Immanent Triadic Transformations

Dane Filipczak
Pittsburgh, PA USA

Abstract

The most common notion of harmonic organization in Western music involves a hierarchical key from which individual chords inherit their identity. Systems for the automatic generation of harmonic progressions typically rely on hierarchical concepts of organization as a result of uncritical adoption of this axiom. This paper describes an alternative approach to the automatic generation of harmony that directly relates subsequent chords through transformational functions without reference to a hierarchical structure. Three variations on implementing this immanent approach to harmonic organization are given, each of which affords expressive generation of triadic harmony within a decidedly tonal vocabulary.

Immanent and Transcendent Tonality

The system of note names, staff notation and key signatures that contemporary musicians have inherited from earlier eras of Western classical music all bear the mark of a deep commitment to the hierarchical organization of the diatonic scale (Cohn 2012). This traditional concept of tonality identifies musical objects in relation to a *key*, or collection of valid tones. Viewed diachronically, the tones of the key express a scale, the root of which becomes the most important tone in the hierarchy. While adventurous composers have experimented with many possibilities, the most common keys by far are those that inherit their intervals from the diatonic scale – the ubiquitous *Do Re Mi Fa Sol La Ti Do*. Diverse theorists across history have relied on the diatonic scale axiomatically in order to explain the psychoacoustic phenomenon of tonal agency (Monahan 2015) – to simplify these approaches, tones are understood as more or less restful depending on how closely they accord with the root. Thus harmonic progression in transcendent tonality is broadly understood as a series of strategies to delay the arrival at the root. This teleological conception of diatonic sovereignty is only rarely questioned fundamentally in the context of tonal music. Twentieth century atonality, iconoclastically exemplified by serial techniques, has led to a proliferation of diverse, often mathematical methods for organization. While the strict interpretation of the 12-tone technique is a transcendent schema because of its top-down organization based on a single row, many atonal methods could be described as relatively immanent. In contrast to the diversity of design concepts apparent in atonal music, methods aiming to formalize tonal music have for the most part continued to rely on a transcendent scale as necessary bedrock to their approach. Even some modern, sophisticated treatments of tonal harmony (Agmon 2013) treat the hierarchical organization of diatonic tones as an axiom, failing to ask whether non-hierarchical approaches may be articulated.

One of the defining aesthetic characteristics of many styles of modern music is a rejection of transcendent structure in favor of emergent macroscopic patterns formed through complex interaction of microscopic materials. This aesthetic orientation towards bottom-up structure has also been reflected in the practice of several contemporary music theorists. The goal of these theorists is to relate chords directly to one another in their analyses without reference to an external tonic or scale. As a result, harmonic progressions come to be conceptualized as a series of transformational functions. This discipline of analysis is often known as *neo-Riemannian theory* in recognition of the founding contributions of theorist Hugo Riemann. However, Cohn (2012) argues that this title is unproductive and prefers the more descriptive *transformational theory*, a title we'll adopt for the rest of this paper.

Hugo Riemann initially formulated the transformational approach to music analysis in response to the inadequacy of the traditional diatonic hierarchy to account for harmonic progressions that were emerging in the music of his contemporaries (Gollin 2011). Composers in the late Romantic period were augmenting traditional diatonic harmony with a new syntax that privileged smooth voice-leading and

common tones – techniques based on the direct relation of subsequent chords that often generated harmony inexplicable by and aesthetically ulterior to the traditional system. Because the creative and analytical catalyst of these progressions is the direct, bottom-up relationship between chords, this approach can be understood as an *immanent* form of tonal organization in contrast to the transcendent organization of key-based approaches.

The immanent vs. transcendent aesthetic dichotomy has been an important concern in recent artistic practice as theoretical approaches to understanding complexity and emergence in the natural world have proliferated (DeLanda 1999). Several contemporary authors, many inspired by the philosophical materialism of Gilles Deleuze, have been concerned with differentiating immanent and transcendent concepts of form. Manuel DeLanda in particular (2000) has shown how a mixture of transcendent top-down and immanent bottom-up processes influences the formation of diverse biological, geological, and linguistic phenomena. He shows how different structural scales of a single phenomenon can demonstrate different concentrations of top-down and bottom-up organizations. Analogously, musical material can participate to various degrees in transcendent or immanent organizational schemes at different points in its development. By conceptualizing the distinction between immanent and transcendent form we can create a useful axis by which to structure our design and analysis of musical form across different scales.

As a representative technique of immanent organization, the transformational concept of harmony can be fruitfully applied to generative music and is in many ways particularly well suited to a generative approach because of its focus on applying functions to discrete objects. What follows is a sample of three approaches to implementing transformational harmonic progressions. These approaches are capable of generating novel, interesting harmonic progressions that contrast and complement traditional diatonic harmony.

The Common Tone Approach

In order to implement automatic transformation from one chord to another one has to first define a limited set of chords qualities. Tymoczko (2011) has demonstrated that a primary factor in the perception of a sequence of chords as tonal is their relative qualitative similarity. For example, a harmonic progression that alternates between quartal and triadic harmony will be perceived as less tonal than a progression that limits the quality of its chords to either quartal or triadic. Here we'll limit ourselves to a single quality of chord because our goal is to generate progressions that will be perceived as tonal. For the sake of simplicity, we'll use the four basic triads: M/major, m/minor, d/diminished, A/augmented.

The first step in the transformational process is to select on of the three tones of the input triad to serve as a common tone. The weights by which this and all subsequent selections are made can be determined by some intelligent criteria or randomly; here we'll assume random weights. After selecting the common tone, one selects which structural role the common tone is to play in the next triad – is it to be the root, third or fifth? Next, the quality of the ensuing triad is selected from the four possible options. Finally, the two remaining notes in the triad are calculated in relation to the common tone according to the intervallic structure of the triad quality.

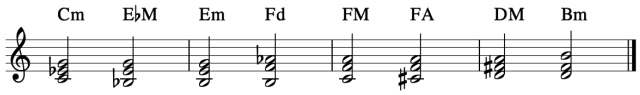

Figure 1. Common Tone Transformations

The Moving Tone Approach

The previous method began by choosing one tone of a triad to remain invariant. An opposite and complementary approach is to choose one tone to alter while retaining the other two. This approach requires more rigorous planning in order to implement effectively because the distance and direction in which a triadic tone travels determines the quality of the triad that the transform will create. It's helpful for the designer to draft a transition table that catalogues the triad qualities and transformations that will be permitted in a given implementation, and one such possible transition table is given below. Columns represent a group of possible triadic qualities, the scope of which is more liberal than the previous example: M – major, m – minor, d – diminished, A – augmented, sus4 – suspended fourth, Mb5 – major with diminished fifth. Rows represent either an upward or downward directional movement, within which the structural function of a tone (1 - root, 3 - third, 5 - fifth), along with its distance of movement (h – semitone, w – whole tone) determines the quality of the resulting triad, regardless of inversion. Not every possible transformation is permitted; rather, a subset of transformations is chosen based on the aesthetic goals of the designer. The table below was conceived for an application wherein the duration of tones are chosen stochastically and tones of successive triads may overlap; therefore certain transformations were discarded when the tetrachord formed by the union of their input and output was considered undesirably dissonant. For example, the transformation from major to minor triad by semitonal lowering of the third is a well-established device in many harmonic vocabularies but was omitted from this design because union of parallel major and minor triads creates a particularly dissonant tetrachord.

	M	m	d	A	sus4	Mb5
↑	1h→d 3h→ sus4 5h→ A 5w→ m	3w→ sus4 5h→ M 5w→d	5h→ m 5w→ M	1h→ m 3h→ m 5h→ m	1h→Mb 5 5h→m 5w→M	5h→ M 5w→ A
↓	1h→ m 1w→ d 5h→ Mb5	1h→A 1w→ M 5h→d	1h→ M 1w→ m	1h→ M 3h→ M 5h→ M	3h→M 3w→m	1h→ sus4

Table 1. Transition Table

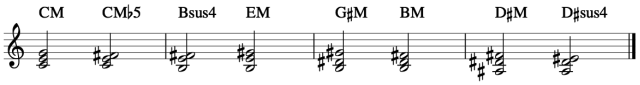

Figure 2. Moving Tone Transformations

The Geometric Approach

The final method we'll consider is more abstract and open-ended than the previous two. Many transformational music theorists have conceived of harmonic progressions as locomotion between proximate territories in a space of voice-leading possibilities. There are many ways of constructing such a voice leading space, and Tymoczko (2011) has given an account of many interesting possibilities in two, three and higher dimensions. Each possible space has a unique topology and requires a unique approach to its navigation. Here we'll take as an example the *Tonnetz* (tone net), a well-known two-dimensional cartography.

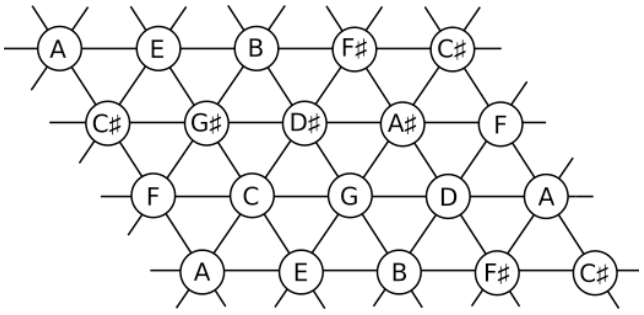

Figure 3. Tonnetz

The Tonnetz is constructed by crosshatching series of major thirds (diagonally from upper left to lower right) and minor thirds (diagonally from upper right to lower left). The interior area of triangles represents major or minor triads inheriting their tones from the nodes at their vertices. Traditionally, movement across the Tonnetz has been understood as a series of flips along triangle edges, each of which retains two vertices in common. The three possible primitive movements are shown below, and several additional compound movements derived from these have become canonized in contemporary Tonnetz-derived analytical approaches. The primitive maneuvers: P – *parallel,* R – *relative,* L – *leading tone.*

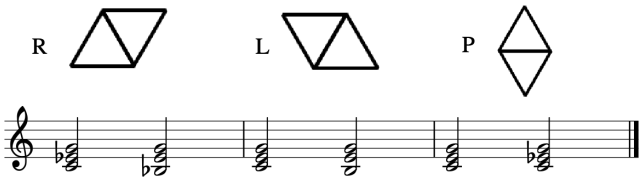

Figure 4. Primitive Maneuvers on the Tonnetz

One valid approach to generating harmonic progressions from the topography of the Tonnetz is to formalize these primitive maneuvers and functions and apply them in different combinations. However, this method doesn't engage the affordances of the Tonnetz as a geometrical cartography. When the Tonnetz is overlaid on a two-dimensional Cartesian plane an agent located at any point on the plane is situated within the domain of a single triad. Continuous motion of the agent through the plane results in a series of triads related by smooth voice leading. Triads become locations in space and chord progressions become choreographies representing movement in that space. Here the manifold methods of simulated locomotion known to computational creativity can greatly behoove the designer; random walks, autonomous steering behaviors, and Newtonian trajectories all offer interesting possibilities. Below we've manually charted an example path; recall that all tones are enharmonically equivalent and are notated solely by preference of legibility.

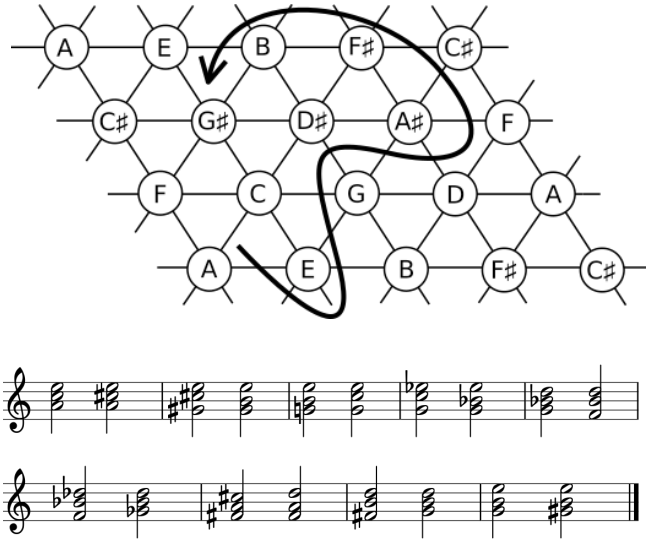

Figure 5. Continuous Movement Through the Tonnetz

Conceived as cartographies through voice leading space, musical geometries offer a powerful approach for the automatic generation of harmonic progressions in a tonal language. The diversity of spaces and endless variety of techniques for their navigation makes this a promising area of experimentation.

Reflections

Triadic progressions generated from the immanent transformational approach can be unique and unexpected. Combined with key-based hierarchical approaches, they yield the mixture of top-down and bottom-up organizational schemas that are common in natural processes. Apart from the current theoretical context, designers of generative music may find the techniques described above to be useful for efficiently generating harmonic novelty in overly homogeneous progressions. While generative music can gain much from incorporation of transformational theory, the relationship is mutualistic; transformational theory is an area of music analysis that can greatly benefit from the techniques of generative music for its explication and continual exploration. To this point in time, transformational approaches to harmony have been leveraged on the analysis of existing canonical works of classical music, but they can also be leveraged to generate new harmonic worlds hitherto underexplored.

References

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