Improvements of a Computational Tool intended to Systematical Production of Abstract Melodic Variations

MODALIDADE: COMUNICAÇÃO

SUBÁREA: COMPOSIÇÃO

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Abstract: This paper is part of a broad research project concerned with the study of musical variation under analytical and compositional perspectives. Associated to the latter approach, a computational complex formed by four modules was developed with the purpose of systematically extracting a large number of variations from a given basic musical cell. There are described some of the improvements and new resources which were recently implemented in the first module, responsible specifically for producing abstract melodic variants. This reformulation contributed to make the whole derivative process significantly simpler, more elegant and efficient.

Keywords: Musical Variation. Abstract Level. Computer-assisted Composition.

Aperfeiçoamentos de uma ferramenta computacional destinada à produção sistemática de variações melódicas abstratas

Resumo: Este artigo é parte de um amplo projeto de pesquisa destinado ao estuo da variação musical sob as perspectivas analítica e composicional. Associada a esta última abordagem, foi desenvolvido um complexo computacional formado por quarto módulos com o propósito de extrair variações sistematicamente de uma dada célula musical básica. São descritos alguns dos aperfeiçoamentos e novos recursos recentemente implantados no primeiro módulo, que é responsável especificamente pela produção de variantes melódicas abstratas. Tal processo de reformulação contribuiu para tornar todo o processo derivativo sensivelmente mais simples, elegante e eficiente.

Palavras-chave: Variação musical. Nível abstrato. Composição assistida por computador.

1. Introduction

This paper integrates a broad research project which essentially aims at studying musical variation under analytical and compositional perspectives. The research is theoretically grounded on the principles of developing variation and *Grundgestalt*, both elaborated by Arnold Schoenberg (1874-1951) and rooted on the ideals of Organicism, which exerted strong influence over part of the Austro-German music in the 19th Century (c.f. MEYER, 1989: 169-189; FREITAS, 2012: 65-67). According to the organicist conception, the musical creation must replicate the biological growth, through the gradual transformation of a basic group of elements (the *Grundgestalt*, in the Schoenbergian terminology) which implies intense use of derivative processes corresponding to the different techniques of developing variation.

The main motivation for initiating this research was the search for systematizing the analysis of musical works built according to an organic logic, basically aiming to properly identify and explain the derivative relations between the structural elements involved (in special, the thematic ideas). For this purpose, in 2011 an analytical model was elaborated and gradually developed. During this phase, the main difficulty was how to adequately map and catalogue extremely diversified processes of variation, frequently idiosyncratic to each work and/or composer. This problem could only be solved after the formulation of a basic premise, which favored the desired analytical systematization. According to this premise, the derivative process in a given musical piece could hypothetically be done in two distinct levels: concrete and abstract. The former corresponds to the conventional meaning of musical variation, or else, this level is associated to the transformations that are applied to a musical idea conceived as an inseparable unity. In other words, a concrete transformation of a musical idea must affect all of its constituent elements. In turn, in the abstract level, variation is obtained through the application of a transformative operation in structural isolated dimensions, abstracted from the musical unity, as its intervallic or rhythmic configurations. The derivative processes in both levels are differently labeled as developing variation of first order (DV1) in the abstract level, and developing variation of second order (DV2) in the concrete level.

The analytical model was tested in the examination of works by different composers, styles and periods.[1] In 2013, the consolidated model (including its basic premise, concepts and terminology) became the basis for a compositional approach, initiating a new phase in the research. A group of four computational tools was idealized aiming to systematically yield developing variations (i.e., variations over variations during an indefinite number of generations) from a referential basic musical cell. Such programs form the four modules of a system named as *geneMus complex* (gM), whose structure is firmly based on the duality abstract/concrete.[2] After a relatively long phase of algorithmic design, implementation (in *Matlab* computational language) and tests, it was recently initiated a deep reformulation of gM, intended to provide internal improvements, simplification of algorithms and codes and addition of several new resources to the graphic interfaces of the modules, aiming to make them simpler, more agile, elegant, robust, and versatile.

2. The gM's basic structure

The four modules act in an integrate way, and are associated to the following functions:

(1) production of abstract variants from a basic musical cell (the *Grundgestalt* or, as it is named in gM, the *axiom* of the system), corresponding to the already mentioned

process of developing variation of first order. These variants (renamed in gM as *genotheorems*, or gT's) are related to two abstracted domains: intervallic (or melodic) and rhythmic;

(2) crossing over of the yield gT's (as pairs of melodic and rhythmic abstracted variants) to form musical concrete unities, named as *phenotheorems* (pT's);

(3) concatenation of selected pT's for creation of more complex musical structures (similarly as occurs in the formation of themes through combination of motives), labeled as *axiomatic groups* (axGr's);

(4) these become references for developing variation of second order, resulting in the production of new variants, the *theorem-groups* (th-Gr's), the most far-reaching products of the system. The graphic scheme of Figure 1 summarizes the whole process.

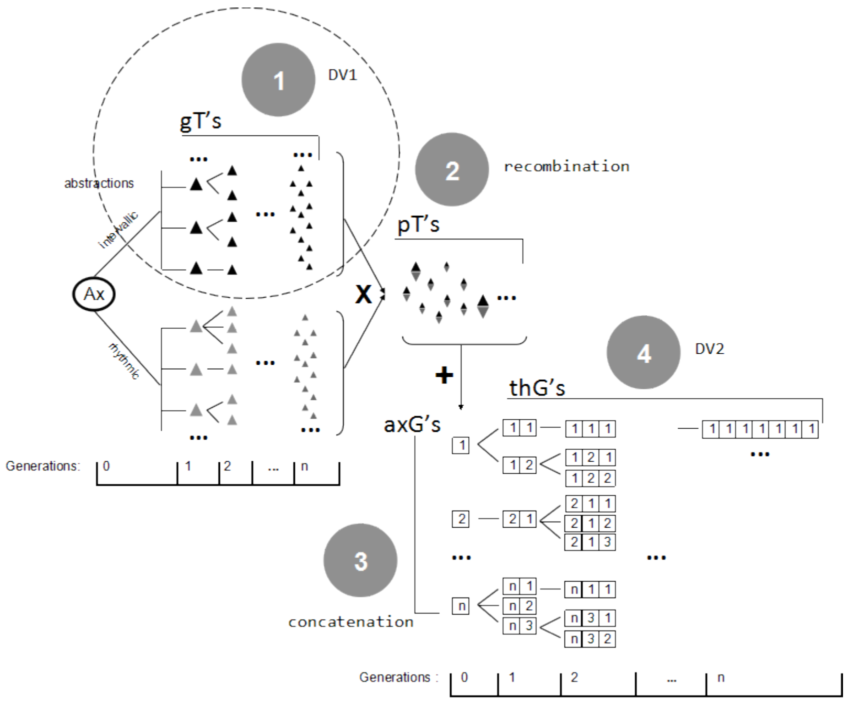

Figure 1: Graphic representation of the integrated structure of gM's four modules. Module 01.i is inserted in the dashed circle (adapted from ALMADA, 2015: 44).

The present paper aims at describing the new version of one of the two parts of gM's first module (henceforward labeled as module 01.i),[3] which is especially addressed in the production of melodic gT's. The next section highlights its operational protocol, the improvements related to the original version and the implemented new resources, adding some examples of its application.

3. The module 01.i, for production of melodic gT's

The derivative process in gM is initiated with the composition of an axiom, the referential basic cell for the system (in general, a kind of short and simple motive), like the one shown in Example 1.

Example 1: A hypothetical axiom, to be taken as reference for the subsequent examples.

The axiom, properly formatted as a monophonic midi file is then taken as input by the module 01.i, whose graphic interface is presented in Figure 2. The musical information related to the axiom's intervallic structure is automatically transcribed by the program as a numeric sequence and transposed to the fields "AXIOM" and "parent" (see in A, Figure 2)[4], since in this initial stage both functions are exerted by the same referential form (from the second generation on, the axiom and a given "parent" will forcibly be different in their contents). Other data printed in the fields are: the coefficient of similarity[5] (the maximum value, "1.00", for the axiom/parent), generation number ("0"), and the lineage or genealogical description[6] (also "0" in this case, since both are progenitors of the future breed of variants).

Developing variation of first order is properly initiated when the user/composer press one of the buttons that correspond to the *transformational operations* (in B).[7] The original 27 operations were reduced to the current 7 options through simplification and implementation of internal alternatives (related, for example, to the desired number of semitones for expanding the intervallic content of the referential form), which made the derivative process much simpler and visually clearer. The current version of module 01.a has also a special button (labeled with a "M" in Figure 2) associated to the option "mutation". When this function is disabled, the whole content of the referential form is affected by the application of a given operation (which is, in this case, classified as "general"). By pressing the "M" button in conjunction with some of the available operations, just one of the elements of the intervallic sequence of the referential form, randomly selected by the program, will be transformed. This intends to simulate the biological process of micromutations, allowing the occurrence of subtle and gradual variations.

Another incorporation of the new module is the possibility of verification of the obtained results, not only considering the auditory aspect (the buttons "play" put aside the lineage fields allow the user to hear the midi versions of the axiom, the "parent" and the "child"), but also visually: by pressing the button "PLOT" (C, Figure 2) the specific graphic contours of the three forms involved are superimposed providing a clear comparison of their profiles. In case of approval of a result the user must press the button "SELECT" (D), and the corresponding gT is properly registered as a member of the system.

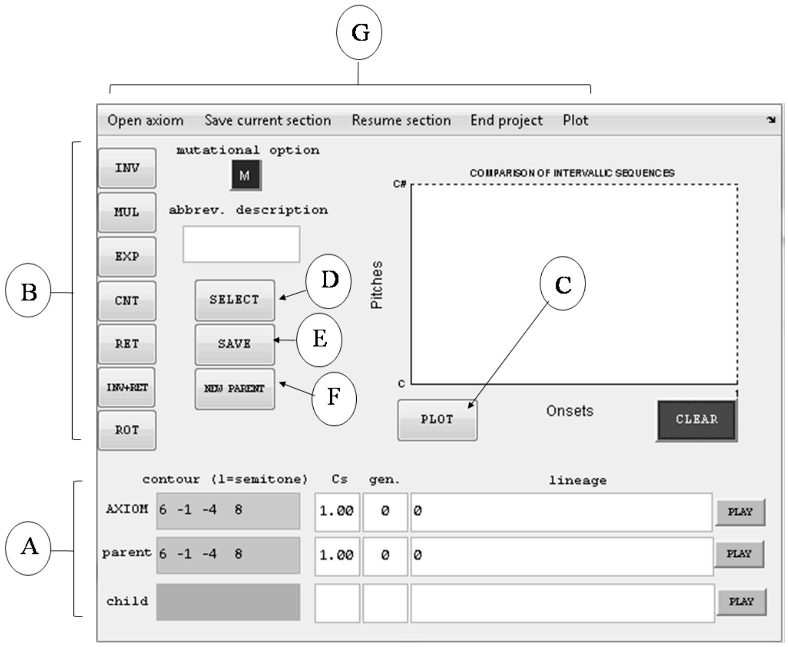

Figure 2: Graphic interface of module 01.i, considering the axiom of Example 1.

Figure 3 exemplifies a selection of two gT's of first generation. In the first case (a) it was applied the general operation of inversion, abbreviated as "G-INV" (a_1). It consists on the multiplication of the whole intervallic content of the "parent" by the factor (-1), resulting in the sequence <-6 1 4 -8> (a_2). The algorithm for similarity calculation attributed to this gT a C_s = 0.8 (a_3). Its generation number is "1" (a_4) and its lineage is described as <0 1>, i.e., it is the first descendant of the form "0" (a_5). The plot of the melodic profiles of the "axiom/parent" and the "child" are respectively shown in a_6 and a_7. The second selected gT (b) resulted from a mutational operation, being transformed by intervallic contraction combined with the activation of the "M" button (abbreviated description: "M-CNT"). The program randomly selected the second element of the sequence, whose original intervallic content was contracted by one semitone (number also randomly chosen), resulting in "0", the unison (b_1). The remaining information can be easily understood by analogy with the precedent case, therefore making any additional explanation unnecessary.

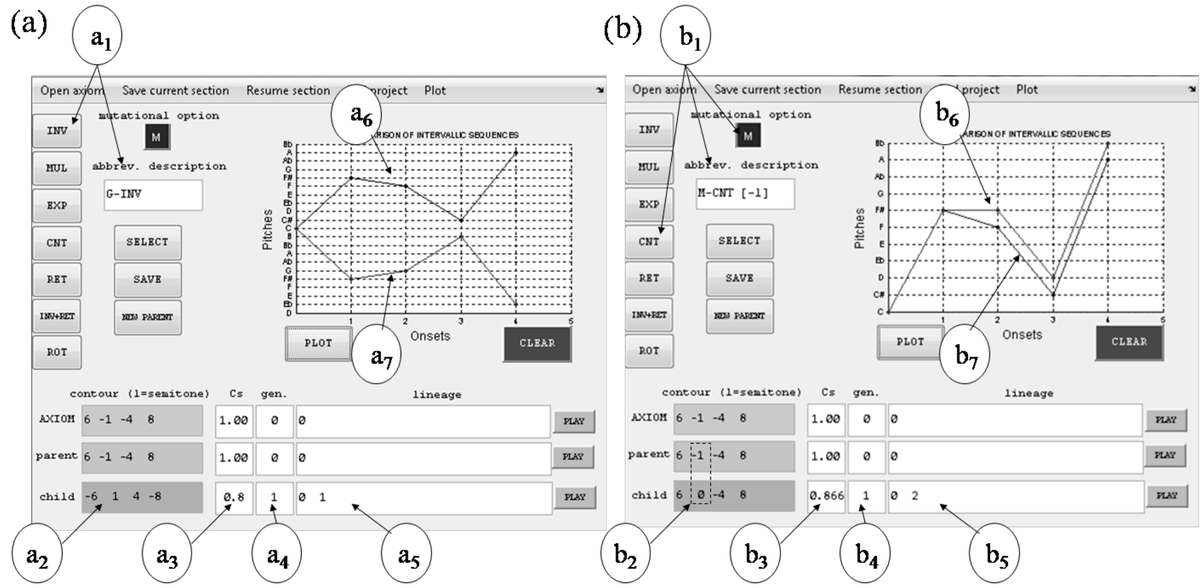

Figure 3: Selection of two gT's based on data from Example 1 and Figure 2: (a) by application of operation of general inversion; (b) by application of operation of mutational contraction.

When the user wants to finish the production of the first generations of gT's, he must press the button "SAVE" (E, Figure 2). Automatically, the numeric sequence (<-6 1 4 -8>) of the first-born gT's (<0 1>) is transposed to the field "parent", as well as its additional information (C_s, generation number and lineage). Figure 4 presents a possible "child" in this stage (<0 1 1>), resulting from retrogradation of the intervallic content of its "parent".

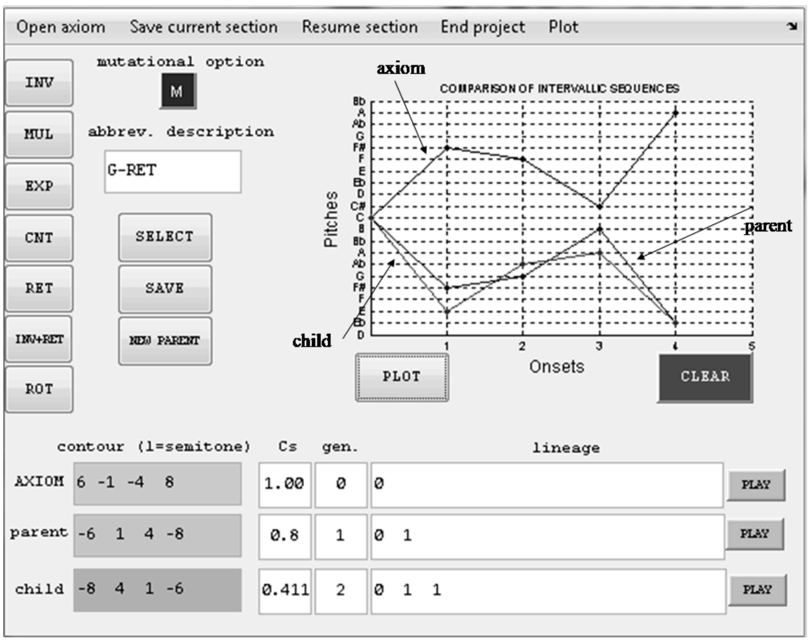

Figure 4: Selection of a gT's based on data from Example 1 and Figures 2 and 3, by application of operation of general retrogradation.

The process of second-generation gT's production follows the same protocol of the precedent case, proceeding according to the particular constructive user's intentions. The change of "parent" (i.e., to <0 2>), consequently allowing the yielding of new descendants, is made through pressing the button "NEW PARENT" (F, Figure 2). An indefinite number of generations (and gT's) may be obtained by repetition of these procedures.

A very practical resource of the module is the option to save a working session and to resume it in a posterior moment. Both functions are located at the interface's upper menu (G, Figure 2). Another new and important tool is available in 01.i: it plots the axiom's genealogical tree, encompassing all of its descendants at a given moment. Figure 5 presents a possible genealogy for the forms of Figures 2, 3 and 4.

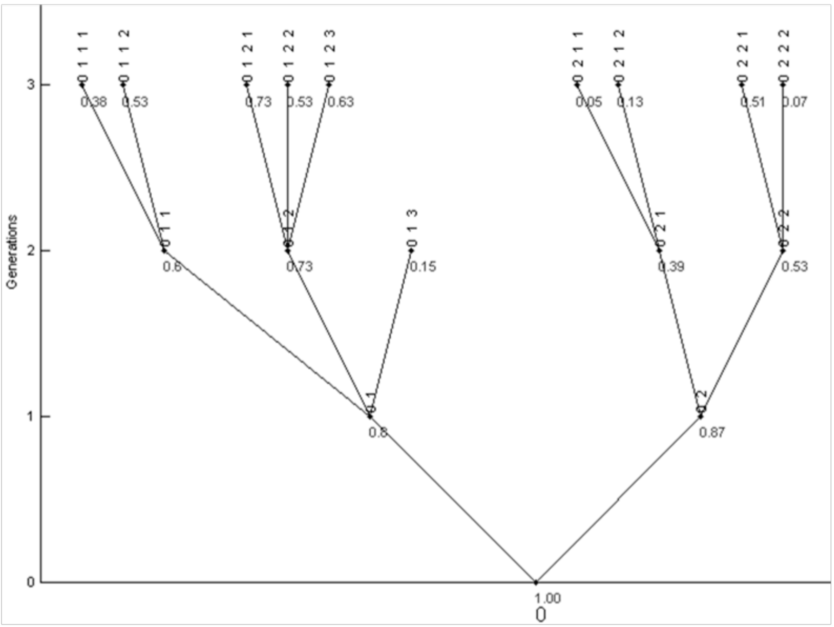

Figure 5: Genealogical tree of a possible offspring of the forms presented in Example 1 and Figures 2, 3 and 4, after three generations. The nodes correspond to the gT's, which are identified by their lineages (vertically displayed) and coefficients of similarity.

Concluding remarks

This paper aimed to describe the new version of module 01.i, the main component of the geneMus complex, responsible for systematically produce abstract melodic variants from a given basic musical reference, the axiom. Several improvements and new resources in relation to its original format, made the current version of the module considerably more simple, elegant and efficient, favoring in a larger extent its operation by eventual users/composers. As a next stage of this current phase, the improvement process will be extended to the remaining modules of gM.

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Notes

[1] See ALMADA (2011a; 2011b; 2013a; 2013b) and MAYR & ALMADA (2014).

[2] A recent description of gM formalization is presented in ALMADA (2015).

[3] The second part, module 01.r, is used for the production of rhythmic gT's.

[4] These are the adopted conventions for the numeric sequences: the integers indicate the size of the intervals (1=one semitone; 2=two semitones, and so on). Positive and negative numbers are associated to the direction of the intervallic movements, respectively, upwards and downwards.

[5] "The coefficient of similarity (Cs), a real number from 0 up to 1 that measures the \parenthood" degree of a given variant in relation to the referential form from which it is derived. By convention, the Cs of the axiom (…) is maximal (= 1). Special algorithms for comparison of melodic or rhythmic contours calculate the loss of similarity between a given form and its immediate offshoot, which results in a Cs inversely proportional to the structural transformation caused in the variant" (ALMADA, 2015: 45).

[6] A special algorithm based on a function created by the Austrian mathematician Kurt Gödel was designed to produce genealogical descriptions of the theorems of the fourth module (i.e., only the concrete ones) of gM's original version. This use is now expanded for the abstracted offspring. Basically, the algorithm returns a numeric sequence that informs the considered genealogy. For example: the sequence <0 1 3> means (it must be read backwards) "the third descendant of the first descendant of the axiom (0)". For a detailed description of this algorithm, see ALMADA, 2014.

[7] The operations are algorithms that when applied to a given referential numeric sequence affect its content producing a new, derived sequence. The adopted operations in the system are: inversion (INV) = multiplies each element by (-1); multiplication (MUL) = multiplies each element (applying modulo 12) by an selected factor;

expansion (EXP) = adds to each element (applying modulo 12) a selected number of semitones; contraction (CNT) = subtracts from each element a selected number of semitones; retrogradation (RET): presents the sequence backwards; retrogradated inversion (INV+RET): combines INV and RET; rotation (ROT): rotates the sequence maintaining its order by a selected number of times.