UNIVERSITI MALAYSIA TERENGGANU

FACULTY OF OCEAN ENGINEERING TECHNOLOGY & INFORMATICS

CSF3253: INTELLIGENT SYSTEM (K1)

GROUP 26

Evolutionary Neural Networks in Algorithmic Art and Music Composition

---

Prepared by:

MUHAMMAD AFIQ HANIF BIN SUHAIMI	S62993
MUAZ BIN ZAINAL	S62250
MUHAMMAD NAJMUDDIN BIN AZLI	S62728

Prepared for:

DR. ROSNIZA BINTI ALI

BACHELOR OF COMPUTER SCIENCE (MOBILE COMPUTING) WITH HONOURS

SEMESTER 1 2023/24

TABLE OF CONTENTS

1.0 BACKGROUND OF APPLICATION

The application "Algorithmic Art and Music Composition (Evolutionary Neural Networks)" involves the use of evolutionary algorithms and neural networks to create art and music. Evolutionary music and art refer to the use of evolutionary algorithms to generate music and art, respectively. This involves the use of computational steps analogous to natural selection to produce audio, such as melodies or loops, based on a population of individuals. The process can be initialized randomly or based on human-generated music.

Research in this field has explored various techniques, such as using genetic algorithms and artificial neural networks for automatic music composition and melody generation. For instance, a study proposed the automatic composition of pleasing music from randomly generated notes using a combination of genetic algorithms and artificial neural networks.

Furthermore, the use of deep learning neural networks, such as the music composition neural network (MCNN), has been suggested for music copyright protection and algorithmic composition.

Overall, the application "Algorithmic Art and Music Composition (Evolutionary Neural Networks)" leverages evolutionary algorithms and neural networks to create art and music, drawing on techniques such as genetic algorithms and deep learning neural networks, as evidenced by the research in the field.

2.0 METHODOLOGY OF APPLICATION

Evolutionary Neural Networks (ENN) merge evolutionary computing strategies with neural network models, forging a distinct path in the automation of artistic and musical creativity. This technique capitalizes on evolutionary algorithms' ability to evolve and optimize, coupled with neural networks' proficiency in recognizing and learning patterns.

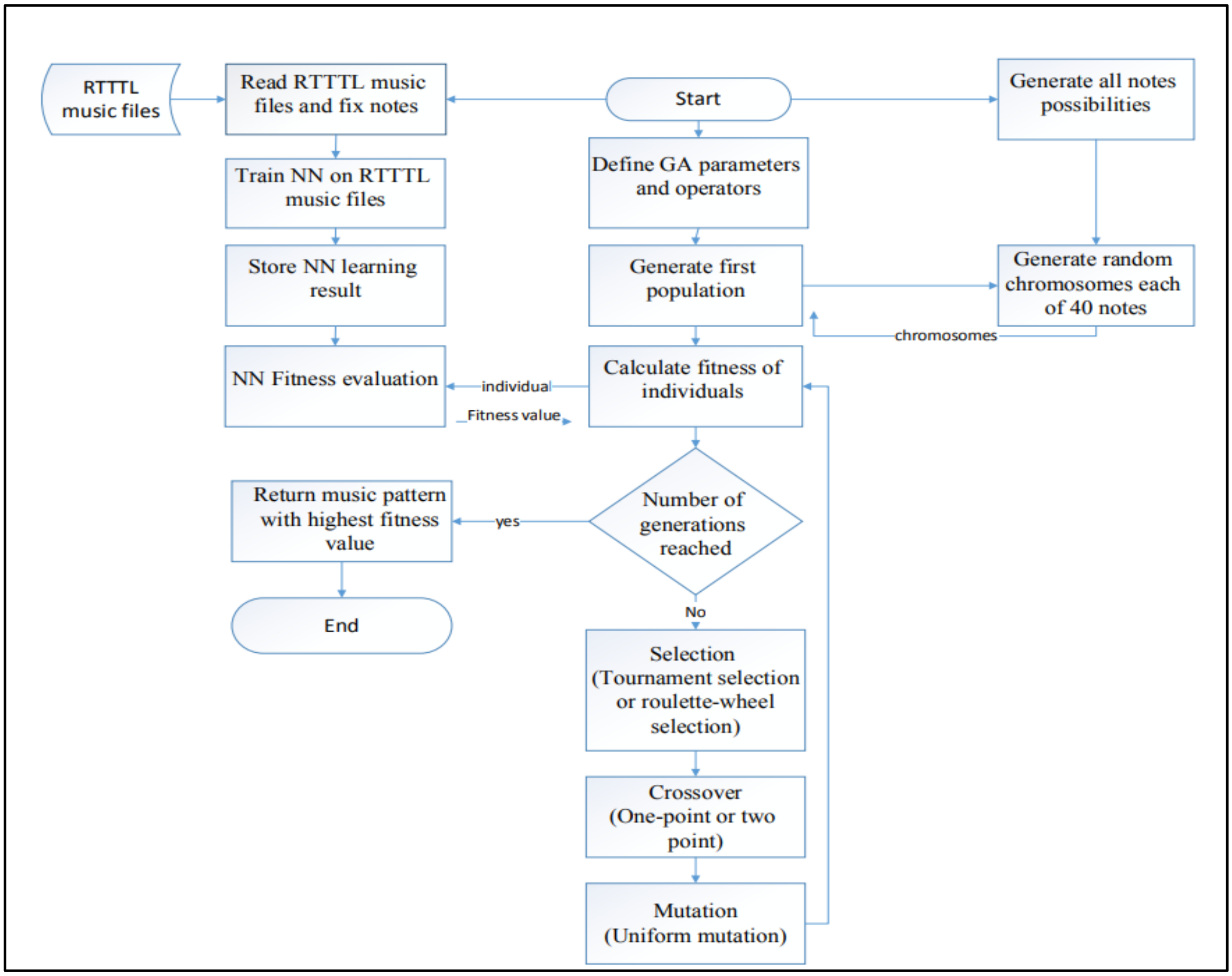

Figure 1: Flowchart of the methodology

1. **Training Set**: This method involves creating melodies using sets of monophonic music files in the RTTTL (Ring Tone Text Transfer Language), a format developed by Nokia for synthesizing simple monophonic ringtones by conducting a series of commands to generate any numbers. In RTTTL, a melody is described in a text-based format and consists of three parts: the title, default parameters, and the actual melody notes.

2. **Artificial Neural Network (ANN)**: The ANN, trained on two sets of good melodies with ideal outputs of 1 and 0, helps distinguish between high and low-quality compositions. It uses backpropagation and the Sigmoid activation function to refine its decision-making process. The trained ANN's parameters then function as a fitness measure in the GA(Genetic Algorithm). This setup allows for the evaluation and development of new melodies, progressively enhancing their quality over successive iterations.

3. **Genetic Algorithm (GA)**: The GA for music composition starts by setting specific parameters like mutation and crossover rates. It begins with a randomly generated initial population, where each individual consists of 40 random music notes. The fitness of each individual is assessed based on similarity to a training set, and the top 50% are retained. Selection for breeding the next generation is done through either Tournament or Roulette Wheel methods. Offspring are then created using one-point or two-point crossover techniques, and mutations are introduced at a set rate. This process of selection, crossover, and mutation continues over several generations, gradually refining and evolving the musical sequences.

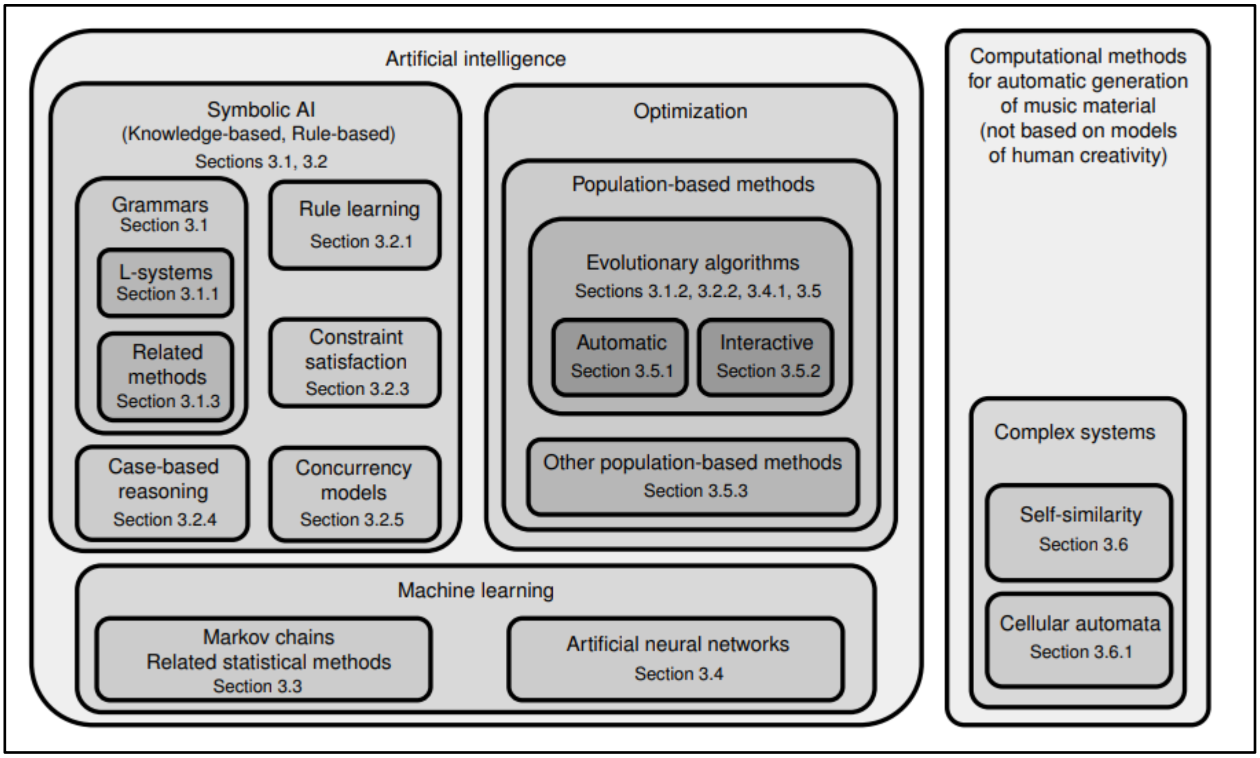

Figure 2: Taxonomy of the methods

4. **Grammars**: This approach involves the use of formal grammars to generate musical compositions. It includes techniques such as L-systems, which are used to model the growth and development of musical structures.

5. **Symbolic, Knowledge-Based Systems**: This approach involves the use of symbolic AI techniques, such as rule-based systems and knowledge representation, to generate music. It includes methods like case-based reasoning, rule learning, and constraint satisfaction.

6. **Markov Chains**: Markov chains are probabilistic models that are used to generate music based on statistical patterns. They are often used to model the transition probabilities between musical events.

7. **Artificial Neural Networks**: This approach involves the use of artificial neural networks to generate music. Neural networks can learn patterns and relationships in musical data and generate new compositions based on this learned knowledge.

8. **Evolutionary Methods**: These methods involve the use of evolutionary algorithms and other population-based optimization techniques to generate music. They simulate the process of natural selection to evolve musical compositions over time.

9. **Self-Similarity and Cellular Automata**: These methods involve the use of self-similarity and cellular automata to generate music. Self-similarity refers to the repetition of patterns at different scales, while cellular automata are computational models that generate music based on simple rules applied to a grid of cells.

Overall, the plethora of algorithmic music composition methods, spanning training sets, artificial neural networks, grammars, symbolic systems, evolutionary techniques, and more, underscores the interdisciplinary nature of this field, providing a diverse toolkit for creating innovative musical compositions.

3.0 BENEFITS OF THE APPLICATION

Automated music composition applications using genetic algorithms and artificial neural networks come with several advantages.

3.1 Creativity and Innovation

The combination of genetic algorithms and artificial neural networks enables the generation of novel and creative musical compositions. These algorithms can explore new patterns and combinations that may not be immediately apparent to human composers, fostering innovation in music creation.

3.2 Competence in Composition

Automated music composition can significantly reduce the time and effort required to create music. Algorithms can process large amounts of music data and produce compositions more efficiently than manual methods.

3.3 Variety and Diversity

Algorithms can be programmed to explore different styles and genres of music. This will lead to the creation of diverse compositions, meeting different tastes and preferences.

3.4 Adaptability

The system can adapt to different input parameters and constraints, allowing users to tailor the music generation process to their specific needs. This adaptability makes it suitable for a variety of applications, from background music in games to film scores.

3.5 Learning and Evolution

Genetic algorithms allow the system to learn and evolve over time. The algorithm can improve and refine its output based on feedback by evaluating and selecting the most successful musical compositions in each generation.

While automatic music composition using genetic algorithms and artificial neural networks has these advantages, it's important to note that it may not fully replace the role of human composers but rather complement their creativity and enhance the overall music creation process.

4.0 CONCLUSION

The field of algorithmic composition has made significant progress in automating various tasks related to musical composition, including melody generation, harmonization, counterpoint, and orchestration. Two main approaches have been explored such as replicating a corpus of compositions or specific styles and automating compositional tasks to varying degrees, from assisting human composers to producing compositions without human intervention. Categories such as Emulating Corpus or Styles which include real-time improvement systems, have seen great success. Algorithms such as EMI Cope and Pachet's Continuator have demonstrated the ability to mimic certain styles effectively. However, challenges persist in bridging the gap between the methodological precision of computer science and the intuition and cultural influences inherent in works of art. Evaluating systems designed to reproduce human creativity poses a challenge because of the elusive nature of artistic creativity. Although various frameworks for assessing computational creativity exist, none offer a universally applicable, controversy-free solution.

The debate on whether algorithmic composition systems can achieve true creativity, although in principle, does not have a strict and clear definition of creativity. The research landscape suggests that continued exploration and experimentation with hybrid approaches is essential. Integrating self-similarity and CA-based systems with machine learning or knowledge-based systems can unlock new possibilities in algorithm composition. As the field evolves, a deeper understanding of creativity and more effective evaluation frameworks will be essential to advance the capabilities of algorithmic composition systems. In conclusion, although algorithmic composition has made significant progress, the quest for true creativity and optimal combination of methods remains an ongoing challenge that requires further interdisciplinary collaboration and exploration.

5.0 REFERENCES

1. Doush, I. A., & Sawalha, A. (n.d.). *Automatic music composition using genetic algorithms and Artificial Neural Networks*. Malaysian Journal of Computer Science: https://adum.um.edu.my/index.php/MJCS/article/view/22007
2. ArXiv.org. (n.d.-a): https://arxiv.org/ftp/arxiv/papers/1907/1907.04258.pdf
3. Automatic music composition using genetic algorithm and artificial ... (n.d.-b): https://www.researchgate.net/publication/361454309_AUTOMATIC_MUSIC_COMPOSITION_USING_GENETIC_ALGORITHM_AND_ARTIFICIAL_NEURAL_NETWORKS
4. Algorithmic music composition based on artificial ... - IEEE xplore. (n.d.-a): https://ieeexplore.ieee.org/abstract/document/8327197