





# Guitar Improvisation Preparation and Practice: A Digital-Assisted Approach Integrating Set Theory and Mechanical Gesture Exploration

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**Abstract.** In this paper, we introduce a framework for improvisation in classical and contemporary guitar preparation. Our proposal follows a digitally assisted approach to support guitarists in practicing improvisation and creating coherent musical discourses. By simplifying the complex tasks involved in evolving a mechanical gesture and controlling harmonic development, the framework aims to enhance improvisation in the context of contemporary classical music. The paper addresses the challenges faced by classical guitarists in improvisation and emphasizes the significance of integrating mechanical memory and audition. We argue that guitarists can expand their harmonic palette and enhance their improvisational skills by following our digitally assisted approach that integrates critically Set theory principles and the exploration of mechanical gestures. The paper discusses the conceptual foundations of the framework, including the integration of Set theory and mechanical gesture exploration. It also outlines the contributions of the authors, which include the framework itself, computer modeling for the problem, and the implementation of an open-source tool for interacting with the framework. Our main goal in this work is to provide a valuable resource for guitarists interested in improvisation and to broaden the possibilities for creative expression in the realm of classical contemporary guitar performance. The interface can be tested on <https://infovis.dev/viz/guitarImproviser>.

**Keywords:** Classical contemporary guitar improvisation · Digital-Assisted Approach for music improvisation · Contemporary Classical music improvisation preparation · Guitar mechanical gesture exploration · Music improvisation using Set Theory

## 1 Introduction

The scope of the work we present is mainly aimed at guitarists who carry out their artistic practice, in different styles of contemporary Western classical music stressing post-tonal music, however, we consider that the approach we present can be consulted, experimented with, and useful for guitarists and composers of other musical fields.

As noted by authors such as Després et al. (2017) [2] there is a growing interest in improvisation within the field of Western classical music, exemplified by the body of literature evidencing the positive impacts on music learning and also in the increasing presence of improvisation in concert halls and competitions.

However, in the learning and practice of performance in Western classical music consolidated mainly since the middle of the nineteenth century, the great majority of performers use their technical skills to memorize repertoires and their interpretative visions, mechanizing every detail and trying to be highly consistent in their performances. This is because the study and practice of Western classical music have been strongly oriented toward some principles such as the approximation from literacy, stylistic correctness, technical development focused on high precision and the search for virtuosity and the study of referents and authority figures such as fidelity to the score, canonical versions of the core repertoire, and adherence to certain schools of interpretation.

As a consequence, and if compared to other styles such as rock or jazz, classical music performers interested in improvisation face problems and insecurities to get started in the world of improvisation, as they feel they must develop a very broad and deep theoretical understanding of musical styles. This becomes much deeper in the classical contemporary era, that is to say, most of the twenty and twenty-first centuries, due to the great variety of individual styles developed by different composers. In addition, the performers' very practice and training focused on reproduction distances them from the necessary development of skills for improvisation. According to Hogan (2022) [6] recent research carried out by David Dolan and Henrik Jensen focused on scanning the brain activity of performers and demonstrated how reproductive memory and improvisation have two separate and very different brain functions. In opposition to this, the approach to improvisation in other styles such as rock and jazz is more intuitive by starting from a more direct link between mechanical memory and audition, as pointed out by authors such as Caporaletti (2018) [1], who call this approach the audio-tactile matrix.

In the field of the contemporary classical guitar repertoire, we find a large number of languages and styles that must be analyzed and understood in order to achieve similar musical results through improvisation and composition, which makes it challenging to proceed directly through an audio-tactile perspective.

Despite this, and bearing in mind that an audio-tactile approach to musical creation and especially to improvisation has proven to be so successful in styles and traditions such as jazz and rock to fluidly create idiomatic musical pieces and performances - in our case for the guitar -. We have wondered whether is it possible to propose a similar framework for creation, improvisation, and performance on contemporary classical guitar. And, if possible, how to achieve

this, taking into account the number of languages and complexities that exist in the field of contemporary classical music and especially in post-tonal music?

One of the most developed analytical theories for the understanding of contemporary classical music is the Set Class Theory, proposed by Allen Forte in 1973 [3] and deepened by other theorists such as Joseph N. Straus in 1991 [10]. This theory allows synthesizing and rationalizing particular harmonic languages in the field of post-tonal music by finding and classifying groups of sounds that can be related by their intervocalic content, in other words, by the harmonic relationships of pitches that exist between the notes that are grouped in a given set.

Nowadays, there are digital tools that can be used to perform the necessary calculations for musical analysis through Set Class Theory; however, from an analytical point of view, these tools help to visualize the calculations to understand the interval content of a given set, but they do not synthesize and order results in a way that allows establishing and easily visualizing relationships of unity, transition, and contrast between sets of notes that allow developing a musical discourse. Much less, they do not offer the possibility of approaching the guitar from an intuitive perspective where audition and mechanical memory are linked in an audio-tactile way, that is to say, the way musicians (in our case guitarists) display the sets of notes in their instrument (guitar) and how they link this with their sense of audition in the course of a musical creation.

In general, there's a shared interest in the pursuit of new ways to understand improvisation and performance in classical contemporary music; and it is for that reason that we present in this work a framework involving conceptual and digital tools that enables one to understand how a set of notes on the guitar can be developed harmonically based on Set Class Theory through relations of unity, transition, and contrast, as well as how one can modulate the degrees of physical coincidence or similarity of the guitarist's mechanical gesture, that is, the displayed fingerings of these sets on the guitar. This enables a method of creating music where guitarists can put more of an emphasis on the intuitive experience of connecting mechanical memory and audition in order to experiment and build skills that will enable them to dive more deeply into the practice of improvisation.

In the following sections, we will present our conceptual approach and examine relevant literature pertaining to the different aspects of our proposal. Subsequently, we will delve into the theoretical foundations of our framework, encompassing the domains of harmonic development within the context of Set Theory and the evolution of the mechanical gesture. We will then outline the integration of these two components through computational modeling and its implementation within an open-source digital application. Additionally, we will provide an example illustrating the interaction between the framework and the digital tool, showcasing the generation of a musical piece through improvisation. Finally, we will discuss the conclusions drawn from this experience and outline potential future directions for this proposal. Drawing from the information presented in this paper, we can summarize our contributions as follows:

- Framework for the composition and improvisation of music for the guitar, based on an exploration of the link between mechanical (physical)

performance gesture and audition and the PC Set theory idiomatically applied to the guitar.

- Computer modeling of the framework.
- Open source tool for interacting with the framework.

## 2 Conceptualization and Related Work

### 2.1 Comprehensive Approach to Improvisation

In this work, the approach adopted acknowledges improvisation as discussed by authors like Andrew Goldman (2020) [4] and Jonathan Leathwood (2019–2020) [7,8]. According to their perspectives, improvisation serves not only as a means to introduce novelty and real-time solo creation in music but also as a valuable tool for learning and practicing technical musical concepts, repertoire exploration, and enhancing comprehension of diverse stylistic frameworks. Furthermore, improvisation is recognized as a catalyst for musical creation, drawing upon various elements found within the Western classical music tradition.

### 2.2 Classical Guitar Improvisation

The practice of improvisation has played a significant role within the tradition of classical guitar, spanning from the Baroque period to the classical and romantic eras. During this time, improvisation was highly regarded in the context of instruments like the Spanish vihuela and baroque guitar, with notable figures such as Gaspar Sanz and Francesco Corbetta showcasing their techniques and ornamentation practices. As musical styles evolved, there was a notable transition from ornamentation-based improvisation within composed works to more extensive improvised sections based on the principle of variation within guitar compositions. Influential guitarists and composers like Fernando Sor and Mauro Giuliani made noteworthy contributions to improvisation techniques, impacting the role of the guitarist as both performer and composer.

However, the practice of classical guitar improvisation experienced a decline during the late nineteenth and early twenty centuries, mainly due to the increasing focus on notation-based performance practices. Nevertheless, there have been notable revivals of interest in classical guitar improvisation in the late twenty and twenty-first centuries. These revivals were spearheaded by innovative practitioners and educators, such as Roland Dyens and Dusan Bogdanovic, who drew inspiration from cross-cultural influences, including jazz, world music, and experimental avant-garde movements. These practitioners embraced improvisation and integrated it into formal education, exploring novel teaching approaches.

These developments have revitalized the practice of classical guitar improvisation, encouraging its inclusion in contemporary performance and pedagogical contexts. By incorporating diverse influences and innovative approaches, improvisation has evolved to meet the demands of the modern musical landscape while retaining its historical significance within the classical guitar tradition.

### 2.3 Classical Contemporary, Post Tonal Music, and Set Theory

Classical contemporary music encompasses a wide range of musical styles and techniques that emerged in the twenty and twenty-first centuries, challenging conventional notions of melody, rhythm, and form.

Classical contemporary music is an art form of the present day that actively engages with the inherited tradition of Western art music while also seeking to push boundaries and explore new sonic territories. Furthermore, classical contemporary music is characterized by its pluralism of styles and aesthetic approaches, reflecting a diversity of individual compositional voices. Composers within this genre often draw inspiration from a variety of sources, including other art forms, cultural traditions, and contemporary social and political issues.

Within Classical contemporary music and according to musicologist Richard Taruskin (2010), post-tonal music is defined as “music that avoids clear tonal centers and traditional tonal hierarchies” (Taruskin, R 2010. p. 413) [11]. This compositional approach seeks to expand the harmonic vocabulary by utilizing dissonance, atonality, and various pitch organization systems such as serialism, Set theory, and pitch-class analysis.

Moreover, music theorist and composer Allen Forte offers a more technical definition, describing post-tonal music as “music in which tonality and the hierarchical relations of pitch are not primary determinants of the musical structure” (Forte. 1973. p. 4) [3]. This definition highlights the shift away from tonal hierarchies and the exploration of alternative methods for organizing musical material. Initially proposed by Forte himself, Set theory offers a formalized approach to understanding the organization, relationships, and transformations of pitch materials in compositions, contributing to a deeper analysis and interpretation of musical structures. Set theory also introduces operations such as union, intersection, complement, and transformational operations like transposition and inversion. These operations enable the examination of musical relationships, symmetries, and transformations within and between pitch-class sets. While Set theory has been influential in music theory, it is worth noting that its applications and interpretations can vary among scholars and composers.

### 2.4 Digital Tools for Set Theory Analysis

Digital tools have revolutionized the application of set music theory [13], offering musicians and scholars resources for analyzing and manipulating pitch-class sets. Here is an overview of some prominent digital tools used in the context of set music theory:

- PC Set Calculator (by David Walters) [14]
- Music Theory Set-Class Calculator (by Jeremiah Goyette) [5]
- Set Calculator (by Dan Román) [9]
- Set Theory Calculator (by Jay Tomlin) [12]

Nevertheless, it is worth noting that while these tools are intended for extracting and visualizing information to facilitate musical analysis, none of them are

specifically designed to offer a framework for creative purposes or cater to the specific needs of guitarists.

### 3 Guitar Improvisation Harmonic Framework Based on Set Theory and the Exploration of the Mechanical Gesture

Constructing a framework for achieving harmonic coherence in improvisation through the exploration of the mechanical gesture involves two key aspects. Firstly, it involves finding ways to produce different sonic outcomes by developing and evolving a particular mechanical gesture. Secondly, to develop the proficiency to establish distinct structural relationships among these sonic outcomes. In order to achieve this end, we will now introduce and explain our harmonic perspective grounded in Set theory. Then, we will outline our approach to exploring and evolving the mechanical gesture as a seed for generating improvisational materials. Subsequently, we will explore the relevance of proposing a digitally assisted approach to implement this framework.

#### 3.1 Harmonic Perspective: From an Analytical to a Creative Perspective of Set Theory

One key aspect of set theory is the concept of pitch-class sets as equivalence classes. It recognizes that different transpositions and inversions of a pitch-class set share essential musical characteristics and can be treated as the same set. This allows for a more abstract analysis of musical structures, focusing on the relationships between pitch classes rather than specific pitches. Guided by this simple principle, and going from an analytical to a creative point of view, we can state that moving from one set to another can be perceived in a way that one can determine relationships of unity, transition, or contrast because of the harmonic content that underlies on each set.

In this context, the concept of the IC Vector, another pivotal aspect of set theory, becomes instrumental in providing us with a harmonic perspective to establish relations of unity, transition, and contrast. Serving as a representation, the IC vector furnishes valuable information on the intervallic content of a set, focusing on interval classes. Each IC captures the frequency of occurrence for every possible interval class within that set. Analyzing the degree of similarity between IC vectors from different sets of notes facilitates the determination of harmonic equivalences, identification of shared characteristics or distinctions between sets, and exploration of opportunities for unity, transition, and contrast within a musical discourse.

According to Joseph Straus (1991) [10] the achievement of compositional unity and diversity through the selection of a pitch-class set as a fundamental structural unit from an analytical perspective. However, our proposal expands on Straus's observation that coherence is established through the use of similar

pitch-class sets. We argue that harmonic consistency can be further attained by examining the evolution of the interval class, as manifested in the IC vectors.

This implies, of course, understanding the notion of a set and its interval content as a primary unit or seed of the audition and meaning in musical discourse, rather than establishing hierarchical relationships departing from the pitch of a single note as a center of gravity as it is in the tonal system. However, this approach does not imply, as it is for instance in twelve-tone serialism, to avoid tonal implications, but allows one to freely enter or leave episodes that can be perceived as tonal in a succession of sets, enriching the overall harmonic frame of a piece.

### 3.2 Exploring the Mechanical Gesture

On the other hand, and for the purpose of designing a harmonic framework that is linked to the exploration of the guitarists' mechanical gesture, it is necessary to inquire about the way in which mechanical memory is linked to audition and performance, and even more so for our purposes with improvisation.

Muscle memory allows guitarists to automate physical movements, enabling them to concentrate on musical expression and interpretation. In other words, to make playing possible, performers develop an interdependence between mechanical operations and cognitive processes, such as attention allocation and musical decision-making. In the case of classical guitarists, this is concentered in mechanical gestures that require coordination between both hands and fingers, including precise placement, as well as the execution of complex chord voicings, single melodic lines, polyphonic textures and patterns, and techniques such as arpeggios, scales, and various types of strumming. As discussed in the introduction, in classical guitar tradition, the dominant approach to performance emphasizes the coordination between mechanical operations and auditory memory, following the line of memorizing repertoires and internalizing musical imagery, synchronizing the physical actions with the internalized auditory representations to enhance accuracy, expressiveness, phrasing, and musical communication. This frequently results in the fact that, for a performer, one complex mechanical gesture corresponds to one concrete auditory and musical representation in a concrete piece of repertoire. This frequently limits the contact with improvisation since, for this practice, it is best to approach and exercise the study having different musical outcomes for similar mechanical gestures, this, is to develop adaptability, and the ability to generate novel musical ideas in real-time performance and skills to focus in the link between audition and mechanical operations.

To accomplish this and adhere to our harmonic perspective, the following principles need to be established:

1. The same mechanical gesture can produce different sets of notes. In other words, performing a specific mechanical fingering in various regions of the guitar, be it the left or right hand, will yield different note sets while retaining the same gestural character.

2. We can describe the similarity between two fingerings by introducing the concept of mechanical modulation. This means a mechanical gesture can be adjusted to create other gestures. For instance, maintaining a finger's position in the right hand while introducing some variation in the left hand's finger design. Therefore, the degree of similarity between gestures will depend on the extent of modulation applied.
3. Introducing the notion of mechanical modulation allows us to consider and observe the development and evolution of a mechanical gesture within a musical context.
4. To achieve structural coherence in a musical discourse derived from the evolution of a mechanical gesture, it is essential to integrate it with a harmonic perspective.

As we will explore further, integrating the domains of harmonic perspective and mechanical exploration requires carrying out several tasks and operations that demand advanced theoretical knowledge and guitar skills. This process can be time-consuming and labor-intensive, but it could be significantly simplified through the use of a digitally assisted approach.

### 3.3 Towards a Digital-Assisted Approach

In order to unify in one framework our vision of developing an improvisation approach based on Set theory and our interest in integrating the exploration of the mechanical gesture, it becomes essential to delineate the required operations that performers need to undertake in both the harmonic and mechanical domains.

First, following our line of approach and the principle of establishing relationships that encompass unity, transition, and contrast among various sets of notes based on their intervallic content as informed by Set theory, performers would engage in a technical endeavor that involves executing the following calculations and processes:

1. Choose a fundamental set that acts as a starting point for generating the harmonic discourse.
2. Perform transposition of the individual pitches within the selected seed set.
3. Identify the fundamental harmonic relationships present within the set.
4. Quantify the number of interval classes within the set to precisely determine the hierarchy of intervallic content, resulting in the creation of an IC vector.
5. Explore and generate additional sets that share the same IC vector, aiming to establish harmonic equivalences within a set group. This process aligns with our approach, ultimately leading to the creation of a diverse harmonic palette comprising multiple sets that exhibit a coherent sense of harmonic unity.
6. Engage in experimentation by exploring different possibilities for rearranging the resulting sets through various dispositions and inversions.
7. Skillfully modulate the harmonic content by altering the IC vector of different sets, leading to the creation of a new palette that facilitates the establishment of a sense of transition and contrast when performing these sets.

8. Iterate step 6 with the modulated sets to develop sections of transition and contrast throughout the musical discourse.

On the other hand, when it comes to exploring the mechanical gesture, guitarists have two paths to explore within this domain. The first approach involves modulating a mechanical gesture to create alternative variations and then analyzing the potential resulting sets to determine whether they can be utilized for developing a discourse that demonstrates coherence and mastery over its harmonic development. In a structured context rooted in Set theory, this would involve examining the interval content of the various configured sets. Within the execution of each mechanical gesture, one would determine its IC vectors and then ascertain whether there exists a sense of unity, transition, or contrast between the sets by comparing their IC vectors. Through this iterative process, a musical discourse can be developed. The second approach involves analyzing the set formed during the execution of a specific mechanical gesture, following the eight steps proposed earlier for the harmonic method based on Set theory. Subsequently, the guitarist would search for fingerings on the guitar that enable them to align the mechanical gesture in accordance with the logic of harmonic discourse.

As it becomes evident, the process of addressing both the harmonic and mechanical domains involves a complex series of steps and operations, requiring significant time and effort from performers to acquire the necessary skills to become fluent in the new language. To overcome this challenge, we propose the implementation of a digital assistance solution that can streamline these operations and simplify the preparation and practice of improvisation within our proposed framework. By integrating such a solution, we can unlock the advantages of an improvisational approach that enables exploration of the languages of contemporary classical music within the idiomatic context of the guitar, firmly rooted in the fundamental exploration of the mechanical gesture.

## 4 Computer Modeling of the Framework

In order to make this approach feasible, it is fundamental to leverage computing power to compute the myriad of calculations required for obtaining the requirements for analyzing both; mechanical modulations of a given gesture and harmonic content of the sets by getting their IC Vectors. The first step towards this goal is to model the technique in a computational way. For this, we need to first **model the overall problem** as an input-processing-output system, and then model the **inputs** and **outputs** in a way understandable to the musical audience. The rest of this section describes three modelings, that were later used to implement an interactive system. We present the modeling of the problem as a contribution to this work, while the details of the interactive prototype are going to be presented in future work.

## 4.1 Overall Problem Modeling

To manage the scope of the framework, we choose to focus on the specific task of helping guitarists generate and explore possible sets of notes, that are based on an inspirational mechanical gesture (seed), which are feasible for the guitar, and which follow the proposed Framework based on the Set theory idiomatically applied to guitar.

As a guiding example, let's think of Alicia, a guitarist who has been studying Leo Brouwer's Etude 6, and has found inspiration in a gesture that naturally implies a mechanical gesture and a set of notes. She wants to improvise a piece of music inspired by that. The framework should then generate all the possible solutions that adhere to a group of restrictions. The main restrictions are **mechanical**, **angular**, and **harmonic**. The mechanical and angular restrictions are inherent to the guitar, while the harmonic pertain to the Set theory. The framework then generates a series of solutions, that have harmonic **unity**, this is the same IC vector, while also having the same mechanical and angular style as the seed. She learns to practice these but then wants to add more flavor to her piece, so she starts exploring other solutions that would generate **contrast** on her improvisation, so she **modulates** the harmonic restriction. Then, to make everything play together nicely, she generates passages that would be in between to have some **transition** on her musical discourse. Finally, and because she is a skilled guitarist she explores modulating also the mechanical and angular restrictions for even more sets that she can add to her repertoire. Then, having all of these solutions, she can practice them for an improvisation concert or maybe compose a piece.

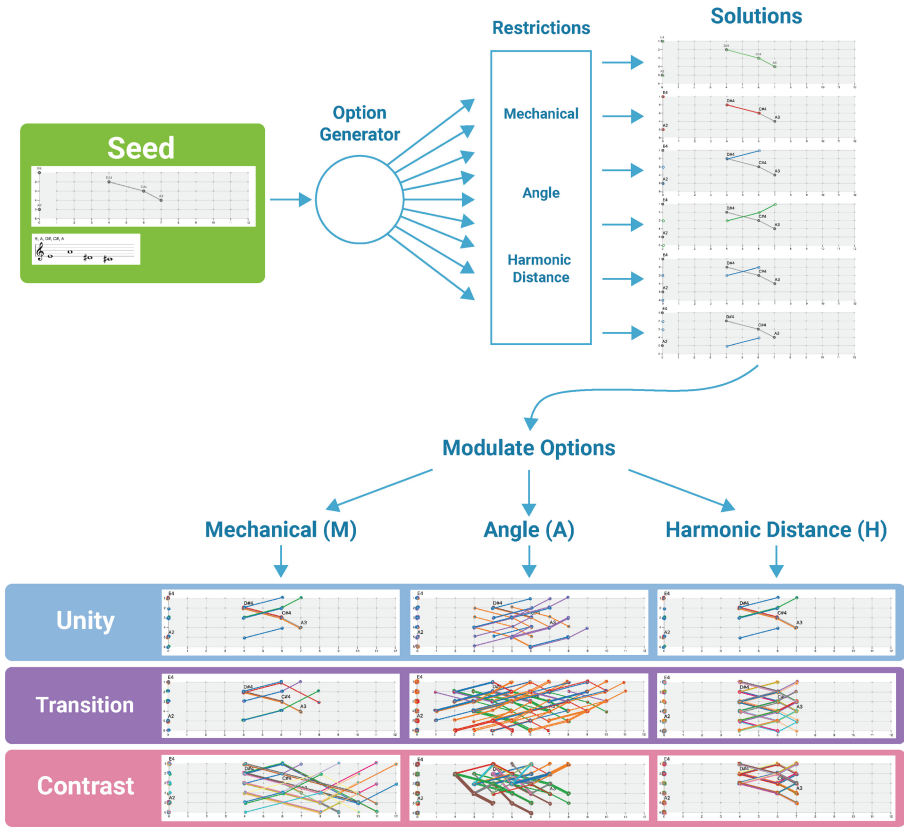
The whole modeling of the framework for this example is summarized in Fig. 1. The model starts with a seed, which is a mechanical gesture that produces a set of notes that the guitarist wants to use as inspiration. This is then passed by an option generator, which will have an algorithm to compute all the possible solutions (other sets of notes) that will satisfy the mechanical, angular, and harmonic restrictions. Then, the guitarist can modulate the options for each one of those three restrictions, to generate unity, transition, and contrast based on their similarity to the original seed. To compute the similarity, we propose distance metrics for the mechanical, angular, and harmonic restrictions.

## 4.2 Modeling Solutions and Inputs

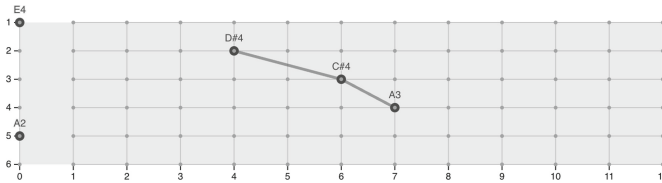
In the framework, solutions are modeled as an array of pairs of integers, representing the combination of fret and string that corresponds to the fingering represented. As an example, fourth fret string two is represented as [2, 4], and the full fingering shown in Fig. 2 is modeled as [[1, 0], [5, 0], [2, 4], [3, 6], [4, 7]].

**Distances.** In order to model the similarity, we defined distance functions for mechanical, angular, and harmonic restrictions.

$$\Delta_{mec}(A, B) = \sum_{i=0}^n [(Fret_i(B) - Fret_i(A))^2 + (String_i(B) - String_i(A))^2]$$

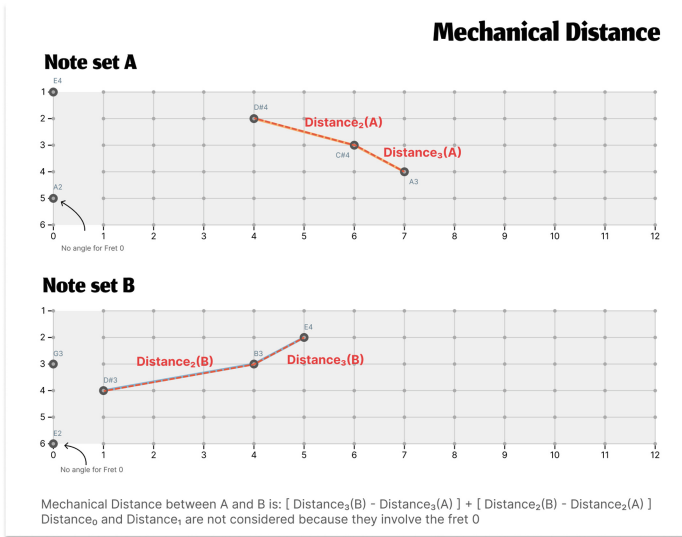


**Fig. 1.** Guitar Improvisation Harmonic Framework problem modeling



**Fig. 2.** Example of a fingering and how it is represented and modeled in the framework

Where  $a$  and  $b$  are the set notes to compare, and  $i$  is the note position in the set starting at 0. Basically, this is an Euclidean distance in the Cartesian plane of the Frets and Strings, but ignoring the square root to speed up the computation as shown in Fig. 3.



**Fig. 3.** Distance between two note sets

The **angle distance** is expressed by computing the difference of each one of the independent angles in the set

$$\Delta_{ang}(A, B) = \sum_{i=0}^{n-1} [(Angle_i(B) - Angle_i(A))]$$

Where Angle is computed using the following formula, and only on notes that aren't on the fret 0 (although there is an option to include these in the calculation)

$$Angle_i(A) = \tan^{-1} \left( \frac{Fret_{i+1}(A) - Fret_i(A)}{String_{i+1}(A) - String_i(A)} \right)$$

With an extra option to ignore the sign of the angle, which produces solutions with mirrored angles. Figure 4 visualizes how the angle distance would be calculated between two note sets.

The Harmonic distance is computed by calculating the element wise distance between IC Vectors

$$\Delta_{harm}(A, B) = \sum_{j=0}^6 [(ICVector_j(B) - ICVector_j(A))]$$

Where *j* is the position in the ICVector, which has six positions in total.

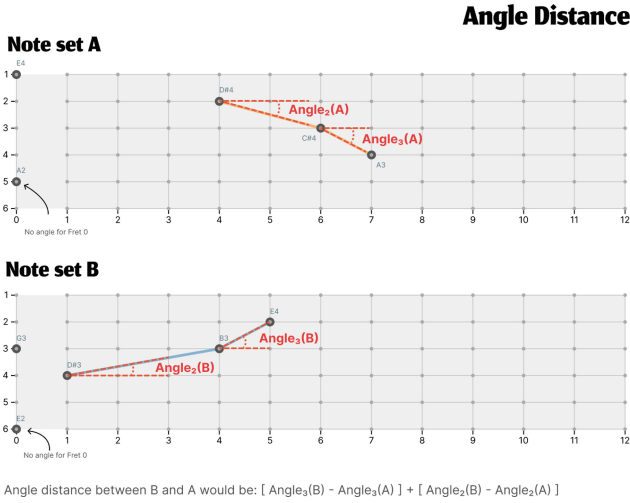


Fig. 4. Angle Distance between two note sets

### 4.3 Modeling Harmonic Perspective

The framework poses the concept of harmonic perspective, aiming to establish categories of unity, transition, and contrast based on the level of intervallic correspondence between sets. This entails assessing the degree of similarity between their IC vectors, thereby reflecting the intervallic content of the sets. As shown in Fig. 5 To capture the concepts of Unity, Transition, and Contrast, for each one of the distances, we set the following ranges:

	Unity	Transition	Contrast
Harmonic Distance $\Delta_{harm}$	[0, 3]	(3, 10]	(10, $\infty$ )

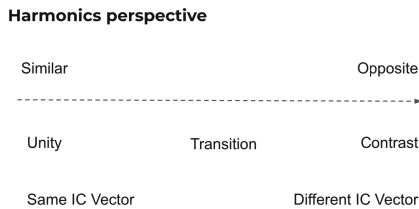


Fig. 5. Guitar improviser’s Harmonic perspective

## Guitar Improviser

English ▾

Guitar Improviser supports the improvisation or composition creative process for the guitar, by providing options to improve the user's vocabulary using an idiomatic approach.

For this, given a set of notes (seed), the tool generates all the possible options that are harmonically coherent with the seed (using PCSet theory) and that are idiomatic and mechanically affordable by the user. Moreover, using the tool interactive widgets, the user can modulate the level of harmonic and mechanical coherence (similarity) of the options compared to the seed. Which is a useful resource to develop musical material and ideas achieving unity, transition and contrast.

Default Values

Modulate Options

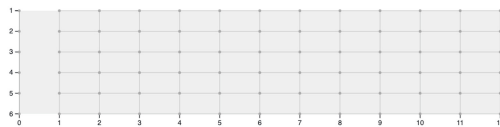


▶ Save/Show Sessions (Returns 26 elements)

▶ Advanced Filtering (Returns 0 elements)

Reset Seed

Enter your notes



Mode  All  Step by step

No solutions to show

0 Classes

Max. solutions

1...

Processing undefined iterations

Show results

Show Seed

Should Play Notes

Seed:



ICVector: 000000

- ▶ Parameter details
- ▶ Mechanic form groups
- ▶ Audio Reproduction Options
- ▶ Algorithm Options

Fig. 6. Guitar improviser interface

## 5 Guitar Improviser: Preparation and Practice Digital Tool

Guitar Improviser is a digital open-source tool developed in accordance with the framework we have described. It seamlessly integrates our approach, combining the exploration of the guitar's mechanical gesture with the inherent restrictions and possibilities it offers, along with our utilization of Set theory to establish a harmonic context that enables the formation of relationships involving unity, transition, and contrast. The tool is designed for guitarists by providing them with the opportunity to experiment with various possibilities for creating a coherent musical discourse. Guitar Improviser interface as shown in Fig. 6 and can be accessed on <https://infovis.dev/viz/guitarImproviser>.

## 6 Example of Basic Use

In this section, we present the basic use of the Guitar Improviser tool to prepare and execute an improvisation based on the Etude 6 for guitar by Cuban composer Leo Brouwer. This sample embodies the framework and concepts discussed in this paper. To begin, we extracted the set of notes generated by the opening gesture depicted in the Etude as shown in Fig. 7.

To start using the Guitar improviser tool, we proceed to introduce the left hand fingering by clicking on the fingerboard shown on the interface, this gesture

1

## ÉTUDES SIMPLES

(ESTUDIOS SENCILLOS)

*Durée totale: 5'20*

Leo BROUWER

*Cette étude peut admettre de nouvelles formules, par ex. :*

VI

The image shows the opening of Etude 6 by Leo Brouwer. It features a musical staff with a treble clef and a 4/4 time signature. The melody begins with a rhythmic pattern of eighth notes: p, a, m, i, a, m, i, p. This pattern is repeated across several measures. Above the staff, the rhythmic notation is written as 'p a m i a m i p p a m i a m i p a m i p'. The score is labeled 'VI' and includes the composer's name 'Leo BROUWER' and the title 'ÉTUDES SIMPLES (ESTUDIOS SENCILLOS)'. A note indicates the total duration is 5'20. A small note above the staff says 'Cette étude peut admettre de nouvelles formules, par ex. :', suggesting alternative rhythmic interpretations.

Fig. 7. Opening gesture Etude 6 by Leo Brouwer. 1978. Editions Max Eschig

will be used as the seed to obtain the harmonic material used in our improvised piece as shown in Fig. 8.

The **Modulate Options** are sliders that allow the user to manipulate the parameters that configure both dimensions discussed in our conceptual and computer modeling approach:

1. Harmonic: Meaning that moving the **Harmonic Distance** slider allows the user to obtain solutions of remaining or changing the IC vector, thus modulating the intervallic content of the seed.
2. Mechanical gesture evolution: Meaning that moving the slider allows the user to manipulate the two parameters (**Mechanical and Angular**) that configure the mechanical gesture evolution.

Modulating options allows one to configure particular settings. Guitar improviser also displays information about the seed. This includes score notation as Pitch classes, this is, that it does not consider octaves. The basic use of the tool also shows the number of solutions calculated by a given setting.

By clicking on the **Show results** and **Show Seed**, and moving the **Max. solutions** slide bar the tool shows solutions for a given setting as shown in Fig. 9. This particular setting having the **Modulate Options** in 0, shows solutions that have perfect coincidence with the seed in both Harmonic and Mechanical dimensions. This means that all solutions have the same IC vector, thus the same interval content, and, that they also exhibit the same fingering properties of the seed in terms of distance and displayed angles between fingers.

**Step by step** check circle allows one to visualize every single solution as shown in Fig. 10 and Fig. 11.

By modulating the **Harmonic Distance** slide bar, the user can obtain solutions that vary the level of harmonic coincidence compared with the seed. Following our conceptual approach means that by doing this, one can achieve motions of unity, transition, or contrast through the musical discourse, depending on the overall harmonic frame of the piece. See Fig. 12.

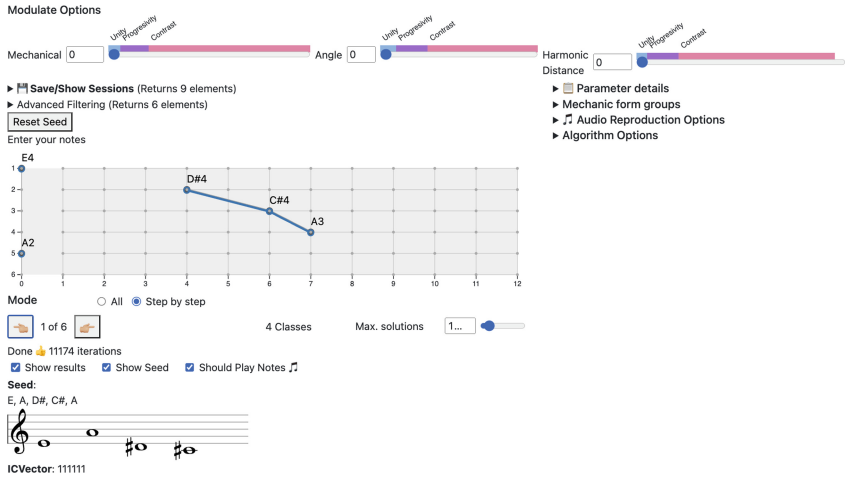


Fig. 8. Seed generated by opening gesture on measure 1 of Etude 6 by Leo Brouwer

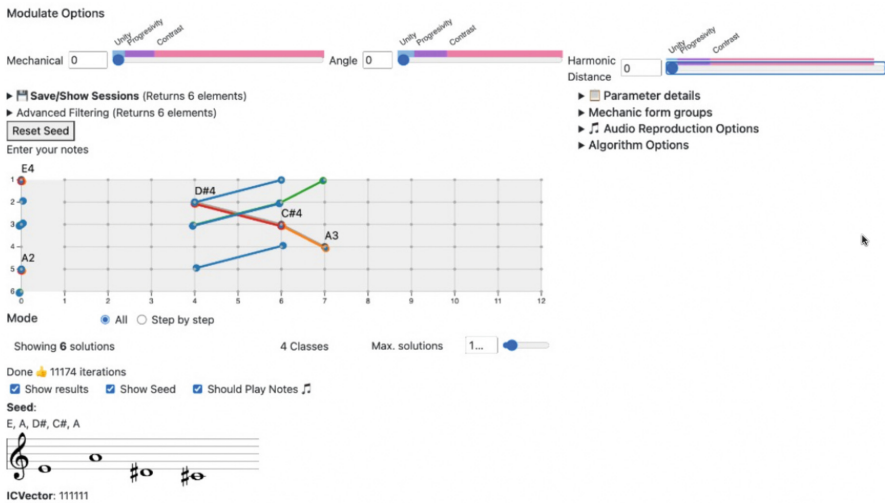


Fig. 9. Opening gesture with Modulate Options in 0

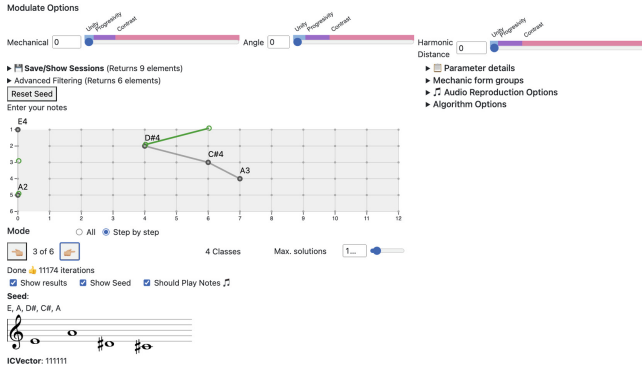


Fig. 10. Solution 1. single visualization

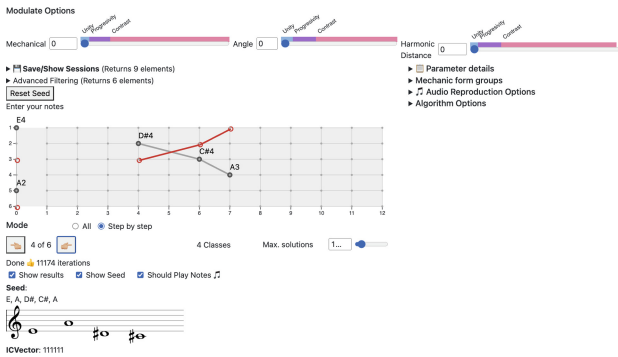


Fig. 11. Solution 2. single visualization

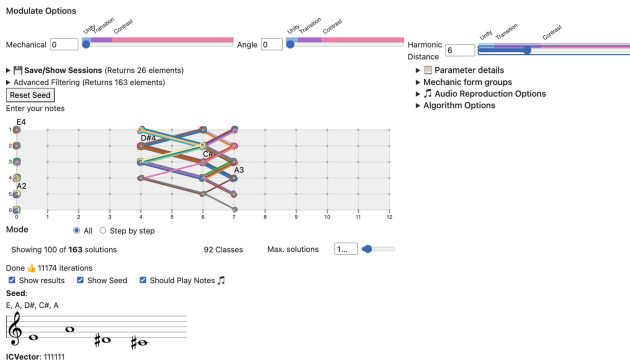


Fig. 12. Harmonic Distance slide bar use

On the other hand **Mechanical** and **Angle** slide bars allow the user to modulate the mechanical gesture and therefore to reinforce the sense of unity,

transition, or contrast by reaching registers close by or far from the seed as shown in Fig. 13 and Fig. 14.

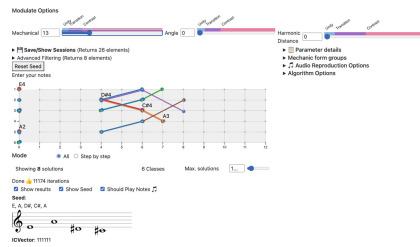


Fig. 13. Mechanical slide bar use

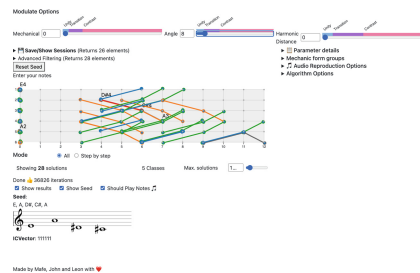


Fig. 14. Angle slide bar use

In the video at [https://infoviz.dev/viz/guitarImproviser/Guitar\\_Improviser\\_demo\\_small.mp4](https://infoviz.dev/viz/guitarImproviser/Guitar_Improviser_demo_small.mp4) from minute 0 to 3:43, we detail the illustration of the basic use using the seed taken from the initial gesture of the Etude 6 by Brouwer. From minute 3:44 to the end, a piece is improvised using the opening gesture of the Etude and following our framework assisted by the Guitar improviser tool.

## 7 Conclusions

Carrying out an approach to improvisation on contemporary classical guitar that allows to navigate its wide stylistic spectrum and that starts from the exploration of the evolution of the mechanical gesture, requires integrating this experimentation with a framework of structural coherence.

The conceptual framework we present necessitates digital assistance due to the intricacy of the operations a performer must undertake to carry out the calculations involved in evolving a mechanical gesture and controlling the aspects of unity, transition, and contrast that we propose as essential categories in the development of musical discourse.

This digital assistance empowers the performer to discover solutions provided by the tool, which seamlessly integrates the control of mechanical gesture evolution and harmonic expression. As a result, the performers can liberate themselves from these complex calculations and focus on developing the mechanical gesture in a more intuitive manner, guided by their sense of hearing. This approach aligns with other musical traditions that rely heavily on the auditory sense and the oral tradition. Hence, the framework we introduce, while exhibiting stylistic compatibility with the context of classical contemporary music in terms of its sound outcomes, also integrates approaches from other traditions when it comes to approaches to the process of thinking about improvisation and musical creation.

Currently, the Open source tool we have created enables us to approach improvisation preparation. However, to operate it in real-time live performance, we would need to adapt the interface to facilitate user interaction without using the mouse.

Composers may also find value in considering the digitally assisted framework we present for their own compositions. By configuring it through the exploration of mechanical gestures, this framework ensures the technical and idiomatic feasibility for guitar, while also enabling composers to experiment with diverse harmonic contexts grounded in our approach to set theory.

## 8 Future Work

Future endeavors encompass both conceptual and practical aspects, enabling the incorporation of additional frameworks to explore the development of various parameters inherent to improvisation. These parameters encompass the evolution of rhythm, timbre, dynamic ranges, articulation, and musical form.

On the other hand, as has been said, projecting this framework beyond the preparation of improvisation to take it to the moment of live performance requires adapting the interface and integrating other devices such as tablets and page-turner pedals.

Future work in this project also includes new papers and presentations that delve into the development of the code that Guitar improviser works with, as well as new user guides and audiovisuals that illustrate the advanced use of the tool.

Finally, we want to emphasize that Guitar improviser's prototype and interface showcased in this paper serve a demonstrative purpose, illustrating our proposal of a digitally assisted framework for studying and preparing improvisation and creation on the contemporary classical guitar ambit along with its logical and computational modeling. However, it's important to note that the development of the algorithm, the code, and the advanced operation of the prototype constitute other contributions that will be fully detailed and addressed in a future paper, where we will elaborate on and acknowledge these specific aspects.

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