How Guitar (Hero) Performance Can Convey Harmonic and Formal Function in Pop-Rock

By Nicholas J. Shea

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I. Introduction

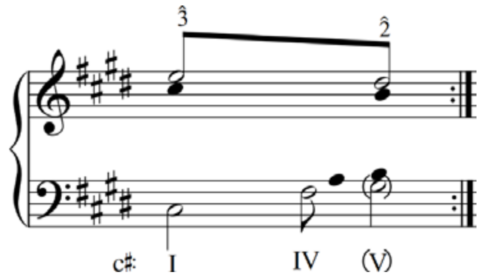
We're in an interesting spot in popular music analysis. As an un-notated form of music, we as music theorists often rely on abstractions –abstractions of pitch and rhythm, for example– to make analytical decisions. Take the McGill Billboard Hot 100 Corpus. This database is an excellent tool for understanding how chords move to other chords in popular music at any given time between the years 1959 and 1991. But because all the harmonic information in this database is encoded as chord symbols, there's no possible way theorists can extrapolate otherwise key musical features – things like melody, bass lines, and voice leading– without doing some labor-intensive transcription.

One of the points I want to address today is that, by relying only on pitch-class representations of chords to define harmonic function, we run the risk of overlooking the influence of other musical features. For example, an octave jump on scale degree 5 is an excellent signifier of an approaching cadence, but you can't necessarily infer that kind of pitch movement from a chord symbol. That is, a cadential 64 figure doesn't tell us whether the dominant root is a fourth below, a fifth above, or both.

Let's take a quick look at an example. Ed Sheeran's The Shape of You" was the most-streamed song of 2017 and, at its core, is based entirely on a simple counterpoint. Here's the four-chord riff that repeats throughout the song:

Play the riff on the piano, put the chords on the board

To be clear, the chord progression C# minor, F# minor, A major, B major *is the song*. So how do we define function with this limited harmonic information? One way is to infer function from scale degrees. Here, I did my best to emulate Walter Everett in this voice-leading sketch. From this perspective we can observe a clear phrase-model progression: a tonic area in I, a predominant area using the submediant/subdominant, and an *implied* dominant based on scale degree 2 in the melody and scale degree 7 in the bass.



This is all fine, but it is true we have to jump through some hoops to make this song fit into our standard phrase model – most obviously by saying B natural and D# are still functioning as dominant scale degrees even though B is clearly the root of the chord and a whole step from C#. By no means is this a big deal, but instead of diving headfirst into scale-degree function and phrase model paradigms –models which are arguably removed from pop music and instead rooted in common-practice analysis– I simply want to ask: "What can these analytical tools can tell us about function that the octave jump can't?" In other words, isn't pitch distance (not *pitch class* distance) just as useful?

I feel over-reliance on pitch class information to determine function is especially dangerous in pop-rock music because the genre clearly doesn't subscribe to common-practice syntax. This becomes obvious when we survey some of the unique ways theorists have approached the issue.

Put citations on the board

These studies reveal two main concerns: an observed shift in harmonic practice between 1950 and 1960 and, more critically, a general propensity toward a common-practice and keyboard-oriented view of voice-leading and harmonic function in current analysis. Nicole Biamonte most clearly articulates these in a 2010 Spectrum article. She says:

> …a large percentage of pop-rock music is conventionally tonal—particularly that of the 1950s and early 1960s (p. 97)
>
> Neo-Riemannian transformations are most successfully applied to post-1990 alternative genres, which favor chromatic thirds and other cross-relations (p. 96)
>
> …in many vernacular genres—including blues, jazz, and rock—nontriadic tones are not unstable… common-practice rules of voice-leading and dissonance do not necessarily apply (p. 95)

> Schenkerian paradigms of linear motion are potentially powerful explicators of melody, but presume a concern for voice-leading and counterpoint often absent from the harmony layer, especially when it is iterated by rhythm guitar rather than keyboard (p. 96)

Regarding the shift in harmonic practice, theorists have long speculated that the culprit is the introduction of the electric guitar into mainstream pop music. Temperley and de Clerq admit that "open chord voicings [on guitar] may be preferred harmonic choices irrespective of the tonic of a particular song." Hubert Léveillé Gauvin, my colleague at OSU, follows up on this claim by demonstrating the emergence of "flat-side harmonies" from the 1960s onward – a time when guitar-driven works became popular. In the same vein, some theorists like Drew Nobile explicitly distinguish rock harmony from pop harmony based on instrumentation. Nobile says, "by the late 1970s, 'pop' referred to keyboard-based music while 'rock' referred to guitar-based music" (p. 224). These accounts suggest that the instruments that convey harmonic information (i.e., the keyboard and guitar) may play a role in the harmonic structure of pop-rock songs.

With this paper, I will attempt to outline the relationship between instruments and pop-rock tonality to demonstrate that common chord progressions can often be understood as a generative result of an instrument's tonal features. In other words, I argue that to really understand how and why chords move to other chords, we need to consider how instruments play a part in the compositional process. Specifically, I'm going to address the following issues:

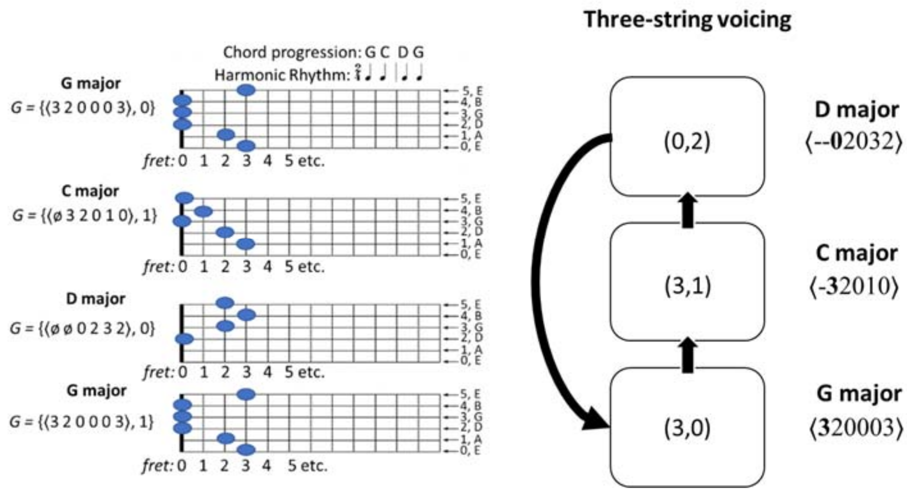
1. How traditional notation obscures metrics of tonal distance in guitar-driven works
2. How keyboard/notation parsimony is not analogous to guitar parsimony
3. How tonal distance on the guitar can indicate harmonic function in pop-rock music, especially at formal boundaries
4. How alternative representations of pitch and pitch-class space can reveal formal relationships

II. Guitar Sets and Networks

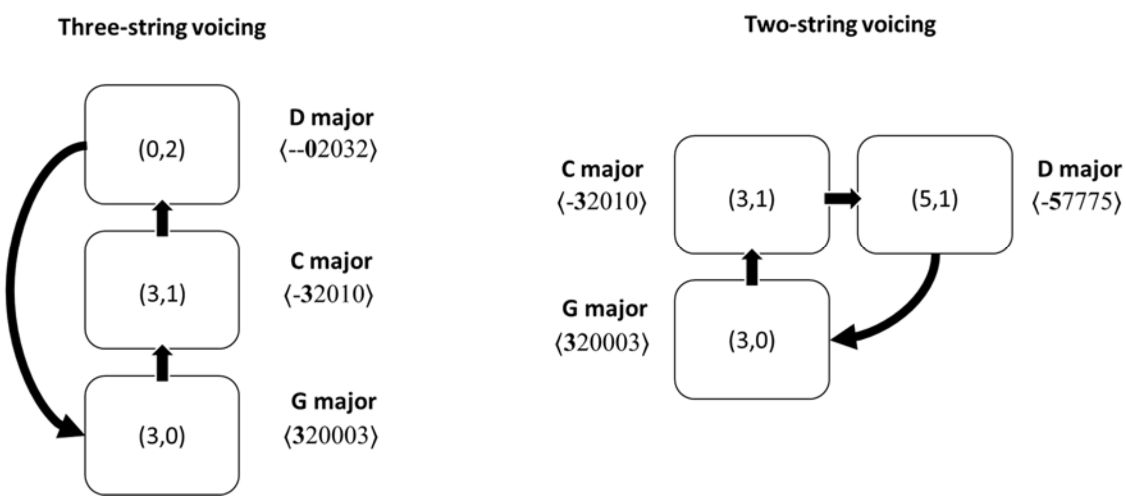
If we're working with the assumption that the physical and tonal organization of the guitar contributes to the tonal and formal organization of pop-rock music, then we need a method that will allow us to systematically track pitch *and* physical movement on the instrument. My approach is largely based on work by Joti Rockwell, Timothy Koozin, and a forthcoming article by Johnathan De Souza, which use sets and networks to highlight some of these relationships. But the key distinction between my work and theirs is that I'm going for direct representation of the guitar fretboard, not a generalizable space.

Let's consider the progression I-IV-V-I in G major on the guitar. Here, I use "Guitar sets" or *G-sets* to track pitch and fret movement from chord to chord. By using G-sets, I indicate two variables: fret and string. Frets are notated integers and, in G-sets, strings are considered implicit in the order of frets. For example, if I say there is a 7 at the start of a G-set, this means that I am playing the 7th fret on "E," the lowest string of the guitar. So, in our first G chord, we have 3 – so 3rd fret on the E string –, 2 – 2nd fret on the A string –, 0 – an open D string –, 0 – an open G string –, 0 – an open B string –, and 3 – 3rd fret on the highest string. The second component to the set, *T*, indicates time, or the time point dictated by the smallest observed rhythmic value. T is included for now, but is not consequential for the rest of the paper.

Since our concern is harmonic function, we'll focus on the root motion of these chords. (From here on out I'll also be working under the assumption that most pop-rock harmonies occur in root position unless otherwise obvious. This follows David Temperley and Trevor de Clerq, who observe this to be true in their Rolling Stone corpus.) G-sets give us an aggregate of pitch information, which is helpful to determine chord quality and voice-leading, but to track root motion specifically, I'll be using an *f*, *s* pair (f for *fret*, s for *string*) in a tiered array. This method comes from Johnathan De Souza's forthcoming Journal of Music Theory article "Fretboard Transformations." So in this diagram we have two components: s a root-motion tiered array and the corresponding G-sets for the chord as a whole.



As you can see, the chord roots (bolded in the sets), move forward one order position before returning to the first. In other words, the chord roots move up in pitch, and also up a string, each time. But what if we chose a different voicing for our V chord? For example, if you give a guitarist the prompt to "play a D chord" as most lead sheets generically indicate, they might instead choose to play the D chord on the A string using a barred voicing ⟨-**5**7775⟩. The following figure compares these two options:



What is helpful about this diagram is it shows that root motion by fourth is extremely idiomatic. De Souza would argue that the root motion from D back to G in the three-string voicing [A(f, s) = (0,2) ⟶ (3,0)] represents a larger *Cartesian* or gestural interval than the two-string voicing [B(f, s) = (5,1) ⟶ (3,0)]. If we use the Cartesian distance formula $i = ((f1–f2)^2 + (s1–s2)^2)$, we obviously arrive at contrasting values:

i(A) = 13; *i*(B) = 5. The difference between these two measurements is stark. In comparing the two voicings, however, my challenge to De Souza is to whether or not a performer would find this difference to be as significant as the values suggest. Due to the open string used in the first example, my experience says "not likely." But before we make any claims about guitar affordances, I think we should first work out some basic root motion distances when all strings are assumed to be fretted or stopped (i.e., not open). In other words, our G sets were a representation of pitch space, where all the harmonic information was implied in fret/string format, but I now want to move toward a pitch-*class* space perspective, where we can generalize about function and distance to and from generic pitches.

III. Cartesian Intervals, Performance Affordances, and an Idiomatic Network

Here's where I straddle the line between pitch and pitch-class space: by using Cartesian intervals, I'm arguing *distance* is the link between root, scale degree, and function. The G-sets I presented earlier provide the means to measure this distance using the formula and act as an analogue to pitch space; but the network I'm about to present syncs root motion to pitches under the condition of distance and is therefore a hybrid of these two spaces. In other words, G sets give us a pitch inventory and the following Cartesian intervals allow us to relate these events linearly. **[CLICK]**

This figure demonstrates some Cartesian intervals from C (3,1) on a guitar fretboard in standard tuning. I do this because we often use C as the point of orientation in determining transposition values. A few things to note here: 1) to orient these intervals around C, I needed to imagine an extra string below the E string, 2) the greyed out boxes represent along-string movements, which we'll get to in a minute, 3) I've chosen a range of +/- 2 frets from C to represent a distance that essentially spans a performers hand, and 4) no open strings are represented.

string↓					
3	8, Ab	5, A	4, Bb	5, B	8, C
2	5, Eb	2, E	1, F	2, F#	5, G
1			0, C		
0	5, F	2, F#	1, G	2, Ab	5, A
-1	8, C	5, C#	4, D	5, Eb	8, E
fret →	**1**	**2**	**3**	**4**	**5**

With this matrix we can observe that movement by perfect fourth is the easiest gesture to perform. But, in this space, a perfect fourth above is not transpositionally equivalent to a perfect fifth below. In other words, C to F, up a fourth, is not the same as C to F, down a fifth. Here, we are linking pitches with intervals, but conditionally so using pitch direction, not mod-12 transposition.

Before we can map Cartesian intervals to all 12 pitch classes, there are still two performance aspects to address: open strings and along-string movement. **[CLICK]** Let's use the whole step C to D to do both. The Cartesian distance formula tells us that this step of a major second, on the same string, is 4. Meanwhile, C to the open D string (0, 2) is 10. Any guitarist will tell you that plucking an adjacent open string or lifting your finger to play the same open string is a breeze. Similarly, shifting a chord shape, for example a power chord, up a step is quite easy, too. So what we need to do is devise a formula that puts same-string slides and open-string transitions on the same level: an affordant compensation to the formula.

[CLICK]To compensate for along-string movements, we can divide the reported Cartesian Interval by the difference in *f*: **[CLICK]** so, if String 1 in *a* is equal to String 2 in *b*, then the interval between *a* and *b* will be divided by the difference between Fret 1 in *a* and Fret 2 in *b*. Similarly, to handle open string transitions, we can simply replace the Fret value in *a* with a 0 when the Fret value in *b* is 0.

C to D, along-string: 4. Compensated: 4/(5-3) = 2.
C to D, open string: 10. Compensated: 1.

With these in place, we can now finally establish a network of intervals as they relate to the fretboard and, more excitingly, put the guitar on equal ground with the keyboard in terms of voice leading and parsimony. **[CLICK]**

As music theorists, we typically describe pitch distance by using the terms *steps*, *skips*, and *leaps*. I categorize Cartesian intervals in the same way; that is, the fretboard space determines pitch distance instead of our commonly-used transposition values. The top half of this table represents *descending* pitch movement from C, while the bottom half represents the reverse: *ascending* pitch movement from C. Again, these are not transposition values. **[CLICK]** For example **[CLICK]**, a 5th above C is not in the same category as a fourth below C.

Interval		Steps		Skips		Leaps
Scale step	0	1	2	3	4	5
					A	
			Bb		F	
		G	Ab	↖	Eb	E
Descending	C	B	F#	D	C#	C
CI:	0	1	2	4	5	8
Ascending	C	C#	F#	Bb	B	Ab
		F	E	↙	A	C
			D		G	
					Eb	

IV. Guitar Performance

I'd like to show this methodology in action with an analysis of one piece as it exists in two different mediums. The first is direct representation of fretboard space, using a notation program called Guitar Pro. The second is the popular performance emulator Guitar Hero, which, instead of a direct representation of pitch space, is more analogous to a reduction. The song I'll be focusing on is "I Believe in a Thing Called Love" by the 2000s British rock group The Darkness. This song is organized into three main formal sections: an introduction, which also serves as the verse, a bridge, and a chorus. You can also think of this organization as a large-scale SRDC. Let's start by focusing on the introduction/verse. I'll play it for you now.

Play the intro riff

What I'd like to demonstrate with this progression is how affordant gestures, or how our re-categorization of stepwise bass motion, can redefine how we expand certain harmonies. I'm going to argue that typically non-functional gestures, such as root motion by 6th, are instead *semantically* functional in the context of pop-rock music; again, due to the tonal organization of the guitar. Specifically, I'm going to demonstrate that less idiomatic gestures often occur at the smaller formal boundaries, while the least idiomatic gesture occurs at the end of the formal cycle.

Okay, so, back to "I Believe in a Thing Called Love." From a traditional harmonic perspective, the root motion between B and E is reflective of a dominant to tonic gesture in E major. **[CLICK]** The compensated Cartesian Interval, on the other hand, suggests that this diatonic leap is negligible and merely a byproduct of fretboard affordance. This distinction is crucial, as a diatonic voice-leading model would necessarily consider the arrival on E as a departure from the F# minor tonality the riff so clearly conveys. If we set this aside and focus on the Cartesian intervals generated by the progression, we might instead regard the progression as analogous to a tonic expansion. **[CLICK x2]** In other words, we all know I-I^{6}-V^{43}-V^{65}-I is a tonic expansion that uses double neighbor bass motion: bass motion that is both a step above and a step below the tonic. Under the Cartesian metric, this is also true: B and E are both a step away from the tonic F#. Notice how when I play the riff, I don't even have to shift.

Play it again.

But this is a local event – a riff that is repeated for the duration of the intro and verse – and exists in the larger context of the bridge and chorus. Instead of walking you through the entire piece myself, I've created a video that establishes the space of the song. By using this video to highlight distance, I hope to show how different regions of the guitar space can be interpreted as analogous to common-practice-specific harmonic tendencies like extended tonicization.

In the video, the introduction and verse material will be in blue, the bridge in pink, and the chorus in green. First, different colored mists will establish the generic space in the first formal cycle, then nodes and slurs will highlight the relationship between chord roots. Let's take a look.

Play the video

What we're left with is a network that relates the chord roots as they occur at the formal boundaries of the piece. What is most striking is that, while the transition from the end of the Bridge to the beginning of the chorus features a true dominant to tonic gesture (B to E), it occurs from a closed-fret chord to a single note on the same open string. As I explained earlier, a performer would simply have to lift their index finger to begin the Chorus. The harder gesture, and I argue the more *functional* gesture, is the cross-string leap at the end of the Chorus that initiates the repetition of the formal progression. **[CLICK]** This is all due to fretboard affordances. In other words, I'm arguing the true cadence of the formal cycle happens at the end of the Chorus, or the Cadential zone of a large-scale SRDC model, because it's the most difficult shift to pull off on the guitar fretboard.

		Note	***G*-set**	**Transposition**	**Comp CI**
Intro	start	F#	⟨244---⟩		
		C#	⟨-4----⟩		
	end	E	⟨0-----⟩	9	4
Verse	start	F#	⟨244---⟩	2	2
	end	F#	⟨2-----⟩		
Bridge	start	E	⟨022---⟩	2	2
	end	B	⟨799---⟩		
Chorus	start	E	⟨0-----⟩	7	3
	end	D	⟨-577--⟩		
Verse	start	F#	⟨244---⟩	8	4

V. Guitar Hero Performance

[CLICK] So, now you might be asking yourself, "What does this have to do with Guitar Hero?" Well, earlier we related the Cartesian intervals from C to pitch intervals by step, skip, and leap. And, what ends up happening is this five-note/five-interval schema starts to resemble the five-button Guitar Hero controller. By organizing the pitches and intervals in this way, the controller has essentially collapsed the two-vector space of the guitar (horizontal and vertical) into a single vertical/linear vector **[CLICK]**. What I mean here is that before we were dealing with *f* and *s* –fret and string – and now we're only dealing with frets as the horizontal vector. But not exactly, because, in this video, the string or vertical vector has been synthesized into the horizontal. As a result, you'll probably notice some incongruities between pitch and pitch height. **[CLICK]** For example, in the Bridge, the E to F# root motion is flipped – E is on the 2nd fret of the Guitar Hero controller, while F# is on the first. (need an image)

This transformation of the fretboard space is similar to the relationship between pitch and pitch-class space. Or, put another way, the relationship between a notated score and a Neo-Riemannian or voice-leading analysis of that score. So on one hand, the previous video gave us specific information about pitches and the following Guitar Hero interface relates or reduces these pitches in a linear fashion. When I play the following video, I'd like you to focus on is the commonalities between these two domains. I've interpolated where I believe the "root" of the chord likely is on the controller, and maintained the blue/pink/green color association to the verse, bridge, and chorus.

Show video no. 2. PAUSE BEFORE END.

As you can see on the left-hand side of the video, I've collected all the transitions as they happen from each formal section. Remember how I said that the introductory riff is essentially a tonic expansion, but on the guitar? Specifically, because there's no shifting involved? The same appears to be true on the Guitar Hero controller, where all the transitions in the blue intro/verse space occur to and from adjacent frets. The critical thing to remember here is that what you're hearing is a series of thirds and fifths, both of which would be considered notable events in a foreground-level Schenkerian sketch or a Neo-Riemannian tonnetz analysis.

You'll notice a lot of similarities between this video and the first one: the transition from the verse to bridge, for example, is clearly less intense than the other formal transitions. This is demonstrated by the step from F# to E or Fret 2 to Fret 1 in the Guitar Hero video. The shift from the Verse to the Chorus, on the other hand, covers a large tonal *and* physical distance, which says "This gesture is functional!" In the first video, we have a transition from the 7th fret on the E string to the open E string, whereas the Guitar Hero video transitions from Fret 5 to Fret 1. Again, this is a true Dominant to Tonic motion in E major, so this makes sense.

But there are also incongruities – a disconnect between the two videos is the repetition of the formal cycle – the transition from the end of the Chorus back to the guitar solo/verse. The Guitar Hero interface says "this event is not a big deal." So does a scale degree perspective. But I say a performer would reach this point in the form, know that this gesture is less idiomatic than all the other transitions before it, and therefore realize this is the end of the formal cycle – regardless of scale-degree content.

By presenting this song in two different mediums, a pitch-like space vs. a pitch-class-like space, I hoped to demonstrate two thigs: 1) how coming back to the physical act of music-making can illuminate musical features otherwise buried in reductive analysis, and 2) how exploring other domains of music representation can offer some clues to how music really functions. Most importantly is the commonality between the two: both allow us to observe how performers as composers of popular music choose to move from chord to chord, from formal section to formal section.

I think this why Biamonte is apprehensive about Schenkerian approaches to rock songs; not because she finds it unhelpful, but because a Schenkerian sketch, by design, is most effective when it conveys linear connections in melodic gestures under common-practice harmonic norms. And there's a precedent here. Schenker was a pianist – a pianist interested in the harmonic structures of Germanic common-practice music; so *of course* this analytical system would work better for keyboard-driven pop songs that feature actual dominant chords.

What would make any assertions about these functional relationships more convincing is if we could observe it more frequently. But, the most obvious obstacle to this approach is the lack of notated scores, which is why I am in the process of developing a fully-notated popular music corpus with scores similar the one you saw in the first video. My plan is to continue to collect these files and see if I can categorize the formal boundary events I've shown in "I Believe in a Thing Called Love." I also hope to make these scores available to music theorists and empirical musicologists once I've completed the project. Ultimately, I want to reach a point where we can make the same nuanced observations about pitch, rhythm, meter and form in pop-rock music that we have in common-practice music. I believe that with further refinement, Guitar-sets, Cartesian intervals, and a fully-realized pop-rock corpus will be a step toward placing these two on the same level.

How my approach differs from statistical approaches to tonality, for example, is that I'm really interested in the thing we're constantly discussing in common practice music: phrases and cadences. Cartesian intervals and tracking root motion on an instrument (whether it's the keyboard or the guitar) allows us to evaluate these important closing gestures in a way that respects performance practice. With this methodology, we can potentially re-categorize the function of scale-degrees with respect to the non-linear spaces that so many pop and rock musicians occupy in their compositional process. Thank you.

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