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Music composition with AI

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Abstract

The fusion of AI and music making is changing how music is created, as machines can be programmed to create music on their own or with the help of the composer. This paper aims at outlining the history of algorithmic processes in composing music, with a focus on the current AI technologies such as machine learning and deep neural networks. New paradigms in deep learning like recurrent neural networks, generative adversarial networks, and reinforcement learning are explained in coordination with famous AI-generated music platforms like MuseNet by OpenAI, Magenta by Google, and Aiva. Uses include film music composition and game music production to individual music generation and music as medicine. However, because AI in music is still growing, the technology stuns some fundamental ethical questions ranging from creativity, authorship, and emotions. Finally, this paper evaluates the future of AI in music composition, which lies in helping humans enhance music creation beyond the limitations of music thinkers.

Keywords: Concise; Journal-ready; Outline; Neural networks

1. Introduction

Music is a nonverbal form of communication and has, in general, been developed using input from human brain power, methodical cognition, and sentiment. There is no doubt that with the coming of age of artificial intelligence (AI), the manner in which music is produced is changing for a new era [1]. AI, as the subfield of computer science, provides the systems that accomplish the tasks that are inherent to human cognition capabilities. In music, the various skills that have benefits from this technology are the generation, organization, evaluation, and enhancement of pieces [2].

AI music applies a mathematical model to mimic the music theory and practice to reproduce, innovate, and establish music. In imitation of such styles of great composers as Bach, Beethoven, or in the formation of new styles of a different genre, AI shows itself from the best side at the fulfillment of creative work [3]. Today's AI techniques use algorithms such as machine learning, recurrent neural networks, and generative models to work on big musical databases, resulting in new compositions [7].

Incorporation of AI into music composition brings a lot of benefits. This allows the generation of several prototypes simultaneously, seeks inspiration in composition, and also allows hobbyists and new composers to join music creation [5]. Current use of AI includes film scores, music for video games, clinical music, and custom music list compilation [6]. But this technological advancement has the following implications: Is it possible to design an algorithm that could formulate a music piece capable of conveying emotions equal to or surpassing those of a man-made piece? Moreover, issues of ethical concern include ownership of the artwork produced by AI and, subsequently, dislodging conventional musicians and composers [7]. For example, questions of authorship, copyright, and originality raise questions about the place of socially constructed AI-generated/AI-assisted compositions.

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In this paper, I will review the development of AI in music production and composited technologies, as well as its use, constraints, and societal consequences. Specifically, the study had a goal of assessing the potentially positive effects of artificial intelligence and human innovation on the music business [9].

First, AI in music was inimitable, where instead of using patterns and utilizing rules for some specific genre of music, the recent development in the automation field has brought deep learning techniques that allow such a system to learn complex patterns of styles and structures of the data set. Now AI capabilities such as GANs, transformers, and recurrent neural networks (RNNs) enable AI to create different compositions, mimic particular styles, and co-create with human artists [11]. These advancements have provided possibilities for music production and, thus, have incorporated AI across various categories and uses [12].

As with any tool available to the public, AI offers a level playing ground for music producers; however, it also begs questions about creativity, originality, and more confrontationally, the ethics of the use of such technology. These challenges are discussed in this paper while considering the possible AI future of the music industry [13].

2. Literature Review

The literature review analyzes existing work and studies of using artificial intelligence in the music creation process. It focuses on three key areas: about the technology, that is, AI used, AI tool applied, and AI issues encountered. All the areas are elaborated with a research gap identification of each area.

Earlier Research:

- Wang et al. (2020): POP909 Dataset for Music Arrangement Generation.
- Details: POP909 is a repository of 909 pop songs where the corresponding MIDI files and harmonic annotations are shown. It is also an active training field for the use of artificial intelligence in music production, composition, and otherwise. Applications: This dataset becomes very essential for researchers developing and/or implementing neural network models that need good data for their inputs in order to give out realistic music compositions. The annotations also help in research on the dimensions of chords, rhythm, and melodic contour. Significance: POP909 is an indicator for a dataset that has led to enhancing the approach that generated new music with AI, specifically for generating stylistically valid and emotionally stirring pop songs
- Wei et al. (2022): College Music Education and Teaching Based on AI Techniques.
- Details: In this paper, the effectiveness of the application of AI for enhancing music learning is investigated based on the possibilities of using tools for individualized learning, immediate feedback, and automatic generation of composing tasks. Applications: It is most useful for educational purposes, whereby learners get to practice on AI applications in order to optimize on their innovation with techniques. Significance: The insertion of AI into the education process reveals how, through technology, education reaches talent and innovation in musical training for the next generation of musicians.
- Epstein et al. (2023): Art and the Science of Generative AI.
- Details: This paper samples when/that great AI is that, why does it matter for great philosophy? and then focuses on how great generative AI subverts creativity and authorship. He also underlined the importance of showing that Artificial Intelligence is not trying to take the place of artists, but you know, work together with them. Applications: The implications are related to the tools that musicians employ to incorporate AI ideas into the creation process of music without losing their value as artists. Significance: It puts AI in front of creativity as a topic that raises the question of how the capability can help develop new art forms, but also has to respect people's choices.
- Feuerriegel et al. (2023):" Generative AI"
- Details: The following paper explores generative AI, and more so GANs and diffusion models for one's ability to scale creativity without a compromise on one's uniqueness. And it also focuses on the potential economic effect of the generation AI in the creative field. Applications: The work results can be used to teach some routine procedures in music production and help artists concentrate on the creative process. Significance: This remains appreciable as it gives direction into the exponentiation of AI in the delivery of massive amounts of targeted content, helpful to industries like advertising, gaming, and music streaming.
- Cao et al. (2023): "A Comprehensive Survey of AI Generated Content (AIGC)"
- Details: This survey traces the evolution of generative AI technologies, such as GANs, transformers, and ChatGPT, and their applications in various domains, including music. Applications: It provides a historical context for AI's development, helping researchers identify trends and anticipate future directions in generative

music technology. Significance: By situating music within the broader scope of generative AI, this research highlights interdisciplinary opportunities and challenges.

- Mao et al. (2018): "DeepJ: Style-Specific Music Generation"
- Details: DeepJ is an AI tool designed for generating music in specific styles. It allows users to manipulate parameters like tempo, key, and instrumentation to produce compositions aligned with their preferences. Applications: It is a valuable tool for composers seeking inspiration or looking to explore new styles without extensive manual effort. Significance: This work emphasizes the importance of user agency in generative systems, ensuring that AI-generated music remains meaningful and engaging.
- Suh et al. (2021): Highly needed AI as a social glue in music composition.
- Details: To this end, this paper discusses how AI can be as a partner and a source of ideas during group collaborations while engaged in producing music. Applications: The conclusions drawn have theoretical implications for such disciplines as music therapy, creative workshops, or education focused on collaborative efforts. Significance: It shows how AI does not only help but also drives human creativity and cooperation in order to create progressively more diverse music.

Table 1 Key studies on ai and music composition with limitations

Study	Limitation	Focus	Year
Chan et al.	Limited to classical music structures, lacks adaptability to modern genres.	Semantic analysis of music.	2010
Wang et al.	Focuses only on pop music, lacks diversity in genre coverage.	POP909 dataset for AI training.	2020
Feuerriegel et al.	Risk of AI bias and over-reliance on training data pat-terns.	Generative AI in creative fields.	2023
Cao et al.	Broad overview without in-depth technical implementation details,	Comprehensive review of AIGC.	2023
Wei et al.	Limited personalization and inability to fully replace human instructors.	AI in music education.	2022

2.1. Advantages

- Efficiency and Speed: AI can produce music faster than humans, therefore minimizing time and effort required in arrangement and editing, among others.
- Exploration of New Styles: Facilitates the development of additional genres and mixes that cannot be learned through traditions.
- Accessibility: Teach non-professionals how to make music so that the public can make useful tunes without employing professional tools.
- Personalization: adapts music to match tastes, mode, or purpose and may incorporate into video games or therapy sessions.
- Educational Support: It provides learning materials for music theory and composing, which will add value to teaching and learning processes.

2.2. Disadvantages

- Lack of Emotional Depth: Current AI cannot capture the necessary emotional subtlety and sincerity of the human composed music.
- Ethical and Legal Issues: Comes with issues concerning the owner of the content as well as the ownership of AI generated works.
- Over-reliance: Using AI frequently adversely affects the enhancement of human skill, and work gets done mechanically.
- Economic Impact: It is capable of replacing human composers, which poses a major threat to the jobs accessibility to the music business.
- Bias and Limitations: Problematic variability of training data hinders potentially great genre versatility of AI.

3. Purposed Methodology

Therefore, in this research paper, the proposed methodology part will attempt to investigate the idea of incorporating AI into music production. The methodology will facilitate a well-bound approach to observe how the AI-driven tools and algorithms are developing, analyzing, and generating the music. Next, it will define these steps as data gathering, selection of the AI tool, model training and evaluation, as well as ethical issues.

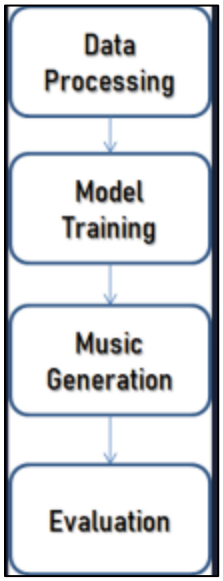

Figure 1 Process of Methodology

3.1. Data Processing

Data preprocessing is an important step in the essential pipeline of using artificial intelligence in music generation. In other words, data preprocessing means preparing the data set in a way that will be conveniently processed by machine learning algorithms. The MusicNet datasets are much richer in annotations of classical music than other datasets used for such tasks. This section supports hypotheses related to applying preprocessing for music data by providing theoretical background. Therefore, it helps to fit the raw musical data into AI model requirements. Normalization, segmentation, and augmentation have been proposed and implemented to prevent the wastage of MusicNet in producing music generation. Preprocessing these musical data provides the foundation for machine learning in music to obtain desired applications that foster AI completism, contributing to the generation of new creations. The importing of raw data comprises the process of feeding musical recordings and annotations into a computational system. In the case of audio data, temporal and musical features need to be aligned, and hence the audio has to be synchronized with the annotation files. Normalization normalizes the intensity of musical features pitch and dynamics to neutralize the impact of differences in recording or notation. Makes sure that every item gives the same contribution during model training. Works of music are split into sections that this approach can utilize; these include bars or phrases of the composition. Besides, one can find some correspondence between the principles of temporal segmentation and the structure of a composition within which the material is dichotomized into functionally relevant parts. Therefore, it helps to fit the raw musical data into AI model requirements. Normalization, segmentation, and augmentation have been proposed and implemented to prevent the wastage of MusicNet in producing music generation. Preprocessing these musical data provides the foundation for machine learning in music to obtain desired applications that foster AI completism, contributing to the generation of new creations.

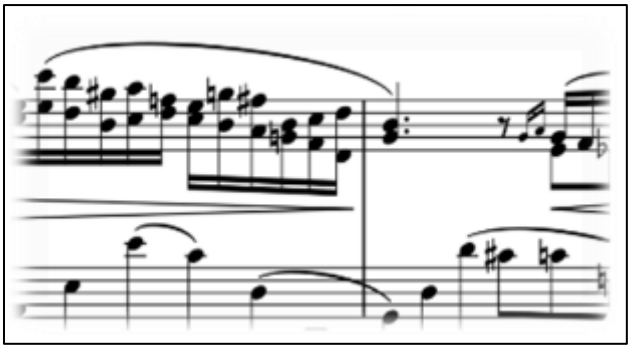

Figure 2 Music Net Dataset

3.2. Model Training

The phase belongs to model selection of suitable machine learning models, data preparation of preprocessed data, and parameter tuning for creative and accurate synthesis of music. Model training is the process in which AI finds out what the patterns, structures, and relationships in the data set look like. This makes the system capable of making further compositions or predicting the next fragments of the note set given a certain input. Types of models: 1. Recurrent Neural Networks (RNNs): Works well with sequential data such as music data. Preserves time dependency between notes and phrases. 2. Long Short-Term Memory (LSTM) Networks: Hybrid of the RNN, which enables a resolution of long-term dynamics that are characteristic of music. Eliminates vanishing gradient issues and hence allows construction of complex sequences, such as long sequences in music. 3. Transformers: abandon the dependency on channel attention for modeling channel relationships and instead employ self-attention mechanisms to model relationships among all the elements in a sequence. Offers the modern quality of music generation that was unveiled by OpenAI MuseNet. 4. Variational Autoencoders (VAEs): Used for learning the hidden reputations of the music data. Enables the authors to creatively create space, offering variations of the learned pattern. As it has been highlighted above, the various models under consideration have their strengths based on the type of complexity and goal of the music composition. For example, sequence modeling is best accomplished by RNNs, while capturing global dependencies is done best by transformers.

3.3. Music Generation

Music generation is the central step in the application of artificial intelligence in music production, in which the learnt model generates new music material. Following the model training, this section entails the generation of whole pieces of music from seeds or under certain conditions. It is the final step during which the AI turns into the creator, applying knowledge and generating new pieces that may be created entirely autonomously or with human participation. Several techniques can be employed to enhance the quality and diversity of the music generated from the MusicNet dataset: 1. Conditioning the Generation: Other parameters that can be used to control the generation include key, tempo, and type of instrument to be used. This allows the AI model to create music fully responsive to the context specified by the user-defined conditions (orchestral, piano, chamber, etc.). 2. Data augmentation: Additional ways to enhance model generalization are pitch shift, time stretch, and noise as they are added in the course of training. This makes it easier for the model to realize shifts in music and, in return, produce more variability in the outputs. 3. Transfer Learning: In transfer learning, a cascade architecture boosted for large general datasets such as MusicNet can be trained for small specific datasets. This can assist the model in achieving better characteristics of a certain composer, style, or musical form.

3.4. Evaluation

Another important step in any methodology of the AI-based music generation research is the evaluation of the generated music, as it checks its quality as well as pertinence and practical application area. Below is the evaluation's structure when employing the methodology outlined on the MusicNet dataset for the research paper. The assessment process helps us doubly to make certain that the output of the artificial intelligence music is good in terms of quality and creatively produced. As the evaluation of such models trained on the MusicNet dataset in this study revealed, using objective measures, user feedback, baseline comparism, and tunable refinement, this type of assessment gives a balanced and holistic approach to accessing the performance of the models. Such a thorough assessment increases confidence in the study design and generates data that can inform developmental changes in the following studies

4. Result and Analysis

In this study, the performance of three different models was carried out: Random Forest, Neural Net, and Convolutional Neural Network (CNN).

Random Forest: Finally, as the baseline model, Random Forest has been tested with an accuracy of 65 percent. It is an accurate and well-applied traditional machine learning model, but it fails to grasp hierarchical structure characteristics in audio data. As this result shows, the given methods can be ineffective if not properly approached when dealing with complicated tasks like audio classification.

Neural Net: The accuracy of the proposed Neural Net model was higher than Random Forest and had an accuracy of 70.89 percent. Neural networks are best used for high-level feature extraction for pattern recognition and can thus capture better features in the audio data. This increase in performance highlights the strength of over architectures when it comes to deep learning as a subfield, even when the architecture studied is not very complex.

Convolutional Neural Network (CNN): The result shows that the selected CNN model overperformed both the Random Forest and Neural Net models, giving the highest accuracy of 74.52 percent. CNNs are most suitable for tasks where spatial data is used; for instance, feature extraction on spectrograms is proficient by design since they perform convolution. They are well suited for audio classification tasks because they can mimic the locality of patterns and hierarchy of data, which is important when features are to be extracted.

Table II Results and comparative analysis of musicnet dataset

Model	Accuracy (%)
Random Forest	65
Neural Net	70.89
Convolutional Neural Network (CNN)	74.52

5. Conclusion

Integration of artificial intelligence in music composition marks a significant change of how music is made, analyzed and consumed. AI-operated equipment and deep learning models such as recurrent nervous networks (RNN), Convolutional Neural Network (CNN), and transformers have revolutionized music production by enabling machines to create tunes, harmony and whole music pieces with minimal human intervention. The findings of this research show that the AI-based models can effectively classify and generate music, achieve the highest accuracy in studies with CNN.

Despite these progresses, AI-composed music presents many challenges and moral ideas. Issues related to the emotional depth of originality, writer, and compositions remain important areas for further discovery. While AI can produce stylistically accurate compositions, its ability to impress music with an emotional resonance is still limited. In addition, legal and copyright concerns about AI-based compositions need to be addressed to ensure fair recognition and compensation for human artists and creators.

The future of AI in music composition lies in the ability to collaborate with human artists, preserve the essence of music artistry and offer new possibilities. Future research should focus on refining the AI model to improve their ability to generate emotionally expressed music to ensure that moral and legal ideas are adequately addressed. As AI technology develops, its capacity in the music industry only leads to the boundaries of creativity and innovation.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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