

College of Engineering and Informatics

Bachelor of Science (Computer Science & Information Technology)

# CT413 Final Year Project Definition Document

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# Chapter 1. Introduction

## Purpose Of Project

Music composition is a new & interesting application area of Artificial Intelligence.

The purpose of this project is to research, explore and implement new concepts,

which algorithmically create music (rhythms/melodies/sounds/compositions)

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.

## Project Topic Description

This project dives into the collaboration of AI and music composition, with the aim of creating a user-friendly environment capable of autonomously generating. The two main aspects of this project are to produce unique/captivating music but also contribute to the evolving field of AI in creative expression, offering new insights into the potential of AI as a tool for artistic creation. AI as a tool for artistic creation

The objective of this project is to use AI to create a new music genre. Asking it to then suggest instruments for the genre, layering these on top of each other to produce a backing track or beat.

The secondary part of the project will be to let AI compose a song deciding on, the lyrics to match the composition made in the first part they will complement the genre.

Another AI will then sing the generated lyrics which will be layered again on top of the backing track.

The result will be an entirely AI inspired generated song with human assistance.

## 1.3 Project Topic Relevance

## 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.

## 1.4 Document Structure

**Summary:** Research and innovate new method to generate beats, which is interactable and customizable by user’s input requests, the algorithm should be able to adapt and learn to different melodies/rhythms/tempos/bars/ to give desired output as closely to the user’s preference as possible

**Introduction:** The first thing to do is research existing concepts, expand and explore potential new concepts of generating sound algorithmically, this will be a collaborative tool to assist human composers rather than replace them entirely. Assisting the user to create new harmonies based on composer’s input and AI hoping to speed up the creative process and inspire brand new ideas.

**Objectives:** Goal and what the project aims to achieve is a brand-new AI generated genre, beat and finally song.

# Chapter 2. Preliminary Literature Review

## 2.1 Existing Approaches

The intersection of AI and music composition has been an intriguing and fascinating rapidly evolving field. Pushing the boundaries of creative expression in the world of AI. This project focuses on the collaboration of AI and music composition.

Generative Models: Several existing approaches leverage generative models to create music autonomously Recurrent Neural Networks (RNNs) Long Short-Term Memory (LSTM) networks and more recently Generative Adversarial Networks (GANs). These models excel in capturing sequential dependencies in musical data, allowing for the generation of coherent and diverse musical compositions.

Image Processing: Style transfer techniques inspired by image processing have found application in music composition. These methods aim to transfer the style of one piece of music one another. Creating new compositions with distinct characteristics. Exploring style transfer and how it can be adapted and enhanced for the creation of an entirely new music genre is a very promising avenue.

Lyric Generation: Studies have explored using neural networks to determine suitable instruments for a given musical piece and even generate lyrics that complement the musical composition. Integrating these elements into a coherent AI-driven music creation system presents both challenges and opportunities.

Human-AI Collaboration: I found researchers focusing on fostering collaboration between musicians & AI systems. Aiming to harness the strengths of both parties, allowing for a more nuanced and expressive musical output. Exploring how this project can incorporate user input and preferences to guide the AI in the composition process to achieve a user-friendly aspect of the proposed system.

Evaluation Metrics for AI-Generated Music: It can be challenging to evaluate the success of AI-generated music as it depends on individuals taste and desired output. Existing literature suggests the use of surjective and objective metrics to assess musical quality/creativity/uniqueness. Developing robust evaluation criteria will be crucial for validating the effectiveness of the proposed system in creating a new genre of music.

Overall, the project draws inspiration from generative models, style transfer and collaborative approaches. Integrating user-friendly GUI’s & the exploration of novel AI-driven techniques for instrumentation and lyric generation on top of this contributing to the project’s potential impact on the evolving field of AI in creative expression.

Some existing approaches online I found were: SCAMP, Google Doodle, OpenAI’s MusicNet, Jukedeck, Amper Music ranging from large-scale generative models to platform that emphasize user collaboration/customization.

SCAMP was the most flexible existing approach I found, it is a Suite for Computer-Assisted Music in Python, flexibly connecting the composer-programmer to a variety of resources for playback and notation. Providing functionality to manage the flow of musical time, play back notes via MIDI to an external synthesiser, and quantizes and exports the result to music notation in the form of LilyPond. A complete API documentation on getting SCAMP up and running on your computer can be very helpful too.

## 2.2 Research

To begin my project I started 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.

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

## 

## 2.3 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.

# Chapter 3. Project Goals and Requirements

## 3.1 Primary Goals and Requirements

The primary goal of this project is to (with the assistance of AI) create a new musical genre. We will query Chat GPT to achieve this.

The new genre must include the following musical elements:

**Sound characteristics:** Rhythm/melody/timbre elements contribute significantly to the sound of the genre. (specific sound characteristics)

**Instrumentation:** The choice and use of specific instruments/electronic sounds plays a crucial role. Some genres may be defined by the predominant use of specific instruments/technology (Saxophone defines jazz)

**Innovative Techniques:** Genres often emerge from artists introducing innovative techniques or approaches to music composition/production/performance.

**Fusion Of Existing Styles:** Combing elements of existing genres in unique ways could lead to the fusion of a new genre. Genre fusion brings together diverse musical influences inspired from al over the world.

**Cultural Movements:** Musical genres often follow specific cultural movements. Changes in cultural values/attitudes/social dynamics can influence the development of new genres. Perhaps in a response to mainstream culture, representing counter-cultural expression seeking to challenge established norms.

The new musical genre must use a combination of innovative musical elements, cultural influences and contextual factors to create a unique and recognizable sound that resonates with its audience. It’s vital to note that the process of genre definition is ongoing, genres can continue to evolve and blend over time.

By working with Chat GPT an AI chat bot, implicating the above and requesting a new genre to be created. Allowing AI to have full control over the sound characterises chosen, the stylistic innovations, cultural and societal context, geographical influence, technological advancements.

The beauty in creating a new musical genre lies in its ability to evolve and inspire further creativity. Feel free to visualise specific artists, iconic progressive albums/covers or even dance movements associated with the new genre. As this genre takes on a life of its own in the realm of music exploration.

Specifying the desired musical style, instrumentation (trumpets/saxophones) the AI processes the lyrical text, analyses its sentiment, themes, pace, and rhythm. Based on specified parameters, the AI generates chord progressions, melodies and instrument arrangements.

Now that the new genre is created, we will ask it to specify instruments and write melodies in the form of a list (pitch, duration) pairs in Python syntax, where the pitch uses the MIDI pitch standard, and the duration represents the number of quarter notes. A pitch of None represents a rest. And layer these.

## 3.2 Secondary Goals and Requirements

The secondary goal of this project is to use AI to write lyrics for the new music composition to compliment the new genre it’s created.

This approach seeks to leverage natural language processing and generative language models to produce lyrical content that aligns with the fusion of the newly created genre.

Requesting the AI to write a chorus and verse for the newly created beat including varies instruments.

Using a different AI such as aitestkitchen.withgoogle.com to convert the lyrical text to a song.

To achieve these parameters will be defined for the AI-generated lyrics such as specifying themes/emotions and stylistic elements that resonate with the genre. Guide the AI to explore the diverse cultural influences and express themes such as urban life, global fusion, the dynamic energy of the city.

The AI produces an audio file that combines the generated musical accompaniment with the genres lyrics. The lyrical audio file will then be layered on top of the beat reflecting the collaborative effort between the AI-generated lyrics and the AI’s musical composition, creating a seamless fusion of words and music.

Continuous iterations and refinements can be made based on feedback, allowing the AI to learn and adapt to the nuances of the new genre. This collaborative and iterative process contributes to the evolution of both AI-generated lyrics and musical compositions within the project.

# Chapter 4. Planned Software Outline

## 4.1 Planned Backend Software

Using Thonny (simple python editor) with SCAMP including the following dependencies

* scamp\_extensions – Offers range of useful extensions such as scales.
* python-rtmidi - Offers ability to stream MIDI to external synthesizer or application).
* abjad – Generates PDFs of music notation using LilyPond.
* pynput – Offers responsiveness to mouse/keyboard events.

Thonny comes with Python 3.10 built in, it can be used to develop scripts that integrate AI music generation models. Importing and using trained models to create musical sequences based on input parameters. Organise AI model scripts into modules for ease of maintenance and integration.

The second dependency mentioned above library handles MIDI streaming, allowing your backend to send MIDI data to external synthesizers or virtual instruments. The second last one allows you to visualise the AI-generated compositions in standard musical notation.

Could create a structured workflow orchestrating the interaction between modules, for seamless integration of AI music generation, MIDI streaming, user interaction and notation generation.

Could also use a virtual environment to manage dependencies for this project. Creating a text file to specify the required libraires and their versions. Structuring the backend software this way, it’s possible to create a modular and maintainable system for the AI music composer. Thonny serves as the development environment, the various libraries and dependencies contribute to the functionality required.

To attempt to train the ai to produce the desired results, it will be told to include:

* A variety of note lengths, alternating frequently juxtaposing between short and long notes.
* Melody stays between MIDI pitch 50 and 100.
* At least 20 notes in length in the melody.
* At least 4 skips of at least a perfect fourth in the melody.
* Include a contour with several high and low points in the melody.

Constructing a diverse dataset that includes examples adhering to the specified criteria. Ensuring the training set covers a wide range of musical patterns, lengths, and contours.

Apply data augmentation techniques to enhance the variety of training examples. Introduce randomness in note lengths, pitch variations and contour shapes to increase the model’s adaptability.

Train the model over multiple hyperparameters allowing it to learn and adapt to the specified criteria.

Monitor the model’s performance on validation data to avoid over/under fitting.

Define evaluation metrics to align with desired musical outcome, pitch accuracy, rhythmic diversity and adherence to melodic skips. This allows the AI to be guided to generate melodies to align with the desired musical characteristics ensuring that the produced compositions meet the specified criteria for note lengths, pitch range, melodic length, skips and contour shape.

# Chapter 5. Planned Steps

## 5.1 Planned Steps & Milestones

# References

* Choosing Chance: An Exploration of Aleatoric Possibilities by Mark Duggan
* Philosophy and Theory of Artificial Intelligence 2017 by Vincent C. Muller