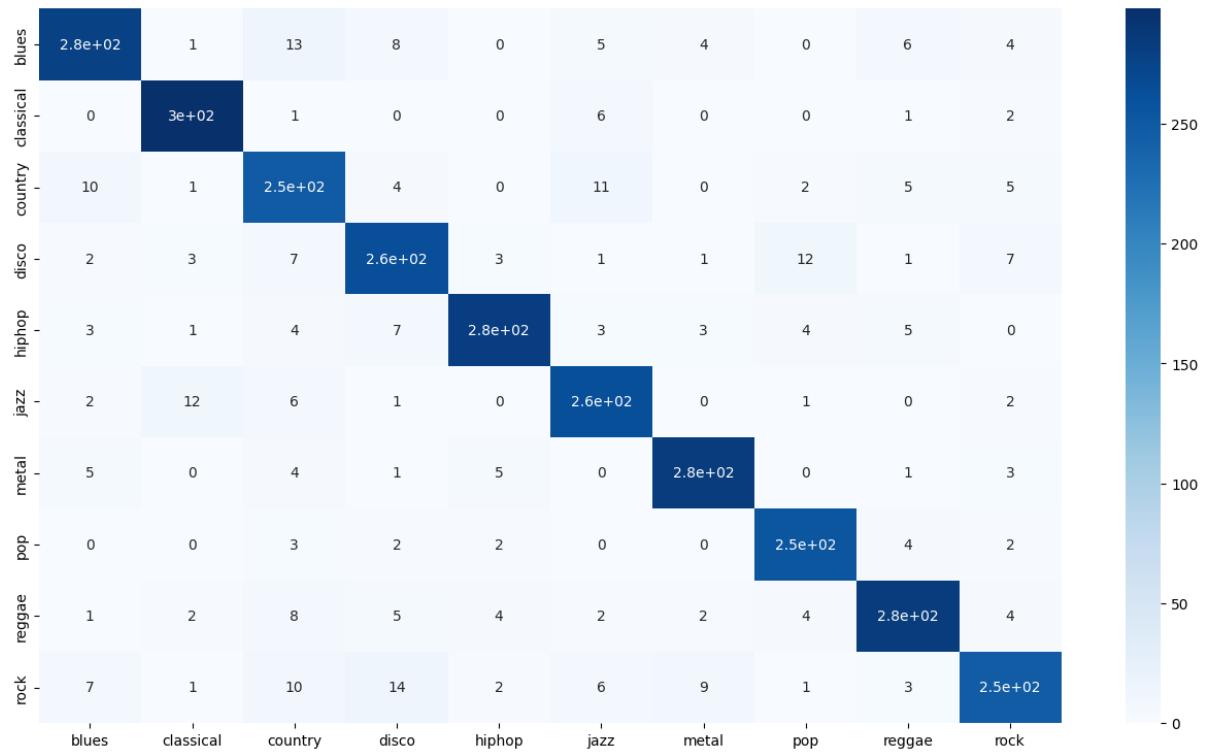
# Confusion Matrix
confusion_matr = confusion_matrix(y_test_le, preds) #normalize = 'true'
plt.figure(figsize = (16, 9))
sns.heatmap(confusion_matr, cmap="Blues", annot=True,
            xticklabels = ["blues", "classical", "country", "disco", "hiphop", "jazz", "metal", "pop", "reggae", "rock"],
            yticklabels=[ "blues", "classical", "country", "disco", "hiphop", "jazz", "metal", "pop", "reggae", "rock"]);
plt.savefig("conf matrix")

import joblib
filename = "trained_genre_model.joblib"
joblib.dump(xgb, filename)

Accuracy : 0.9009
['trained_genre_model.joblib']

```

To summarise the final model, figure above shows the source code for calculating the accuracy score, exporting the model as a joblib file and confusion matrix to display where the remaining accuracy percentage go (wrong predictions) as shown as figure below.



From the confusion matrix, it shows that classical music will be predicted correctly in the highest chances among other genres.

Feature Importance

```
[ ] featureimp = xgb.feature_importances_
print(max(featureimp))
features = list(X_test.columns)
i = 0
featuresimp = []
for feature in features:
    featuresimp[0][i] = feature

    print(feature + " : " + str(featureimp[i]))
    i=i+1
```

To determine the importance of the features, the value has been calculated by the source code shown as figure above.

```
0.077804394
length : 0.0
chroma_stft_mean : 0.039776483
chroma_stft_var : 0.03305271
rms_mean : 0.017231159
rms_var : 0.025998192
spectral_centroid_mean : 0.025510374
spectral_centroid_var : 0.018350953
spectral_bandwidth_mean : 0.06312611
spectral_bandwidth_var : 0.010036608
rolloff_mean : 0.028533503
rolloff_var : 0.028012201
zero_crossing_rate_mean : 0.01707093
zero_crossing_rate_var : 0.0064032776
harmony_mean : 0.019954279
harmony_var : 0.02897413
perceptr_mean : 0.01927809
perceptr_var : 0.077804394
tempo : 0.019557714
mfcc1_mean : 0.025685623
mfcc1_var : 0.029625462
mfcc2_mean : 0.013357366
mfcc2_var : 0.008249055
mfcc3_mean : 0.014304628
mfcc3_var : 0.019440422
mfcc4_mean : 0.038215935
mfcc4_var : 0.013036821
mfcc5_mean : 0.0147100985
mfcc5_var : 0.021140585
mfcc6_mean : 0.020626167
mfcc6_var : 0.01349897
mfcc7_mean : 0.012621708
mfcc7_var : 0.020622566
mfcc8_mean : 0.013133483
mfcc8_var : 0.012003808
mfcc9_mean : 0.01878312
mfcc9_var : 0.010101349
mfcc10_mean : 0.007816278
mfcc10_var : 0.013865611
mfcc11_mean : 0.014582151
mfcc11_var : 0.0064847744
mfcc12_mean : 0.018242775
mfcc12_var : 0.008965662
mfcc13_mean : 0.012724192
mfcc13_var : 0.009176425
mfcc14_mean : 0.008275815
mfcc14_var : 0.0048733396
mfcc15_mean : 0.008419079
mfcc15_var : 0.0051811514
mfcc16_mean : 0.007831324
mfcc16_var : 0.0069849617
mfcc17_mean : 0.010965102
mfcc17_var : 0.006566104
mfcc18_mean : 0.01095284
mfcc18_var : 0.008146166
mfcc19_mean : 0.0062981662
mfcc19_var : 0.013165049
mfcc20_mean : 0.009229783
```

mfcc20_var : 0.011425116

The highest importance among all the features is the variance of percept which mean it must be include by the model for accurate prediction while length in the audio data is useless for the prediction since every audio is 3 seconds in this dataset.

9.2 Screenshots for UI implementation

This section shows the actual look for the UI implementation for the system as well as the HTML code for to achieve the design.

9.2.1 Screenshot for theme design (style.css)

```
style.css
1  * {
2    box-sizing: border-box;
3    font-family: -apple-system, BlinkMacSystemFont, "segoe ui", roboto, oxygen, ubuntu, cantarell,
4    "fira sans", "droid sans", "helvetica neue", Arial, sans-serif;
5    font-size: 16px;
6    -webkit-font-smoothing: antialiased;
7    -moz-osx-font-smoothing: grayscale;
8  }
9  body {
10   background-color: #435165;
11   margin: 0;
12 }
13 .login, .register {
14   width: 400px;
15   background-color: #ffffff;
16   box-shadow: 0 0 9px 0 rgba(0, 0, 0, 0.3);
17   margin: 100px auto;
18 }
19 .login h1, .register h1 {
20   text-align: center;
21   color: #5b6574;
22   font-size: 24px;
23   padding: 20px 0 20px 0;
24   border-bottom: 1px solid #dee0e4;
25 }
26 .login .links, .register .links {
27   display: flex;
28   padding: 0 15px;
29 }
30 .login .links a, .register .links a {
31   color: #adb2ba;
32   text-decoration: none;
33   display: inline-flex;
34   padding: 0 10px 10px 0;
35   font-weight: bold;
36 }
37 .login .links a:hover, .register .links a:hover {
38   color: #9da3ac;
39 }
40 .login .links a.active, .register .links a.active {
41   border-bottom: 3px solid #3274d6;
42   color: #3274d6;
43 }
44 .login form, .register form {
45   display: flex;
46   flex-wrap: wrap;
47   justify-content: center;
48   padding-top: 20px;
49 }
50 .login form label, .register form label {
51   display: flex;
52   justify-content: center;
53   align-items: center;
54   width: 50px;
55   height: 50px;
56   background-color: #3274d6;
57   color: #ffffff;
58 }
```

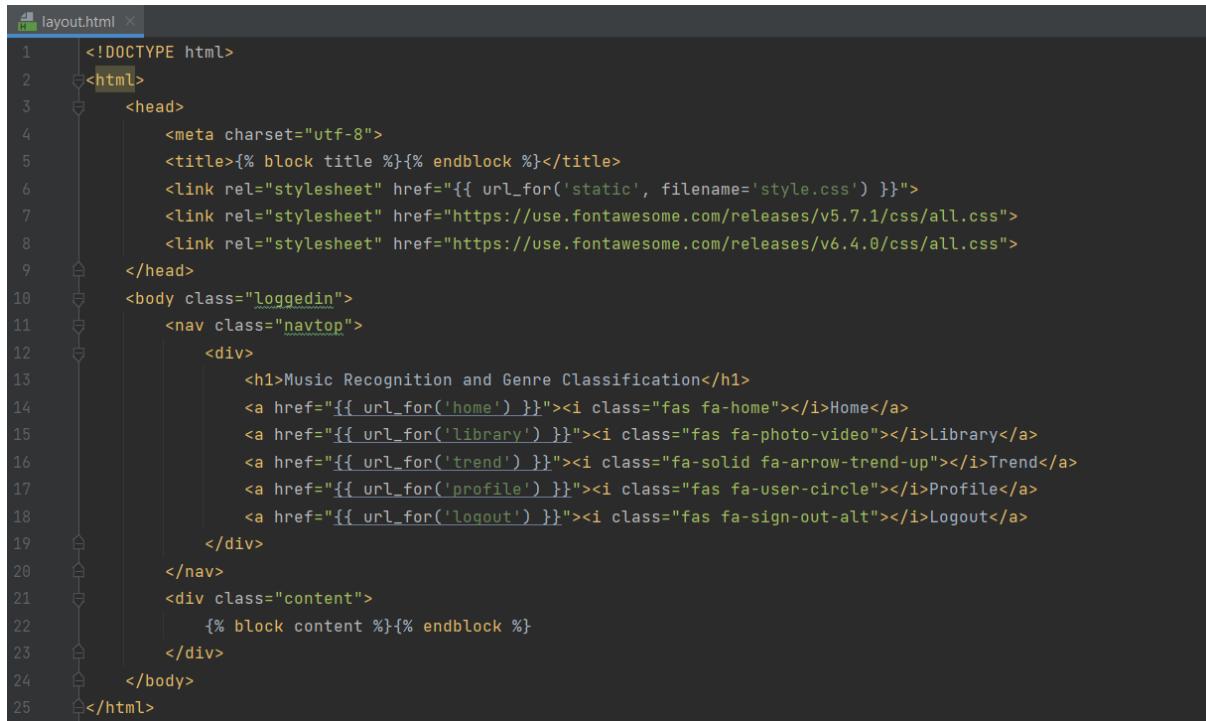
```
59     .login form input[type="password"], .login form input[type="text"], .login form input[type="email"],
60     .register form input[type="password"], .register form input[type="text"], .register form input[type="email"] {
61         width: 310px;
62         height: 50px;
63         border: 1px solid #dee0e4;
64         margin-bottom: 20px;
65         padding: 0 15px;
66     }
67     .login form input[type="submit"], .register form input[type="submit"], .content > div form input[type="submit"],
68     .content > div a{
69         width: 100%;
70         padding: 15px;
71         margin-top: 20px;
72         background-color: #3274d6;
73         border: 0;
74         cursor: pointer;
75         font-weight: bold;
76         color: #ffffff;
77         transition: background-color 0.2s;
78     }
79     .login form input[type="submit"]:hover, .register form input[type="submit"]:hover,
80     .content > div form input[type="submit"]:hover, .content > div a:hover{
81         background-color: #2868c7;
82         transition: background-color 0.2s;
83     }
84     .navtop {
85         background-color: #2f3947;
86         height: 60px;
87         width: 100%;
88         border: 0;
89     }
```

```
90     .navtop div {
91         display: flex;
92         margin: 0 auto;
93         width: 1000px;
94         height: 100%;
95     }
96     .navtop div h1, .navtop div a {
97         display: inline-flex;
98         align-items: center;
99     }
100    .navtop div h1 {
101        flex: 1;
102        font-size: 22px;
103        padding: 0;
104        margin: 0;
105        color: #eaebed;
106        font-weight: normal;
107    }
108    .navtop div a {
109        padding: 0 20px;
110        text-decoration: none;
111        color: #c1c4c8;
112        font-weight: bold;
113    }
114    .navtop div a i {
115        padding: 2px 8px 0 0;
116    }
117    .navtop div a:hover {
118        color: #eaebed;
119    }
```

```
120   body.loggedin {
121     background-color: #f3f4f7;
122   }
123   .content {
124     width: 1000px;
125     margin: 0 auto;
126   }
127   .content h2 {
128     margin: 0;
129     padding: 25px 0;
130     font-size: 22px;
131     border-bottom: 1px solid #e0e0e3;
132     color: #4a536e;
133   }
134   .content > p, .content > div {
135     box-shadow: 0 0 5px 0 rgba(0, 0, 0, 0.1);
136     margin: 25px 0;
137     padding: 25px;
138     background-color: #fff;
139   }
140   .content > p table td, .content > div table td {
141     padding: 5px;
142   }
143   .content > p table td:first-child, .content > div table td:first-child {
144     font-weight: bold;
145     color: #4a536e;
146     padding-right: 15px;
147   }
148   .content > div p, .content > form select {
149     padding: 5px;
150     margin: 0 0 10px 0;
151   }
152
153   .content > div form select {
154     width: 100%;
155     padding: 15px;
156     margin-top: 20px;
157     border-style: solid;
158     cursor: pointer;
159     font-weight: bold;
160   }
```

Figure above is the css file for the system which is the theme design that will be used by every element of HTML in the system, so that the visual of the web application will be consistent in term of colour and design for the users.

9.2.2 Screenshot for navigation bar (layout.html)

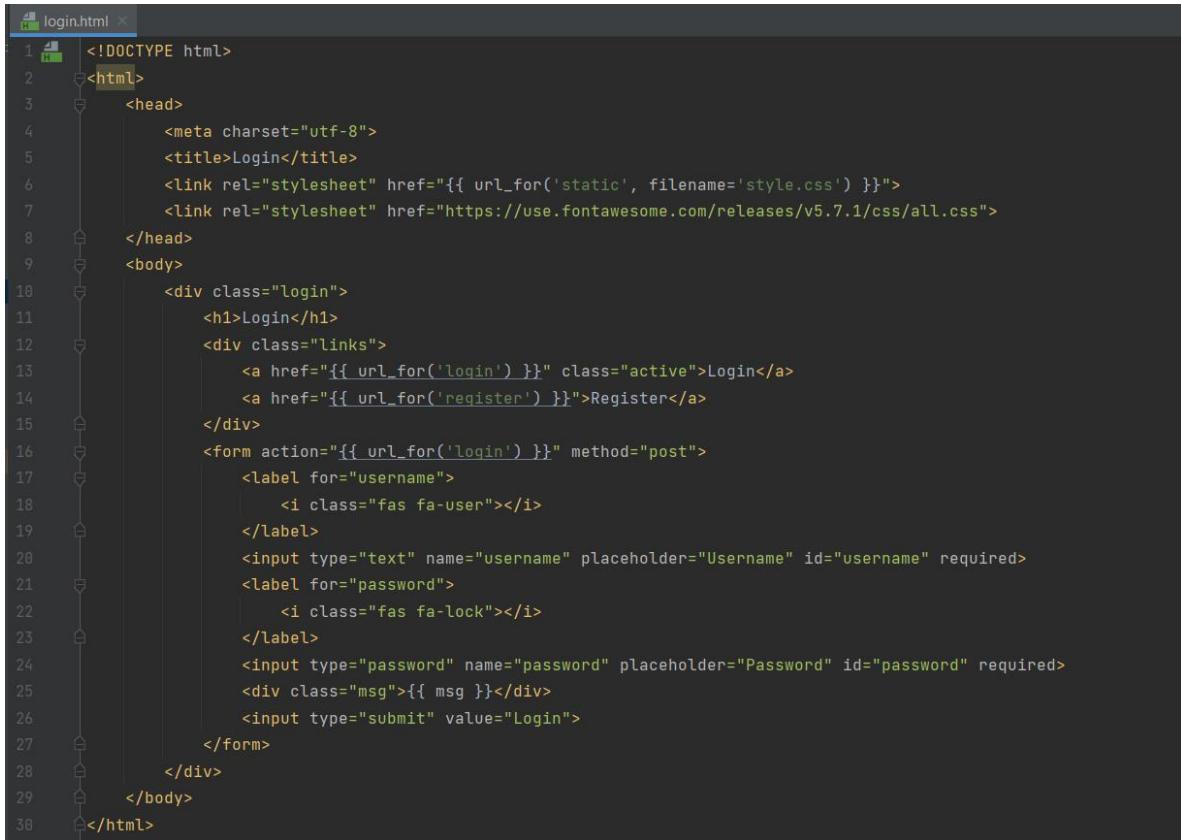


```
layout.html
1  <!DOCTYPE html>
2  <html>
3      <head>
4          <meta charset="utf-8">
5          <title>{% block title %}{% endblock %}</title>
6          <link rel="stylesheet" href="{{ url_for('static', filename='style.css') }}>
7          <link rel="stylesheet" href="https://use.fontawesome.com/releases/v5.7.1/css/all.css">
8          <link rel="stylesheet" href="https://use.fontawesome.com/releases/v6.4.0/css/all.css">
9      </head>
10     <body class="loggedin">
11         <nav class="navtop">
12             <div>
13                 <h1>Music Recognition and Genre Classification</h1>
14                 <a href="{{ url_for('home') }}><i class="fas fa-home"></i>Home</a>
15                 <a href="{{ url_for('library') }}><i class="fas fa-photo-video"></i>Library</a>
16                 <a href="{{ url_for('trend') }}><i class="fa-solid fa-arrow-trend-up"></i>Trend</a>
17                 <a href="{{ url_for('profile') }}><i class="fas fa-user-circle"></i>Profile</a>
18                 <a href="{{ url_for('logout') }}><i class="fas fa-sign-out-alt"></i>Logout</a>
19             </div>
20         </nav>
21         <div class="content">
22             {% block content %}{% endblock %}
23         </div>
24     </body>
25 </html>
```

Figure above shows the code for the navigation bar design, it will be displayed on every page after login by extending it on other HTML file and it can be used to navigate between each pages including home, library, trend, profile and logout.

9.2.3 Screenshot for login & logout page (login.html)

9.2.3.1 Description

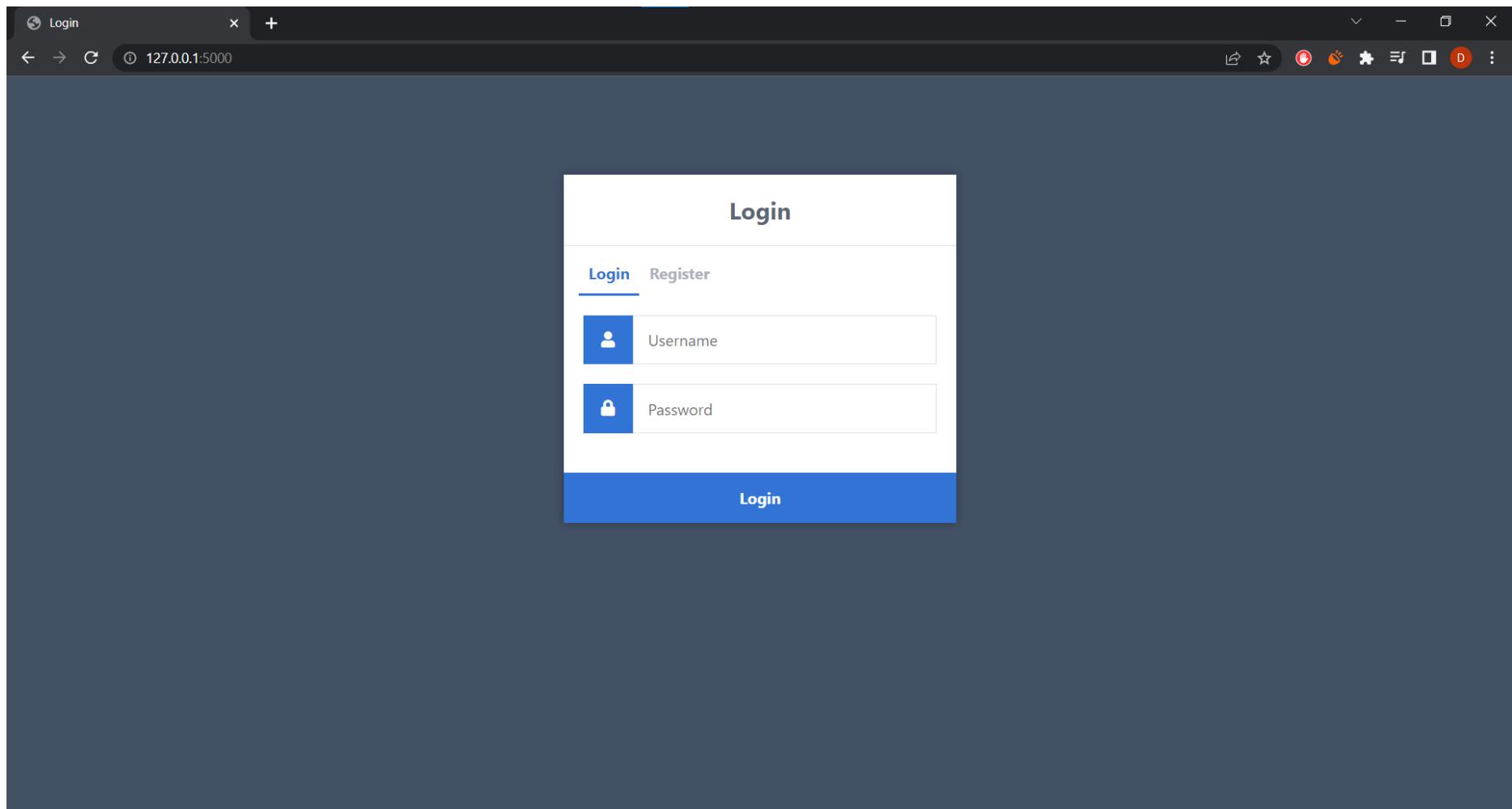


The screenshot shows a code editor window with the file 'login.html' open. The code is an HTML template for a login page. It includes a header with meta information and links to external stylesheets. The main content features a login form with fields for username and password, and a submit button. There is also a registration link and a message div.

```
<!DOCTYPE html>
<html>
    <head>
        <meta charset="utf-8">
        <title>Login</title>
        <link rel="stylesheet" href="{{ url_for('static', filename='style.css') }}>
        <link rel="stylesheet" href="https://use.fontawesome.com/releases/v5.7.1/css/all.css">
    </head>
    <body>
        <div class="login">
            <h1>Login</h1>
            <div class="links">
                <a href="{{ url_for('login') }}" class="active">Login</a>
                <a href="{{ url_for('register') }}>Register</a>
            </div>
            <form action="{{ url_for('login') }}" method="post">
                <label for="username">
                    <i class="fas fa-user"></i>
                </label>
                <input type="text" name="username" placeholder="Username" id="username" required>
                <label for="password">
                    <i class="fas fa-lock"></i>
                </label>
                <input type="password" name="password" placeholder="Password" id="password" required>
                <div class="msg">{{ msg }}</div>
                <input type="submit" value="Login">
            </form>
        </div>
    </body>
</html>
```

Figure above shows the design for login and logout pages where it will have two text input for both username and password to be filled, the user can then click the login button as a submit input to login to the system, any message such as account not found and logout message will be displayed under the second text input. Besides that, there is also a register page that can be accessed by pressing the register word.

9.2.3.2 Screenshot



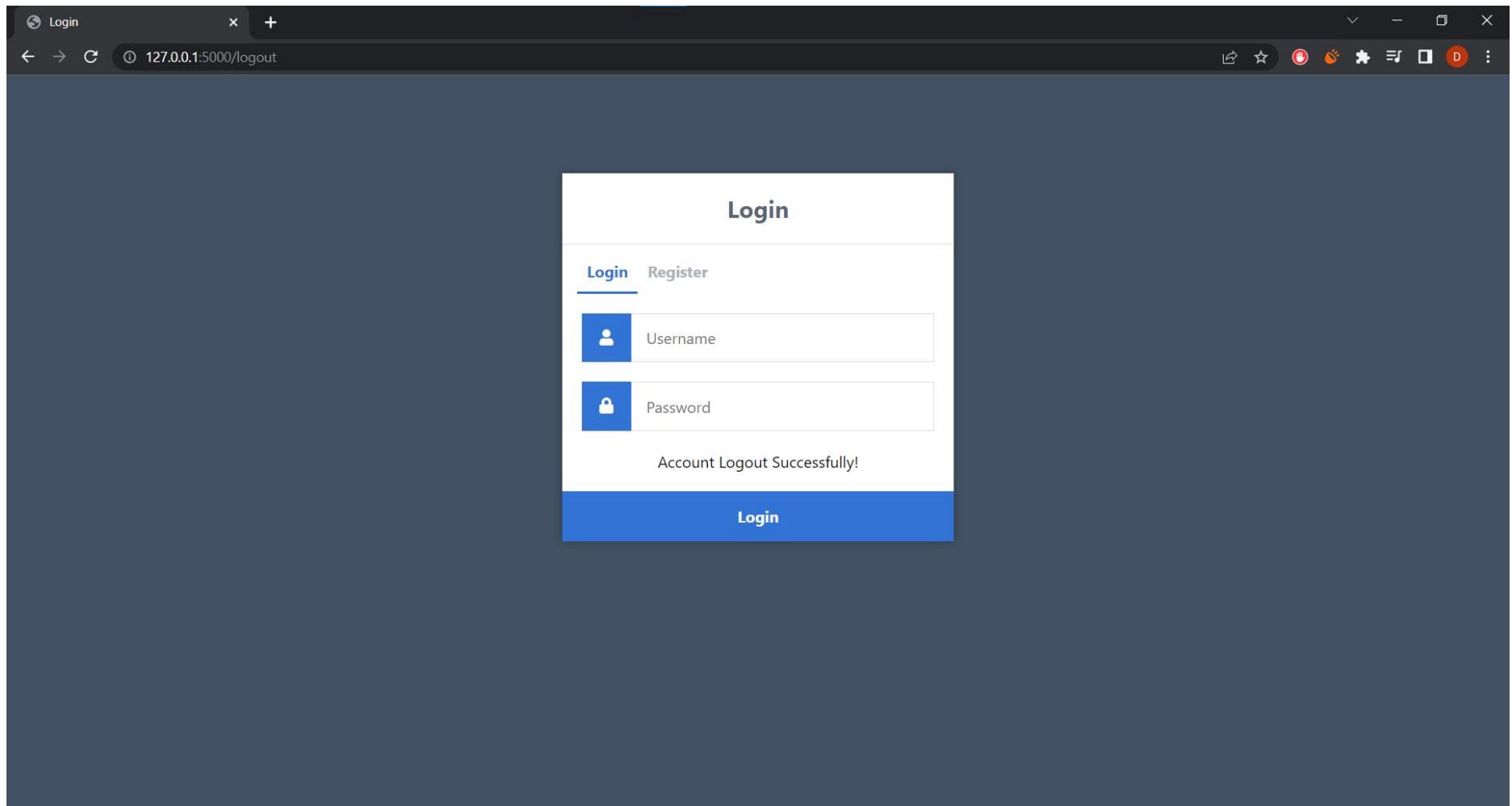
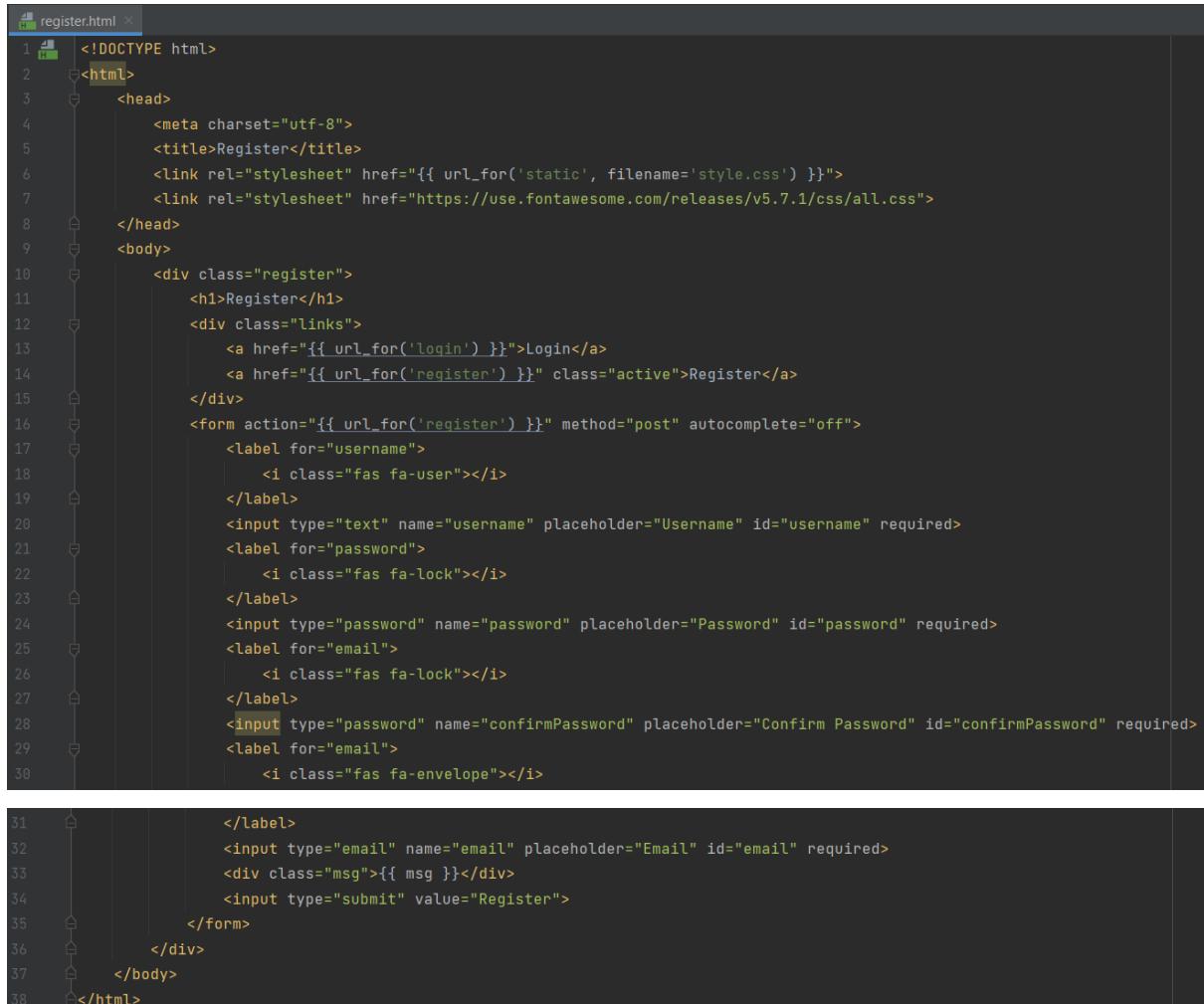


Figure above shows how the message will be displayed after logout.

9.2.4 Screenshot for register page (register.html)

9.2.4.1 Description

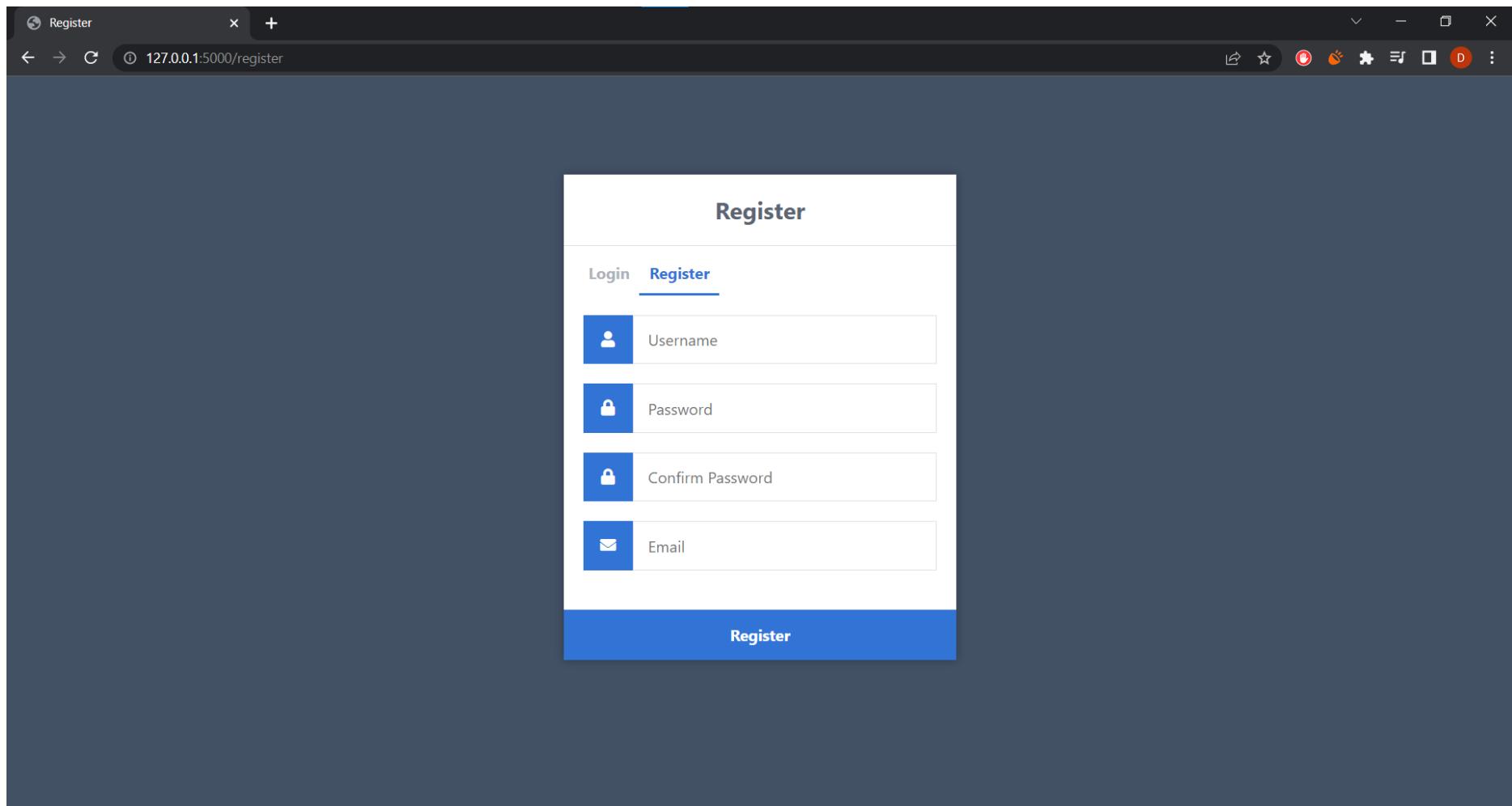


The screenshot shows the code editor interface with the file 'register.html' open. The code is an HTML form for user registration. It includes a title, CSS links, and a registration form with fields for username, password, confirm password, and email. A message div is also present.

```
<!DOCTYPE html>
<html>
    <head>
        <meta charset="utf-8">
        <title>Register</title>
        <link rel="stylesheet" href="{{ url_for('static', filename='style.css') }}>
        <link rel="stylesheet" href="https://use.fontawesome.com/releases/v5.7.1/css/all.css">
    </head>
    <body>
        <div class="register">
            <h1>Register</h1>
            <div class="links">
                <a href="{{ url_for('login') }}>Login</a>
                <a href="{{ url_for('register') }}" class="active">Register</a>
            </div>
            <form action="{{ url_for('register') }}" method="post" autocomplete="off">
                <label for="username">
                    <i class="fas fa-user"></i>
                </label>
                <input type="text" name="username" placeholder="Username" id="username" required>
                <label for="password">
                    <i class="fas fa-lock"></i>
                </label>
                <input type="password" name="password" placeholder="Password" id="password" required>
                <label for="email">
                    <i class="fas fa-lock"></i>
                </label>
                <input type="password" name="confirmPassword" placeholder="Confirm Password" id="confirmPassword" required>
                <label for="email">
                    <i class="fas fa-envelope"></i>
                </label>
                <input type="email" name="email" placeholder="Email" id="email" required>
                <div class="msg">{{ msg }}</div>
                <input type="submit" value="Register">
            </form>
        </div>
    </body>
</html>
```

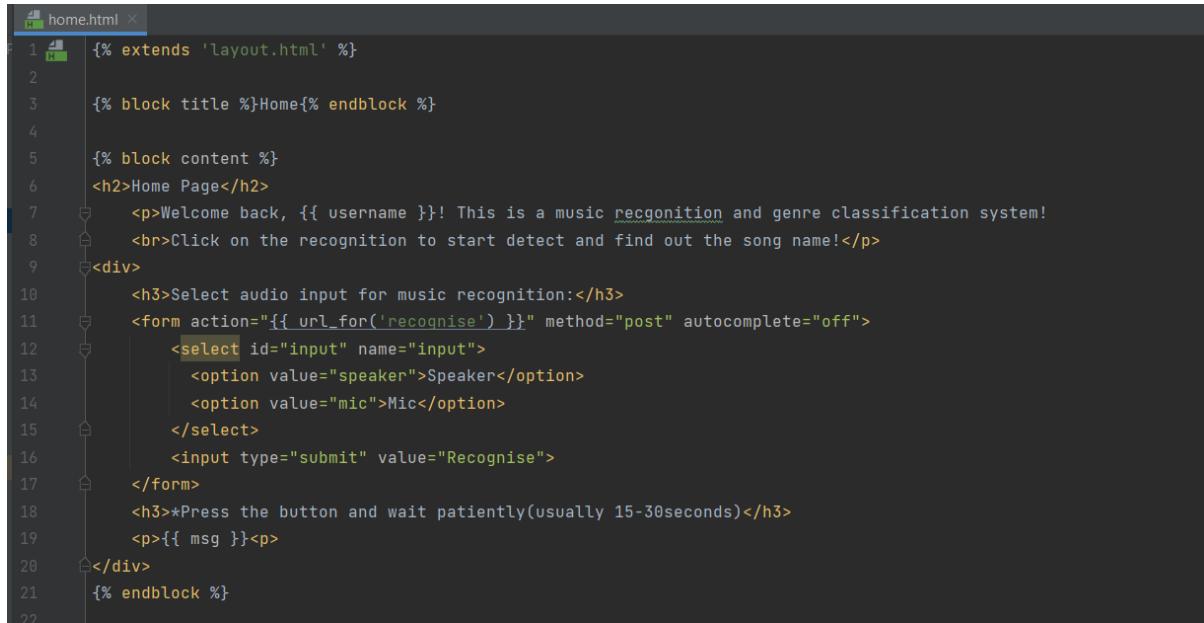
Figure above shows the design for register page where it will have four text input for the user to fill including username, password, confirm password and email, the user can then press the register button to submit those data to the system to register an account, any message such invalid input and account exists message will be displayed under the second text input. Besides that, there is also a login page that can be accessed by pressing the login word upon register.

9.2.4.2 Screenshot



9.2.5 Screenshots for home page (home.html)

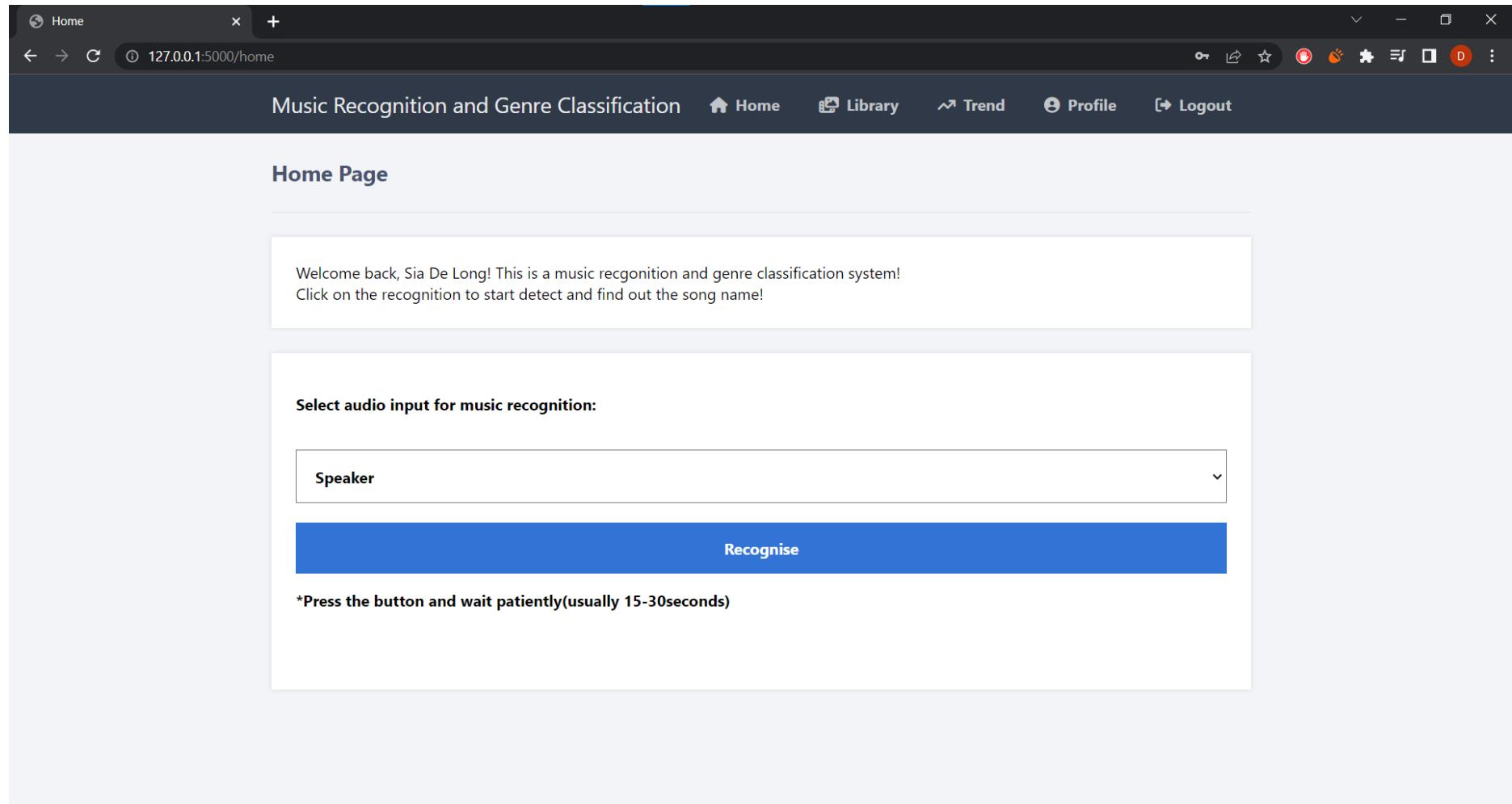
9.2.5.1 Description



```
1  {% extends 'layout.html' %} 
2
3  {% block title %}Home{% endblock %}
4
5  {% block content %}
6      <h2>Home Page</h2>
7      <p>Welcome back, {{ username }}! This is a music recognition and genre classification system!
8      <br>Click on the recognition to start detect and find out the song name!</p>
9      <div>
10         <h3>Select audio input for music recognition:</h3>
11         <form action="{{ url_for('recognise') }}" method="post" autocomplete="off">
12             <select id="input" name="input">
13                 <option value="speaker">Speaker</option>
14                 <option value="mic">Mic</option>
15             </select>
16             <input type="submit" value="Recognise">
17         </form>
18         <h3>*Press the button and wait patiently(usually 15-30seconds)</h3>
19         <p>{{ msg }}</p>
20     </div>
21     {% endblock %}
```

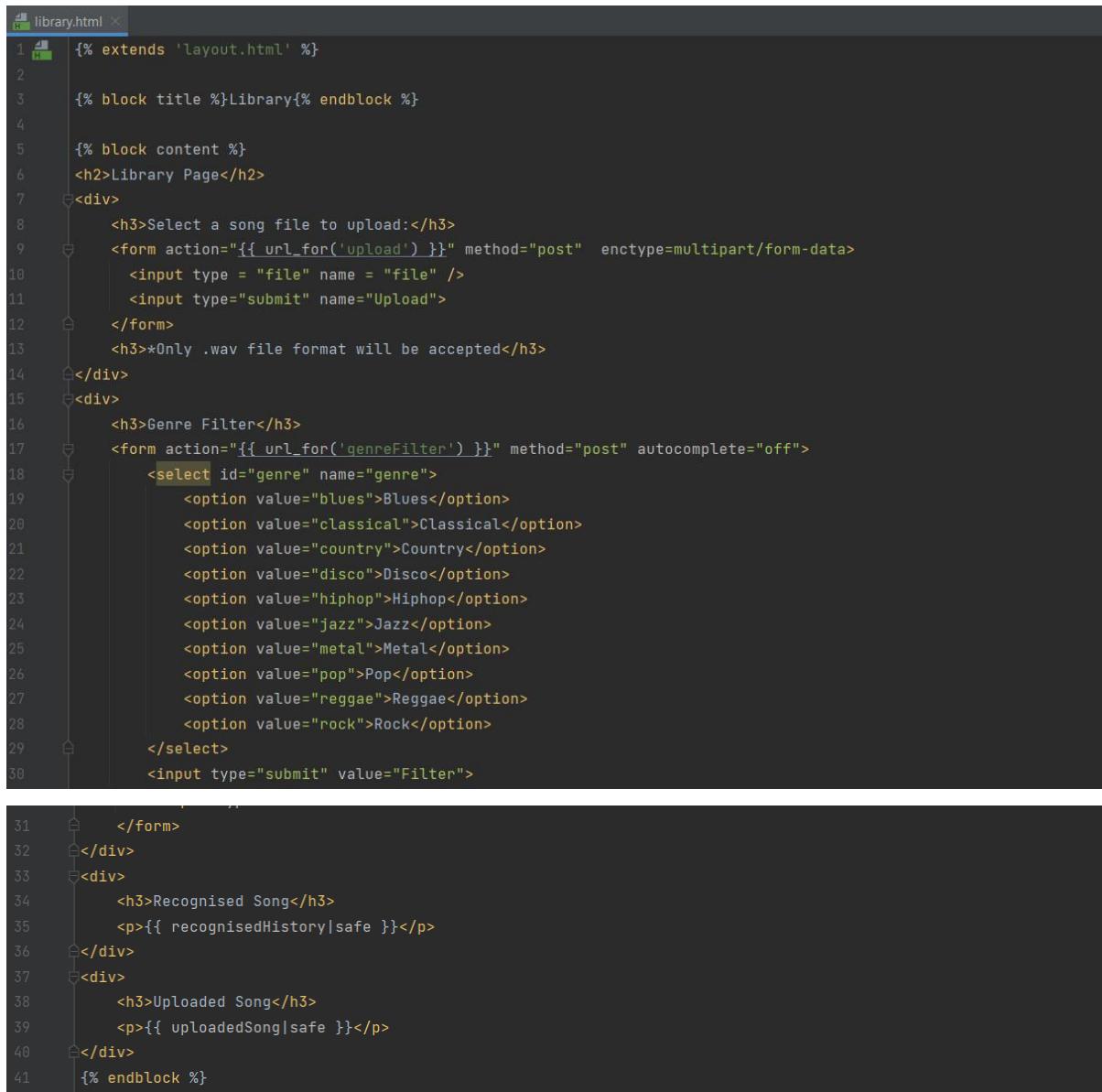
This is a page that will be displayed upon login to an account, navigation bar on top can be used to navigate between every page of the system. Home page will have a button for the user to press after choosing the input method to capture the audio data. User will need to wait usually 15 to 30 seconds after pressing the button to wait for the system to recognise the music and redirect the user to the result page or display a message when no song found from the audio.

9.2.5.2 Screenshot



9.2.6 Screenshots for library page (library.html)

9.2.6.1 Description



The screenshot shows a code editor window with the file 'library.html' open. The code is a Django template for a library page. It starts with an extends tag to inherit from 'layout.html'. It then defines a title block and a content block. The content block contains an H2 tag for 'Library Page'. Inside a div, there is a form for uploading a song file. The form has a file input and a submit button labeled 'Upload'. A note says '*Only .wav file format will be accepted'. Below the upload section, there is a genre filter section. It has an H3 tag for 'Genre Filter' and a form with a select dropdown containing options for various genres: Blues, Classical, Country, Disco, Hiphop, Jazz, Metal, Pop, Reggae, and Rock. A submit button labeled 'Filter' is also present. The template continues with more divs for recognised and uploaded songs, and ends with an endblock tag.

```
{% extends 'layout.html' %}

{% block title %}Library{% endblock %}

{% block content %}
    <h2>Library Page</h2>
    <div>
        <h3>Select a song file to upload:</h3>
        <form action="{{ url_for('upload') }}" method="post" enctype=multipart/form-data>
            <input type = "file" name = "file" />
            <input type="submit" name="Upload">
        </form>
        <h3>*Only .wav file format will be accepted</h3>
    </div>
    <div>
        <h3>Genre Filter</h3>
        <form action="{{ url_for('genreFilter') }}" method="post" autocomplete="off">
            <select id="genre" name="genre">
                <option value="blues">Blues</option>
                <option value="classical">Classical</option>
                <option value="country">Country</option>
                <option value="disco">Disco</option>
                <option value="hiphop">Hiphop</option>
                <option value="jazz">Jazz</option>
                <option value="metal">Metal</option>
                <option value="pop">Pop</option>
                <option value="reggae">Reggae</option>
                <option value="rock">Rock</option>
            </select>
            <input type="submit" value="Filter">
        </form>
    </div>
    <div>
        <h3>Recognised Song</h3>
        <p>{{ recognisedHistory|safe }}</p>
    </div>
    <div>
        <h3>Uploaded Song</h3>
        <p>{{ uploadedSong|safe }}</p>
    </div>
{% endblock %}
```

The library page is a page for the user to see the recognised history and uploaded song to the system, user can also upload song from the local device to the system on this page to perform genre classification for the song. The history information can also be filtered by selected genre by choosing an option from the combo list and press the filter button.

9.2.6.2 Screenshot

The screenshot shows a web browser window with the following details:

- Header:** The title bar includes a 'Library' icon, a search bar with the URL '127.0.0.1:5000/library', and various browser control icons.
- Navigation:** A dark blue header bar contains links for 'Home', 'Library', 'Trend', 'Profile', and 'Logout'.
- Main Content:** The main area is titled 'Library Page'. It features a form for file upload with the instruction 'Select a song file to upload:' and a 'Choose File' button. Below the button is the message 'No file chosen'. A large blue 'Submit' button is centered below the input field.
- Genre Filter:** A second form titled 'Genre Filter' contains a dropdown menu set to 'Blues' and a blue 'Filter' button.

The screenshot shows a web browser window with a dark theme. The title bar reads "Library" and the address bar shows "127.0.0.1:5000/library". The main content area is titled "Recognised Song" and lists ten songs with their titles and genres. The songs are:

- Title: Never Coming Back - Evan Call
Genre: classical
- Title: Under Heroine - TUYU
Genre: classical
- Title: Don't Wanna Lie (feat. Blak & Hosea) - Patrick Brasca
Genre: classical
- Title: Circles - Kastrø & Alex Byrne
Genre: classical
- Title: Just For A Moment (feat. Iselin) - Gryffin
Genre: classical
- Title: Beautiful in White - Divine Destiny
Genre: pop
- Title: This is love - Eric Chou
Genre: classical
- Title: At Least I Remember - Eric Chou
Genre: classical
- Title: 像极了 - Ryan.B
Genre: disco
- Title: fReESTyLE - HOYO-MiX
Genre: classical

Library

127.0.0.1:5000/library

Title: Circles - Kastr & Alex Byrne
Genre: classical

Title: Just For A Moment (feat. Iselin) - Gryffin
Genre: classical

Title: Beautiful in White - Divine Destiny
Genre: pop

Title: This is love - Eric Chou
Genre: classical

Title: At Least I Remember - Eric Chou
Genre: classical

Title: 像极了 - Ryan.B
Genre: disco

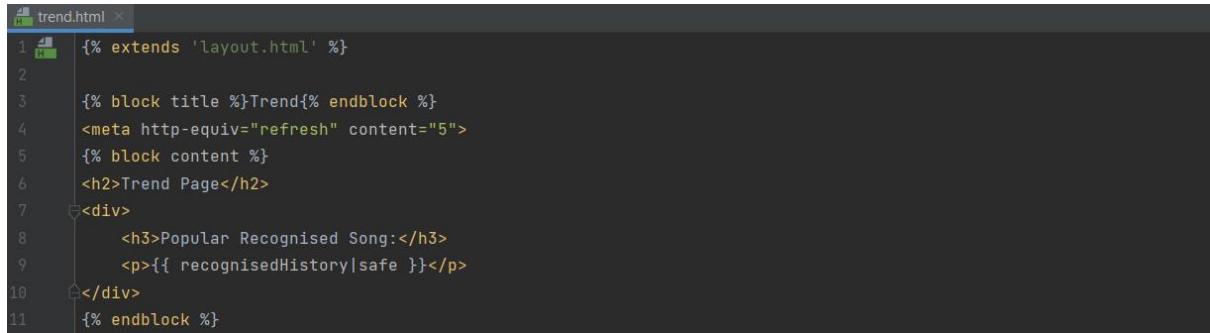
Title: fReEStyLE - HOYO-MiX
Genre: classical

Uploaded Song

Title: dont-say.wav
Genre: pop

9.2.7 Screenshots for trend page (trend.html)

9.2.7.1 Description



```
trend.html
1  {% extends 'layout.html' %} 
2
3  {% block title %}Trend{% endblock %}
4  <meta http-equiv="refresh" content="5">
5  {% block content %}
6    <h2>Trend Page</h2>
7    <div>
8      <h3>Popular Recognised Song:</h3>
9      <p>{{ recognisedHistory|safe }}</p>
10   </div>
11  {% endblock %}
```

This page will be displaying the popular recognised song which means that the most recognised count song will be arranged in ascending order to let the user have the information for which song and its genre is trending at the moment.

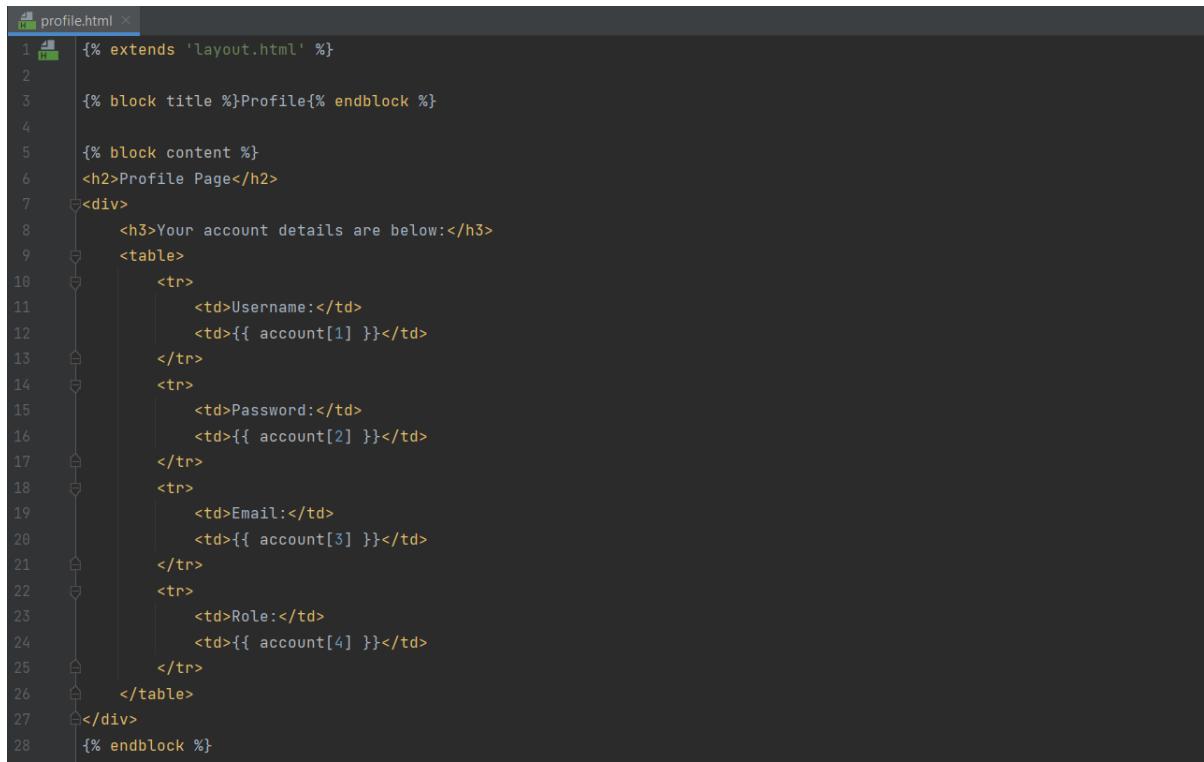
9.2.7.2 Screenshot

The screenshot shows a web browser window titled "Trend" with the URL "127.0.0.1:5000/trend". The page header includes links for Home, Library, Trend (the active tab), Profile, and Logout. The main content area is titled "Trend Page" and features a section titled "Popular Recognised Song:". Below this, a list of songs is displayed with their titles, genres, and recognised counts.

Song Title	Artist(s)	Genre	Recognised Count
Never Coming Back	Evan Call	classical	2
Don't Wanna Lie (feat. Blak & Hosea)	Patrick Brasca	classical	2
Under Heroine	TUYU	classical	1
Circles	Kastr & Alex Byrne	classical	1
Just For A Moment (feat. Iselin)	Gryffin	classical	1
Beautiful in White	Divine Destiny	pop	1

9.2.8 Screenshots for profile page (profile.html)

9.2.8.1 Description



The screenshot shows a code editor window with the file 'profile.html' open. The code is a Django template for displaying user profile information. It extends the 'layout.html' base and defines a 'Profile' block. The content block contains an H2 header 'Profile Page', a descriptive message 'Your account details are below:', and a table with four rows, each mapping a field name to its corresponding account index.

```
1 1 profile.html
2
3 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
15 16 17 18 19 20 21 22 23 24 25 26 27 28
16 17 18 19 20 21 22 23 24 25 26 27 28
17 18 19 20 21 22 23 24 25 26 27 28
18 19 20 21 22 23 24 25 26 27 28
19 20 21 22 23 24 25 26 27 28
20 21 22 23 24 25 26 27 28
21 22 23 24 25 26 27 28
22 23 24 25 26 27 28
23 24 25 26 27 28
24 25 26 27 28
25 26 27 28
26 27 28
27 28
28
```

This page will be displaying the profile information including user name, password, email and role for the user in current session.

9.2.8.2 Screenshot

The screenshot shows a web browser window with the title "Profile" and the URL "127.0.0.1:5000/profile". The page header includes the text "Music Recognition and Genre Classification" and navigation links for Home, Library, Trend, Profile, and Logout. The main content area is titled "Profile Page" and contains a section titled "Your account details are below:" with the following information:

Username:	Sia De Long
Password:	sia
Email:	sia@outlook.com
Role:	User

9.2.9 Screenshots for recognise page (recognise.html)

9.2.9.1 Description

```
recognise.html ×
1  {% extends 'layout.html' %}
2
3  {% block title %}Recognise{% endblock %}
4
5  {% block content %}
6      <h2>Recognise Result</h2>
7      <div>
8          <center>
9              
10         </center>
11     </div>
12     <div>
13         <table>
14             <tr>
15                 <td>Title: {{ song[0] }}</td>
16             </tr>
17             <tr>
18                 <td>Author: {{ song[1] }}</td>
19             </tr>
20             <tr>
21                 <td>Full Title: {{ song[2] }}</td>
22             </tr>
23             <tr>
24                 <td>Classified Genre: {{ song[7] }}</td>
25             </tr>
26             <tr>
27                 <td>Shazam Url: {{ song[4] }}</td>
28             </tr>
29         </table>
30     </div>
31     <div>
32         <center>
33             <a href="{{ song[5] }}"><i>Open On Youtube</i></a>
34             <br>
35             <br>
36             <br>
37             <a href="{{ song[6] }}"><i>Open On Spotify</i></a>
38         </center>
39     </div>
40  {% endblock %}
```

This page will be displaying the result of recognised song in an organised way where the image of the song will be displayed and other information including song title, author, classified genre, and Shazam URL. Besides that, there will have two buttons in the bottom which can redirect user to search the user on both YouTube and Spotify platform respectively.

9.2.9.2 Screenshot

Screenshot of a web application titled "Music Recognition and Genre Classification". The URL in the browser is 127.0.0.1:5000/recognise.

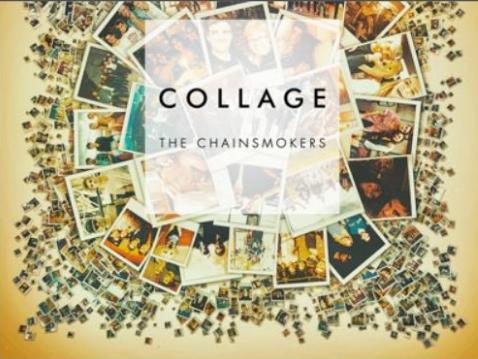
The main content area displays the "Recognise Result" for a song. The result is presented as a circular collage of numerous small, overlapping images, likely album covers or promotional photos. In the center of this collage, the word "COLLAGE" is printed in large, bold, black capital letters, with "THE CHAINSMOKERS" printed below it in a smaller font.

Below the collage, the results are summarized in a box:

- Title: Closer (feat. Halsey)
- Author: The Chainsmokers

Recognise

127.0.0.1:5000/recognise



Title: Closer (feat. Halsey)
Author: The Chainsmokers
Full Title: Closer (feat. Halsey) - The Chainsmokers
Classified Genre: classical
Shazam Url: <https://www.shazam.com/track/324443962/closer-feat-halsey>

[Open On Youtube](#)

[Open On Spotify](#)

9.3 Sample code

```
1  from flask import Flask, render_template, request, redirect, url_for, session
2  import re
3  import operator
4  import soundcard as sc
5  import soundfile as sf
6
7  from pydub import AudioSegment
8
9  import genre_classifier as gc
10
11 import json
12 import mysql.connector
13
14 from definitions import (TEMPGENRE_PATH,
15                           RATE,
16                           RECORD_SECONDS,
17                           EXCERPT_PATH,
18                           UPLOAD_PATH)
19
20 from api_utils import get_shazam_data
21 from web_utils import get_yt_search_link, get_spotify_search_link
22
23 conn = mysql.connector.connect(
24     host="localhost",
25     database="accountdb",
26     user="root",
27     password="admin"
28 )
29
30 app = Flask(__name__)
31
32 # Change this to your secret key (can be anything, it's for extra protection)
33 app.secret_key = 'your secret key'
```

Figure above shows the libraries import and global declarations in the main function of the web application.

9.3.1 Utilities

9.3.1.1 Sample codes for definitions.py

```
definitions.py ×
1  import os
2
3  # global
4  ROOT_DIR = os.path.dirname(os.path.abspath(__file__))
5
6  # recorder settings
7  RATE = 48000
8  RECORD_SECONDS = 9
9  EXCERPT_PATH = os.path.join(ROOT_DIR, "../FlaskWebApplication/excerpt.wav")
10 TEMPGENRE_PATH = os.path.join(ROOT_DIR, "../FlaskWebApplication/temp.wav")
11 UPLOAD_PATH = os.path.join(ROOT_DIR, "../FlaskWebApplication/uploads")
12 MODEL_PATH = os.path.join(ROOT_DIR, "../FlaskWebApplication/genreclassification/trained_genre_model.joblib")
13 DATA_PATH = os.path.join(ROOT_DIR, "../FlaskWebApplication/genreclassification/Data/features_3_sec.csv")
14
15 # api
16 HOST = "http://2.56.240.213:4000"
17 API_LINK = HOST + "/api/v1"
```

This python file is to define the keywords that will be used in various python file such as the path of the trained model file in the project directory.

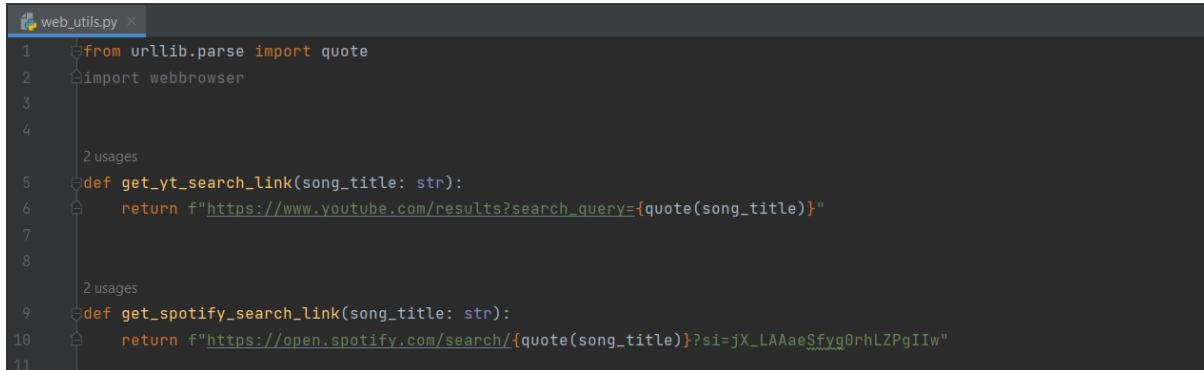
9.2.1.2 Sample codes for api_utils.py



```
api_utils.py
1 import requests
2 from definitions import API_LINK
3
4 2 usages
5 def get_shazam_data(music_bytes: bytes):
6     r = requests.post(API_LINK, files={"b_data": music_bytes})
7     if r.status_code == 200:
8         return r.text
9     else:
10        raise Exception(f"API status code {r.status_code}")
```

This is the core source code for the music recognition function where it will request data from the Shazam API by feeding the audio data in bytes, the data will then be return to the main function in text form while exception will be raised if any happen during the runtime.

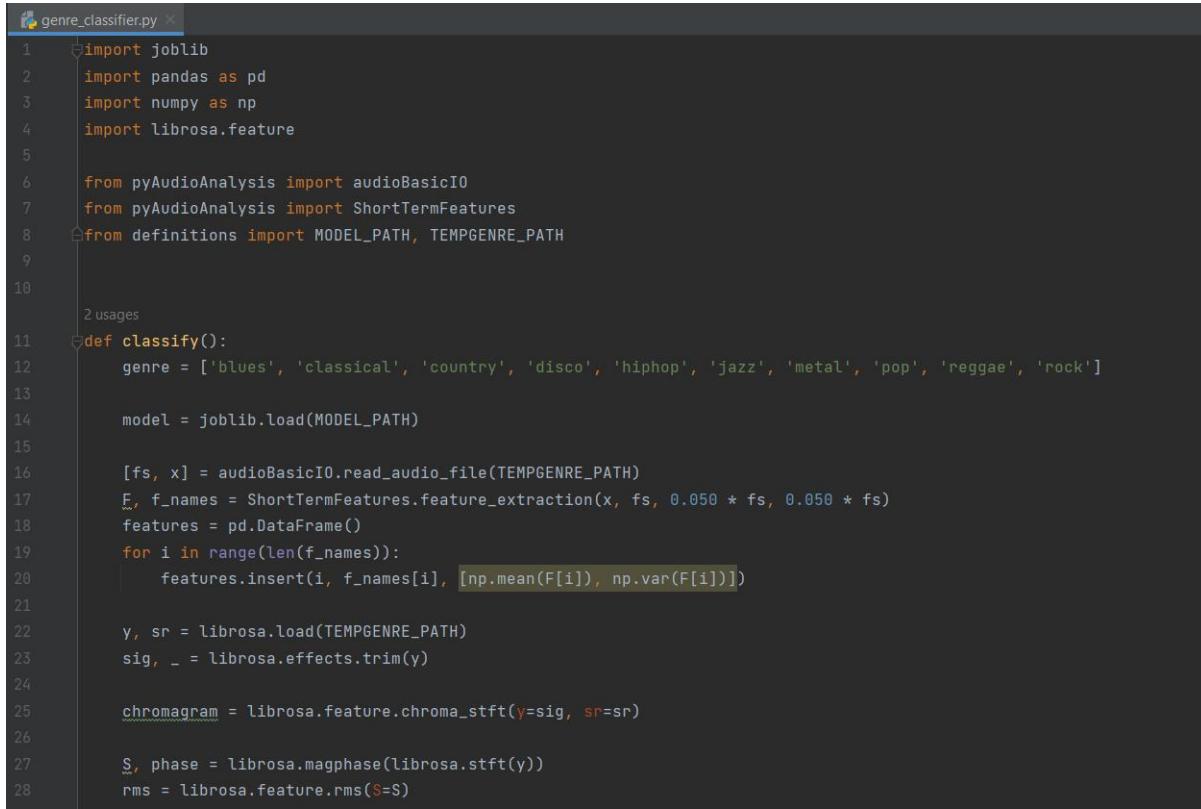
9.2.1.3 Sample codes for web_utils.py



```
web_utils.py
1 from urllib.parse import quote
2 import webbrowser
3
4 2 usages
5 def get_yt_search_link(song_title: str):
6     return f"https://www.youtube.com/results?search_query={quote(song_title)}"
7
8 2 usages
9 def get_spotify_search_link(song_title: str):
10    return f"https://open.spotify.com/search/{quote(song_title)}?si=jX_LAAaeSfyg0rhLZPgIIw"
```

This is the utility for the main function to let the system to redirect the user to YouTube or Spotify link and search the song title.

9.2.1.4 Sample codes genre classifier.py



```
genre_classifier.py ×
1  import joblib
2  import pandas as pd
3  import numpy as np
4  import librosa,feature
5
6  from pyAudioAnalysis import audioBasicIO
7  from pyAudioAnalysis import ShortTermFeatures
8  from definitions import MODEL_PATH, TEMPGENRE_PATH
9
10
11 2 usages
12  def classify():
13      genre = ['blues', 'classical', 'country', 'disco', 'hiphop', 'jazz', 'metal', 'pop', 'reggae', 'rock']
14
15      model = joblib.load(MODEL_PATH)
16
17      [fs, x] = audioBasicIO.read_audio_file(TEMPGENRE_PATH)
18      F, f_names = ShortTermFeatures.feature_extraction(x, fs, 0.050 * fs, 0.050 * fs)
19      features = pd.DataFrame()
20      for i in range(len(f_names)):
21          features.insert(i, f_names[i], [np.mean(F[i]), np.var(F[i])])
22
23      y, sr = librosa.load(TEMPGENRE_PATH)
24      sig, _ = librosa.effects.trim(y)
25
26      chromagram = librosa.feature.chroma_stft(y=sig, sr=sr)
27      S, phase = librosa.magphase(librosa.stft(y))
28      rms = librosa.feature.rms(S=S)
```

```

29     spectral_bandwidth = librosa.feature.spectral_bandwidth(y=sig, sr=sr)[0]
30
31     y_harm, y_perc = librosa.effects.hpss(sig)
32
33     tempo, _ = librosa.beat.beat_track(y=sig, sr=sr)
34
35     mfccs = librosa.feature.mfcc(y=sig, sr=sr, n_mfcc=20)
36     for i in range(13, 20):
37         features.insert(i, "mfcc_" + str(i + 1), [np.mean(mfccs[i]), np.var(mfccs[i])])
38
39     X_data = pd.DataFrame()
40     X_data.insert(0, "length", [66149])
41     X_data.insert(1, "chroma_stft_mean", [np.mean(chromagram)])
42     X_data.insert(2, "chroma_stft_var", [np.var(chromagram)])
43     X_data.insert(3, "rms_mean", [np.mean(rms)])
44     X_data.insert(4, "rms_var", [np.var(rms)])
45     X_data.insert(5, "spectral_centroid_mean", [features.loc[0, 'spectral_centroid']])
46     X_data.insert(6, "spectral_centroid_var", [features.loc[1, 'spectral_centroid']])
47     X_data.insert(7, "spectral_bandwidth_mean", [np.mean(spectral_bandwidth)])
48     X_data.insert(8, "spectral_bandwidth_var", [np.var(spectral_bandwidth)])
49     X_data.insert(9, "rolloff_mean", [features.loc[0, 'spectral_rolloff']])
50     X_data.insert(10, "rolloff_var", [features.loc[1, 'spectral_rolloff']])
51     X_data.insert(11, "zero_crossing_rate_mean", [features.loc[0, 'zcr']])
52     X_data.insert(12, "zero_crossing_rate_var", [features.loc[1, 'zcr']])
53     X_data.insert(13, "harmony_mean", [np.mean(y_harm)])
54     X_data.insert(14, "harmony_var", [np.var(y_harm)])
55     X_data.insert(15, "perceptr_mean", [np.mean(y_perc)])
56     X_data.insert(16, "perceptr_var", [np.var(y_perc)])
57     X_data.insert(17, "tempo", [tempo])
58
59     c = 18
60     for i in range(1, 21):
61         X_data.insert(c, "mfcc" + str(i) + "_mean", [features.loc[0, 'mfcc_' + str(i)]])
62         c += 1
63         X_data.insert(c, "mfcc" + str(i) + "_var", [features.loc[1, 'mfcc_' + str(i)]])
64         c += 1
65
66     pred = model.predict(X_data)
67
68     return genre[pred[0]]

```

This is the source code for the genre classifier where the first thing will do is importing the libraries, declare the genre array and importing trained model. The keyword of audioBasicIO from pyAudioAnalysis will be used to read the signal wave and sample rate from the audio file at the temporary path. Then ShortTermFeatures from also pyAudioAnalysis will be use to extract most of the features from the audio and mean and variance will be calculated from it to store them in a dataframe variable while the rest will be using librosa library to extract the feature. MFCC from the ShortTermFeatures is not enough axis for the model so librosa will do the rest and chuck it in to the dataframe too. Finally, the proper data format for X will be create by appending the column one by one and feed it to the model to do genre classification and return the result to the main function.

9.3.2 Sample codes for login function

```
36     @app.route('/', methods=['GET', 'POST'])
37     def login():
38         # Output message if something goes wrong...
39         msg = ''
40
41         # Check if "username" and "password" POST requests exist (user submitted form)
42         if request.method == 'POST' and 'username' in request.form and 'password' in request.form:
43             # Create variables for easy access
44             username = request.form['username']
45             password = request.form['password']
46             # Check if account exists using MySQL
47             cursor = conn.cursor()
48             cursor.execute('SELECT * FROM acc WHERE username = %s AND password = %s', (username, password))
49             # Fetch one record and return result
50             account = cursor.fetchone()
51             # If account exists in accounts table in out database
52             if account:
53                 # Create session data, we can access this data in other routes
54                 session['loggedin'] = True
55                 session['id'] = account[0]
56                 session['username'] = account[1]
57                 session['role'] = account[4]
58                 # Redirect to home page
59                 return redirect(url_for('home'))
60             else:
61                 # Account doesn't exist or username/password incorrect
62                 msg = 'Incorrect username/password!'
63         # Show the login form with message (if any)
64         return render_template('login.html', msg=msg)
```

The login function will start from requesting data of username and password from the login page, then it will declare a MySQL cursor that connect to the database and execute a query that look for matching for both username and password record. If the account is found, session will store the login status, id, username and role for the account then redirect the user to the home page, else incorrect username or password will be displayed.

9.3.3 Sample codes for register function

```

66     @app.route('/register', methods=['GET', 'POST'])
67     def register():
68         # Output message if something goes wrong...
69         msg = ''
70
71         # Check if "username", "password" and "email" POST requests exist (user submitted form)
72         if request.method == 'POST' and 'username' in request.form and 'password' in request.form and 'confirmPassword' in \
73             request.form and 'email' in request.form:
74             # Create variables for easy access
75             username = request.form['username']
76             password = request.form['password']
77             confirmPassword = request.form['confirmPassword']
78             email = request.form['email']
79
80             # Check if account exists using MySQL
81             cursor = conn.cursor()
82             cursor.execute("SELECT * FROM acc WHERE username = %s", (username,))
83             account = cursor.fetchone()
84
85             # If account exists show error and validation checks
86             if account:
87                 msg = 'Account already exists!'
88             elif not re.match(r'^[a-zA-Z0-9]+@[a-zA-Z0-9]+\.[a-zA-Z0-9]+$', email):
89                 msg = 'Invalid email address!'
90             elif not re.match(r'^[A-Za-z0-9]+$', username):
91                 msg = 'Username must contain only characters and numbers!'
92             elif password != confirmPassword:
93                 msg = 'Confirm Password is not same as Password'
94             elif not username or not password or not confirmPassword or not email:
95                 msg = 'Please fill out the form!'
96
97             else:
98                 # Account doesn't exist and the form data is valid, now insert new account into accounts table
99                 cursor.execute('INSERT INTO acc VALUES (NULL, %s, %s, %s, %s)', (username, password, email, "User"))
100                conn.commit()
101                msg = 'You have successfully registered!'
102
103            elif request.method == 'POST':
104                # Form is empty... (no POST data)
105                msg = 'Please fill out the form!'
106
107            # Show registration form with message (if any)
108            return render_template('register.html', msg=msg)
109
110
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```

The register function will start from requesting data of username, password, confirm password and email from the register page, then it will declare a MySQL cursor that connect to the database and execute a query that look for matching username record. If the account is found, then the registration will not complete else the input will be run through validation to make sure that those inputs are valid for the system such as the format of the email. Finally, the insert query will be executed if every condition pass and display a success register message on the register page.

9.3.4 Sample codes for home function

```
107     @app.route('/home', methods=['GET', 'POST'])
108     def home():
109         # Check if user is loggedin
110         if 'loggedin' in session:
111             # User is loggedin show them the home page
112             return render_template('home.html', username=session['username'])
113         # User is not loggedin redirect to login page
114         return redirect(url_for('login'))
```

The home function will check the login status first to prevent exception happen when user use the /home link to direct themselves to the home. If the session is not having the login status, the user will be redirect back to the login page, else the user will remain on the home page with the user's name displayed.

9.3.5 Sample codes for recognise function

```

139     @app.route('/recognise', methods=['GET', 'POST'])
140     def recognise():
141         device = request.form['input']
142
143         if device == "speaker":
144             with sc.get_microphone(id=str(sc.default_speaker().name), include_loopback=True).recorder(
145                 samplerate=RATE) as mic:
146                 # record audio with loopback from default speaker.
147                 data = mic.record(numframes=RATE * RECORD_SECONDS)
148
149                 # change "data=data[:, 0]" to "data=data", if you would like to write audio as multiple-channels.
150                 sf.write(file="excerpt.wav", data=data[:, 0], samplerate=RATE)
151                 sf.write(file="temp.wav", data=data[:, 0], samplerate=RATE)
152         elif device == "mic":
153             with sc.get_microphone(id=str(sc.default_microphone().name), include_loopback=True).recorder(
154                 samplerate=RATE) as mic:
155                 # record audio with loopback from default speaker.
156                 data = mic.record(numframes=RATE * RECORD_SECONDS)
157
158                 # change "data=data[:, 0]" to "data=data", if you would like to write audio as multiple-channels.
159                 sf.write(file="excerpt.wav", data=data[:, 0], samplerate=RATE)
160                 sf.write(file="temp.wav", data=data[:, 0], samplerate=RATE)
161
162         with (open(EXCERPT_PATH, mode='rb') as excerpt_data):
163             shazam_data = get_shazam_data(excerpt_data.read())
164             song_data = json.loads(shazam_data)["data"]
165
166             # noinspection PyBroadException
167             try:
168                 fullTitle = f'{song_data[1]["track"]["title"]} - {song_data[1]["track"]["subtitle"]}'
169                 yt_url = get_yt_search_link(fullTitle)
170                 spot_url = get_spotify_search_link(fullTitle)
171
172                 genre = gc.classify()
173
174                 song = [song_data[1]["track"]["title"],
175                         song_data[1]["track"]["subtitle"],
176                         fullTitle,
177                         song_data[1]["track"]["share"].get("image"),
178                         song_data[1]["track"]["url"],
179                         yt_url,
180                         spot_url,
181                         genre]
182
183                 cursor = conn.cursor()
184                 cursor.execute('INSERT INTO recognisefile VALUES (NULL, %s, %s, %s, %s, %s, %s)', (
185                     song[2], song[3], song[5], song[6], genre, session['id']))
186                 conn.commit()
187
188             return render_template('recognise.html', song=song)
189         except Exception as e:
190             return render_template('home.html', msg="song not found")

```

The recognise function will start from requesting data of input method from the home page, then it will capture the audio data based on the input method either from speaker or microphone using soundcard library and soundfile library to write the file with desired file name and in mono data. After that, the data will be feed to Shazam API to recognise the song based on the data. If there is any result found, the result will be given a genre by executing the genre classifier and

stored both of the data in database, then display the result on the recognise page, else if the song is not found by the API, message will be displayed to the user on home page.

9.3.6 Sample codes for library function

```

193     @app.route('/library', methods=['GET', 'POST'])
194     def library():
195         return displayData()

```

When user go to library page, displayData function will be called to display data from database to the library page.

```

296     def displayData():
297         cursor = conn.cursor()
298         if session['role'] == "Admin":
299             cursor.execute('SELECT * FROM recognisehistory')
300             history = cursor.fetchall()
301
302             cursor.execute('SELECT * FROM uploadedsong')
303             uploaded = cursor.fetchall()
304         else:
305             cursor = conn.cursor()
306             cursor.execute('SELECT * FROM recognisehistory WHERE userid = %s', (session['id'],))
307             history = cursor.fetchall()
308
309             cursor.execute('SELECT * FROM uploadedsong WHERE userid = %s', (session['id'],))
310             uploaded = cursor.fetchall()
311
312         title_list = {}
313
314         # loop through the data
315         for row in history:
316             # get the title from the row
317             title = row[1]
318
319             # if the title is not in the dictionary, add it with a count of 1
320             if title not in title_list:
321                 title_list[title] = row[5]
322
323             recognisedHistory = ""
324
325             for title in title_list:
326                 for record in range(len(history)):
327                     if history[record][1] == title:
328                         recognisedHistory = recognisedHistory + "Title: " + str(history[record][1]) + "<br>Genre: " + str(
329                             history[record][5]) + "<br><br>"
330                         break
331
332             uploadedSong = ""
333
334             for record in range(len(uploaded)):
335                 uploadedSong = uploadedSong + "Title: " + str(uploaded[record][1]) + "<br>Genre: " + str(
336                     uploaded[record][2]) + "<br><br>"
337                 break
338
339             return render_template('library.html', recognisedHistory=recognisedHistory, uploadedSong=uploadedSong)

```

The displayData function will be fetching data for recognised history and uploaded song from the database while organised the data into a string without displaying duplicate song for the recognised history, then the string will be used to display it on the library page.

```

254     @app.route('/genreFilter', methods=['GET', 'POST'])
255     def genreFilter():
256         genre = request.form['genre']
257         cursor = conn.cursor()
258         cursor.execute('SELECT * FROM recognisehistory WHERE userid = %s AND genre =%s', (session['id'], genre,))
259         history = cursor.fetchall()
260
261         cursor.execute('SELECT * FROM uploadedsong WHERE userid = %s AND genre =%s', (session['id'], genre,))
262         uploaded = cursor.fetchall()
263
264         title_list = {}
265
266         # loop through the data
267         for row in history:
268             # get the title from the row
269             title = row[1]
270
271             # if the title is not in the dictionary, add it with a count of 1
272             if title not in title_list:
273                 if row[5] == genre:
274                     title_list[title] = row[5]
275
276             recognisedHistory = """
277
278             for title in title_list:
279                 for record in range(len(history)):
280                     if history[record][1] == title:
281                         recognisedHistory = recognisedHistory + "Title: " + str(history[record][1]) + "<br>Genre: " + str(
282                             history[record][5]) + "<br><br>"
283                     break
284
285             uploadedSong = """
286
287             for record in range(len(uploaded)):
288                 if uploaded[record][2] == genre:
289                     uploadedSong = uploadedSong + "Title: " + str(uploaded[record][1]) + "<br>Genre: " + str(
290                         uploaded[record][2]) + "<br><br>"
291                 break
292
293             return render_template('library.html', recognisedHistory=recognisedHistory, uploadedSong=uploadedSong)

```

The genreFilter function do the same thing just like the displayData function but with one extra condition which only will accept selected genre to be displayed on the library page.

9.3.7 Sample codes for upload function

```
230     @app.route('/upload', methods=['GET', 'POST'])
231     def upload():
232         data = request.files['file']
233         data.save(UPLOAD_PATH + "/" + data.filename)
234
235         try:
236             song = AudioSegment.from_wav(UPLOAD_PATH + "/" + data.filename)
237             song = song.set_channels(1)
238
239             # save to file
240             song.export(TEMPGENRE_PATH, format="wav")
241         except Exception as e:
242             pass
243
244         genre = gc.classify()
245
246         cursor = conn.cursor()
247         cursor.execute('INSERT INTO uploadedsong VALUES (NULL, %s, %s, %s)', (data.filename, genre, session['id']))
248         conn.commit()
249
250     return displayData()
```

The upload function will start from requesting file data from the library page and save it to the desired path, then the path will be used to change the channel to mono audio and convert the format to wav as a temporary audio file for the genre classifier to work. Finally, the classified result will be recorded into the database and call the displayData to refresh the library page.

9.3.8 Sample codes for trend function

```

198 @app.route('/trend', methods=['GET', 'POST'])
199 def trend():
200     cursor = conn.cursor()
201     cursor.execute('SELECT * FROM recognisehistory')
202     history = cursor.fetchall()
203
204     title_counts = {}
205     genre = {}
206
207     # loop through the data
208     for row in history:
209         # get the title from the row
210         title = row[1]
211
212         # if the title is not in the dictionary, add it with a count of 1
213         if title not in title_counts:
214             title_counts[title] = 1
215             genre[title] = row[5]
216
217         # if the title is in the dictionary, increment the count
218         else:
219             title_counts[title] += 1
220
221         sortedTitle = dict(sorted(title_counts.items(), key=operator.itemgetter(1), reverse=True))
222         trend = ""
223
224         for title in sortedTitle:
225             trend = trend + "Title: " + str(title) + "<br>Genre: " + str(genre[title]) + \
226                     "<br>Recognised Count: " + str(title_counts[title]) + "<br><br>"
227
228     return render_template('trend.html', recognisedHistory=trend)

```

The trend function will be fetching data for recognised history and uploaded song from the database then the data will be sorted ascendingly from the most recognised count to lowest while organised the data into a string without displaying duplicate song for the recognised history, then the string will be used to display it on the trend page.

9.3.9 Sample codes for profile function

```
117     @app.route('/profile')
118     def profile():
119         # Check if user isloggedin
120         if 'loggedin' in session:
121             # We need all the account info for the user_so we can display it on the profile page
122             cursor = conn.cursor()
123             cursor.execute('SELECT * FROM acc WHERE id = %s', (session['id'],))
124             account = cursor.fetchone()
125             # Show the profile page with account info
126             return render_template('profile.html', account=account)
127         # User is notloggedin redirect to login page
128         return redirect(url_for('login'))
```

The profile function will check the login status first to prevent exception happen when user use the /profile link to direct themselves to the profile page. If the session is not having the login status, the user will be redirect back to the login page, else the user will remain on the profile page with the account information displayed by fetching data from the database using the session id.

9.3.10 Sample codes for logout function

```
131     @app.route('/logout', methods=['GET', 'POST'])
132     def logout():
133         session['loggedin'] = False
134         msg = 'Account Logout Successfully!'
135         # Show the login form with message (if any)
136         return render_template('login.html', msg=msg)
```

The logout function will remove the login status for the session and redirect user to the login page with a logout message displayed.

Chapter 10 System Validation

10.1 Unit testing

Case No	Test Case	Test Condition	Expected Result	Actual Result	Status
1	1. Leave any field in Login page empty 2. Click Login button	Username: empty Password: empty	Empty field warning	Empty field warning	Pass
2	1. Input existing username and password in Login page 2. Click Login button	Username: admin Password: admin	Login successfully and go to Home page	Login successfully and go to Home page	Pass
3	1. Leave any field in Register page empty 2. Click Register button	Username: empty Password: empty Confirm Password: empty Email: empty	Empty field warning	Empty field warning	Pass
4	1. Fill in the all the fields in Register page 2. Click Register button	Username: Sia De Long Password: sia Confirm Password: sia Email: sia@outlook.com	Account registered successfully and display a message	Account registered successfully and display a message	Pass
5	1. Select speaker option in Home page 2. Click Recognise button	Open a song on YouTube of the device running the web application	Song recognised successfully with genre	Song recognised successfully with genre	Pass

			classified and go to result display page	classified and go to result display page	
6	1. Select microphone option in Home page 2. Click Recognise button	Open a song on YouTube from a mobile phone and play it to the microphone of the device running the web application	Song recognised successfully with genre classified and go to result display page	Song recognised successfully with genre classified and go to result display page	Pass
7	Upload a mp3 format file on Library page	A mp3 file	File upload fail and stay at the same page	File upload fail and stay at the same page	Pass
8	Upload a wav format file on Library page	A wav file	File upload successfully and genre classified with message display	File upload successfully and genre classified with message display	Pass
9	1. Select classical option in Library page 2. Click Filter button	-	Data in the library page get filtered by the selected genre	Data in the library page get filtered by the selected genre	Pass

10	Navigate to trend Page	-	Go to the trend page with data displayed	Go to the trend page with data displayed	Pass
11	Navigate to Profile Page	-	Go to the profile page with profile information displayed	Go to the profile page with profile information displayed	Pass
12	Navigate to Log out page	-	Profile log out successfully and go back to login page with message displayed	Profile log out successfully and go back to login page with message displayed	Pass

10.2 User acceptance testing

Name		Yan Mun Kye				
Date of Testing		25 th April 2023				
No	Criteria	Test Rating				
		1	2	3	4	5
1	User Interface - Interaction with the web application - Information is clearly displayed and organised - Easy to use and learn - Overall experience				✓	
2	Model Evaluation - Music recognition accuracy is high - Consistent genre classification and suitable genre classified			✓		
3	Website Design - Theme consistent for all the pages - Suitable colour combination used					✓
4	Functionalities - Free of bugs - Error and validation message is displayed					✓
Feedbacks and Suggestions: Overall the system is working well as expected but the genre classified by the system can be weird when performing music recognition since most of the music are classified as classical. Besides that, some of the information did not display on the interface.						

Name		Hor Shen Hau				
Date of Testing		25 th April 2023				
No	Criteria	Test Rating				
		1	2	3	4	5
1	User Interface - Interaction with the web application - Information is clearly displayed and organised - Easy to use and learn - Overall experience					✓
2	Model Evaluation - Music recognition accuracy is high - Consistent genre classification and suitable genre classified		✓			
3	Website Design - Theme consistent for all the pages - Suitable colour combination used				✓	
4	Functionalities - Free of bugs - Error and validation message is displayed					✓
Feedbacks and Suggestions: The system is performing very good in term of the interface design and flow but the model seem to not meeting the satisfaction because few of the music cannot be recognised by the system unless try multiple time. However, the system is well designed and meeting the aim and objective.						

Name		Tan Sheng Jeh				
Date of Testing		25 th April 2023				
No	Criteria	Test Rating				
		1	2	3	4	5
1	User Interface - Interaction with the web application - Information is clearly displayed and organised - Easy to use and learn - Overall experience				✓	
2	Model Evaluation - Music recognition accuracy is high - Consistent genre classification and suitable genre classified				✓	
3	Website Design - Theme consistent for all the pages - Suitable colour combination used					✓
4	Functionalities - Free of bugs - Error and validation message is displayed			✓		
Feedbacks and Suggestions: All of the functionalities are meeting the requirements and expectations but the upload function seem to lack of validation display where no message being shown after uploading a wrong format file.						

10.3 Summary

To summarise, it takes precise and effective algorithms to analyse audio recordings in order to perform difficult tasks like music recognition and genre classification. Both music enthusiasts and business professionals can benefit from a web application that can effectively identify and categorise music genres. A high-quality web application that accurately recognise music and categorises music genres was produced as a result of the effective and successful unit testing method. The programme quickly and accurately produced results after analysing audio recordings from multiple sources. Besides that, the account authentication system is performing as expected and able to release for the users. Moreover, the application was able to delivered by the developer on schedule.

For user acceptance test, user interface, model evaluation, website design and functionalities are the criteria that will be rated by the tester, there are three students in APU successfully conduct the test and leave value feedback from each of them which can be used for further improvement in the future. In short, the music recognition and genre classification web application had effective acceptance testing, which produced a high-quality product that surpassed end-user expectations.

Chapter 11 Conclusions and Reflections

11.1 Critical evaluation

From the experience of investigation report for the proposed topic, the developer has significantly improved research skills. In the first chapter, the developer is able to understand the background and the problem context of the project topic after conducted some research which enable the developer to determine whether the proposed solution is able to overcome the issues and provide potential benefits in the form of tangible and intangible. Hence, the information enables the developer to define the project scope including aim, objectives, deliverables, target users and nature of challenges that will be faced. In chapter 2, the developer conduct literature reviews based on the domain area in term of the importance of music recognition and genre classification system and algorithms used for music recognition and genre classification in order to obtain insights from them, not only that, research on similar system is also conducted to understand the requirements in the current market to determine the deliverables for the proposed system. In chapter 3, technical research is conducted to choose the most suitable tools to be used by the system which include programming language, IDE, libraries and tools, database and operating system, the decision is based on their advantages and disadvantages or based on the comparison result with alternative selection. In chapter 4, the developer made the decision of using RAD methodology to develop the system after comparing it with waterfall methodology. In chapter 5, the decision on selecting suitable research method on collecting qualitative and quantitative data is made which are interview and questionnaire, the responses are collected and then analysed and evaluated in chapter 6 with summary provided. Last but not least, the time management skill of the developer has been improved to complete this report as the tasks of this report has been given duration and date to complete.

On the other side, the developer got another whole new experience for system development process. There are a few achievements, reflections and challenges met during and after the development of the system where the first one must be the completion of MRGCS, the final system that meeting the aim and objectives of the project is able to be delivered and tested by few users within the given time range. In addition, the accuracy for both of the music recognition and genre classification are relatively high and it has been proven to be reliable by the result. However, there

are some reflections for the model training process where music recognition does not have a model trained and instead using a Shazam API which is because of the huge dataset that API provided, it allows the user to recognise almost all song that you can found in open source and for that reason the developer has decided to use the Shazam API instead to perform the music recognition function. Besides that, the genre classification model has a high percentage of producing classical genre as the output if the input is from the recognition module since there is not enough length of the audio data given to the model. This has become the challenge of the proposed system where both of these functions must be integrated together and work properly as expected, this challenge is not overcome completely as the issue is still existing but another challenge of extracting every required feature for the model to predict the genre is overcome completely which any audio data can fit to the model without any issue.

Other than that, there are also some user feedbacks collected from user acceptance test which can be used to do critical evaluation on the final version of the system. The feedbacks shows that there is still some case where the model will not work correctly and the interface is not displaying enough information message for providing guidance and warning to the users.

11.2 Conclusion

In a nutshell, the developer completed the final system that meeting the aim and objectives of the project is able to be delivered and tested by few users within the given time range. The developer has improved the skill on audio signal processing and machine learning techniques after the development of the project. Besides that, the developer was facing some problems time to time due to the lacks of critical research for the project topic causing the developer lost direction when studying the audio signal data which is not covered in the academic syllabus. Problem from that can lead to bring more limitation for the final system such as the lacks of accuracy for music recognition when the audio is having someone speaking while recognising, although some of the results are recognised correctly, there is still limitation in this function which should can be overcome if pre-processing for the audio is studied and implemented to make it perfect for the Shazam API to recognise in an audio that consist of many noises without any issue. Besides that, the integration between music recognition and genre classification is not good enough to let the genre classification working properly causing there is huge number of classical genres classified by the model while it is obviously that the music is not even close to classical. This issue is cause by the lack of knowledge on acquiring the actual song data after recognised the song by the user audio input. In other word, there is still not enough research conducted to reach the system requirements in a stable state since the system is working as expected sometime. With that being said, the final system delivered by the developer is still considered to be good work but several research can be done to improve further more on the main features of the system.

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Appendices

1.0 Project Log Sheet



(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

Notes on use of the project log sheet:

1. This log sheet is designed for meetings of more than 15 minutes duration, of which there must be at minimum SIX (6) during the course of the project (SIX mandatory supervisory sessions).
2. The student should prepare for the supervisory sessions by deciding which question(s) he or she needs to ask the supervisor and what progress has been made (if any) since the last session, and noting these in the relevant sections of the form, effectively forming an agenda for the session.
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7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name:Sia De Long..... **Date:** ...28th September 2022...**Meeting No:** ...1.....

Project title: Music Recognition and Genre Classification System **Intake:** APD3F2209CS(IS)

Supervisor's name: Imran Medi (Assoc. Prof . Dr.)..... **Supervisor's signature:**

Items for discussion (noted by student before mandatory supervisory meeting):

1. Background of the project
2. Problem Statement
3. Deliverables' scope
4. Dataset for machine learning

Record of discussion (noted by student during mandatory supervisory meeting):

1. Acceptance of the background and problem statement
2. The suitable range of the deliverables' scope
3. Suggestion on dataset

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Organise deliverables' scope to main features and extra features
2. Explore and study on suitable dataset

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Project Log Sheet



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Student's name:Sia De Long..... **Date:** ...6th Decemeber 2022...**Meeting No:** ...2.....

Project title: Music Recognition and Genre Classification System **Intake:** APD3F2209CS(IS)

Supervisor's name: Imran Medi (Assoc. Prof . Dr.)..... **Supervisor's signature:**

Items for discussion (noted by student before mandatory supervisory meeting):

1. Data gathering
2. IDE and tools decision
3. Content from PPF and PSF

Record of discussion (noted by student during mandatory supervisory meeting):

1. Changes from PPF and PSF are allowed
2. IDE and Tools can have modification with justification given
3. IR pages content

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Schedule for next meeting
2. Finalise IR

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.



(APU: Serial Number)

PLS V1.0

Project Log Sheet – Supervisory Session

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7. The log sheet is an important deliverable for the project and an important record of a student's organisation and learning experience. The student **must** hand in the log sheets as an appendix of the final year documentation, with sheets dated and numbered consecutively.

Student's name:Sia De Long..... **Date:** 9th Decemeber 2022...**Meeting No:** ...3.....

Project title: Music Recognition and Genre Classification System **Intake:** APD3F2209CS(IS)

Supervisor's name: Imran Medi (Assoc. Prof . Dr.)..... **Supervisor's signature:** ...IMK.....

Items for discussion (noted by student before mandatory supervisory meeting):

1. Anonymity of data gathering method
2. Need of comparison
3. Optional topic

Record of discussion (noted by student during mandatory supervisory meeting):

1. Focus point of IR
2. The need of some optional topic on technical research
3. Comparison clarifying

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Finalise IR

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.



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PLS V1.0

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6. It is recommended that students bring along log sheets of previous meetings together with the project file during each supervisory session.
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Student's name: ...SIA DE LONG... Date: ...3 rd April 2023... Meeting No: 1/Semester 2

Project title: Music Recognition and Genre Classification System Intake: APD3F2209CSIS

Supervisor's name: ... Imran Medi (Assoc. Prof . Dr.) ... Supervisor's signature:IMK.....
--

Items for discussion (noted by student <u>before</u> mandatory supervisory meeting):
--

1. API usage discussion

Record of discussion (noted by student <u>during</u> mandatory supervisory meeting):
--

1. Suggestion on the API implementation

Action List (to be attempted or completed by student by the <u>next</u> mandatory supervisory meeting):

1. Modification on the system architecture

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.



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Student's name: ...SIA DE LONG... **Date:** ...11st April 2023... **Meeting No:** 2/Semester 2

Project title: Music Recognition and Genre Classification System **Intake:** APD3F2209CSIS

Supervisor's name: ... Imran Medi (Assoc. Prof . Dr.) .. **Supervisor's signature:**IMK.....

Items for discussion (noted by student before mandatory supervisory meeting):

1. Documents for the final submission

Record of discussion (noted by student during mandatory supervisory meeting):

1. Documents approval and signing

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Attach those documents to the final submission file

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

Project Log Sheet



Project Log Sheet – Supervisory Session

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Student's name: ...SIA DE LONG... **Date:** ...14th April 2023... **Meeting No:** 3/Semester 2

Project title: Music Recognition and Genre Classification System **Intake:** APD3F2209CSIS

Supervisor's name: ... Imran Medi (Assoc. Prof. Dr.) ... **Supervisor's signature:**IMK.....

Items for discussion (noted by student before mandatory supervisory meeting):

1. Presentation method and date

Record of discussion (noted by student during mandatory supervisory meeting):

1. Way to schedule a presentation and the method

Action List (to be attempted or completed by student by the next mandatory supervisory meeting):

1. Schedule a date for both supervisor and second marker

Note: A student should make an appointment to meet his or her supervisor (via the consultation system) at least ONE (1) week prior to a mandatory supervisor session – please see document on project timelines. In the event a supervisor could not be booked for consultation, the project manager should be informed ONE (1) week prior to the session so that a meeting can be subsequently arranged.

2.0 Project Proposal Form (PPF)

Office Record Date Received: Received by whom:	Receipt Student name: Student number: Received by: Date:
---	---



PROJECT PROPOSAL FORM

Proposal ID :

Supervisor :

1. Ms. Nor Anis Asma Sulaiman
2. Assoc Prof Dr. SIVAKUMAR
3. Mr. Raheem
4. Assoc Prof Dr. IMRAN MEDI
5. Dr. HAMAM MOKAYED

Student Name : SIA DE LONG

Student No. : TP060810

Email Address : TP060810@mail.apu.edu.my & ericsiadelong@outlook.com

Programme Name : Bachelor of Computer Science (Hons) (Intelligent Systems) (CSIS)

Title of project : Music Recognition and Genre Classification System (MRGCS)

~~~~~

Please record which module(s) your topic is related to:

**Introduction to Database (CT042-3-1-IDB)****AI Methods (062021-ZAB)****Further Artificial Intelligence (092022-AAN)****Enterprise Programming for Distributed Application (092022-KGT)**

### 1. Introduction

*Assume the reader has very little knowledge of the subject. Introduce the topic, the sector of business/industry concerned and how the project relates to it. Define the context of the problem and identify the research required to solve it.*

In this current era, people are more favor to listen to their dearest music via digital album from various music player platform. This is because a digital music album allows them to listen to it from anywhere at all time, while physical album disc will require a CD player in order to listen to it. This technology has brought quite a few advantages to the people including people do not have to queue up for so long or fighting each other for a famous artist album anymore.

Besides that, the genre of music on those platforms are more than enough to fulfil everyone taste such as pop, funk, classical, techno, country and rock and many other more. Moreover, the users can also browse all the related artist's work and find the title of particular music from music recognition. To accomplish the user satisfaction, most of the artists are developing their work on digital album.

In a digital music album, there are a few of digital music. Digital music or digital audio file is a method of representing sound as numerical values and is identical to MP3 music since that is the most widely used file format that digital music exists in. Digital audio file is created by converting analog data into digital data while using various encoding formats to store the audio information (Harris, 2021). As example, a music can be downloaded from the internet and listen to it from the computer or mobile device. That way, the artist can easily promote their work and the audience can have their convenience.

However, the widely used of digital music also has some down side to it. It has caused too many music created by the artist to the platform due to the easement, the main problems come from it are the unbalanced for every work exposure and the difficulty of user to search for a particular music. Therefore, the project will be implementing music recognition and genre classification to overcome the existing problems and improve all the users' experience.

Music recognition is a concept that can be accomplish by using the query-by-example (QBE) music search service to let users find out the identity of audible pre-recorded music by sampling a few second of audio using an audio recording device. There are some other methods of music recognition but QBE recognition technique has been sought by many organisations around the world because of the flexibility on music recognition (Wang, 2006). By implementing music recognition into the system, the difficulty for users to identify a particular music will be overcome because the users can get the result as long as there is a sample audio for that target.

Genre classification is a concept to enable machine to automatically categories and structure the large collections of music available on the internet. The automation of genre classification can assist or replace the manual work from human in this process and would be a valuable addition to music information retrieval systems. Besides that, genre classification establishes a framework for creating and assessing features for any type of content-based analysis of musical signals (Tzanetakis & Cook, 2002). With the use of genre classification, the users can easily find the desired genre based on the genre category.

In this project, the concept of music recognition and genre classification will be analysed in deep for a better understanding to develop a better technique or improve the current existing model. The result produced from this project should be meeting the expected accuracy and reliable. So that, a web application can be developed while applying the introduced concepts to overcome the current problem facing by all type of users.

## 2. Problem Statement

*Identify past and current work in the subject area. Outline the key references to other people's work, indicate for the most pertinent of these how your proposal relates to the ideas they contain.*

### 1. Noise and distortion of music recognition sample audio

The process of acquiring sample audio for the music recognition to conduct the comparison may exist noise and distortion. It has been proven to be one of the challenges facing by the music recognition from the paper (Wang, 2006). The user is expected to be anywhere when using the microphone of the device to recording the sample audio, the background noise such as traffic noise, ambient sound and human speech noise might be appearing in the sample. Therefore, the problem of identify and extract the actual music audio from the signal will be facing by the system. Besides that, the distortion of audio created by the equipment either from source or microphone are also needed to be identify by the system. With the solution for this problem, the music recognition function for the system will be more accurate and providing high reliability for the users.

### 2. Lyrics meaning extraction for genre classification

Most of the genre classification are classifying the music based on the typical features extracted from the music including timbre, melody or harmony and rhythm (Zoia, Nicolas, & Mlynek, 2006). Besides that, the automatic genre classification seems to be only classifying the typical music which is too little and restricting the flexibility for users to search their desired genre. Therefore, a lyric meaning extraction algorithm should be applied by using natural language processing to let the machine not only understanding the rhythm but also combining the meaning with the lyric, with that, the accuracy of the genre classification should be highly increased. In addition, the genre should not be only restricted to the main music type, instead, some emotion keyword such as happy, exciting and sad can be added as a genre during the machine learning phase.

### 3. Key and tempo changes for the sample audio

Key and tempo of the sample audio can be significantly affecting the music recognition result which is proven from the paper (FLORA & XIAO, 2019). The same music with different key can be easily notice and identify by a human hearing. However, it is not the case for the

music recognition algorithm as it not designed for the particular case. From the same paper stated that modification for the algorithm can be made to overcome the issue and recognize the music even when the key and tempo of the sample are incorrect. The study is needed for the modification and product a reliable music recognition algorithm that ready to face key and tempo changes from the sample while ensuring the accuracy of the result is meeting the requirement.

### 3. Project Aim and Objectives

*Identify the AIM(s) of the project, i.e. what the overall achievement is intended to be, in terms of both academic and commercial/industrial advances. Identify the particular intellectual difficulties posed by the proposal, the problems to be addressed, and explain how these might be solved. Clearly list individual measurable OBJECTIVES which can be related to the workplan and deliverables.*

*Aims and objectives are subject to approval from supervisor and students are expected to revise them if deemed inappropriate for a Level 3 project.*

The aim of this project is to improve the accuracy and reliability of music recognition and develop a stable genre classification for the web application system. Therefore, the exposure for every artist's work can be balanced and the difficulty for user to search for a particular music can be ease.

The objectives of this project are:

1. To study the existing machine learning model for music recognition and genre classification.
2. To identify the advantages and disadvantages of the model and improve it with modification or introducing a new technique.
3. To acquire the require and suitable datasets to train the model for the expected result from the machine when testing.
4. To acquire the data of the result produced by the modified model for the record and prove of the improvement.
5. To develop a web application that having account authentication for each role while implementing the model to the system.
6. To identify the weakness and possible future improvement for the final product developed in this project.

#### 4. Literature Review

In this early phase of the project, study on relevant topic and report is conducted to provide a review based on the fact investigation and backing up the project topic. The literature on music recognition and genre classification are mostly describing the process of improvement or implementation to the existing system. Along with that, the information such as limitation and significant improvement from those reports are to be collected as a fact. Due to that, this project can renovate some new ideas that can overcome the limitation while maximize the improvement for the system.

Based on the report produced by Avery Wang, QBE technique is one of the ways to achieve music recognition but it must overcome some technical challenges to produce a good result including dealing with the ambient or environment sound mixing with the target music audio, the distortion such as reverberation and absorption caused by the source equipment and the database management which adding million of music do not decrease the probability of finding the correct target (Wang, 2006). Although these challenges are discovered from QBE technique, these challenges should still be given attention to in order to improve the music recognition.

In the project conducted by Blaise Agüera y Arcas team, they stated that all the existing music recognition applications require a connection to a server that perform the actual recognition which is causing the high battery consumption during the process. Therefore, the team install a small music detector to the digital signal processor to wake it up only when it is confident that music is present, then the music fingerprint will then used to compare with the fingerprint database on the device. The conclusion prove that the battery consumption is decreased significantly while alleviating the need for users to query a server and thereby preserving the user's privacy (Arcas, et al., 2017). This project result has reminded that the importance of battery and time consumption for the music recognition since they are both well related.

Fangjian Flora and Xiao conducted some experiments with the famous Shazam Music application for the identification algorithm. In the conclusion of the experiments, the music can be easily recognised despite the background noise because the algorithm is not fundamentally built to recognize musical structure. However, difference in key and

tempo of the sample can confuse the result produced by the application but there are some ways to modify the algorithm for recognising them (FLORA & XIAO, 2019). This study finds out the key changing in the sample audio can affect the result of music recognition significantly. Hence, this can be a problem for the project to overcome to identify the target music even when the key or tempo change exist in the sample.

According to the report from George Tzanetakis and Perry Cook, musical genre classification can be performed automatically with the result which significantly better than human genre classification in term of chance and performance despite of the fuzzy nature of genre boundaries. Besides that, the paper stated that the result can testifies to their potential as basis for other type of technique including similarity retrieval, segmentation and audio thumbnailing which are describing the musical content by extracting the features (Tzanetakis & Cook, 2002). From this study, the genre classification is proven to be useful for categorising the music by genre and many other techniques are introduced and may be useful for this project.

On the other report conducted, Scaringella Nicolas, Giorgio Zoia, and Daniel Mlynek review the automatic genre classification and present new directions in automatic organization of music collections. Expert system, unsupervised clustering and supervised classification technique were used in that review and identified their advantages and drawbacks for each of them. Besides that, the paper listed out three typical features used to characterize music content which are timbre, melody or harmony and rhythm (Zoia, Nicolas, & Mlynek, 2006). From that, the common element act as parameter needed to perform genre classification are identified while idea of other way to classify music is innovated.

Based on the report conducted by Cory McKay and Ichiro Fujinaga, the paper stated that automatic genre classification is a difficult and problematic task that nonetheless has important value in terms of both pure research and commercial application. Therefore, they come out with some further improvement for the genre classification on a list to get genre classification concept out of local maximum (McKay & Fujinaga, 2006). There are some improvements can be referred to from the paper to be implement on the project for better genre classification to be truly useful for the users.

Although some paper can be slightly unrelated to the music recognition and genre classification, most of them are still quite useful for the project research. The papers show the common way of achieving the functionalities which can be used or introduce a different way of recognition or classification to the music.

## 5. Deliverables / Functionalities

The final product of the project is a web application that having account authentication for every type of user. The web application is acting as a music platform for artist to upload their work and audience to listen to it. The developed music recognition and genre classification algorithm will be utilized and implemented to improve the user experience and overcome the problem brought by the introduction of digital music.

### Target Users:

System administrators, Managerial staff, Music artist, Music audience, Music market analyzer

#### MRGCS allows system administrators

- Login to the system
- Add or remove account for every type of role in the system
- Able to modify or access to all the database in the system
- Browse music from the database while using the genre category
- Perform music recognition

#### MRGCS allows managerial staff

- Login to the system
- Register an account
- Produce a report of the accuracy of the result

- Add or restrict account of music artist, music audience and music market analyser for inappropriate actions.
- Browse music from the database while using the genre category
- Perform music recognition

**MRGCS allows music artist**

- Login to the system
- Register an account
- Upload music work to the system
- Observe own work viewed count and exposure from the system
- Obtain the information of similar percentage of other music compare to own music
- Identify the popular genre of the music in the database
- Browse music from the database while using the genre category
- Perform music recognition

**MRGCS allows music audience**

- Login to the system
- Register an account
- Browse music from the database while using the genre category
- Perform music recognition

**MRGCS allows music market analyzer**

- Login to the system
- Register an account
- Produce a graph showing the history of user listen to a particular music
- Identify the popular genre of the music in the database
- Browse music from the database while using the genre category
- Perform music recognition

## 6. References

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- FLORA, F., & XIAO. (2019). EXPERIMENTS WITH THE SHAZAM MUSIC IDENTIFICATION ALGORITHM. Illinois, Urbana.
- Harris, M. (2021). *Lifewire*. Retrieved September 10th, 2022, from <https://www.lifewire.com/what-is-digital-music-2438426>
- McKay, C., & Fujinaga, I. (2006). Musical genre classification: Is it worth pursuing and how can it be improved? *ISMIR*, 101-106.
- Tzanetakis, G., & Cook, P. (2002). Musical Genre Classification of Audio Signals. *IEEE TRANSACTIONS ON SPEECH AND AUDIO PROCESSING*, 293-302.
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### **3.0 Project Specification Form (PSF)**

STUDENT ID : **TP060810**  
INTAKE ID : **APD3F2209CS(IS)**  
STUDENT NAME : **Sia De Long**

#### **Project Title**

“MRGCS” - Music Recognition and Genre Classification System

#### **Project Background**

##### **Problem Context**

In this current era, people are more favour to listen to their dearest music via digital album from various music player platform. This is because a digital music album allows them to listen to it from anywhere at all time, while physical album disc will require a CD player in order to listen to it. This technology has brought quite a few advantages to the people including people do not have to queue up for so long or fighting each other for a famous artist album anymore. Besides that, the genre of music on those platforms are more than enough to fulfil everyone taste such as pop, funk, classical, techno, country and rock and many other more. Moreover, the users can also browse all the related artist’s work and find the title of particular music from music recognition. To accomplish the user satisfaction, most of the artists are developing their work on digital album. In a digital music album, there are a few of digital music. Digital music or digital audio file is a method of representing sound as numerical values and is identical to MP3 music since that is the most widely used file format that digital music exists in. Digital audio file is created by converting analog data into digital data while using various encoding formats to store the audio information (Harris, 2021). As example, a music can be downloaded from the internet and listen to it from the computer or mobile device. That way, the artist can easily promote their work and the audience can have their convenience. However, the widely used of digital music also has some down side to it. It has caused too many music created by the artist to the platform due to the easement, the main problems come from it are the unbalanced for every work exposure and the difficulty of user to search for a particular music.

## Rationale

To overcome the problem stated above, a music recognition and genre classification system “MRGCS” will be a web application that recognize the music with a sample audio provided and classify the music existing in the library. One of the advantages of the system would be the difficulty for users to identify a particular music cause by too many digital music existing will be overcome because the users can get the result as long as there is a sample audio of the target music provided to the system. Besides that, with the use of genre classification, not only the audience can easily find the desired genre based on the genre category but also ease the artist to label their music uploaded to the system with a constant genre classification algorithm. In conclude, the final product of the web application will provide two types of benefits shown as below:

### Tangible Benefits:

- Reduce the cost of time, unrenewable energy such as electricity for the audience needed to search for a music they heard or only having a small portion of the full music.
- The action of artist using physical album disc to promote and distribute their music work will be reduced significantly to have a greener environment since the digital music is also reliable on the organised system.
- There will be no need for audience to store their disc in their storage of shelf rack, instead they can store lot of their music into a single hard disk if they want to download the music to their device.
- Music market analyser can predict or obtain the information of which genre of music is popular among the audience to produce a work that is expected to be liked by the audience.

### Intangible Benefits:

- Artist who uploads work to the system can enjoy the convenience from genre classification system identifying their work’s genre to the audience.
- Audience can easily explore for music that have similar genre with their favourite music with the use of genre classification.
- Artist can easily know how many people had viewed their own work from the system.

## **Nature of Challenge**

First and foremost, the user interface is one of the challenges in this project since the final product will be a web application that can be access from every device that able to run a browser, different type of device will have a different resolution for the display screen which will cause the elements of the interface appear at a not desired place. Therefore, the design of dynamic interface will be a challenge to the web application. Besides that, the security of the web application is also very important to this project in order to prevent any malicious modification to the database causing the model to produce a wrong answer. Moreover, the skills and techniques for signal processing and the filtering for the noise and distortion to the music audio file is the most crucial challenge to the project since it will directly affect to the project functionalities result. Last but not least, the constant project coding file structure is also a challenge part where all the naming contention and coding technique must be oriented and constant throughout the whole project.

## **Project Objectives**

### **Deliverables**

The final product of the project is a web application that having account authentication for every type of user. The web application is acting as a music platform for artist to upload their work and audience to listen to it. The developed music recognition and genre classification algorithm will be utilized and implemented to improve the user experience and overcome the problem brought by the introduction of digital music. However, the main feature of the web application would be the music recognition and genre classification, other features will be considered as extra and will only be completed if there is sufficient time for them.

### **Target Users:**

System administrators, Managerial staff, Music artist, Music audience, Music market analyser

**Main Features:****MRGCS allows every user type**

- Browse music from the database while using the genre category
- Perform music recognition

**Extra Features:****MRGCS allows system administrators**

- Login to the system
- Add or remove account for every type of role in the system
- Able to modify or access to all the database in the system

**MRGCS allows managerial staff**

- Register an account
- Login to the system
- Produce a report of the accuracy of the result
- Add or restrict account of music artist, music audience and music market analyser for inappropriate actions.

**MRGCS allows music artist**

- Register an account
- Login to the system
- Upload music work to the system while the genre will be classified
- Observe own work viewed count and exposure rate to the audience from the system
- Obtain the information of similar percentage of other music compare to own music
- Identify the popular genre of the music in the database

**MRGCS allows music audience**

- Register an account
- Login to the system

**MRGCS allows music market analyser**

- Register an account
- Login to the system
- Produce a graph showing the history of user listen to a particular music
- Identify the popular genre of the music in the database

**Resources needed by the proposal****Hardware**

There is a minimum hardware requirement to perform the project activities and meet the objectives of project which are:

- Processor - Intel Pentium 4
- 512MB of Random Access Memory (RAM)
- Keyboard and Mouse
- Microphone
- Router or Wi-Fi

**Software**

The minimum software requirement for this project including:

**Integrated Development Environment for Coding and Database Management System**

- Visual Studio 2019 16.8.5
- Microsoft SQL Server Management Studio 18

**Server-Side Scripting, Web Server and File Transfer Protocol (FTP) Software**

- PHP 8.1
- Apache 2.4.54
- FileZilla 3.62.0.

### **Documentation and Schedule Planning**

- Microsoft Word 2016
- Microsoft Project 2016

### **Access to information / expertise**

The machine learning and signal processing knowledge area will require consultation from experienced expert including the project supervisor and other lecturers. Besides that, the required information will be collected from APU students and lecturers through the interviews section and questionnaire survey regarding existing similar system.

### **User Involvement**

The user who will be involved are students and lecturers from APU which will include different level of user on existing system which are novice, casual and expert to collect different feedback from different point of view. Interview and questionnaire will be conduct at first to gather information about existing system, then feedback will be collected after the new system introduced by the project. Besides that, they will be involved to the usability testing for the system.

### **Academic research being carried out and other information, techniques being learnt.**

Some domain knowledge and dataset are required to complete the deliverables of this project, so the books that I will study and the dataset that will be used are:

### **Books**

- Name : Fundamentals of Music Processing: Audio, Analysis, Algorithms, Applications
- Author : Meinard Müller
- Publisher : Springer, 2015

- Name : Speech and Audio Signal Processing: Processing and Perception of Speech and Music  
Author : Ben Gold, Nelson Morgan, Dan Ellis  
Publisher : John Wiley & Sons, 2011
- Name : Deep Learning  
Author : Ian Goodfellow, Yoshua Bengio, Aaron Courville  
Publisher : MIT Press, 2016
- Name : Handbook of Artificial Intelligence for Music: Foundations, Advanced Approaches, and Developments for Creativity  
Author : Eduardo Reck Miranda  
Publisher : Springer Nature, 2021
- Name : Neural Network Music Genre Classification  
Author : Nikki Pelchat  
Publisher : Faculty of Graduate Studies and Research, University of Regina, 2021
- Name : Machine Learning for Automatic Genre Classification  
Author : Aidan Finn  
Publisher : University College Dublin, 2002
- Name : Learning Web App Development: Build Quickly with Proven JavaScript Techniques  
Author : Semmy Purewal  
Publisher : "O'Reilly Media, Inc.", 2014
- Name : Web Application Security, A Beginner's Guide  
Author : Bryan Sullivan, Vincent Liu  
Publisher : McGraw Hill Professional, 2011

## Datasets

- Name : Million Song Dataset  
Available from : <http://millionsongdataset.com/>
- Name : MTG-Jamendo  
Available from : <https://github.com/MTG/mtg-jamendo-dataset>

## **System Development Methodology**

The decision of the system development methodology should be made in the early phase of the project and it is very critical as the whole project schedule need to always refer to the methodology principles. There are two type of system development methodology which are traditional and agile methodology where traditional method will be more fixed to the flow while agile method can be more flexible and adaptive to any urgent or unexpected changes during the development phases after the planning (Whee Yen, Kim Yeow, & Chan Wai, 2013). Therefore, the chosen development method for this project will be **Scrum** which is under the agile methodology framework. Scrum is a framework that having multiple sprint that include the phases of planning, implementation, review and retrospective. The reason of choosing scrum is that it works very well for innovative and complex development projects because it will have a product backlog that list out the priority of the project which emphasize on the main feature of music recognition and genre classification for this project, so that they can be completed first before extra feature add on to the system. Besides that, the flexibility of defining the duration for each sprint can help the developer to easily manage the time for each of the functionalities for the system, hence the important feature can have more time to develop while small feature will be less. Moreover, scrum will take account on review from stakeholder for every sprint in the project, with it, the system can be improved on a more critical direction and fixing unexpected exception happened from the users such as the accuracy of music recognition is not meeting their satisfaction (Mahnic & Drnovscek, 2005).

## **Evaluation and Test Plan**

### **Success Criteria**

The main goal of the Music Recognition and Genre Classification system will be focusing on the main feature which are the accuracy of music recognition and a constant genre classification feature. In order to prove these two features are functioning as the project needs, 5 students and lectures from APU will be chosen to conduct a testing to the system.

## **Unit Testing**

Unit testing referring to testing all the functionalities in units including the music recognition and genre classification function. Each of the unit will be tested separately and result produced by a single unit will not affect each other to confirm that every unit is working as expected to meet the project requirement and goal. For example, in the music recognition, there will have a unit that acquire audio wave from the device's microphone. After all the unit in the system are tested, then the testing can be moved on to the integration testing phase.

## **Integration Testing**

With the confirmation of every unit is working accordingly, the integration of units will be tested subsequently. The testing will be conducted by looking at the result produced from the integration of modules, this will make sure that the data is transferred correctly from page to page on the web application. For example, the user can select a genre to search for, then the system will request for data list that carrying the same genre and display it to the front end. The process of the interaction between the front end and back end will be tested to make sure everything is working properly.

## **Usability Testing**

The usability testing will be carried out by letting a few of the tester to interact the system using real data. It will mainly test on the user satisfaction based on their experience to the system. The design of the interface should be user friendly which can be easily understand and learn to use especially for novice level user while the flow of the web page and the response time between server and client will also be evaluated, so that the system can be proven as reliable for real situation usage to the users.

## References

- Harris, M. (2021). *Lifewire*. Retrieved September 10th, 2022, from <https://www.lifewire.com/what-is-digital-music-2438426>
- Mahnic, V., & Drnovsek, S. (2005). Agile Software Project Management with Scrum . *EUNIS Conference-Session papers and tutorial abstracts*, (p. 6).
- Whee Yen, W., Kim Yeow, T., & Chan Wai, L. (2013). The Importance of a Software Development Methodology in IT Project Management: An Innovative Six Sigma Approach - A Case Study of a Malaysian SME Organization. *IEEE Symposium on Business, Engineering and Industrial Applications*. Kuching, Malaysia.

## 4.0 Fast-Track Ethics Form

|                   |                                       |
|-------------------|---------------------------------------|
| Office Record     | Receipt – Fast-Track Ethical Approval |
| Date Received:    | Student name:                         |
|                   | Student number:                       |
|                   | Received by:                          |
| Received by whom: | Date:                                 |

**APU / APIIT FAST-TRACK ETHICAL APPROVAL FORM (STUDENTS)**

|                                                                                                                                                                                                                                             |                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tick one box (level of study):<br><input type="checkbox"/> POSTGRADUATE (PhD / MPhil / Masters)<br><input checked="" type="checkbox"/> UNDERGRADUATE (Bachelors degree)<br><input type="checkbox"/> FOUNDATION / DIPLOMA / Other categories | Tick one box (purpose of approval):<br><input checked="" type="checkbox"/> Thesis / Dissertation / FYP project<br><input type="checkbox"/> Module assignment<br><input type="checkbox"/> Other: _____ |
| Title of Programme on which enrolled ..... Bachelor of Computer Science (Hons) (Intelligent Systems) .....                                                                                                                                  |                                                                                                                                                                                                       |
| Tick one box: <input checked="" type="checkbox"/> Full-Time Study or <input type="checkbox"/> Part-Time Study                                                                                                                               |                                                                                                                                                                                                       |
| Title of project / assignment ..... Music Recognition and Genre Classification System (MRGCS) .....                                                                                                                                         |                                                                                                                                                                                                       |
| Name of student researcher ..... SIA DE LONG .....                                                                                                                                                                                          |                                                                                                                                                                                                       |
| Name of supervisor / lecturer..... Imran Medi (Assoc. Prof . Dr.) .....                                                                                                                                                                     |                                                                                                                                                                                                       |

**Student Researchers- please note that certain professional organisations have ethical guidelines that you may need to consult when completing this form.**

**Supervisors/Module Lecturers - please seek guidance from the Chair of the APU Research Ethics Committee if you are uncertain about any ethical issue arising from this application.**

|   |                                                                                                                                                     | YES | NO | N/A |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|-----|
| 1 | Will you describe the main procedures to participants in advance, so that they are informed about what to expect?                                   | ✓   |    |     |
| 2 | Will you tell participants that their participation is voluntary?                                                                                   | ✓   |    |     |
| 3 | Will you obtain written consent for participation?                                                                                                  | ✓   |    |     |
| 4 | If the research is observational, will you ask participants for their consent to being observed?                                                    | ✓   |    |     |
| 5 | Will you tell participants that they may withdraw from the research at any time and for any reason?                                                 | ✓   |    |     |
| 6 | With questionnaires and interviews will you give participants the option of omitting questions they do not want to answer?                          | ✓   |    |     |
| 7 | Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs? | ✓   |    |     |
| 8 | Will you give participants the opportunity to be debriefed i.e. to find out more about the study and its results?                                   | ✓   |    |     |

If you have ticked **No** to any of Q1-8 you should complete the full Ethics Approval Form.

|    |                                                                                                                       | YES | NO | N/A |
|----|-----------------------------------------------------------------------------------------------------------------------|-----|----|-----|
| 9  | Will your project/assignment deliberately mislead participants in any way?                                            |     | ✓  |     |
| 10 | Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort? |     | ✓  |     |
| 11 | Is the nature of the research such that contentious or sensitive issues might be involved?                            |     | ✓  |     |

If you have ticked **Yes** to 9, 10 or 11 you should complete the full Ethics Approval Form. In relation to question 10 this should include details of what you will tell participants to do if they should experience any problems (e.g. who they can contact for help). You may also need to consider risk assessment issues.

|    |                                                                                                                                                                                                                                                       | YES                                                                                                                                                                                                                              | NO | N/A |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----|
| 12 | Does your project/assignment involve work with animals?                                                                                                                                                                                               |                                                                                                                                                                                                                                  | ✓  |     |
| 13 | Do participants fall into any of the following special groups?<br><br><b>Note that you may also need to obtain satisfactory clearance from the relevant authorities</b>                                                                               | Children (under 18 years of age)<br>People with communication or learning difficulties<br>Patients<br>People in custody<br>People who could be regarded as vulnerable<br>People engaged in illegal activities ( eg drug taking ) | ✓  |     |
| 14 | Does the project/assignment involve external funding or external collaboration where the funding body or external collaborative partner requires the University to provide evidence that the project/assignment had been subject to ethical scrutiny? |                                                                                                                                                                                                                                  | ✓  |     |

If you have ticked Yes to 12, 13 or 14 you should complete the full Ethics Approval Form. There is an obligation on student and supervisor to bring to the attention of the APU Research Ethics Committee any issues with ethical implications not clearly covered by the above checklist.

**STUDENT RESEARCHER**

Provide in the boxes below (plus any other appended details) information required in support of your application, THEN SIGN THE FORM.

**Please Tick Boxes**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| I consider that this project/assignment has no significant ethical implications requiring a full ethics submission to the APU Research Ethics Committee.                                                                                                                                                                                                                                                                                                 | ✓ |
| <b>Give a brief description of participants and procedure (methods, tests used etc) in up to 150 words.</b>                                                                                                                                                                                                                                                                                                                                              |   |
| Questionnaire made by google form will be distributed among student in APU to gather mostly quantitative data while interview will be conducted as well to collect qualitative data as it will be more details. Interview can be conducted via physical or virtually depend on the participant preference. These two methods may be conducted on lecturer from APU as well to collect data if available.                                                 |   |
| I also confirm that:<br>i) All key documents e.g. consent form, information sheet, questionnaire/interview are appended to this application.<br><br>Or<br>ii) Any key documents e.g. consent form, information sheet, questionnaire/interview schedules which need to be finalised following initial investigations will be submitted for approval by the project/assignment supervisor/module lecturer before they are used in primary data collection. |   |

E-signature..... Sia ..... Print Name..... SIA DE LONG..... Date 17<sup>th</sup> Nov 2022  
(Student Researcher)

*Please note that any variation to that contained within this document that in any way affects ethical issues of the stated research requires the appending of new ethical details. New ethical consent may need to be sought.*

The completed form (and any attachments) should be submitted for consideration by your Supervisor/Module Lecturer

**SUPERVISOR/MODULE LECTURER  
PLEASE CONFIRM THE FOLLOWING:**

| Please Tick Box                                                                                                                                                                                                                                                                                                                                                                                                                |                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| I consider that this project/assignment has no significant ethical implications requiring a full ethics submission to the APU Research Ethics Committee                                                                                                                                                                                                                                                                        | <input checked="" type="checkbox"/> X |
| i) I have checked and approved the key documents required for this proposal (e.g. consent form, information sheet, questionnaire, interview schedule)                                                                                                                                                                                                                                                                          | <input type="checkbox"/>              |
| Or                                                                                                                                                                                                                                                                                                                                                                                                                             | <input type="checkbox"/>              |
| ii) I have checked and approved draft documents required for this proposal which provide a basis for the preliminary investigations which will inform the main research study. I have informed the student researcher that finalised and additional documents (e.g. consent form, information sheet, questionnaire, interview schedule) must be submitted for approval by me before they are used for primary data collection. | <input checked="" type="checkbox"/> X |

**SUPERVISOR AND SECOND ACADEMIC SIGNATORY**

**STATEMENT OF ETHICAL APPROVAL (please delete as appropriate)**

- 1) **THIS PROJECT/ASSIGNMENT HAS BEEN CONSIDERED USING AGREED APU/SU PROCEDURES AND IS NOW APPROVED**
- 2) **THIS PROJECT/ASSIGNMENT HAS BEEN APPROVED IN PRINCIPLE AS INVOLVING NO SIGNIFICANT ETHICAL IMPLICATIONS, BUT FINAL APPROVAL FOR DATA COLLECTION IS SUBJECT TO THE SUBMISSION OF KEY DOCUMENTS FOR APPROVAL BY SUPERVISOR (see Appendix A)**

E-signature... IMK ... ... ... ... Print Name... Imran Medi ... ... ... Date...17/11/2022...  
(Supervisor/Lecturer)

E-signature... .... Print Name... .... Date... ....  
(Second Academic Signatory)

|                   |                                               |
|-------------------|-----------------------------------------------|
| Office Record     | Receipt – Appendix A (Fast-Track Ethics Form) |
| Date Received:    | Student name:                                 |
| Received by whom: | Student number:<br>Received by:<br>Date:      |

**APPENDIX A  
AUTHORISATION FOR USE OF KEY DOCUMENTS**

**Completion of Appendix A is required when for good reasons key documents are not available when a fast track application is approved by the supervisor/module lecturer and second academic signatory.**

I have now checked and approved all the key documents associated with this proposal e.g. consent form, information sheet, questionnaire, interview schedule

Title of project/assignment... .... Music Recognition and Genre Classification System (MRGCS) .... .....

.....  
Name of student researcher ..... SIA DE LONG .....

Student ID: ..... TP060810 ..... Intake: ..... APD3F2209CS(IS) .....

E-signature... IMK ..... Print Name... Imran Medi ..... Date...17/11/2022...  
(Supervisor/Lecturer)

## 5.0 Questionnaire

# Music Recognition and Genre Classification System (MRGCS)

My name is Sia De Long. I am a student from Asia Pacific University of Technology and Innovation (APU) pursuing my degree in Bachelor of Computer Science (Hons) (Intelligent Systems). I am currently working on my final year project titled "Music Recognition and Genre Classification System (MRGCS)". The aim of this project is to improve the accuracy and reliability of music recognition and develop a stable genre classification for the web application system. Therefore, the exposure for every artist's work can be balanced and the difficulty for user to search for a particular music can be ease.

The questionnaires is conducted for gathering data about the opinion on related question on problem context and requirements of the system. It will only take less than 5 minutes of your time to be completed. Your participation is voluntary and may withdraw from it anytime throughout the questionnaires. All the collected data from your response will be strictly confidential. If you have problems or concerns regarding this questionnaires, please fell free to contact me through the contact information as provided below.

Thank you for your corporation.

Sincerely,  
Sia De Long TP060810  
TP06010@mail.apu.edu.my

\* Required

### Participation Note

1. Your participant is completely voluntary and you are considered to be read the study description. \*

Understood

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## Music Recognition and Genre Classification System (MRGCS)

\* Required

## Demographic

2. What is your gender? \*

- Male
- Female

3. What is your age group? \*

- Under 25
- 26 - 35
- 36 - 45
- 46 - 55
- 56 and above

4. What is your main language? \*

- Malay
- Mandarin
- English
- Other

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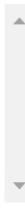
This content is created by the owner of the form. The data you submit will be sent to the form owner. Microsoft is not responsible for the privacy or security practices of its customers, including those of this form owner. Never give out your

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## Music Recognition and Genre Classification System (MRGCS)

\* Required

## 5. Music Recognition \*

|                                                                                                    | Strongly Disagree     | Disagree              | Neutral               | Agree                 | Strongly Agree        |
|----------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I had experience listening to a song but do not know the name                                      | <input type="radio"/> |
| I want to know the name of the music when the music is play on public places (shopping mall, club) | <input type="radio"/> |
| I have the experience of getting the wrong result from existing music recognition system           | <input type="radio"/> |
| I want to know the name of the music when I only have a part of the audio                          | <input type="radio"/> |
| I want to know the name of the music even though it is only instrumental                           | <input type="radio"/> |
| I want the music recognition not only accept audio from microphone but also from files (MP3, WAV)  | <input type="radio"/> |
| I want the music recognition startup as soon as possible                                           | <input type="radio"/> |
| I can remember all the name of the music that I heard before                                       | <input type="radio"/> |

## 6. Genre Classification \*

|                                                                         | Strongly Disagree     | Disagree              | Neutral               | Agree                 | Strongly Agree        |
|-------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I can classify genre for the music myself consistently                  | <input type="radio"/> |
| I feel confuse when the classification is too many and detail           | <input type="radio"/> |
| I look for music through the selection of genre first                   | <input type="radio"/> |
| I can easily remember genre for everyone music I have                   | <input type="radio"/> |
| I want to know the most popular genre of the current trend              | <input type="radio"/> |
| I want to look for music that have similar genre with my favorite music | <input type="radio"/> |

## 7. I would like the web application to have following extra features: \*

Please select at most 2 options.

- Able to observe your music work's viewed count and exposure rate to the audience from the system
- Able to obtain the information of similar percentage of other music compare to your own work
- Able to identify the popular genre of the music in the database
- Able to produce a graph showing the history of user listen to a particular music

## 8. I am more focus on \*

- The accuracy of music recognition
- The consistency of genre classification
- The user friendliness of the web application

Back

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## 6.0 Interview Questions

### **Music Recognition and Genre Classification System (MRGCS) Interview Questions**

Age : \_\_\_\_\_

Date : \_\_\_\_\_

Main Language : \_\_\_\_\_

Interviewer Name : \_\_\_\_\_

1. What is the main factor for music recognition that will make you think it is reliable?

A:

2. What is music data acquisition method (microphone, audio file) you prefer for the music recognition?

A:

3. What is your opinion in term of number and consistency on genre?

A:

4. What is the way that you choose for a music at any time?

A:

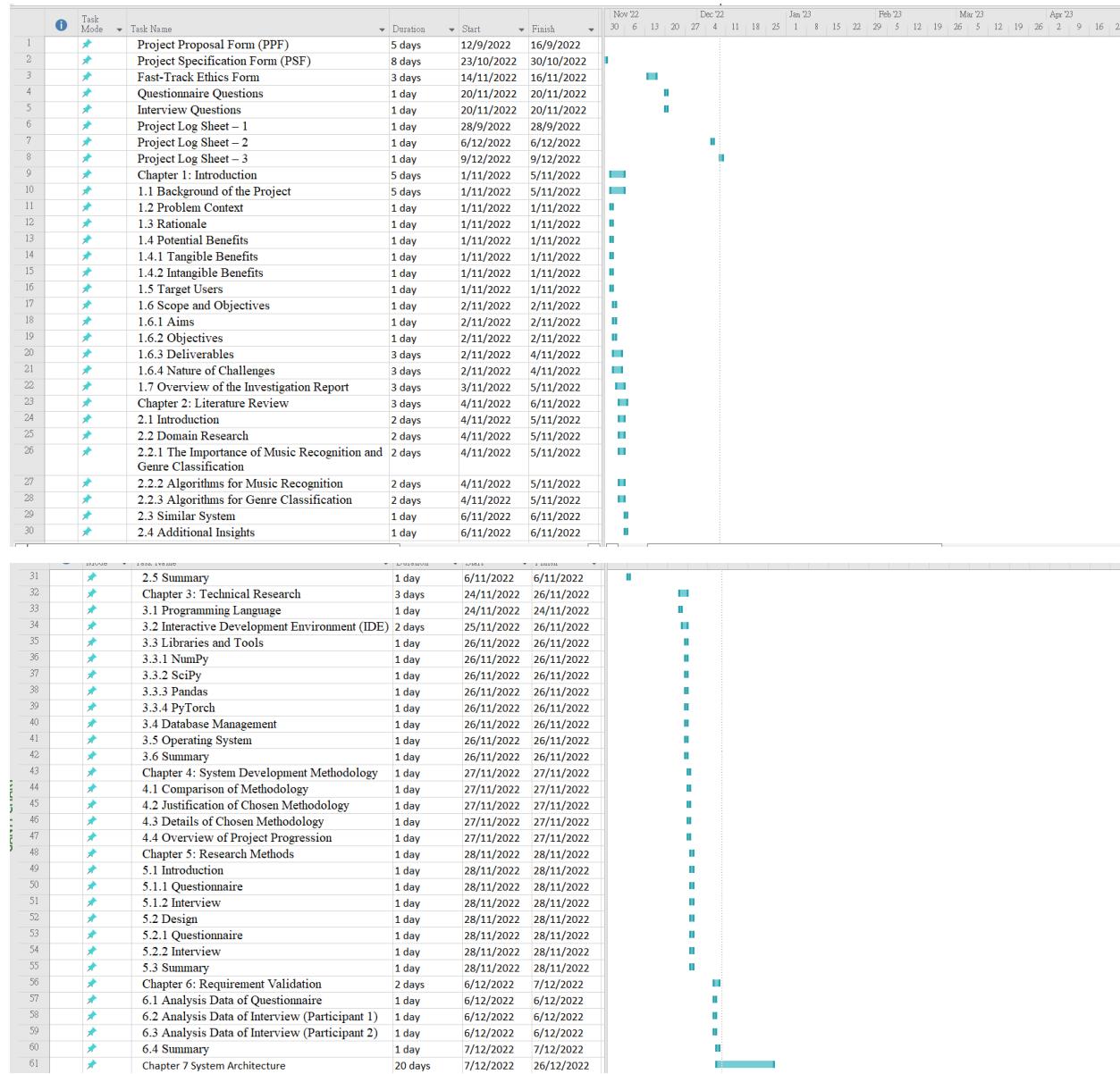
5. What extra features that you desired the most?

A:

6. What is your main expectation for that web application of music recognition and genre classification?

A:

## 7.0 Gantt Chart





## 8.0 Project Poster

**Music Recognition and Genre Classification System (MRGCS)**

Sia De Long  
Bachelor of Computer Science (Hons) (Intelligent Systems) - APD3F2209CS(IS)


**A • P • U**  
ASIA PACIFIC UNIVERSITY  
OF TECHNOLOGY & INNOVATION

**Introduction**

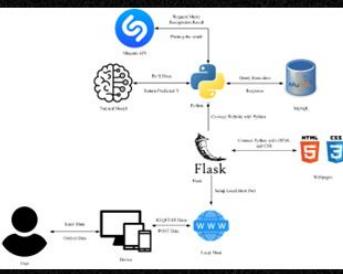
In this current era, people are more favour to listen to their dearest music via digital album from various music player platform. This is because a digital music album allows them to listen to it from anywhere at all time, while physical album disc will require a CD player in order to listen to it. This technology has brought quite a few advantages to the people including people do not have to queue up for so long or fighting each other for a famous artist album anymore. Besides that, the genre of music on those platforms are more than enough to fulfil everyone taste such as pop, funk, classical, techno, country and rock and many other more. Moreover, the users can also browse all the related artist's work and find the title of particular music from music recognition. To accomplish the user satisfaction, most of the artists are developing their work on digital album.

**System Features**

- Browse music from the database while using the genre category
- Perform music recognition
- Prioritised extra feature (if there is extra time):
  - Able to identify the popular genre of the music in the database
  - Able to look for music that have similar genre with their favourite music
- Highlighting Features:
  - Music recognition that only need a part of the audio
  - Music recognition that recognises not only song with lyrics but also instrumental music
  - Acquiring sample audio not only from microphone but also accept speaker as input
  - Fast boot up speed and straight-forward design to perform music recognition immediately
  - Consistent genre classification

**Project Goal**

The concept of music recognition and genre classification will be analysed in deep for a better understanding to develop a better technique or improve the current existing model. The result produced from this project should be meeting the expected accuracy and reliable. So that, a web application can be developed while applying the introduced concepts to overcome the current problem facing by all type of users.







**Implementation**

  
**Flask**

The MRGCS uses Flask framework to implement the final system on the platform provided by PyCharm. Python-based Flask is a web application framework that enables quick and simple web application development. Developers may create scalable, modular, and simple-to-maintain web applications with the aid of the libraries and tools offered by Flask. Besides that, Static files, templates, and a collection of Python files make up the majority of Flask applications.

## 9.0 Confidentiality Form

### DECLARATION OF THESIS CONFIDENTIALITY

Author's full name: **DE LONG SIA**

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Thesis/Project title: **Music Recognition and Genre Classification System  
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