

# Demo: Counterpoint by Construction

Youyou Cong  
Tokyo Institute of Technology  
Tokyo, Japan  
cong@c.titech.ac.jp

John Leo  
Halfaya Research  
Bellevue, WA, USA  
leo@halfaya.org

Western music of the common practice period tends to loosely follow sets of rules, which were developed over time to help ensure the aesthetic quality of the composition. Among various rules, those for harmony [Piston et al. 1987] and counterpoint [Fux and Mann 1965] are continue to be taught to music students, not only as a means to understand the music of that period, but also as a foundation for modern art and popular music. To help analyze and synthesize tonal music, it is worthwhile to encode these rules into a programming language, and in particular, functional programming languages have proven ideally suited to this task. In the past decade, quite a bit of work has been done in Haskell [De Haas et al. 2011, 2013; Koops et al. 2013; Magalhães and de Haas 2011; Magalhães and Koops 2014] to encode the rules of harmony, but little progress has been made on counterpoint [Samozvancev 2016]. Furthermore, due to the lack of full dependent types, Haskell’s type system is not strong enough to encode the logic of counterpoint in a natural way; indeed, existing implementation relies on a number of language extensions.

In this demonstration of work in progress, we present Music Tools [Cong and Leo 2019], a library of small tools that can be combined functionally to help analyze and synthesize music. The library is written in Agda (with Haskell used for I/O), which allows simple and natural encoding of rules by means of dependent types. As an application of the library, we demonstrate an implementation of species counterpoint [Fux and Mann 1965], which uses Agda’s rich type system to ensure (by construction) that all rules are followed. We show how this both aids human composition and allows for computer-generated creation of correct counterpoint. We also contrast our approach to a recent study on generating natural-sounding counterpoint by machine learning [Huang et al. 2017], which does not give us correctness guarantees. Finally, we discuss further applications of our library, including handling of functional harmony.

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