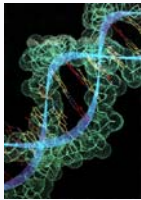


Abstract

Evolutionary Algorithms (EAs) is an interdisciplinary research field with a relationship to biology, Artificial Intelligence, numerical optimization and decision support techniques.

While the concept of using genetic algorithms (GA) to compose music has been attempted in the past, the success of such systems has been somewhat limited. This project is an ongoing venture in that direction.

Theory - Genetic Algorithms



- **Genetic Algorithms (GA)** were invented by **John Holland** and developed by him and his students and colleagues.
- Inspired by Darwin's theory of evolution
- Used as a method of global optimization based on the evolutionary improvement of populations.

Definitions:

Gene: String of bits representing one of the parameters to be optimized.

0 1 1 0 1 1

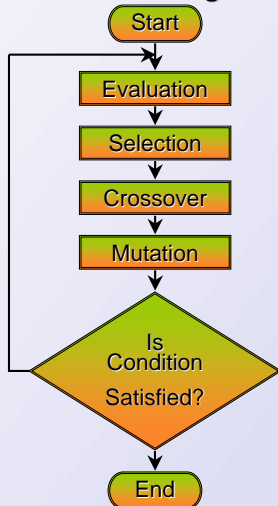
Population: A predefined number of chromosomes

Fitness: The goodness of each chromosome.

Chromosome: A string of genes representing *all* parameters to be optimized.

0 0 1 0 1 1 0 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 0 1 1

A Basic Genetic Algorithm:



Evaluation: Analysis of the existing population and *assignment of a fitness value*.

Selection: Picking of fitting parent chromosomes from the population, usually using the *roulette wheel* technique.

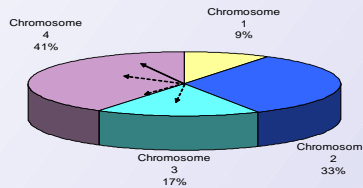
Crossover and Mutation: Breeding of parent chromosomes to produce offspring population with an overall *higher fitness value*.

Test: A check to determine whether the *end condition was satisfied or not*. Continues the process if the check fails.

The Roulette Wheel Selection Technique

This operator selects chromosomes in the population for reproduction. The fitter the chromosome, the more times it is likely to be selected to reproduce.

Chromosome	Fitness	Chance of Being Selected
Chromosome 1	12	12/135 → 9%
Chromosome 2	45	45/135 → 33%
Chromosome 3	23	23/135 → 17%
Chromosome 4	55	55/135 → 41%
Total Fitness = 135		



Stage 1:

	Motif	Gene 1	Gene 2	Gene 3	Gene 4	...	Gene 16
1							
2							
3							
4							
...							
16							

Stage 2:

Phrase A

4	3	13	8	12	2	5	1
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Phrase B

16	2	8	8	3	3	5	11
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Final Melody = A A' B A'

Results

The Evolutionary Music Composer

The Challenge:

There is no single absolute that governs the interpretation of music. Each person has their own musical tastes, and therein embeds the primary obstacle: **How do we intelligently and autonomously produce music that is pleasant to hear to the average person?**

Two Stage Evolutionary Music:

Limitations:

The four major diatonic keys:	C, D, F, G
13 possible note outcomes:	C, C#, D, D#, E, F, F#, G, G#, A, A#, B, rest
2 octave range:	High and Low
5 duration values:	1, 1/2, 1/4, 1/8, 1/16

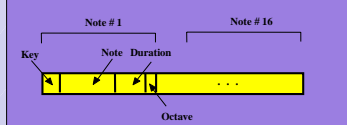
Motif: A melodic or rhythmic 'thought' that appears throughout a musical piece. Defined as 1 measure.

Phrase: A collection of motifs, defined here as 8.

Note Gene Structure:

Note	Duration	Octave
0000	REST	000 1 0 Low
0001	C	001 1/2 1 High
0010	C#	010 1/4
0011	D	011 1/8
0100	D#	100 1/16
0101	E	
0110	F	
0111	F#	
1000	G	
1001	G#	
1010	A	
1011	A#	
1100	B	

Motif Chromosome Structure:



Fitness Functions:

Intervals: How well do two adjacent notes sound together?

Major Key Evaluation: How well do the notes match the specified major key?

Ratios Analysis: How well does the spectrum of notes match the ideal ratio of tonal centers/color notes/chromatic notes?

Conclusion and Future Work

In a multi-dimensional optimization problem such as automating music composition, there is no guarantee that the result will be aesthetically pleasing to every listener, but great strides are being made to insure the music is as innovative as possible.

This project has great potential for the future due to new techniques that better evaluate motifs and phrases, as well as introducing new features, including the ability to choose the style of music.

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