NEvAr – System Overview

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Abstract

In the past few years, a new Artificial Intelligence area has begun to emerge, usually named Creative Reasoning. While some researchers approach the study of creativity from a human perspective, and thus try to model human creativity, we follow a different approach: we consider nature to be creative, and hence try to it in an attempt to create systems that have the potential to be creative. In this paper we make an overview of the evolutionary art tool NEvAr – a system that allows the evolution of populations of images.

1. Introduction

NEvAr (Neuro Evolutionary Art) is an ongoing research project being developed at the Creative Systems Group of the UC-AI Lab (Artificial Intelligence Laboratory - University of Coimbra). This Group focuses its activity on areas such as Music and Image Generation, Design, Creativity and Artificial Intelligence. The ultimate goal of the project is to build an Artificial Artist, a computer application able to generate artworks autonomously. In its current state of development, NEvAr is an Evolutionary Art tool, inspired in the works of K. Sims [1] and R. Dawkins [2]. It allows the evolution of populations of images according to the aesthetic preferences of the user. NEvAr follows an evolutionary paradigm; in other words, it tries to mimic the mechanisms underlying natural selection, namely: survival of the fittest, recombination of their genetic material, and slight random modification (mutation).

2. System Overview

In this section we make a brief overview of NEvAr. A more detailed analysis can be found in [3]. In its simpler mode of operation, NEvAr follows the traditional evolutionary cycle:

1. The program generates a random population of images;
2. The user evaluates the images, assigning a fitness value to them;
3. The program breeds a new population of images trough the recombination and mutation of the genetic code of the images of the current population; images with higher fitness values have higher probabilities of being selected for breeding;
4. Return to point 2.

NEvAr implements a parallel evolutionary algorithm, in the sense that we can have several different and independent evolutionary runs taking place simultaneously. It is also asynchronous, meaning that we can have an experiment that is in population 0 and another one that is in population 100. Additionally, we can transfer individuals between experiments (migration). In figure 1 we present the implemented evolutionary model.

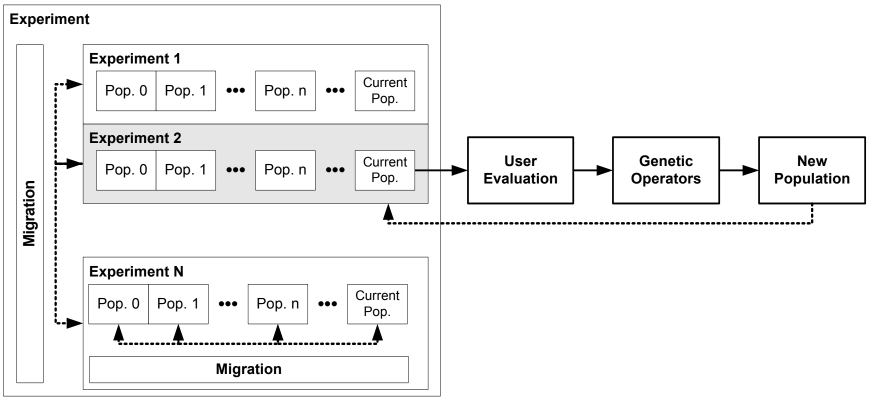

Figure 1. The evolutionary model of NEvAr. The active experiment is depicted in grey.

2.1 Representation

In NEvAr, the characteristics of the individuals (images) are determined by their genetic code. So we have a *phenotype* (the individual) and a *genotype* (the genetic code that, once expressed, results in the individual). The genotypes are trees constructed from a lexicon of functions and terminals. The function set is composed mainly of simple functions such as arithmetic, trigonometric and logic operations. The terminal set is composed of a set of variables x and y and random constants. The phenotype is generated by evaluating the genotype for each (x,y) pair belonging to the image. Thus, the images generated by NEvAr can be seen as graphical portrayals of mathematical expressions (see Figure 2).

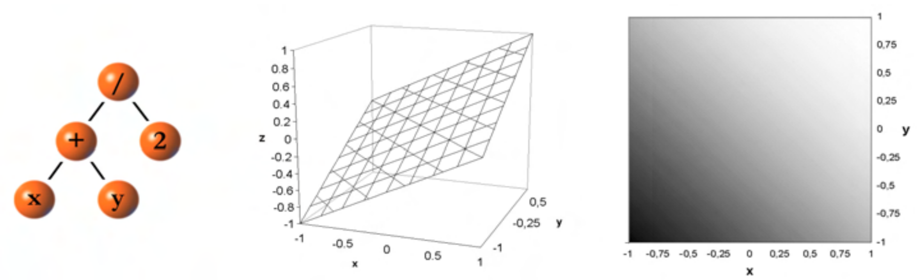

Figure 2. On the left, the expression $f(x)=(x+y)/2$ represented in tree format; in the middle, a 3d-graph of the mathematical expression; on the right, an image generated by assigning a greyscale value to each $f(x)$ value.

2.2 Genetic Operators

The genetic operations (recombination and mutation) are performed at the genotype level. In Figure 3, we present an example of a recombination operation. In order to produce colour images we resort to a special kind of terminal that returns a different random value depending on the colour channel – Red, Green or Blue – being processed.

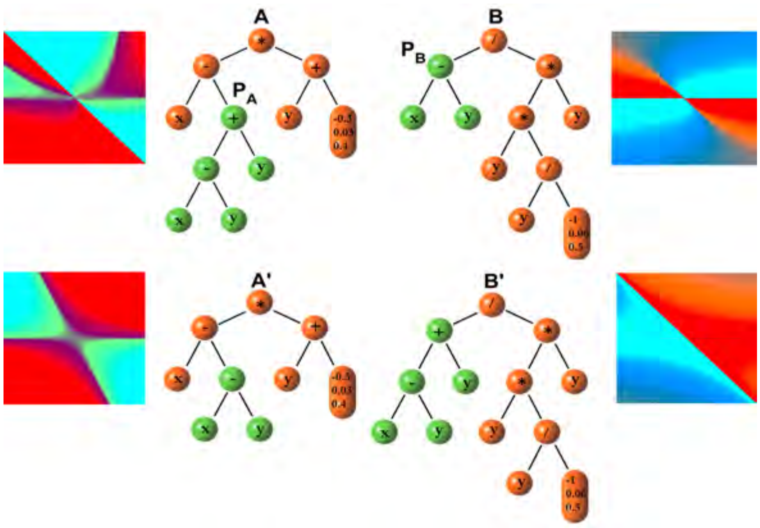

Figure 3. Example of the recombination operation. The code of the individuals A and B is recombined by exchanging the sub-trees implicitly defined by 2 randomly chosen points P_A and P_B, giving rise to the individuals A' and B'.

2.3 Assessment

Working with NEvAr is an iterative process, as the number of populations increases the average quality of the images also tends to increase, giving rise to new, interesting, and aesthetically sound images (at least to the eye of the user conducting the program). Like any other tool, NEvAr requires a learning period. To explore all the potential of a tool, the user must know it in detail and develop or learn an appropriate work methodology. The results, and user satisfaction, depend not only on the tool but also on its mastering. In Figure 3 we present some examples of images generated with NEvAr. Additional images can be found at: http://www.dei.uc.pt/~machado/NEvAr/

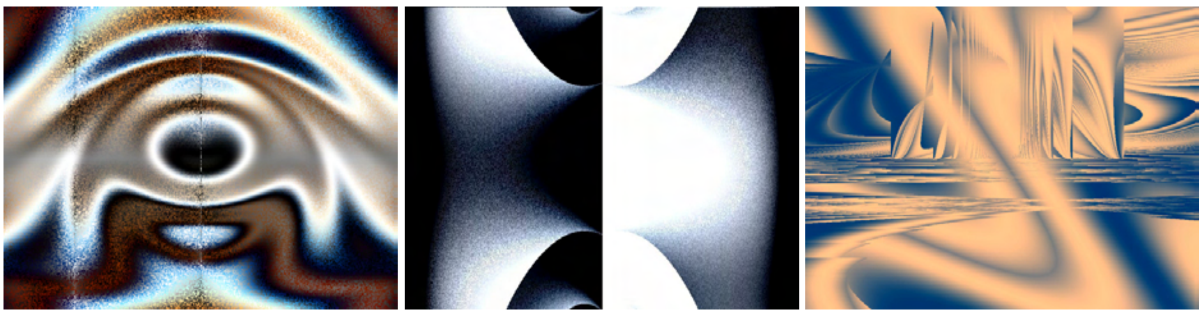

Figure 3. Some examples of images created with NEvAr.

3. Recent Developments

As stated before, the ultimate goal of this project is to build an Artificial Artist. In its current form the automatic fitness assignment procedure [3] only takes into account the lightness information of the images, discarding the hue and saturation information. Therefore, in this mode of execution, we are limited to greyscale images. Figure 4 shows several images generated by NEvAr without any kind of human intervention.

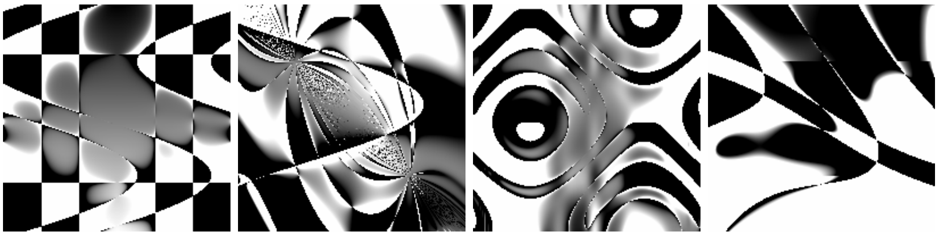

Figure 4. Examples of images evolved by NEvAr without human intervention.

To overcome this limitation we are developing a system that learns to colour greyscale images [4]. We employ Genetic Programming to evolve programs that mimic the colourings of a training set of images. Once such program is found, we can use it to colour the greyscale images generated by NEvAr. One of the advantages of this approach is the ability to use, as training images, artworks of well-known artists, which, assuming that the approach is successful, will enable NEvAr to mimic the colourings of these authors. In [5] we propose a general framework for the development of Artificial Art Critics (AACs), and tested it in the musical domain. Following this framework we are developing an AAC in the domain of visual arts, which will replace the current fitness assignment procedure.

4. Conclusions

We consider NEvAr to be a tool with great potential from an artistic perspective. Through the use of NEvAr, the artist is no longer responsible for the generation of the idea, which results from an evolutionary process and from the interaction of artist and tool. Thus, the use of this tool implies changes to the artistic and creative process. In spite of these changes, the artworks follow the aesthetic and artistic principles of the artist. The use of NEvAr implies losing of control; however, this lack of control isn't necessarily negative. The artist can express her/himself through the use of the tool and review her/himself in the works created.

References

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