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An Investigation of Musical Structure with Persistent Homology

While topological data analysis (TDA) is seldom used in natural language processing, TDA techniques have been even more rarely applied to the realm of music. Therefore, we are seeking to understand the topological structure of music with persistent homology, a TDA tool for measuring the persistence of simplicial complex filtrations. Borrowing a “bag of words” technique from natural language processing, we are converting measures in a song to “bag of notes” vectors. From these vectors, we will produce Vietoris-Rips filtrations of the songs and analyze the resulting filtrations with persistent homology. Using this approach, we hypothesize that we will be able to define an inverse relationship between a song's underlying persistence and its constituent notes. This inverse topological descriptor could be used to highlight structural components of a song that would not be evident by merely observing a song's notes. This tool would be quite useful to topologists and musicians alike, and would lay the foundation for future research on the structure of music.