Evolutionary Algorithms: A new hope for the future of music teaching

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ABSTRACT

In this paper, we describe the experience gained when Evolutionary Algorithms were applied to SATB music composition and the impact it is demonstrating in Spanish Professional Music Conservatories for the last three years. To our knowledge, this is the first time that an EA-inspired tool has been used at a national level in music conservatories.

CCS CONCEPTS

• **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability.

KEYWORDS

Evolutionary Algorithms, Music composition, SATB harmony

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1 INTRODUCTION

Music composition has been frequently addressed from the evolutionary algorithms point of view. Recently, a survey has been published that includes the main attempts and techniques employed during the last decade, which includes Evolutionary Algorithms for 4-voices SATB (Soprano, Alto, Tenor and Bass) harmony composition [3].

SATB harmony is the first subject dealing with music composition that every European music student must follow in conservatories when pursuing a professional music degree. When mastered, they study counterpoint and other more advanced topics in the following years.

The first attempts to address SATB harmony as an optimisation process from the point of view of EAs were published in [1]. The main goal was to evolve the four voices considering the standard rules (encoded within the fitness function) that students must learn.

Yet, although the algorithm was built, run, and the first results produced, as described in the above-referred publication, the only way of fine-tuning it and checking their quality was to involve music teachers that are in charge of SATB harmony in conservatories, given that they are the experts in the area.

We describe here the experience we gained when involving a number of teachers and conservatories, that has allowed us to improve and fine-tune the fitness function, and how the tool we developed is nowadays routinely used: 2500 (> 10% active) users have downloaded it.

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2 SHARPMONY - THE TOOL

For an evolutionary algorithm to attain its goal, together with a proper parameter selection, finding a solution strongly depends on the fitness function we encode.

When we ran our first experiments, the fitness function included up to 9 classic harmony rules. This set of rules was enough as an initial attempt at the problem faced, yet we decided to involve professional music teachers to validate the approach. Thus in 2018, we contacted the head of the professional music conservatory of Mérida, Spain. He was interested in checking the tool and collaborating for fine-tune its capabilities. Since then, 5 different music conservatories from 4 Spanish regions have also adopted the tool and use it as an AI teaching-assisted tool to help students and teachers. Although the evolutionary approach to solving the problem is not available for students (given we want them to learn and master the rules thorough a series of exercises over a couple of academic years), the fitness function, with its core rules, is part of the tool in charge of checking the quality of composition exercises students perform. This way, we allow teachers and students to test the fitness function and provide us with hints about how to improve it.

2.1 How the tool works

Students are provided with both an Android APP (check Sharpmony in Google Play) and also a web editor (https://sharpmony.unex.es)) that allows them to complete SATB exercises and upload them to the cloud. Once exercises are uploaded, Sharpmony is in charge of checking all the rules and showing the errors using colour codes, as shown in figure 1. Students can check the errors and improve the exercise until no errors are found. On the other hand, teachers have complete access to their student's exercises and errors, can thus provide help to students, and also report errors detected in those corrections, which ultimately allows us to improve the fitness function in charge of checking the exercises.

2.2 The Genetic Algorithm at a glance

As described in [3], the GA works in a double round: Firstly, a suitable progression are evolved for the melody at hand; then, the three remaining voices (Alto, Tenor and Bass) are also progressively

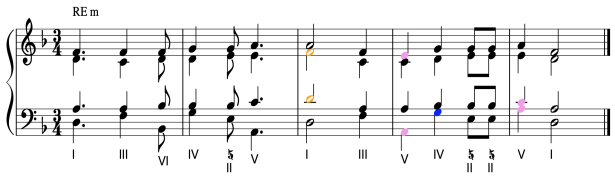

Figure 1: Exercise checked by sharpmony with errors detected (color codes described in sharpmony's web site).

evolved chord by chord, trying to minimize the number of errors that the set of rules detect within the exercise. Three different variations were tested in 2017 using the available set of rules at that time. Solutions obtained then, are nowadays not valid anymore, given that the number of rules have doubled since then, thus detecting an enlarged number of errors that were missed in that first approach. Therefore, the same algorithm with the new fitness function, is much more capable of producing better results today.

3 RESULTS

We show in figure 2 the number of exercises checked in the last 3 and a half years, month by month. We may notice the low number of exercises checked in 2020 when only two conservatories were involve in the project. The third conservatory joined in 2021, and the final two very recently, by the end of 2022.

Thus, the fitness function has been applied more than 7800 times during these years to actual exercises, and their performance has been checked by experts: the teachers. The tool also provides teachers with the capability of reporting errors missed by the fitness function. The result of this three-year fine-tuning period is a fitness function that includes 20 different rules.

Secondly, when the GA is applied with the new tuned fitness function, results are of similar quality as those produced by a student that master the rules (check Figure 3)

Moreover, the tool has recently received attention from Spanish music conservatories offering bachelor and master degrees [2]. The idea is that the evolutionary approach to music composition that the tool embodies could be part of the music composition subject so that it can be considered as an available AI-assisted music composition technique.

According to feedback from music teachers, Sharpmony saves them many hours previously spent on checking exercises: 7800 exercises x 5 minutes/exercise = 650 hours saved since we launched the tool. Not only that, but they also report a complete change in teaching methodology, which now spends all class time explaining harmony, whereas before, half the time was spent on checking exercises.

4 CONCLUSIONS AND FUTURE WORK

Sharpmony project is allowing a nationwide adoption of an EA-based software tool for improving music teaching in music conservatories, which has allowed us to fine-tune a fitness function that has already checked more than 7800 SATB exercises and also provide competitive ea-based SATB music composition.

We plan now to focus on improving the evolutionary algorithm in charge of SATB composition and hope this new tool will be useful for advanced students of music composition.

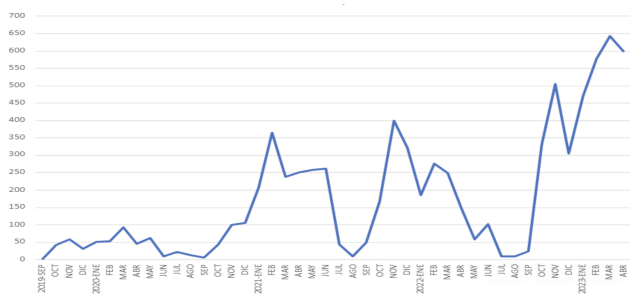

Figure 2: Evolution of exercises checked, more than 7800 since sharpmony was launched (see https://sharpmony.unex.es).

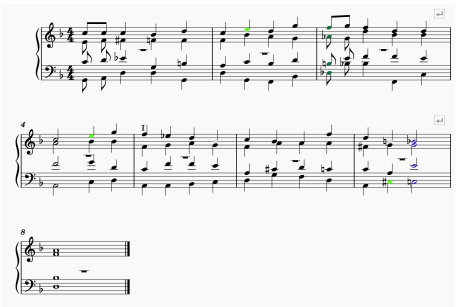

Figure 3: An melody harmonized with the fine-tuned fitness function.

5 ACKNOWLEDGMENTS

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