SBART 2.4: an IEC Tool
for Creating 2D Images, Movies, and Collage

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Abstract

This paper describes an overview of the inside of SBART 2.4, an interactive tool to create an abstract 2D images, collage, and movies. It is one of the successors of Karl Sims' system running on a small size computer, which uses a function to calculate the color value for each pixel as a genotype. All of the ranges and domains are three dimensional vectors. It has *multi-field user interface* to enhance the diversity of production. It also has optional facilities to create collage of external images, and to make a short movie.

1 INTRODUCTION

SBART is one of the successors of Karl Sims' system (Sims 91) that enables the user to create an abstract drawing only by selecting his/her favorite images displayed on the computer screen. Similarly to the other *Interactive Evolutionary Computing* (IEC) systems, the main mechanism of SBART is an iteration of visualization, selection by the user, and genetic operation. The window, named *field window*, that appears on the screen at the start time, consists of twenty sub-windows to display all individual images of the current population, as shown in Figure 1. This latest version works on the MacOS 7.6 or upper.

The following sections describes the distinct feature of SBART 2.4, which includes genotype representation, multi-field user interface, facility to create collage, and facility to make a short movies.
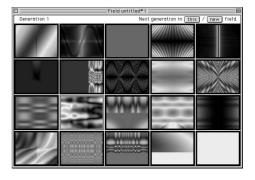
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Figure 1: An example of field window.

2 GENOTYPE

Each individual has a chromosome in a style of functional expression, just as of Genetic Programming (Koza 92), where the nonterminal symbols are a number of numerical functions and the terminal symbols are three dimensional vectors of constants and variables. A constant is a triplet of unique scholar values in $[-1, 1]$, $(0.2, 0.2, 0.2)$ for instance. A variable vector is a permutation of x, y, and 0, that is $(x, y, 0)$, $(x, 0, y)$, $(y, x, 0)$ and so on, six types in total. Each 0 in these variable vectors is replaced with the time variable t when creating a movie. In contrast from Sims' system, the domain and range of calculation are three dimensional vector. Some functions, such as addition, subtraction, and other ordinary numerical functions calculate three values independently. In the case of addition,

$$(x_1, x_2, x_3) + (y_1, y_2, y_3) = (x_1 + y_1, x_2 + y_2, x_3 + y_3), \quad (1)$$

for example. The other exceptional functions calculates its values by combination among given values. For example, the function named max takes two arguments, compares their first elements, and then returns either argument in which first element is larger than

the other one, that is,

$$\max(\boldsymbol{x}, \boldsymbol{y}) = \begin{cases} \boldsymbol{x} & \text{if } x_1 > y_1 \\ \boldsymbol{y} & \text{otherwise.} \end{cases} \quad (2)$$

The final result value of calculation is mapped onto a point in the HSB (hue, saturation, and brightness) color space, substituting the coordinate of the pixel to the variable x and y. If the result value of any element is beyond the border of the range $[-1, 1]$, it is forced to be in this range by a saw-shaped function as follows.

$$f(x) = \begin{cases} x - 2k(x) & \text{if } k(x) \bmod 2 = 0 \\ -x + 2k(x) & \text{otherwise} \end{cases} \quad (3)$$

where $k(x) = \lfloor (x+1)/2 \rfloor$.

It is finally mapped onto the RGB color space to paint each pixel on the computer display. The drawing area is always assumed to be a rectangle. The coordinate values are scaled so that the length of the shorter edge is 2. The origin of the coordinate axis is placed at the center of the rectangle.

3 SELECTION

The selection is in a style of *Simulated Breeding* but not *Interactive Genetic Algorithm*, that is, the user directly selects an arbitrary number of individuals from the population as parents by pointing his/her favorite drawing. This was designed based on an analogy with what the breeders have done on agricultural products and pet animals. He/She does not need to assign the fitness points for each individual. After selecting the parents, it produces their children through a genetic operation specified by the user. By default, the population is replaced by the mutants, if the number of selected parent is only one. If the user selects more than one parents, children's genotypes are produced by crossover operation between parents genotype.

4 MULTI-FIELD USER INTERFACE

It is also possible to generate a new field window which children fill in, instead replacing parents with them. We call this style *Multi-field user interface* (Unemi 98), which provides more flexible breeding and brings richer diversity of genotypes by the similar effects of the island-model in GA.

It is often necessary to cope with *premature convergence* in any types of evolutionary computing, because of the complicated multi-modal landscape in a structural optimization problem. It is one of solutions to introduce migration among islands, where populations
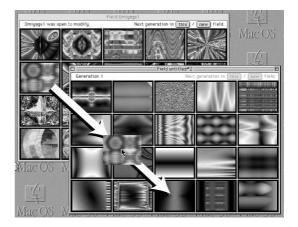

Figure 2: Drag and drop an individual for migration.

have evolved independently each other. The user can let an individual migrate between field windows by *drag and drop* operation, as show in Figure 2.

5 MAKING COLLAGE

We introduced an unary function named *image* to embed any external image data. This function picks up HSB color value of the (x, y) position indexed by the argument vector (x, y, z) from the image data. The calculation includes smoothing process of pixel values because the original image might be enlarged in arbitrary magnitude. It returns *gray* if no image data is registered. From the version 2.4, the user is allowed to register up to four external images, and the function is extended to blend those images by the ratio based on the third element z in the argument.

Figure 3 illustrates the correspondence between the value of z and the ratio of blending when the user sets up from one to four external images. Gray-blending, that takes the weighted average between pixels in the selected source images according to blend ratio, is only one method implemented in the current version of SBART.

6 MAKING MOVIES

The user can make a short movie that is similar to a clip in Sims' film named *Primordial Dance* in 1991. The system produces a series of images by changing the time parameter t in the variable vector, such as (x, y, t), continuously. Figure 4 shows the GUI, which allows the user to designate the range of t, movie's time duration in second, compression method of movie and sound, the number of frames per second, width and height of the frame, and so on. It optionally attaches
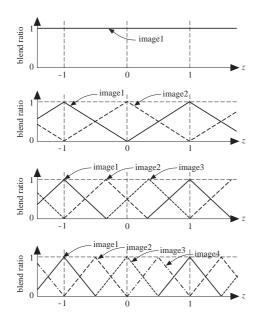
Figure 3: Blend ratio for z in the cases of one, two, three and four images from top to bottom respectively.
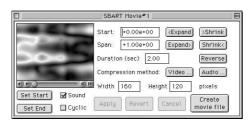

Figure 4: GUI to create a movie.

the sound track produced automatically from the average values of HSB vector for each frame.

7 GENOME EDITOR

The user is allowed to edit genome, a function, of any individual on the field. Figure 5 shows an example of the windows of genome editor. As shown in the right window of the Figure 5, the user selects a node from tree structure of genome to cut, copy, paste, and swap with the subtree in the cut buffer, and to replace it with another symbol.

8 EXTENSION IN FUTURE

One of the features lacked in SBART is a mechanism for stochastic selection that the other IGA-based systems have. The reason why we had not implemented it is only on the designer's polisy as described above. The author, namely the designer, believe that it is already
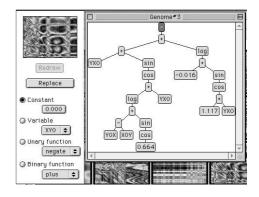

Figure 5: Genome editor.

powerful enough without introducing the IGA's feature, but it would show us another side of this method if we could add the optional facility to index the individual fitness value by the user.

Taro Kamei, a club VJ[1] in Tokyo, suggested the author that it would be smart if we could import an external movie as just like as an external image into SBART. It could be realized when faster CPU would be available for three dimensional rendering.

The information on the latest version of SBART is available on the following URL:

http://www.intlab.soka.ac.jp/~unemi/sbart/

We hope many people enjoy SBART.

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[1] Abbreviation for Video or Visual Jockey. A club VJ performs an improvisatorial arragement of visual clips displayed on a large screen in a dance club, as just like a club DJ playing with audio disks.