'Xa-lan': Algorithmic Generation of Expressive Music Scores Based on Signal Analysis and Graphical Transformations

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Abstract

Xa-lan is a computer program written in Common-LISP to generate music scores with a high level of notational/symbolic expressivity. Generation is driven by audio-analysis of melodic profiles. Once a melodic contour is input to the software, graphic transformations of the original profile stochastically control the different notational elements of the score. The Xa-lan routines display their final output using the 'Expressive Notation Package' of PWGL, a LISP-based visual composition environment.

A full range of traditional and non-conventional music notation elements can be algorithmically generated with Xa-lan, retrieving to the user a 'ready-to-play' or fully expressive music score.

Introduction

The concept of algorithmically generate music and some sort of symbolic/notational representation of that generation has been present in different tools for computer aided composition (e.g. PatchWork (Assayag et al. 1999), OpenMusic (Assayag et al. 1999), AC Toolbox (Berg 2003), etc.); however, notational representations in computer assisted environments are usually implemented just to orient the user in his/her compositional process and are not an end in themselves. Some algorithmic composition tools such as FOMUS (Psenicka 2007) or Abjad (Adan and Baca 2006), allow for more refined algorithmic possibilities to generate scores with sophisticated levels of expression; these software tools however, are formatting programs that produce output to be used in external notational environments such as LilyPond (Nienhuys and Nieuwenhuizen 2003) or some other notation programs via MusicXML.

Xa-lan was conceived to be a 'native-object' within the visual language of PWGL (Laurson and Kuuskankare 2002), an algorithmic composition environment written in Common LISP and OpenGL. Xa-lan formats its output to the PWGL-Score-Editor where post-editions of the resulting score can be made and/or use this object to drive a synthesis engine for playback of the score.

Composing/Notating with Xa-lan

When the Xa-lan object is evaluated, the user is asked to provide a sequence of numbers or the analysis of an audio signal to extract the profile of a melody; then, Xa-lan formats those values to the different notational aspects of a music score. The original sequence of numbers is internally represented as a graphic tendency that automatically undergoes different transformations. Some of those transformations are indeed 'contrapuntal' derivations of the original plot such as the *inversion*, *retrograde*, the *inversion of the retrograde*, etc. Each newly derived plot controls one symbolic aspect of the score, such as the probability of having ties, rests or grace notes in the generated score. Every single plotting variation is then mapped to reasonable values of the notational aspects being under control; for instance, if a plot is driving pitch, the scaling should take into account the tessitura and range of the instrument that will be playing the score. Figure 1 shows a typical series of transformations of the original plot displayed at the top-left corner.

The Xa-lan routines generate music scores in 'notational layers': first the pitch/tonal material and the metric-rhythmic configuration of the piece are defined; subsequently, articulation markings, dynamics and finally note-head changes are encoded (see Figure 2). It is important to mention that every notational layer has a very high level of resolution; for instance, pitch material ranges from any possible microtonal subdivision of a tone to diatonic and chromatic configurations; the rhythmic notation is also very refined allowing for dynamic metronome and metric changes, complex nested rhythms and control of grace-note values, among other features. Example 3-A shows a possible rendering of the first generation/transcription layer of the score. As seen, this melodic line encodes microtonal values and the rhythmic structure includes metric changes, metronome marks, nested rhythms, rests, ties and grace note values with different groupings.
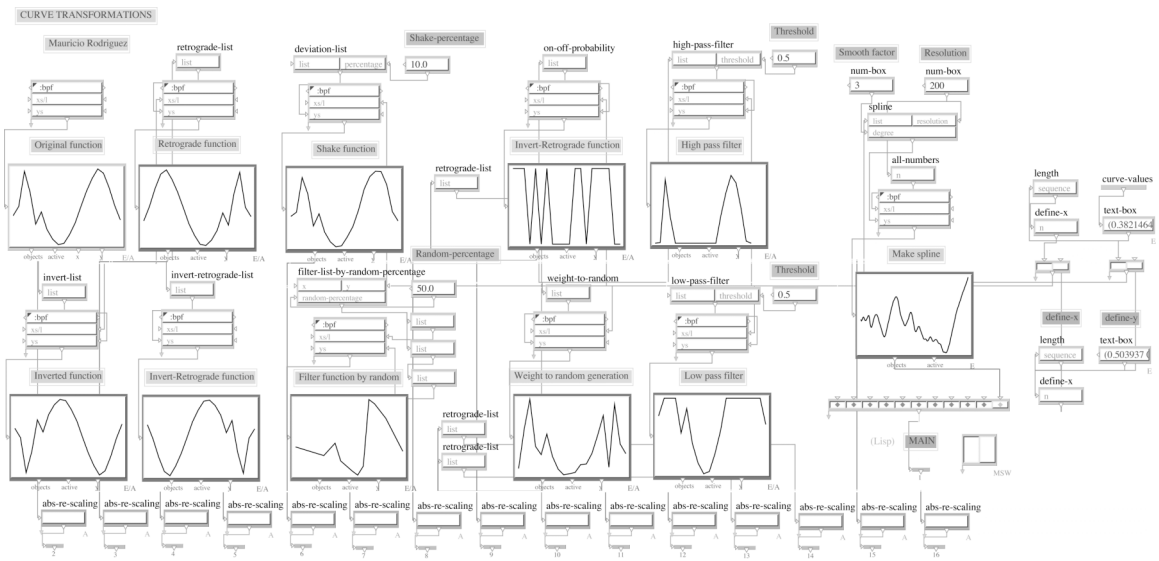
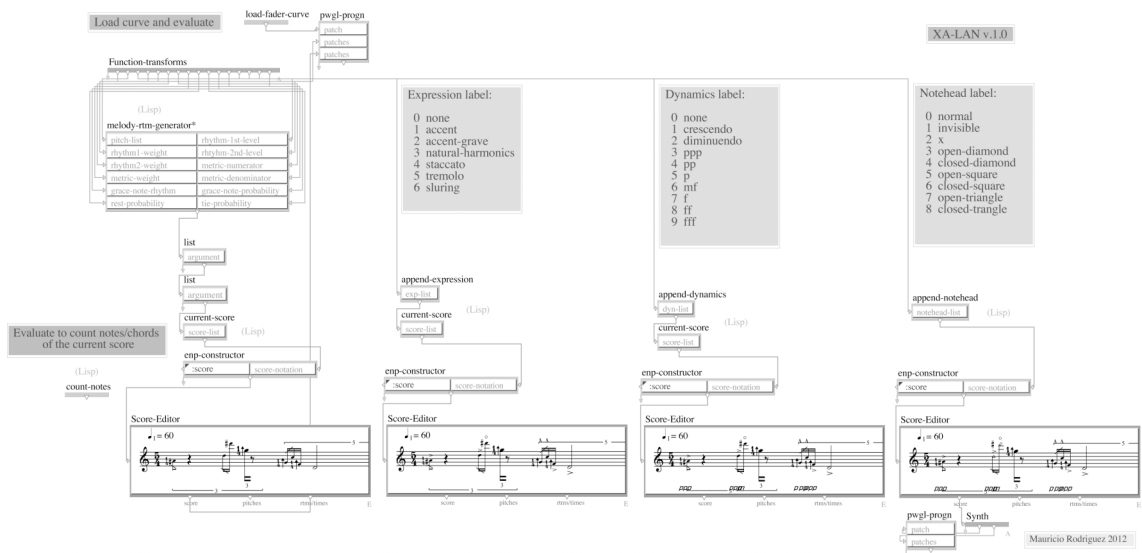Figure 1. Graphic transformations of original melodic profile.
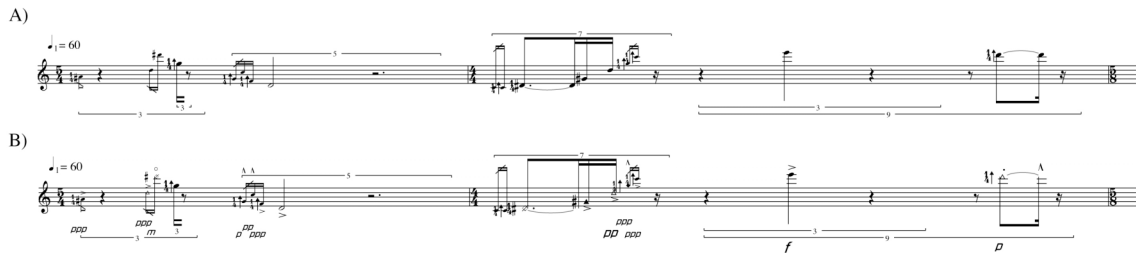

Figure 2. Notation layers of Xa-lan.

Figure 3. A) Pitch and rhythmic rendition sample, B) Expressive notation rendition sample.

Once Xa-lan renders a first score-layer version with the data provided by the user, different score renderings can be applied to the same data by consecutive evaluation of the Xa-lan object until a possible final version is chosen. Once all the expressive notation layers are applied to the chosen version, a fully expressive notation is generated (compare A and B of Example 3).

Lastly, the final version of the score can be used to drive a synthetic instrument that is responsive to the expressive attributes of the score.

References

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