# **Report on Algorithmic Music Composition System:**

**Overview**

This system utilizes Markov Chains and Genetic Algorithms to create algorithmic music compositions. The process starts with generating random transition probability matrices and evolves through selection, crossover, and mutation to produce high-quality musical compositions. Below is a detailed explanation of the key concepts, processes, and functions used in this system, including how genre-specific motives are incorporated.

**1. Initial Population and Genome Structure**

**Initial Population:**

* **Population Size:** The system begins with an initial population of randomly generated genomes. Each genome represents a potential musical composition, characterized by three transition probability matrices corresponding to pitches, rhythms, and chords.

**Genome Structure:**

* **Pitches:** The pitch matrix has a size of NUM\_PITCHES x NUM\_PITCHES (12 x 12 in this case). Each row represents the probability distribution of transitioning from one pitch to another.
* **Rhythms:** The rhythm matrix has a size of NUM\_RHYTHMS x NUM\_RHYTHMS (8 x 8), representing the probability distribution of rhythm transitions.
* **Chords:** The chord matrix has a size of NUM\_CHORDS x NUM\_CHORDS (36 x 36), representing chord progression probabilities.

Each genome consists of these matrices, defining the rules for generating a composition.

**2. Generating Compositions**

**Process:**

* **Generation:** A composition is created by simulating the Markov Chains defined by the genome’s matrices. Starting with an initial random pitch, rhythm, and chord, the system iteratively selects the next pitch, rhythm, and chord based on the current state and the corresponding transition probabilities.

**Output:**

* **Composition:** The generated composition includes sequences for pitches, rhythms, and chords, forming the structure of a musical piece.

**3. Fitness Evaluation with Genre-Specific Motives**

**Motives and Variations:**

* **Motives:** The system generates primary motives, which are short melodic sequences (size 4), created randomly or based on specific genre characteristics.
* **Variations:** Motives are transformed using operations like transposition and inversion to produce different musical variations, which are then used in the evaluation process.

**Genre-Specific Motives:**

* **Blues:** Motives may use the minor pentatonic scale, emphasizing blue notes (flatted third, fifth, and seventh).
* **Jazz:** Motives could feature syncopated rhythms and use the ii-V-I chord progression or improvisational patterns typical of jazz solos.
* **Classical:** Motives might involve stepwise motion or sequences with clear tonality, modeled after motifs from Baroque or Classical periods.
* **Electronic Dance Music (EDM):** Motives might focus on repetitive, rhythmically driving patterns with a strong beat, using synthesized sounds and effects.

**Ear Module:**

* **Function:** Simulates auditory perception by evaluating the harmonic content of the composition against genre-specific motives.
* **Fitness Score:** Calculated based on how well the transitions in the composition align with the genre-specific patterns. A higher score indicates that the composition adheres to the desired stylistic characteristics.

**4. Genetic Algorithm: Crossover and Mutation**

**Crossover:**

* **Operation:** Combines two parent genomes by averaging their matrices. This operation allows the child genome to inherit characteristics from both parents.

**Mutation:**

* **Process:** Introduces variations by altering the transition matrices with a certain probability. This is achieved by combining the current matrix with a newly generated random matrix and normalizing it. Mutation introduces diversity, enabling exploration of a wider range of compositions.

**Generational Evolution:**

* **Iteration:** The genetic algorithm iterates over multiple generations, selecting the best-performing genomes (based on fitness scores) to form the next generation. Through crossover and mutation, the population evolves, improving composition quality over time.

**5. Output: Music Composition**

**Pitches, Rhythms, and Chords:**

* **Pitches:** Uses a 12-note pitch scale, represented by indices 0 to 11, mapped to notes from C to B.
* **Rhythms:** Eight rhythmic durations, from whole notes to 128th notes.
* **Chords:** A set of 36 chord types, including major, minor, diminished, augmented, and extended chords.

**MIDI and MusicXML Export:**

* **Conversion:** Final compositions are converted into musical streams using the music21 library and exported as MIDI and MusicXML files. This allows for easy playback and analysis in digital audio workstations or music notation software.

**6. Summary of Functions**

* **create\_random\_genome:** Generates random pitch, rhythm, and chord transition matrices.
* **generate\_composition:** Creates a musical composition based on a genome's transition matrices.
* **generate\_motives and create\_variations:** Generates and transforms motives for fitness evaluation.
* **EarModule and evaluate\_composition:** Simulates auditory evaluation and calculates fitness scores based on genre-specific motives.
* **crossover\_and\_mutate:** Performs crossover and mutation to evolve the population.
* **genetic\_algorithm:** Manages the generational evolution process and outputs the final compositions.

Git Hub Link to the Project Repository: <https://github.com/Noonela12/Algorithmic-Music-Composition>