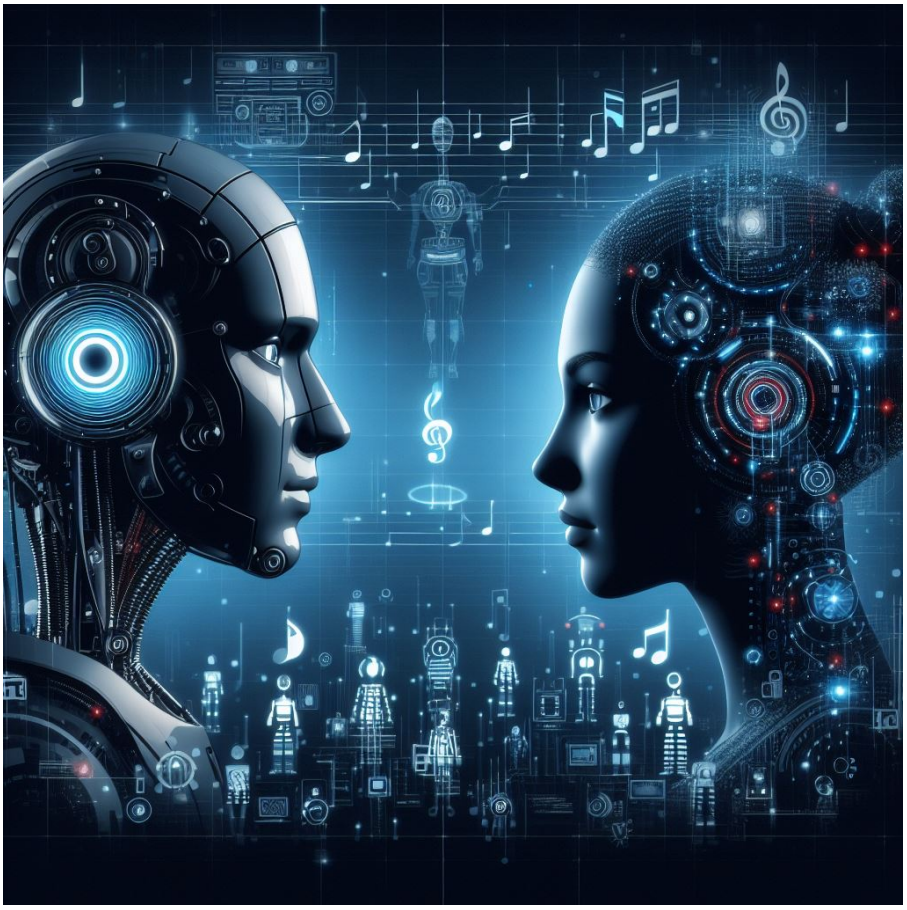
Co-Creative System for Music Generation using Genetic Algorithm and User Feedback

Assignment 3: Weird Science

Student 1: Anca-Mihaela Matei - s4004507
Student 2: Giulia Rivetti - s4026543
Student 3: Kacper Kadziolka - s4115945



Abstract

This research delves into the development of a co-creative music generation system, leveraging a genetic algorithm and user preferences to produce music in a user-specified genre. Inspired by earlier research, the project investigates the incorporation of human feedback as a fitness function, utilizing generative systems throughout the ideation and background research stages. The importance of previous studies in the field that use generative AI to create music is also covered in this project.

Our design sought to use the cooperative potential of human-AI interaction, embracing the genetic algorithm's iterative ability to develop and adapt based on user feedback.

1 Co-Creativity Research

Introduction

Musical co-creativity, a dynamic intersection between human ingenuity and artificial intelligence (AI), seeks to forge collaborative partnerships for the composition of music. The integration of AI in music creation has evolved over time, with the dual objectives of augmenting both creative expression and technical innovation. In this context, our paper delves into the development of a Co-Creative System for Music Generation, utilizing a Genetic Algorithm and user feedback as integral components.

The history of music creation experiments involving artificial systems dates back to the inception of computing. Events and societies dedicated to the fusion of computers and music[7] , such as 'The Computer Arts Society' established in 1968, have contributed to the evolution of AI in the creative domain. More recent endeavors, exemplified by the 2017 'CrowdAI' music generation challenge, showcase the ongoing pursuit of leveraging AI for musical expression.

In the landscape of AI-driven music generation, two fundamental approaches emerge: AI as automation and AI as suggestion [7]. The former liberates composers from specific compositional sub-tasks, enabling a focus on more creatively demanding aspects. Our project, however, centers on the latter approach—AI as automation. Here, AI is strategically employed to suggest solutions for compositional sub-tasks, with the ultimate decision-making authority resting with the composer. This nuanced exploration aims to unravel the potential of AI as a creative collaborator, offering insights into the synergies between human intuition and computational suggestion within the domain of music composition.

Background

The background research phase involved an exploration of existing literature on generative AI in music composition. Notable contributions include the works of the authors of [3], who employed deep learning techniques for music generation, most specifically employing transformers and the self-attention mechanism, and of [2], who utilized an architecture similar to WaveNet [10]. These studies provided valuable insights into the capabilities and challenges of generative systems in music composition. However, it is crucial to note that while these studies significantly advanced the field of generative music, they did not integrate user feedback as a crucial element in the music creation process.

In the study documented in [8], the authors adeptly amalgamated genetic algorithms and genetic programming to formulate an interactive evolutionary computation-based system. Remarkably, this system exhibits proficiency in the precise composition of rhythms, marking a pioneering exploration into the realm of co-creative systems for music generation.

The idea of using genetic algorithms for music creation was also used in [5], where a system was designed to automatically generate music pieces through the analysis of exemplar MIDI files. The primary goal of this project is to craft a unique musical composition informed by the content of the source pieces. The system extracts musical features from two specified MIDI files and employs a genetic algorithm to automatically produce a new music piece. Users have the flexibility to determine the desired length of the composition and the weighting of musical features from each MIDI file, providing guidance for the generation process. The resulting output

offers composers a fresh music piece derived from the selected source files. However, the co-creative aspect is limited as the fitness function remains unaffected by user input. The merit function is determined by thirteen MIDI features, each contributing proportionally to the overall fitness.

Focusing on the same idea of using genetic algorithms for generating songs starting from MIDI files, research from [4] was conducted. The concept indicates a co-creative system through user involvement in determining the fitness of computer-generated music. Users play a pivotal role by selecting how well a musical generation aligns with their personal or business project. Assigning integer scores to each generation empowers users to actively shape the direction of the computational model. This collaborative process underscores the co-creative nature of the system, blending user preferences with algorithmic generation for a more personalized outcome.

As such, the ideation stage focused on developing a co-creative framework that could easily integrate generative algorithms with user preferences. Taking inspiration also from the insights of the study presented in [9], which delved into the use of user ratings to guide an interactive evolutionary algorithm in the realm of image generation, our research advocated a parallel methodology for music composition. Furthermore, in alignment with our exploration, we drew insights from a tutorial available at [1]. This tutorial, coupled with the principles elucidated in [9], demonstrated the feasibility of integrating the previous ideas into the realm of music generation.

Conclusion

The generative system assumed a pivotal role throughout the developmental stages, contributing significantly to the creation of a diverse array of audio samples and conducting a comprehensive assessment of the feasibility of various design approaches. Through the facilitation of rapid music sample generation using evolving genetic algorithms, the system emerged as a critical component in discerning potential challenges and identifying opportunities within the co-creative framework.

Its adaptability and responsiveness played a crucial role in refining the design, acting as a guiding force to ensure seamless alignment with not only the discerning user preferences but also the inherent capabilities embedded within the generative algorithms. This iterative process, driven by the generative system's dynamic nature, proved instrumental in enhancing the precision, creativity, and user-centricity of the final co-creative music generation system.

2 Co-Creative System Implementation

We implemented a genetic algorithm, characterized by a population of melodies, each one represented as a binary string. The program asks the user to input some parameters, which are then used to generate the melodies. In the original code [1], which helped us build ours and from which we took inspiration, the program asked the user questions which we felt were difficult to understand for a person who didn't study music; for example the algorithm asked the number of bars, the number of notes per bar or the key and scale to be used. Therefore, we decided to simply ask the user to decide a music genre, between the four given: rock, house, Mozart (piano) and Vivaldi (violin). Then, based on the selected genre, the program automatically chooses some music parameters: the length of the generated melody in bars, the number of notes within a bar, the number of pitches per bar, the presence or absence of pauses in a melody, the key and scale of the song, the pitch of the scale and the velocity of the rhythm. By changing these values, we have created melodies with different styles, and we have shaped

those parameters according to the music genre we have created. For the rock genre, we have chosen a faster rhythm (higher bpm value) and a higher number of notes within a bar in order to reflect the energetic soul of rock music. We have consulted some websites for more specific parameters like the key and scale to set [6]. As for the house genre, we went with a darker and harsher tone and gained some information from ChatGPT to set the specific parameters. Then, we have decided to generate melodies similar to Vivaldi's music, so a really fast rhythm constructed to be played by violins, taking inspiration from Vivaldi's masterpiece *Four Seasons*. For the last genre we were again inspired by a great musician, none other than Mozart, and we therefore tried to create in this case melodies suited for the piano.

The first part of co-creativity of our system lies in the fact that the user can choose the type of music he wants to generate. Moreover, he/she is also asked how many melodies the program should generate, as well as the number of mutations and the mutation probability for the genetic algorithm. The second part of co-creativity is given by the fact that when the program generates each melody, it asks the user to rate the song with a number from 0 to 5 and then the fitness function takes into account these ratings for the evaluation of each individual.

After the user has given a grade to all the songs in the population, the program selects the two best melodies and then stores all of them as midi files. Since the program takes into account the ratings given by the user, there is a significant human contribution to the final product and based on what the user likes or doesn't like, he/she can create music accordingly, so it's significantly customizable based on one's interest.

3 Co-Creative System Evaluation

Automatic Evaluation

The evaluation of our co-creative genetic algorithm was conducted through a series of experiments done for each of the four genres, thus later on, results were analyzed to provide us with insights into its effectiveness in creating new distinct, previously unheard sounds. It's done by giving the appropriate score to each of the sounds produced, therefore evaluation step consists mainly on scoring the subsequent generation until a satisfactory result is obtained. To transform the MIDI sequences into more meaningful, human-friendly output, we have used the soundtrap web-tool - which, with gratitude to the authors, is free for student-purpose use. It's not only converting the MIDI extensions to mp3, but allows us to set the instrumental background for each of the genres. In particular, we have used the following instruments provided by discussed website:

- for rock music: *Guitar - Rock - Warm Lead*
- for house music: *Synths - Rythmic - The Best*
- for Vivaldi (violin) music: *Orchestral - String Ensemble - Studio Quartet Spiccato*
- for Mozart (piano) music: *Keys - Pianos - Grand piano*

It's worth to denote the environment and parameters setting that was used in the evaluation stage. They are a population of size 10, and number of mutations equals 2 with mutation probability of 0.5. These are indeed default parameters suggested by our system. We have executed our system for one genetic run for each of genres, which resulted of 4 independent evaluations in total. Thankful to population size of 10, we have given the 10 scores for each of the genre, which was absolutely enough to produce the satisfactory songs.

We are attaching evaluated by us songs explicitly along with following report as ”Final songs” directory. In which, four files are named after their genre, additionally with information which states the number of midi sequence chosen from a list of 10.

Human Evaluation

In our quest to comprehensively evaluate the user experience and the quality of our generated musical compositions, we sought feedback from four individuals with diverse backgrounds. It is noteworthy that none of these participants are currently pursuing a computer science-related subject, offering a valuable perspective from non-technical users. Of the four evaluators, three possess prior musical experience, having played instruments such as the piano, violin, and guitar in their earlier years. This mix of musical backgrounds and non-technical expertise provides a well-rounded assessment of our program, ensuring that our evaluation is not confined to a specific demographic or skill set. They provided insight into both the usability of the program and the quality of the generated songs.

1. Comments while trying to use the program

1. They would like to be asked by the program which kind of sound the new melodies should have, in terms of sweetness or harshness.
2. They liked the fact that the program suggests a default value for each parameter it asks for input, since they did not know what a genetic algorithm was and therefore did not exactly know to which value set the mutation rate and the number of mutations.
3. They would have preferred having a wider variety of music genres from which to choose.
4. The notes do not cover the full range of the musical scale, which they would have preferred.
5. Instead of hearing the first and second songs again, they would have preferred to hear the first and last.
6. Besides the genre, they would have liked the program to ask which instrument to use.
7. They found it enjoyable to rate the tunes and appreciated that the program takes those ratings into account. It made the whole experience more engaging and interactive for them.
8. They suggested adding a rating for the entire program, which should automatically adjust some parameters if the program is rated too low or stay with the same parameter if it has a good rating.

2. Ratings and Comments on Final Songs

Rock

Person	Rating (0-5)	Comment
Francesca	3	"Repetitive but credible with respect to the genre"
Sara	3	She liked the melody, but she would have appreciated stronger notes, which characterize the rock genre.
Arianna	3	She preferred a polyphonic melody and not a monophonic one.
Beatrice	2	"Interesting rhythm but the melody lack of energy"

Table 1: Human Ratings on the Generated Rock Songs

House

Person	Rating (0-5)	Comment
Francesca	1	"It doesn't seem like the house genre, not rhythmic enough, the rhythm is too slow"
Sara	1	"Some notes were ok, but many of them seemed off-key (the notes didn't feel related to one another)"
Arianna	2	The melody is too slow and she expected a polyphonic melody, not a monophonic one.
Beatrice	3	"Not my favorite, but cool because it seems like the beginning a Daft Punk's song"

Table 2: Human Ratings on the Generated House Songs

Mozart

Person	Rating (0-5)	Comment
Francesca	4	"The variation of notes is ok". She would have liked notes with varying lengths and higher pitches.
Sara	3	Nice, but would have appreciated more higher notes.
Arianna	4	Would have appreciated a more polyphonic melody.
Beatrice	3	The notes make sense together but she would have preferred having higher notes.

Table 3: Human Ratings on the Generated Mozart Songs

Vivaldi

Person	Rating (0-5)	Comment
Francesca	4	"The melody is nice". She would have preferred the presence of higher notes and fewer pauses.
Sara	4	She liked the variation of notes but she would have appreciated more a faster rhythm.
Arianna	4	Nice, but she didn't like a long pause in the melody. She suggested that we modify the melody so that the last note of a bar is longer than the others.
Beatrice	5	She loved it; "it seemed like the beginning of a ball". She enjoyed the balance between higher and lower notes.

Table 4: Human Ratings on the Generated Vivaldi Songs

4 Conclusion

In conclusion, this report has delved into the development of a co-creative system able to generate music with a genetic algorithm by employing users' feedback to construct the fitness function. By taking into account the initial parameters and the ratings assigned by the user, the system was able to create melodies according to the user's specific preferences. Once the system generated songs for four different genres, we used an online tool to process them to make them more melodious. But the co-creativity didn't end with the program; indeed we asked 4 people to evaluate the system, in order to strengthen even more the co-creative part of it. From the evaluation emerged that they all liked the program and the idea behind it, but they also made some suggestions to improve it. We trust that our work can highlight the benefits coming from combining an algorithm with the user's preferences, opening doors to new ideas and possibilities in the field.

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