Abstract submitted to ICCCM 2025

Quantum jazz: spectral representation of musical harmony

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We describe an approach to incorporating a spectral representation of harmonic semantics in a jazz grammar. Our work is based on Steedman's combinatory categorial grammar for jazz chord progressions. Steedman's grammar projects its semantic interpretation on a tonal space induced by harmonic relations, and takes particular interest in effectively unbounded sequences of cadences, in which ambiguity is tolerated by listeners in a surprising way. Our work is motivated by the search for a more cognitive and perceptual account of this phenomenon. We define a spectral vector space which we use for semantic representation, and which we posit, along with its meaningful geometry, as a candidate cognitive model. In this space, tonalities are represented by vectors which may be thought of as combinations of waves, or wave-shapes, in the neural substrate. Changes in tonality are described as linear transformations over this space, representing changes of waveshape in the biology. We define the syntax of the grammar in the formalism of pregroups, which has been successfully used in so-called Quantum Natural Language processing. This results in a common category-theoretic structure capturing both syntax and semantics: a compact closed category. We exploit this common structure to project the semantics of the individual chords to the entire chord progression according to the syntax. In particular, we show how the indeterminate length of the blues cadence sequence may be captured, correctly maintaining ambiguity until the final resolution, but still representing the harmonic movement in a uniform way.

We believe this is the first time that mathematics from quantum theory has been used in this way to model musical harmony and music cognition. It builds on our previous work that shows how Western Tonal Harmony can be modelled in mathematical systems that may in principle be directly implemented through wave interaction in a brain.