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ANNOTATING SYMBOLIC TEXTURE IN PIANO MUSIC: A FORMAL SYNTAX

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ABSTRACT

Symbolic texture describes how sounding components are organized in a musical score. Along with other high-level musical components such as melody, harmony or rhythm, symbolic texture has a significant impact on the structure and the style of a musical piece. In this article, we present a syntax to describe compositional texture in the specific case of Western classical piano music. The syntax is expressive and flexible, unifying into a single text label information about density, diversity, musical function and note relationships in distinct textural units. The formal definition of the syntax enables its parsing and computational processing, opening promising perspectives in computer-aided music analysis and composition. We provide an implementation to parse and manipulate textural labels as well as a bestiary of annotated examples of textural configurations.

1. INTRODUCTION

Texture commonly refers to a high-level feature of music which strongly relates to musical style and form, and to the auditory perception of the musical flow. In the context of this work, as in symbolic music analysis in general, texture describes how sounding components (voices, chords, notes) are organized. *Variations* in classical music are examples of compositional practices in which a given melody and an underlying harmony are realized or arranged through different possible symbolic textures. Song covers in popular music are also intuitive examples in which an original texture is changed by another one while conserving the original chords and melody. Although essential in musical scores, symbolic texture appears to be challenging to formalize, probably due to the variety of musical concepts it gathers. This study aims at proposing such formalization through a well-defined syntax for the specific case of Western classical piano music.

Musicological studies of symbolic texture. In the musicological field, the description of the textural dimension

for Western classical music is rather recent, compared for example to the study of harmony that has been developed from Rameau's treatise in 1722 [1]. The notion of texture was mentioned in the 1920s as an essential element to the study of form in non tonal compositions [2]. It has been developed in parallel to the analysis of contemporary music through the 20th century, with analogies with fine art paintings analysis (see [3] for usage of textural references by composers of late 19th and 20th). The term texture was only introduced in 1980 in the New Grove Dictionary of Music and Musicians, as *referring to the vertical aspect of musical structure [...] with regards to the way in which individual parts or voices are put together*. Berry [4] considers texture as one of the *structural function* in music, and several works have assessed its impact on the perception of structure [5, 6]. When referring to the overall organization of instrumental or vocal parts, some compositions can be categorized into common textural types like monophony, homophony or polyphony [5, 7, 8].

The principle of texture is closely related to timbre and register, and those dimensions particularly arise when considering orchestral texture [9–11]. In the case of piano music of the early 19th century, Hérold [12] dissociates the *textural factors of timbre*, as for example rhythmic or harmonic (horizontal or vertical) density, from its *pianistic factors*, which are more specific to the characteristics of the instrument.

Finally, a texture-based compositional approach can be found in the work of Moreira [13]. Textural configurations are thus described formally in the case of additive texture by stacking distinct textural parts. Different levels of abstraction and complexity are used, from ordered or unordered partitions of textural parts to more global categorizations in combinations of block and line elements.

MIR studies of symbolic texture. In the Music Information Retrieval field (MIR), the notion of texture is mostly studied in the audio domain where it is commonly associated with timbral properties [14] for tasks such as genre classification [15, 16].

In the symbolic domain, works on texture identification are still sparse, probably due to the difficulty to formalize this notion. However, a few attempts have been made, restricting the study to a specific repertoire. A machine learning approach has been used for the classification of

texture in Italian madrigals of the 16th century [17]. On classical string quartets, a syntax has been proposed, highlighting for each instrument its role (melody or accompaniment) and its relations to other voices [18, 19]. Identifying musical roles through texture analysis has also been done for the specific case of guitar popular music, using audio [20] and symbolic data [21]. Detecting textural changes was also shown to be a promising approach to delimit successive sections of a piece in music structure retrieval [22]. Alternatively, the formalization of some selected textural figures has been used to synthetically increase the training set of a machine learning model dedicated to roman numeral analysis [23].

Beyond musical analysis, the recent growth of the music generation field has also contributed to bring new challenges in symbolic texture modeling. This is the case for music style transfer where the texture of a first musical piece, commonly assimilated to its *style*, is mapped on the harmony and melody of a second one [24]. The separation of harmony and texture is also found in [25], where these two dimensions are disentangled in a latent space for more controllable music generation.

Motivation and outline. We believe that texture analysis can improve our understanding of compositional practice by helping the study of both musical style and musical structure. We also think that such improvements will benefit to the field of music generation where these high level musical layers are known to be difficult to control.

This work introduces a syntax to annotate texture for symbolic piano music. In comparison to texture analysis in other repertoires, such as classical string quartets [18] in which each instrument mostly plays one voice at a time, a major challenge of piano music is the complex organization and high variability of voices and streams during the piece. Here, we focus on the specificities of piano music of Viennese classicism, whose major composers were Haydn, Mozart and Beethoven. By doing so, we ensure consistency and possibility of comparison with previous work on string quartets.

The contributions of this work are as follows. We identify the major characteristics of symbolic texture that are relevant for classical piano music based on existing studies (Section 2). In Section 3, we define a formal syntax to facilitate the computational manipulation of these characteristics. Finally, Section 4 presents a collection of annotated examples.

2. TEXTURAL CHARACTERISTICS

Based on musical and musicological resources, complementary aspects of texture have been taken into account in our study to describe the texture of a score region. Selected characteristics are detailed in this section and illustrated in Figure 1.

2.1 Diversity and density

The analysis of texture is related to the organization of atomic musical components – i.e. notes – into perceptu-

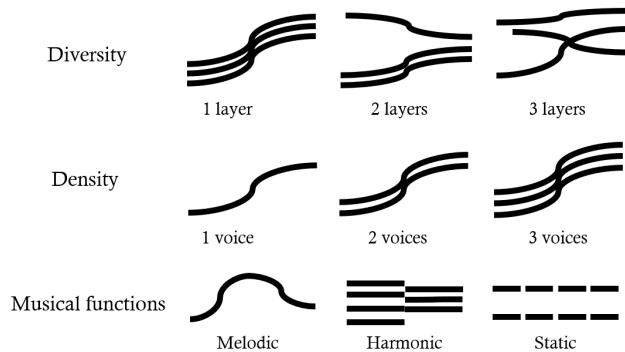


Figure 1. Schematic representation of main textural characteristics. Diversity: three voices to form respectively one, two or three layers. Density: a unique layer of density 1, 2 or 3. Musical functions: melodic, harmonic, static. Additional elements are used to qualify the internal organization of each layer, to indicate characteristic musical figures or specific relationships between their voices.

ally coherent textural units. According to Huron [7], *diversity* and *density* respectively qualify the quantity and the (in)homogeneity of sounding components in an auditory scene. Similarly, Moreira [13] defines a textural configuration by *the organization of n threads (quantitative aspect) into m textural parts (qualitative aspect) in a given passage of music*. In our work, these textural parts are referred to as *layers*. One layer can be made of either one unique voice, as for example in the case of a single melodic line, or several voices gathered by some kind of similarity, as for example voices in homorhythm (sharing the same rhythm). Three-voice inventions by Bach are typically composed of 3 single-voice layers (similarly to the top right representation in Figure 1), whereas a chorale is more likely to be made of one unique 4-voice layer, due in this case to the homorhythm of the voices. Note that homorhythmic voices are not necessarily perceived as a single layer for example if their respective register, motion or articulation make them differ enough. Algorithms to group notes in voices or coherent groups (streams) have been proposed in [26–28] but without specifically qualifying the texture of those groups.

2.1.1 Distinct layers (diversity)

The perception of distinct textural layers can emerge from several grouping mechanisms described in the works of McAdams and Bregman [29, 30], including both vertical and horizontal similarities (simultaneity and sequentiality). Onset-synchrony and semblant motions are core criteria for the fusion of notes or voices into layers, as highlighted in [7]. The number of distinct layers (named cardinality in [13]) corresponds to the *diversity* of the texture. In our work, based on these considerations, a primary step is to identify the distinct layers that would be most plausibly perceived as independent by a human listener. Note that we will not directly refer to the number of distinct layers, we will simply describe them one by one.

Figure 2. First bars of the *Presto* from Piano Sonata n°2 by W. A. Mozart (K. 280/189^e), annotated with texture labels using proposed syntax. Textural labels are given in their detailed expression which begins with their global density value. However, this information can be omitted when the global density is equal to the sum of the density of each layer. The label of bar 5 can be shortened this way: $M1s/M1t$ instead of $2 [M1s/M1t]$. On the contrary, $1 [M1s/M1_]$ in bar 6 cannot.

2.1.2 Number of voices (density)

The (vertical) *density* of a layer (named thickness in [13]) corresponds to the number of simultaneous notes heard at the same time in this layer. When considering a musical fragment with several concurrent layers, the *global density* of this fragment can be considered in most cases as equal to the sum of the densities of the constituting layers, as it is done in Moreira's textural spaces [13] or Gentil-Nunes Partitional Analysis [31]. But in some more complex textural configurations, we allow for the global density to take a value different from the sum of the densities of its constituting layers. For example, the alternation of two single-voice layers in call and response would lead to a global density value equal to one. In Figure 2, bar 1 has a global density of 1 (1 layer of density 1), bar 5 has a global density of 2 (2 layers of density 1), whereas bar 6 has a global density of 1 (since the bass layer is very short compared to the upper layer).

2.2 Melodic/harmonic/static functions

In [18], the distinction is made between melodies and accompaniment parts. Instead of characterizing such roles in the overall textural configuration, we propose to focus on the functional aspect of each layer taken individually, expressed by a combination of three labels: *melodic*, *harmonic* and *static*. These terms are named based on Benward and Saker's primary elements of musical texture [8]. These three complementary dimensions respectively convey ideas of horizontality, verticality and stability.

Melodic A layer labeled as *melodic* (M) is shaped as a sequence of notes that expresses a strong sense of temporal continuity. It is not limited to dominant phrases. The scope of melodic layers includes primary, secondary or supporting melodies in Benward and Saker's primary elements [8]. Counterpoint only has M-function layers, each voice existing independently. In most cases, a bass line could also be considered as an M layer. Furthermore, a melodic-function layer is not necessarily monodic – that is to say, with a density of one. It can be a sequence of harmonic thirds, sixths or even denser chords that form a melodic continuity. In this last case, it would additionally be labeled as *harmonic*. In the extract of Figure 2, the upper layer has systematically a melodic function and the left hand sometimes also has a melodic function, as from bar 5 to bar 8.

Harmonic *Harmonic* layers (H) qualify harmony-related layouts, such as chords or broken chords, which raise generally consonant combination of notes. For example, in bars 2 to 4 in Figure 2, the left hand plays a two-voice harmonic layer. Note that the density of a harmonic layer can be equal to one, as in the case of arpeggios.

Static Derived from Benward and Saker's *static supporting parts* [8], our *static* label (S) encompasses layers structured with short-term repetition or sustained notes, like pedal notes or drones. Repeated notes might not necessarily be consecutive: ostinati are typically considered as static layers for they repeat short cells and are character-



Figure 3. Example of textural layers with combined melodic M, harmonic H and static S musical functions. From Mozart K.280/189^e mm. 1-2; K.279/189^d mm. 6, K.265/300^e variation 6 mm. 1-3 and K.309/284^b, mm. 58.

ized by regularity or persistency. In Figure 2, the bass layer in bars 16 to 20 is static, since it is constituted of a single repeated note. Although this concept is rarely mentioned in the literature, it has shown to be helpful in our preliminary annotation experiments.

Function combination Multiple functions can apply to a single layer. Common examples of each combination are given in Figure 3.

- (MS) A melody with short term repetition, expressing both continuity in the voicing and insistence on a given pitch, could have both melodic and static function;
- (MH) A chordal melody would have both melodic and harmonic function;
- (HS) A repeated Alberti bass, emphasizing harmony with a repetitive figure, would have both harmonic and static function, as would have a triple hammer blow [32] on a given chord;
- (MHS) In rare cases, a layer can involve at the same time the three dimensions M, H, and S. For example, a hammer blow which does not repeat exactly the same chord, but has a changing upper note, involves some melodic movement.

2.3 Internal organization of a layer

2.3.1 Voice relationships within a layer

In the case where several voices are gathered in the same layer because of similar rhythm or semblant motion, it appears important to specify which degree of similarity they share. Inspired by terminology and description of [18], we use three levels of description between voices of a single layer.

- Homorhythmy (h): all the voices or notes in the layer share a strongly similar rhythm. In the bars 2 to 4 in Figure 2, the left-hand harmonic part has its two voices played simultaneously, in homorhythmy.

- Parallel motions (p): all the voices in the layer share (almost) the same rhythm and the same intervallic consecutive motions. With third or sixth doubling, for example, major or minor intervals are tolerated. See the melodic layer in measures 17, 18 and 19 in Figure 2.

- Octave motions (o): all the voices in the layer have parallel motions plus the same pitch classes. In Figure 2, bars 13-14, the left-hand echoes the motion in bars 5-6, this time with octave doubling.

Note that octave motions are a specific case of parallel motions, which are also a subcase of homorhythmy. Because of these inclusive relations, we consider the most restrictive attribute to systematically induce the included ones. Single voice layers are naturally not concerned by these relations.

2.3.2 Characteristic musical figures

Each layer can be associated with specific attributes to precise how it is written. We defined some characteristic figures that seem relevant to the studied repertoire:

- sustained notes (τ): the notes in the layer are sustained during most of a musical segment (see the left hand part in bar 5 and 13 in Figure 2).
- repeated notes (x): short-term repetition of the exact same pitches one after another. Each new pitch in the layer is repeated at least once (see Figure 2 bars 16 to 20).
- sparse (·): layers with low horizontal density, locally. On an indicative basis, less than half time of studied section is filled with the notes of the layer (see Figure 2 bars 2 to 4).
- scale (s): ascending or descending sequence of short duration notes (see Figure 2 bars 13 and 14). Repeated ascending or descending short motives can also be considered (see Figure 2 bars 5 to 7).
- oscillation (b): fast alternation between two notes. An example can be found in the bestiary that is provided at the end of the paper, bars 38 and 41 to 43.

These last attributes tend to be more style-specific and are intentionally biased towards Western classical style, here. Room is left for future extensions.

2.4 Sublayer decomposition

In addition to the decomposition of a texture into simultaneous layers, a single layer can be decomposed itself into several *sublayers*. A sublayer decomposition can be useful to indicate relationships between a subset of voices included in the same layer. In a homorhythmic chorale for example, this would be done by splitting the top-level MH layer into multiple M sublayers. Sublayer decomposition can also be useful in case of compound melodies [33] or

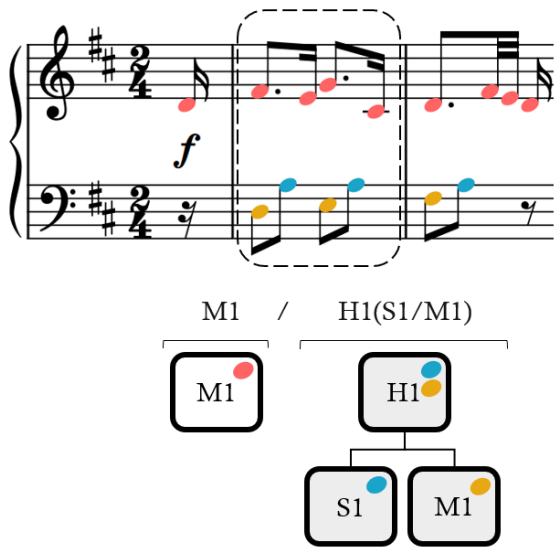


Figure 4. Textural annotation and tree structure of the first measure of the *Allegro moderato* from *Partita in D major for piano*, attributed to J. Haydn (Hob.XVI.14, 1767). The bar is labeled $2 [M1/H1 (S1/M1)]$. Two main layers with density of one are separated: a melodic (M1) and a harmonic (H1) part. Furthermore, the lower part can be decomposed into two sublayers: a melodic stream can be distinctly heard (M1: D, E, F sharp), in alternation with the repeated note A with static function (S1).

two-part accompaniments such as stride piano. In the latter case, it enables to describe bass notes and chord notes in two distinct sublayers.

Top-level textural layers are described rather independently, whereas sublayers are interconnected and help describing the content of a given single layer. The subdivision of layers into sublayers occurs recursively and handles vertical separation at different levels of precision. An example of sublayer decomposition is shown Figure 4.

3. A SYNTAX FOR TEXTURE ANNOTATION

In this section, we develop a general syntax for notating symbolic piano texture in flat text that is both musically intuitive and flexible but at the same time rigidly structured. The syntax enables to depict into a single text label the five characteristics of texture described in Section 2 and illustrated Figure 1.

3.1 Formal structure

In this work, and similarly to [18], it is proposed to annotate texture at the bar level. We estimate that a description of texture with shorter time span would indeed limit the representation of high level textural concepts previously described. On the other hand, notating the texture of several consecutive bars by a single annotation might yield to labels that would be either overloaded in text or too approximative regarding the musical surface. It is not uncommon to see a drastic change of texture in the middle of a bar, for example at the transition between two different

structural sections. To overcome such cases, the syntax enables to indicate two consecutive textures separated with a comma.

Topologically, we represent a textural configuration by a data structure of forest, i.e. a set of trees, in which each tree corresponds to a top-level layer. It transcribes the sublayer description in section 2.4 by splitting a layer description (a node) into the individual descriptions of their sublayers (children nodes). The depth in the tree represents a level of precision: roots of a textural tree portrays surface description of the top-level layers whereas leaves can detail a finer voice-specific description. An example is given in Figure 4.

3.2 Flat text syntax

The syntactic formalism we propose is described in Backus-Naur form in Figure 5. A texture is either composed of a unique textural layer or a set of layers. In the latter case, the layers are ordered from high to low register and separated by the character /. Each layer is expressed individually by the combination of its musical functions (M, H, S, MH, MS, HS, MHS or N for None) and its density (as a positive integer value), followed by all the relevant attributes describing the internal organization of the layer: M1, MH4h or S2ot for example.

In case a sublayer decomposition is needed, it has to be inserted after each corresponding layer by defining the ordered set of sublayers in parenthesis: $A/B (B_a/B_b)$. Finally, an integer indicating the global density is added by encompassing the whole label with brackets []. This notation is only necessary when the global density does not correspond to the sum of all layer densities: $M1/M1/S2$ is a shortcut notation of $4 [M1/M1/S2]$, which is perfectly equivalent. At this global level, additional tags may also be added, like in the second measure of Figure 2, $3h [M1/H2h]$, which links two separated layers with homorhythmy.

A *Python* implementation of this structure can be found at <http://algomus.fr/code>. It allows the parsing of the syntax by converting flat text texture labels into structured objects.

3.3 Influence of the context

Even though texture is annotated at the granularity of the musical bar, it is worth mentioning that the context (i.e. neighbor bars) plays an important role in the identification of the local texture. We illustrate how it impacts the annotation by using three examples from Figure 2.

- *pattern repetition*: the inclusion of the scale attribute (s) in bar 5 to 7 takes into account the repetition of the melodic cell on the three bars. The motive is consecutively transposed in a descending manner. Bar 5 alone is not sufficient to detect this pattern.
- *layer continuity*: the parallel attribute (p) in the upper part of bar 16 results from a continuity of the layer $M2p$ (two-voice parallel melodic layer) started in bar 15.

```

<bar-texture> ::= <texture> [' ' <texture>] # Label for a single bar
<texture> ::= <description> '[' <layer-list> ']' # Detailed
| <layer-list> # Shortcut
| _ # Silence

<layer-list> ::= <layer> ['/' <layer-list>]
<layer> ::= <layer-function><description> [' (' <layer-list> ')']
<description> ::= <density> [<relation>][<attribute-set>]
<attribute-set> ::= <attribute> [<attribute-set>]
<layer-function> ::= M | H | S | MH | MS | HS | MHS | N
<relation> ::= h | p | o # homorhythmy, parallel motions, octave motions
<attribute> ::= s | t | b | r | _ # scale, sustained, oscillation, repetition, sparse
<density> ::= .. integer in N* ..

```

Figure 5. Syntax of Texture Notation in Backus Naur Form. As an example, the $2 [M1/H1 (S1/M1)]$ label from Figure 4 contains a `<layer-list>` of two elements. The first `<layer>` (M1) has a melodic `<layer-function>` M and a `<density>` of one. The second `<layer>` has a nested `<layer-list>` S1/M1, to describe its sublayers. The value of 2 corresponds to the global `<density>` in the detailed `<description>`.

- *layer separation*: Bars 2, 3 and 4 could have been annotated MH3h in another context due to the onset synchrony, which tends to merge notes into the same stream [7]. However, the choice has been made to annotate it with two distinct top-level layers, to preserve the continuity of the melodic part that has been heard just before. It assumes that the perception of streams is in this case more influenced by the sequential grouping of notes rather than vertical grouping. The homorhythmy is then indicated as a global attribute, resulting in the label 3h [M1/H2h].

4. ANNOTATED EXAMPLES

To accompany the presentation of our syntax, we provide a *Bestiary of musical textures* (see Figure 6), which aims at illustrating some useful and common examples of textural configurations.

The bestiary does not intend to provide an exhaustive description of all possible combinations of layers that can be found in classical piano music. Instead, it focuses on the illustration of typical layers. It constitutes not only a useful tool and reference to understand textural annotation, but also a catalog of textural ideas created to be extended in the future.

In addition to the synthetic fragments gathered in the bestiary, the syntax was experimented on musical extracts from the classical piano repertoire. The first measures of the third movement of Mozart Piano Sonata n°2 (K. 280/189^e) are shown in Figure 2. The annotation of the full piece is available in text format at <http://algomus.fr/code>.

5. CONCLUSIONS

In this article, a new syntax has been defined and illustrated for the annotation of symbolic texture in piano music of the Western classical-era. Based on musicological reflexions, the textural elements we presented and their organization provide a practical framework for texture analysis. By integrating them in a unified syntax, we facilitate their computational manipulation for automated analysis and generation tasks.

Future works include the elaboration of a distance function that could systematically be applied to evaluate the

similarity between two textural labels. The similarity between two labels should reflect the similarity between the corresponding symbolic textures. Besides texture analyses and comparison between composers or eras, this project also aims at studying the evolution of texture within a single piece of music. Strong links are to be found between texture and the structure of the piece, for instance in the case of sonata form. Future work will also include the creation of a consistent dataset with texture annotations. Resulting data would be usable for the training of supervised models for automatic texture estimation in classical piano scores. Additionally, our texture model is a step towards the interpretation of arbitrary texture categories that would be discovered using unsupervised methods. It would finally contribute to further improve the understanding and the control of this musical dimension in generative tasks.

Acknowledgments

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Melodic layers

Single thread / density=1 Octave doubling (d=2) Parallel motions Nested parallel motions

Label : M1 M2o M2p M3p(M2o/M1)

5 Chordal monophony Homorhythmy Block chord melody

MH4p MH3h(M1/M1/M1) ; or 3h[M1/M1/M1] MH5h(M2o/H3h)

8 Sequential separation / rupture Scale (descending, ascending) Compound, descending

H6h, M1 M1s M1s

Harmonic layers

11 Chords: homorhythmy Sustained ("tenu") Repeated Bass + chords Sparse

H3h H4ht H3hr HS3hr(H3hr/MS1) H3h_

17 Arpeggios (back and forth) Arpeggios (ascending) (descending) Broken chords

H1 HS1 HS1 H1

23 Alberti bass Variant Alberti with nested melody Compound melody

HS1(S1/M1) HS1(S1/M1) HS1(S1/M1) MHS1(S1/M1) MHS1(M1/HS1) MS1(M1/S1)

30 **Multilayer** Homorhythmic Alternation (global density: 1)

2[M1/M1] (or abridged in M1/M1) 2h[M1/M1] or MH2h(M1/M1) MH4h or even 4h[M1/M1/MS1r/M1] 1[M1/M1]

Static layers

34 Pedal note: sustained Repeated Pedal and oscillation ("battement") With pattern, ostinato

2[M1/S1t] (or abr. M1/S1t) 2[M1/S1] (M1/S1, etc.) 2[MS1r/S1r] 2[M1/S1b] 2[M1/S1]

39 Octave doubling Octave oscillation With melodic contour Smaller oscillations

3[M1/S2ot] 2[MS1r/S1b] 2[M1/MS1b] 2[M1/HS1b]

43 **Coda** Silence

3[M1/HS2b(S1r/HS2r)] MHS5h H5h_

Figure 6. *Bestiary of musical textures*. The texture of each bar is annotated with the syntax defined in Figure 5, illustrating various textural layers and combination of layers that could be found in piano music. The file is available at <http://algomus.fr/code>.

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