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Artificial Intelligence Techniques for Music Composition

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ABSTRACT

Artificial Intelligence (AI) has different computational techniques which can be applied in music industry for creating creative compositions. Computer has no creative ability hence, it can be achieved via AI research by substituting something inventive to meet the same creative spark as humans possess. This survey aims to compare three different AI algorithms applied in music composition.
Keywords : Music Composition, Markov Chain, Routing Plaining, Genetic Algorithm.

I. INTRODUCTION

Artificial Intelligence (AI) based problem solving systems are capable in identification and decision making. AI techniques can be applied to solve several problems related to designing, diagnosis, and optimization. For accuracy, solutions provided by AI techniques are to be compared with similar solutions provided by the human experts. The creative task like composing music can be achieved via AI research by substituting something inventive to meet the same creative spark as humans possess.

AI applied to music composition varies in both aspects. In one method, music composition spectrum is used to generate a musical accompaniment in real time scenario. In other, AI system composes music from scratch. Moreover, AI systems which uses both methods are used to create similar sounding compositions by training based on previously composed music. AI based music composition is different from computer generated music such as MIDI technology.

Humans perform music composition in many ways. Some people hear music and transcribe it into sheet music. Some create music through a thoughtful process and others creates music via random jamming process. Musician might also merge these three approaches to create music theory. Knowledge based reasoning is done with a stochastic approach, routing planning, and genetic algorithms respectively . In AI research into music composition, genetic algorithm is the most preferred technique. Other approaches includes fractal geometry, neural network, and stochastic approaches using Markov chains.

II. LITERATURE REVIEW

This section introduces three algorithms which might be used for generating music composition.

A. Markov Chain

A Markov chain is a state transition diagram with probabilities annotated over the links. It's a statistical model which can be used to generate a possible sequence of events along with the probability of sequence might arise. Figure 1 illustrates a simple Markov chain of daily diet patterns. If today's diet is of grains, then the probability of diet for the next three days consisting grains, grains, seafood, would be .4*.4*.2. Respectively, the probability of diet for the next three days consisting vegetables, vegetables, grains would be .4*.6*.3.

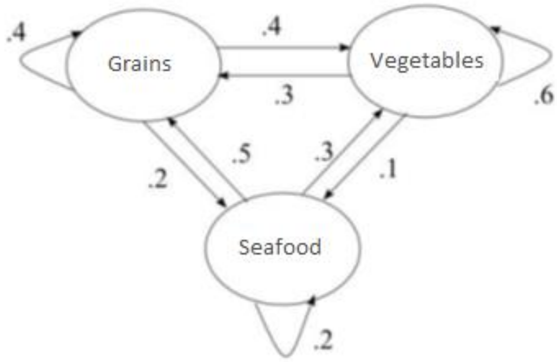

Figure 1. A Markov Chain

The statistical model can be easily generated from a database of events. For instance, the data from figure 1 could come from several months of diet data.

B. Routing Plaining

Routine planning (or routine design) captures the prototypical sequence of problem solving activities undertaken in planning or designing an artifact. It is a knowledge based approach that provides the solution to a problem using the routine knowledge of domain expert on the basis of past experiences. Routine planning (or routine design) has been used to solve a number of routine problems such as air force mission planning and nutritional meal planning. The knowledge base breaks into various categories. First is a hierarchy of the components involved in the routine design or planning problem. Plan decomposition is done to construct an artifact for which each components and subcomponents are designed individually. Second, to design any given subcomponent with different specific plan steps done by experts. An appropriate plan step is selected on the basis of pattern-matching knowledge that identifies the plan step with the greatest chance of providing success in the designed artifact meeting user specifications, along with decisions already made on the design of other components. Redesign steps are available for instance decreasing a component's size to avoid the nullification of partial design. Lastly, failure handling knowledge can be applied if designed artifact fails to meet its intended functionality or user specifications.

Figure 2 shows plan decomposition along with the plan steps available to design each (sub)component.

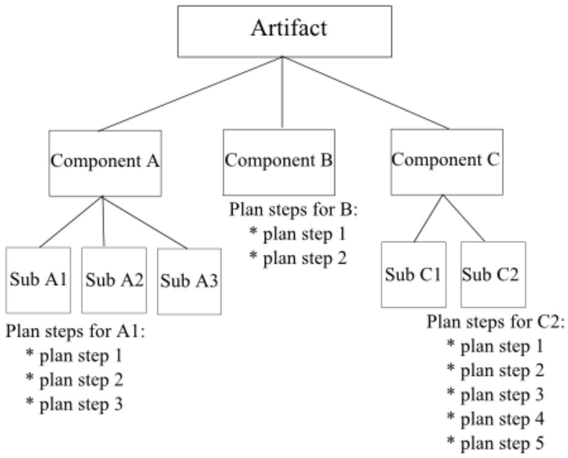

Figure 2. Routine Design Plan Decomposition

C. Genetic Algorithm

The genetic algorithm (GA) is a process of natural selection to provide a better solution. The GA models consists of a genetic representation string called a chromosome and a fitness function. The evolution starts from a base set of chromosomes treated as parents through a series of genetic operations (mutation, inversion and crossover). Mutation changes one or more values in a chromosome from its initial state. Inversion reverses or re-arranges a sequence of chromosome. Crossover swaps portions of the parents chromosomes and generate children. The population evolved in each iteration is called a generation. Fitness function is used to evaluate evolved child chromosomes. The fittest chromosomes are selected through a selection mechanism and acts as parents for next iteration (generation). The cycle continues until a child has been found whose fitness exceeds some desired threshold.

III. METHODOLOGY

Music composition is a creative task and required some basic specifications to determine the type of song. These specifications are as follows.

- Transition between two chords or notes determines the melody of song. A higher transition size leads to create a song with more dissonant sound while a small transition size leads to create a boring song.

- Repetition of chords or notes determines the creativity of song. The lower the repetition, the higher the creativity.
- Variety of chords, notes and song structure determines the complexity of song. A higher variety with more parts and more diversity within parts leads to a complex song.
- Range of octaves covered by the variety of chords or notes.
- Major/Minor key and tempo of the song determines the mood of song. A minor key with slower tempo leads to somber mood. A major key with faster tempo leads to upbeat mood. An intermediate mood may cause by using major and minor keys for different parts of the song.
- The selection of instruments may also affect the mood of the song.

Each of the three algorithms (stochastic approach, planning approach, genetic algorithm approach) generates a song via planning decomposition, as shown in figure 3. The first task is to generate song's structure. Song structure consists of few components: introduction (I), verses (V), choruses (C), bridges (B), solo sections (S) and outros (O). A simple song may have less components with structure of I-V-C-V-C-O and more complex song may have more components with structure of I-V-V-C-V-B-C-S-C-O.

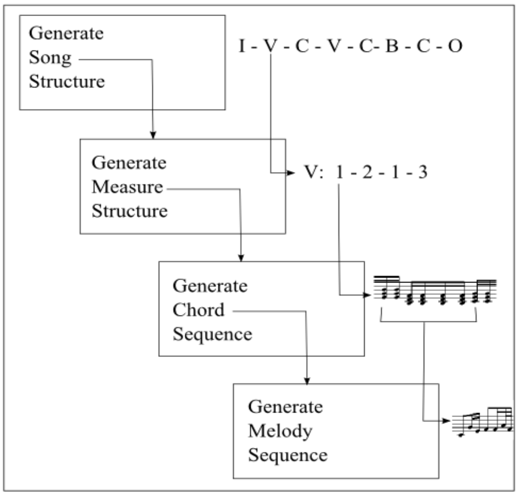

Figure 3. Four Steps to Generate a Song

After deciding the song structure or song components, the next step is to generate the structure within components. This structure is based on the number of and types of measures. For example, a verse might consist of 4 or 8 measures. These measures may identical or alternate between different chord sequences. A 8-measure component may follow a pattern like 1-1-1-2-1-1-1-2 or 1-2-1-3-1-2-1-3 or 1-1-1-1-1-1-1-1 or even 1-2-3-4-1-2-3-4.

Each measure consist of number of "beats". In 4/4 timing a measure might consist of 4 quarter notes or 8 eighth notes or 1 whole note. The variety in notes (quarter, eighth, whole) will help to decide duration of chords i.e. whether all chords have the same duration or whether some chords will be longer and/or shorter than others. A more diverse measure might consist variety of notes for example, a half note followed by a quarter note followed by two eighth notes.

Each of the three algorithms (stochastic approach, planning approach, genetic algorithm approach) performs planning decomposition in different ways.

IV. DATA ACQUISITION

This section examines and compares two sets of songs, each of them generated using three algorithms. For the first set of songs, the user specified high variety, high transition, low repetition highly rhythmic and high range. Excerpts from the stochastic, planning and genetic algorithm are shown in figures 5, 6 and 7 respectively.

Figure 5. Excerpt from Stochastic Approach

Figure 6. Excerpt from Planning Approach

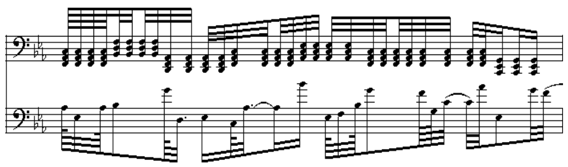

Figure 7. Excerpt from Genetic Algorithm Approach

figure 5, the melody of the stochastic approach has large transitions between notes along with rapidly changing notes resulting into chaotic and uneven sound. The melody generated by the genetic algorithm (figure 7) is sparser than melody generated by other two songs leading to more listenable melody. However, the chord sequences have a rhythmic pattern which makes the song less listenable as chords are played continuously in the measure. The melody generated by the planning approach (figure 6) offers a compromise between these two extremes. The melody is neither chaotic nor with large step sizes. It does not suffer from a lack of rhythm also the chord structure is not as diverse as the genetic algorithm approach. The melody generated from the planning approach is far more listenable.

For the second set of songs, the user specified low variety, low transition, low range, high repetition and less rhythmic. The low range leads to slower tempo for all three generated songs. Excerpts from the stochastic, planning and genetic algorithm are shown in figures 8, 9 and 10 respectively.

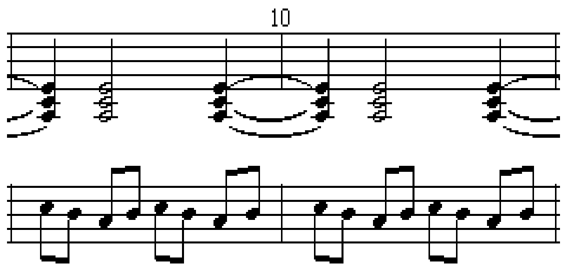

Figure 8. Excerpt from Stochastic Approach

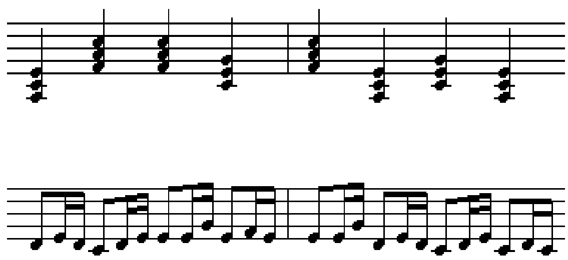

Figure 9. Excerpt from Planning Approach

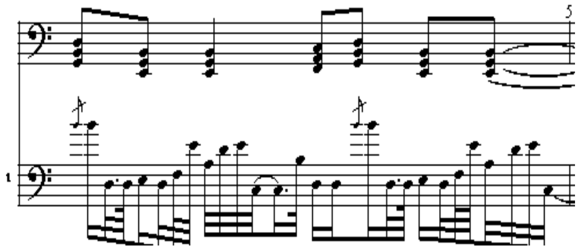

Figure 10. Excerpt from Genetic Algorithm Approach

In figure 8, the melody of the stochastic approach is highly repetitive and quite simple to the point of being boring. The melody of planning approach (figure 9) is slightly more interesting while remaining basic. The melody of the genetic algorithm shows variability however, the large step sizes between notes cause this song to lack coherence.

V. CONCLUSIONS

While looking at the results of three algorithms it is concluded that the stochastic algorithm is at a disadvantage because it does not apply any explicit strategy to either follow music theory or compositional strategies that make a song listenable. The main depreciator of the songs generated by the genetic algorithm is the overly random nature of the notes. The planning approach does not suffer from either of these problems but may lack in originality because it is impacted the least by randomness.

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