

Title: AI Music Genre Classification

University of Galway

School of Computer Science

Final Year Project

Author: Connor Adams

Supervisor: Dr. Adrian Clear

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I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of (degree or higher diploma or masters) is entirely my own work and had not been taken from the work of others save and to the extent that such work has been cited and acknowledged with the text of my work.

Signed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Abstract**

This enhanced structure incorporates detailed methodologies from the Tzanetakis and Cook paper, providing a comprehensive framework for your research on classifying music genres using AI. It emphasizes a systematic approach to feature extraction, classifier design, and the evaluation of AI models, ensuring a robust exploration of AI-driven music classification.

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**Acknowledgments**

I would like to take a moment to say thanks to my supervisor, Adrian Clear, in assisting me in completing this Final Year Project. Despite the area in AI/Music which I chose neither of which being his fields, regardless Adrian still took on Michael Schukat’s project for me on AI Music Composition as I was extremely fascinated in this area. Providing weekly in person meetings some being up to an hour-long Adrian was persistent in keeping me on track and bringing focus to the project. I initially was interested in using AI to compose a new genre of music, following discussion and research we decided that a Musical Genre Classification approach would be more suited for what we wanted to achieve. I would also like to thank friends and family who helped me narrow my ideas through discussion.

# Introduction

## Background

Music information retrieval (MIR) is an emerging research area that receives growing attention from both the research community and music industry (Fu et al., 2011).

* Write a nice paragraph on the background of the field of research that you’re exploring.

Automatic musical genre classification can potentially automate this process and provide an important component for a complete music information retrieval system.

Tazans paper reference (Tzanetakis and Cook, 2002)

Music Genre Classification: Discuss the concept of music genres and their subjective nature. Review the traditional and AI-based methods in music genre classification, focusing on the challenges of defining and categorizing music genres.

Feature Extraction in Music Analysis: Provide an overview of feature extraction methods for music signals, comparing traditional audio features with those specifically designed for music content analysis. Highlight the importance of timbral, rhythmic, and pitch features.

Classification Techniques: Review statistical pattern recognition classifiers, including Gaussian Mixture Models (GMM), K-Nearest Neighbors (K-NN), and their application in music genre classification. Discuss the relevance and performance of these techniques in existing studies.

## Project Overview

Project Overview: Introduction to the importance of music genre classification and the potential of AI in transforming how we interact with music. Discuss the challenges in automated music genre classification, including the complexity of music as a signal and the subjective nature of genre categorization.

**Problem Statement:**

How might we (fix some sort of problem) by (doing something about it).

**Research Objectives:**

Objectives: Detail the aim to develop an AI-based tool capable of analysing music samples and accurately classifying them into genres by assessing timbral, rhythmic, and pitch content. This project could have significance in enhancing music recommendation systems, organizing music libraries, and assisting in musicology research.

1. Review the literature in the field of artificial intelligence applied to automated classification of music datasets.

2. Develop a piece of code capable of classifying audio data based on timbral, rhythmic and pitch features.

3. Test the code on datasets and compile results

To begin my project starting with research, my project supervisor advised me to spend some time on Google Scholar, looking up relevant topics on AI Music Composition he also showed me how to use the cited by feature to find the most relevant recent material relating to the topics I was researching. I found a fascinating paper by Vincent C. Müller called ‘Philosophy and Theory of Artificial Intelligence 2017’. There was a lot of content in the paper, but I was particularly intrigued by sections on the impossibility of artificial consciousness and the phenomenal consciousness (first-person experience of having qualia – sensory experiences) Or what it’s like to see, hear, taste, touch, and feel. The debate revolves around whether AI can possess subjective experiences akin to human consciousness. This question is still largely speculative and a subject of ongoing philosophical and ethical inquiry.

Creativity: “A widely recognised feature of musical works (MWs) is that they did not exist before being created by a composer: a MW to be identified as such, is necessarily created. We can thus claim that the composer performs an act of creativity. To assess whether computers can create MWs, then it is necessary to ask the question: “Can a computer be creative?”, -quote from the paper mentioned above.

One argument here is that creativity involved the generation of novel & original ideas, driven by human experiences, emotions, and cultural context. Computers, lacking consciousness, and personal experiences might be limited to combining existing elements in novel ways rather than creating entirely new concepts.

When asking Chat GPT to produce new melodies including stepwise scalar motion as well as leaps and arpeggiations and to also suggest a changing chord progression the results were initially quite boring, addressing these issues (opening just a c major scale hardly even a melody/abrupt ending). All the notes given are from a C major scale, but the more interesting issue emerging is metric phase (where you are in the beat/measure) the revised melody by Chat GPT moved the part of the melody we liked (middle) and puts it in a different metric phase then the original. Should have placed the high E on the beat. This all points to the fact that GPT does not understand rhythmic context. It is concatenating little segments of melody without considering for how these segments line up with rhythmic cycles.

My brother’s friend Mark Duggan completed a degree of MA Creative Music Technology in Maynooth University called Choosing Chance: AN Exploration of Aleatoric Possibilities. I reached out to him on social media informing him of my project specification and course and he was more than happy to share his portfolio with me and discuss obstacles he encountered and overcame and how he approached his topic. Mark used CSound which is a musician friendly version of C with one-word commands in place of more code for less confident coders to implement, he mentions in his portfolio he uses CSound to create plugins to achieve reverb, filter, stereo chorus and wave-shaping effects. Mark used CSound to create a piece that would never be the same twice. Mark mentions Aleatoric music which is a type of music where some element of the composition is left to chance or is indeterminate. Giving the music an unintentional unpredictability in some way (Britannica, Miriam-Webster) Described as chance music and indeterminacy. Essentially a piece is designed with an element of chance which allows the performance to create a unique version of a piece each time it is played. Key characteristics of Aleatoric music include: Indeterminacy/Freedom for Performers/ Graphic Notation/ Collaborative Creation gaining prominence in the mid-20th century as part of the broader avant-garde and experimental movements, its influence persists and contemporary composers continue to explore the creative possibilities offered by chance and indeterminacy in music.

Compositions which have been written with the intention of using chance to avoid some of the tendencies that a composer might use excessively in their work. Each piece contains some element beyond my control as a composer to create the final pieces.

I hoped that my lack of choice in some areas would mean that instead of struggling to decide on every detail of a piece.

## Project Context and Relevance

* Write some stuff here about how you originally wanted to compose music with AI but after you became more familiar with the research field, you decided to focus on genre classification. My initial idea for this project was to query ChatGPT on creating a brand new musical genre, potentially blending existing ones together. As I have a huge passion/interest in this area I was excited to explore it, however following a couple of supervisor meetings I decided to focus more on genre classification as I was struggling to find a practical use for my original idea and it may have just been a composition at the end instead of a tool which artists can use to compose music.

The goal is to advance the realm of music composition, researching/exploring and with the aid of innovative AI algorithms, the plan is to create a system which can autonomously generate upon user request, unique/creative compositions. The aim is to encompass existing methods to create rhythms/melodies/entire compositions, to create and train a model which takes user rating to learn and improve on generated beats. Project seeks to push the boundaries of AI as we know it in the realm of art & music, capturing new never heard before music while simultaneously contributing to the understanding between the crossover between creative arts and technology. The relevance of this lies in its ambition to break new ground in AI’s application in the arts, the creative-technology crossover, tuning an algorithm to a user’s desired taste. It focuses on pioneering music composition through AI algorithms. It is significant and timely as it may inspire further development in the collaboration between AI and arts in a world where the two are rapidly intertwined a fascinatingly new and growing area.

• Push boundaries of AI in Art & Music

• Contribute to Arts & Technology

• Novelty in Music Composition

• Research & Innovation

AI-Generated Music: AI algorithms like neural networks, have been used to compose music, generate melodies, and create harmonious compositions. Projects like Google’s Magenta and Aiva have shown that AI can be a powerful tool in music composition.

Context and Motivation: Expand on the growing significance of music classification in digital music distribution and the challenges inherent in automatic music genre classification.

Scope and Contributions: Outline the specific contributions of your research in the context of existing work, emphasizing advancements or novel methodologies in AI-driven music classification.

## Document Structure

This document is laid out as follows:

# Literature Review

Introduction

* Outline the literature review section. What are the areas that you’ve read about. Possibly name a few key papers/authors. Could mention Mark Duggan too.

The issue of querying and retrieving certain types of music from large datasets is discussed in, ‘A Survey of Audio-Based Music Classification’ paper referenced below. This paper also explores the difference in the features and the types of classifiers used for different classification tasks. Music information retrieval (MIR) is an emerging research area in multimedia to cope with such necessity a key issue is classification, assigning labels to each song based on genre. Most end users may only be interested in certain types of music a classification system would enable them to search ­­for the music they are interested in.­

Music classification has received much attention from MIR researchers in recent years. In the MIR community, an annual event, ‘Music Information Retrieval Evaluation eXchange (MIREX) is held for competitions on important tasks in MIR since 2004.

The purpose of music annotation is to annotate each piece of song with a set of semantically meaningful text annotations called tags

## Background

### Music Genre Classification:

Provide a brief overview of music genre classification, including its challenges and significance.

Few papers with their references: ­­

MUSIC EMOTION RECOGNITION: A STATE OF THE ART REVIEW (Kim et al., 2010)

A Survey of Audio-Based Music Classification and Annotation (Fu et al., 2011)

PANNs: Large-Scale Pretrained Audio Neural Networks for Audio Pattern Recognition (Kong et al., 2020)

The Million Song Dataset (Bertin-Mahieux et al., 2011)

Musical genre classification of audio signals (Tzanetakis and Cook, 2002)

GTZAN Dataset - Music Genre Classification (“GTZAN Dataset - Music Genre Classification,” 2020)

### AI in Music Analysis:

Discuss the role of AI in music analysis, highlighting developments in music information retrieval (MIR) and affective computing relevant to genre classification. This field of research explores how music conveys emotion, how these emotions can be automatically recognized by computational systems, and the implications for music information retrieval (MIR). It draws from various disciplines including electrical and computer engineering, computer science, psychology, and music theory, aiming to develop systems that can organize, classify, and recommend music based on emotional content.

Given the multidisciplinary approach that combines elements of music theory, psychology (particularly the psychology of emotion), computer science (with a focus on machine learning, signal processing, and natural language processing), and engineering, this research can be broadly classified under the umbrella of Music Information Retrieval (MIR) and Affective Computing. MIR focuses on retrieving information from music for analysis, search, and recommendation, while Affective Computing emphasizes the development of systems and devices that can recognize, interpret, process, and simulate human affects, including emotions conveyed through music.

## Review of Existing Approaches

### Timbral Analysis:

Summarize key studies on timbral analysis for genre classification.

Discuss common AI models and features used in timbral analysis.

### Rhythmic Analysis:

Outline approaches to analysing rhythm in music and their effectiveness in genre classification.

Highlight AI techniques and algorithms specifically suited for rhythmic analysis.

### Pitch Content Analysis:

Review studies that utilize pitch content for genre discrimination.

Mention AI models that excel in handling pitch information for classification purposes.

## Comparative Analysis of Methodologies

### Comparison of Techniques:

Compare and contrast the effectiveness of various AI models (e.g., SVM, CNNs, RNNs) in analysing timbral, rhythmic, and pitch content.

### Advancements and Limitations:

Discuss the advancements achieved with different approaches and their limitations or challenges.

## Applications and Implications

### Music Recommendation Systems:

Explore how accurate genre classification enhances music recommendation systems.

### Music Libraries Organization:

Discuss the impact of AI-based classification on managing and organizing large music libraries.

### Musicology Research:

Highlight the tool's potential contribution to musicology research, facilitating the study of music genres and their evolution.

## Future Directions and Emerging Trends

### Technological Advancements:

Speculate on future technological advancements in AI that could further improve music genre classification.

### Interdisciplinary Approaches:

Suggest the potential for interdisciplinary approaches combining music theory, cognitive science, and AI in enhancing genre classification accuracy.

## Conclusion

Concisely summarize the reviewed literature, emphasizing the most promising AI-based approaches for music genre classification.

Research Gaps: Identify gaps in the current literature that your research aims to address.

Contribution of Your Work: Articulate how your project intends to contribute to the field, considering the development of an AI-based tool for analysing music samples.

## Innovative Approach

An innovative approach within the context of an AI music composer project could involve a combination of deep learning techniques and reinforcement learning to implement an adaptive and evolving musical composition system. The goal is to go beyond traditional by-the-book generative models and incorporate a form of learning and response mechanism inspired by the dynamic nature of human improvision. Below some of these approaches will be explored.

Dynamic: learning environment where AI system receives continuous feedback during composition

Feedback may come from the user or the system or both (real-time audience reactions)

Reward-based: AI is rewarded for generating musical segments that align with certain defined criteria such as emotional expressiveness/coherence/stylistic fidelity. Reinforcement learning algorithm learns and adapts based on these rewards, improving gradually with its ability to generate compositions that resonate with users or meet specific objectives.

Interactive User Feedback: Enable user feedback to play a role in shaping the composition. Providing feedback on specific musical elements/make high level evaluations of the overall composition. AI then uses this feedback to adjust its approach in real-time creating a collaborative continuously integrated interactive musical composition experience.

Blend of Human/AI Styles: Integrate human & AI-generated musical elements within the same composition. Encouraging a symbiotic relationship where the AI system complements/enhances the creative input of human musicians, resulting in a brand-new fusion of styles.

Adaptive Model Training Approach: Continuous learning mechanisms where the AI model is periodically retrained using new datasets. Ensuring the model stays current with evolving modern musical trends and adapts to changing user preferences over time.

Evolutionary Algorithms: Introduce variability/innovation in the composition process. Involve the mutation and recombination of musical motifs over successive generations, allowing AI to explore novel creative spaces.

Combining these elements, the innovative approach seeks to create an AI music composition system that not only generates high quality adaptive compositions but also actively engages with users and evolves over time in response to changing musical preferences. Aiming to push boundaries of AI in creative expression, fostering dynamic collaboration and continuous learning.

# Methodology

## Introduction

Describe the development phase's goals, focusing on creating an AI model for music genre classification.

## Planning

Outline the project plan, including the selection of AI technologies, dataset preparation, and model training strategies.

Implementation Details:

## Tools and Frameworks

Discuss the software and AI frameworks used for developing the model.

Evaluation Framework: Outline the approach for evaluating the performance of the classifiers, including cross-validation methods and the construction of genre-specific datasets for testing.

## Data Preparation

Explain the process of collecting and preprocessing music samples, including feature extraction for timbral, rhythmic, and pitch analysis.

Feature Extraction: Describe the process of extracting timbral texture, rhythmic content, and pitch content features from audio samples. Detail the computational techniques and algorithms used, referencing the discrete wavelet transform (DWT) and Mel-frequency cepstral coefficients (MFCC) as in the Tzanetakis and Cook study.

Classifier Design and Training: Explain the selection and training of classifiers for music genre classification. Discuss the rationale behind choosing specific classifiers and the training process using real-world datasets.

## Model Development

Describe the AI model architecture, training process, and the rationale behind model choices.

## Error Handling and Prevention

Address potential issues in model training and classification accuracy, including overfitting and class imbalance, and present strategies for mitigation.

## Conclusion

Reflect on the development process, challenges encountered, and solutions implemented. Assess the application's effectiveness in meeting project objectives and its potential impact on users.

# Results

## Introduction

Summarize the project outcomes and the significance of the AI model in music genre classification.

## Evaluation

Present a comprehensive evaluation of the model's performance, including accuracy metrics, comparisons with existing systems, and user feedback if available.

## Deliverables

List the project's outputs, including the AI model, documentation, and any associated software or tools developed.

## Future Work

Suggest areas for future research and potential improvements to the system, such as incorporating additional musical features or enhancing user experience.

## Conclusion

Conclude with reflections on the project's contributions to the field of music analysis and AI, emphasizing the value of classifying music into genres using AI.

This detailed structure provides a blueprint for documenting the development and evaluation of an AI-based system for music genre classification, tailored to your project's specific objectives.

# Discussion

## Classification Performance

Report the classification accuracy and analyse the results. Compare the performance of different classifiers and feature sets, drawing comparisons with human classification performance where relevant.

## Feature Effectiveness

Discuss the effectiveness of timbral, rhythmic, and pitch features in distinguishing music genres. Highlight any particularly insightful findings regarding the importance of specific features.

## Challenges and Limitations

Address any challenges encountered during the research, including limitations of the feature extraction methods or classifiers. Discuss the implications of these challenges for future work.

# Conclusions and Future Aspects

Summarize the key findings and contributions of the research, emphasizing the potential of AI in music genre classification.

Reflect on the impact of your research on music information retrieval systems and potential applications.

Propose directions for future research, including the exploration of additional features, alternative classification techniques, and the application of the findings to other areas of music analysis.

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# Appendix

## Appendix A: Code

Throw your code in here.