Music Composition with Artificial Intelligence System based on Markov Chain and Genetic Algorithm

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Abstract: Music production is a creative task and humans use different techniques to produce music composition as per their mood, genre and knowledge. Artificial intelligence techniques can be applied to create music composition which can resemble human flair. This paper presents an artificial intelligence system which uses Markov chain and Genetic algorithm respectively to create music composition based on user specifications.

Index Terms **- Music Composition, Markov chain, Genetic algorithm, Artificial intelligence.**

I. INTRODUCTION

Music composers apply thought process and creativity to manually write down music compositions into a transcribe sheet called "staff notation". However, researcher in Artificial Intelligence field have provided platform to create music composition digitally. This paper presents a system which uses two artificial intelligence algorithms, Markov chain (stochastic approach) and Genetic algorithm to create music composition. The process of creating music involves many challenges hence, a programmer must choose programming language according to required music structures.

II. METHODS

2.1 Markov Model

Markov chain is a stochastic approach used to analyze and learn from environmental data (existing music pieces and songs) for creating music. Existing data is analyzed to generate an optimal matrix of actions for each event to maximize the highest reward, which is fixed number assigned to the model upon generation of structured music. Given a larger database, the model can achieve convergence towards the optimal matrix faster.

2.2 Genetic Algorithm

Genetic algorithm is a problem solving technique based upon natural selection procedure for finding high quality solutions. Genetic algorithm requires a genetic representation called "Chromosome" and a fitness function for evaluating solution domain. The evolution starts from a base set of chromosomes treated as parents. A series of genetic operations mutation, inversion and crossover are applied over base set to generate new population. The population evolved in each iteration is called a generation, acts as parent for next iteration. Fitness function is used to evaluate evolved chromosomes generated in each iteration. The fittest chromosomes are selected on the basis of selection process involved and cycle continues till the fittest generation has not found.

Chromosome: Musical information (e.g., time, duration, interval, pitch) is represented in chromosome.

A selection process: A fitness function is used to judge fitness of each chromosome and decide reproduction opportunity of each chromosome.

Reproduction operators: Search controlled knowledge is embedded in the reproduction operators. Applying these operators ensures that all points in the state space can be reached.

III. METHODOLOGY

An Artificial Intelligence system which comprises of two algorithms, Markov chain and Genetic algorithms to create music composition. The system takes user specifications as input and generates a song in the form of WAV file. The user specifications are below mentioned.

- Transition between two notes or chords. A higher transition leads to dissonant sound and smaller transition leads to boring one. Transition should be appropriate as it determines the melody of the music.

- Repetition of notes and chords determines the creativity of the music i.e., low repetition leads to high creativity.
- Variety of notes and chords determine the complexity of music.
- Major/Minor keys and tempo of music determines the mood of song.
- See figure 1 for overview of the AI system's architecture.

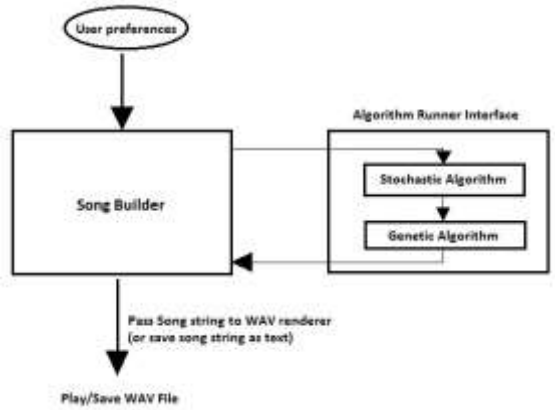

Figure 1: AI system's architecture.

Both algorithms (Markov Model and Genetic Algorithm) uses below mentioned steps to generate a music composition.

1. Generate song structure.
2. Generate measure structure.
3. Generate chord sequence.
4. Generate melody sequence.

The system takes user specifications as input and stores it in song builder. The system will generate a single music composition using both algorithms respectively and pass the music string to WAV renderer. The output file cane be played and saved for further use.

Figure 2 shows the method used to create a single note named 'A'

```
Fs=8000;
Ts=1/Fs;
t=[0:Ts:1];
F_A=440; %Frequency of note A is 440 Hz
A=sin(2*pi*F_A*t);
```

Figure 2: Method create note 'A'.

The frequencies of notes B, C#, D, E and F # are 493.88 Hz, 554.37 Hz, 587.33 Hz, 659.26 Hz and 739.99 Hz, respectively.

Figure 3 shows the adjacency list generated by system

```
    a a#  b  c  c# d  d# e  f  f# g  g#
a [[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
a# [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
b  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
c  [0, 0, 0, 6, 0, 1, 0, 0, 0, 0, 2, 0],
c# [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
d  [0, 0, 0, 1, 0, 0, 0, 2, 0, 0, 0, 0],
d# [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
e  [0, 0, 0, 1, 0, 2, 0, 3, 1, 0, 0, 0],
e# [0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0],
f  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
f# [0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 2, 0],
g  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
g# [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]]
```

Figure 3: Adjacency matrix.

IV. RESULTS

The result from the experimental AI system reveals how computerized music programs can reflects artificial intelligence. This section examines excerpts from each stochastic, genetic algorithm and experimental AI system are shown in figures 3, 4 and 5 respectively.

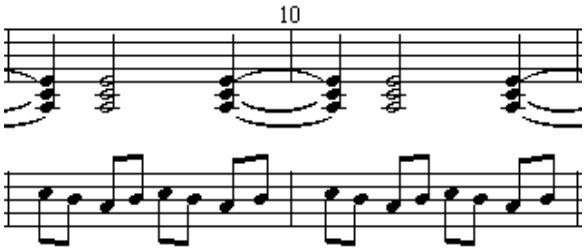

Figure 4: Excerpt from Stochastic Approach.

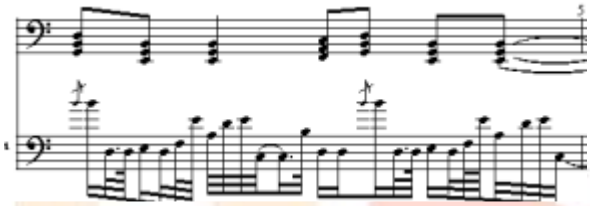

Figure 5: Excerpt from Genetic Algorithm Approach.

Figure 6: Excerpt from Experimental AI system.

In figure 3, the melody created by stochastic approach is repetitive and simple which leads to boring sound. In figure 4, the melody created by genetic algorithm shows variability however, the large step sizes between notes cause this song to lack coherence. Figure 5, the melody created by experimental AI system is much more creative and listenable. There is no repetition and lack of coherence.

V. CONCLUSIONS

While looking at the result of experimental artificial intelligence system it can be observed that the disadvantage occurred during creating music by stochastic algorithm and genetic algorithm individually has been overcome. The melody created by experimental AI system is much more listenable with no repetition and lack of coherence. AI system is capable of creating original music on the basic of user specifications.

VI. REFERENCES

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