Evolving Four-Part Harmony Using Genetic Algorithms

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Abstract

This paper presents a genetic algorithm (GA) that evolves a four-part musical composition--melodically, harmonically, and rhythmically. Unlike similar attempts in the literature, our composition evolves from a single musical chord without human intervention or initial musical material. The mutation rules and fitness evaluation are based on common rules from music theory. The genetic operators and individual mutation rules are selected from probability distributions that evolve alongside the musical material.

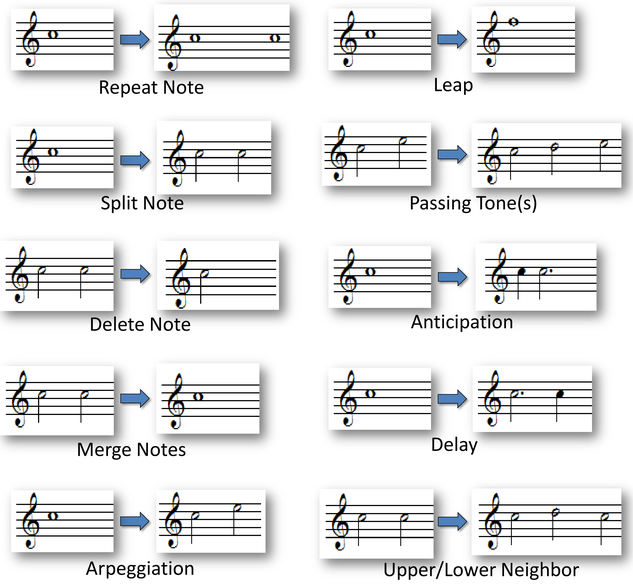
Overview

Our system composes four-part musical harmony with a GA without user intervention or initial musical material. We represent a four-voice composition using a variable length chromosome and utilize the genetic operators of mutation, duplication, inversion, and crossover. The mutation operator and the fitness function are based on music theory rules. Each chromosome contains a set of probabilities used to select the genetic operators and these probabilities evolve alongside the musical material. As the most fit individuals of the population survive to reproduce from generation to generation, their probabilities most often reflect the rules which contributed to their high fitness and are probabilistically more likely to be used again.

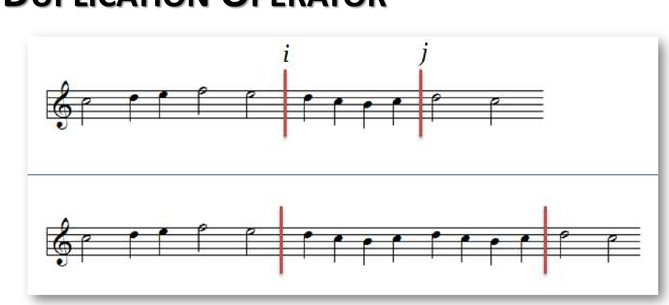
Fitness Rules

- Opening and closing chord must be a tonic chord
- Closes with a perfect authentic cadence
- Range of a single part should be less than major thirteenth
- Leaps should be smaller than major sixth
- Large leaps must resolve by step in opposite direction
- Voice should not cross with another part
- Parts must stay in their respective vocal range
- No pitch should repeat more than three times consecutively
- Half of melodic movement should be step-wise
- No two parts should have parallel octaves or parallel fifths
- Parts should form only vertical consonances
- Piece should contain examples of all duration types
- No note type should repeat more than three times

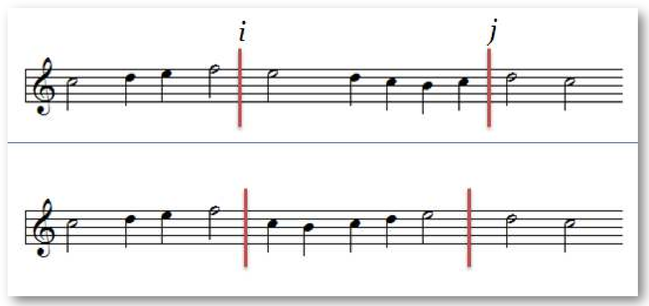
Mutation



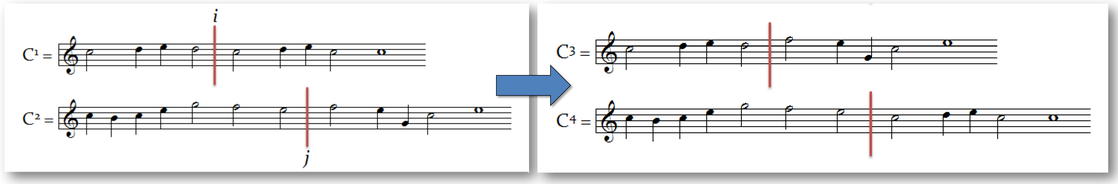
Duplication Operator



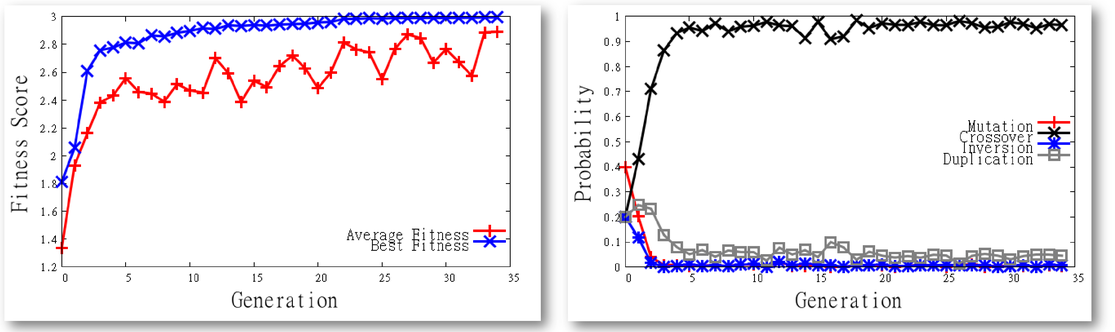
Inversion Operator



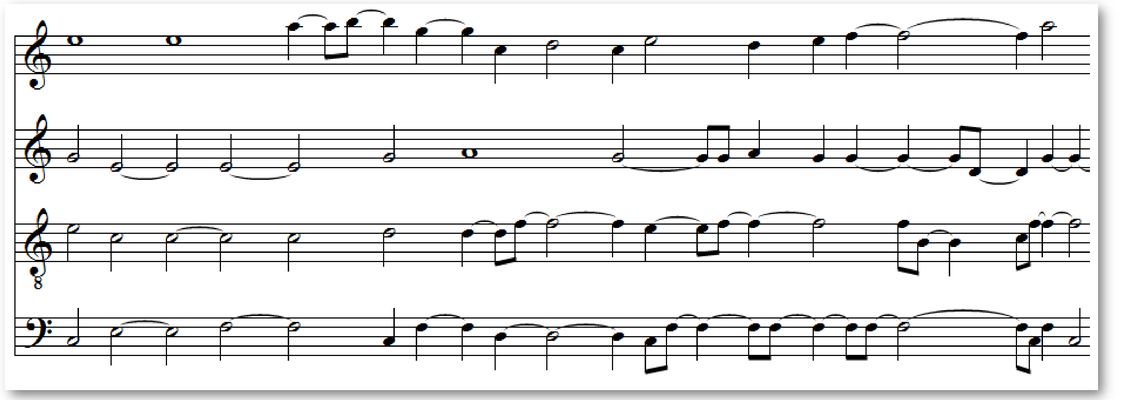
Crossover Operator



Results



Experimental run of 34 generations showing (left) the average and the best fitness score for each generation and (right) operator probabilities averaged over entire population, demonstrating a strong annealed preference to the crossover operator.



This system demonstrates that it possible to evolve four-part musical compositions entirely from an initial single chord. The resulting compositions show a number of desirable musical qualities, such as preference for leaps in the outer parts, preference for stepwise motion in the inner parts, contrary motion between parts, and singable parts in the proper musical ranges.

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