

# SBART 2.4 : Breeding 2D CG Images and Movies and Creating a type of Collage

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## Abstract

This paper proposes a method to embed a function to create a type of collage into an application of *Interactive Evolutionary Computing* for artistic CG design named SBART. It is an application of *Simulated Breeding* method, that is an extended popular version of Karl Sims' System. The latest version 2.4 includes a facility to create a type of collage from external image data and files. By combining with other functions previously implemented, such as multi-field user interface, direct editing of genotypes and so on, the variety of production is largely extended.

## 1. Introduction

Interactive Evolutionary Computing (IEC) method has been applied to some esthetic area of both graphics and music for more than ten years [Takagi 98]. SBART that works on PC Unix and Power Macintosh is a more popular and extended version of Karl Sims' System [Sims 91] that works originally on an integrated computer system including one large scale parallel machine CM-2 and sixteen SGI Indigo graphics workstations. The extended part of SBART includes an alternative style of function-value space, a multi-field user interface [Unemi 98], a facility for direct editing of genotypes, and some other functions to provide easier operation to export the bred images and movies to another application software. Additionally to these functions, we develop a method to import several external image data and files to create a type of *collage* among them for the latest version 2.4. The previous version also can import an external image, but only one image. The new function enables to import more than one images to extend the variety of production.

The following parts of this paper describes an overview of SBART, presents the detail mechanism of collage creation, and shows some sample productions.

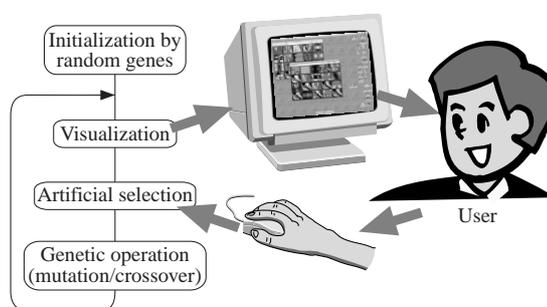


Figure 1: Schematic diagram of SBART.

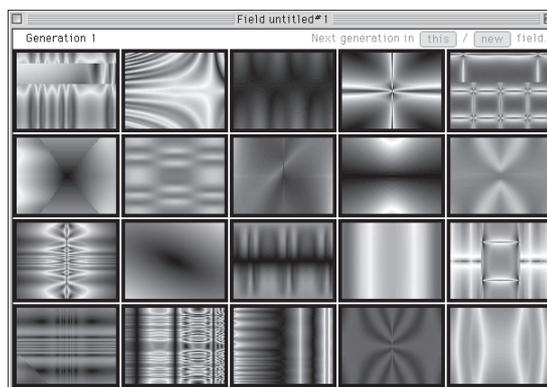


Figure 2: An example of the field window of SBART.

## 2. An Overview of SBART

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 IEC systems, the main mechanism of SBART is an iteration of visualization, selection by the user, and genetic operation as shown in Figure 1. Figure 2 shows a window, named *field window* in SBART, that always appears on the screen just after

Table. 1: Functions for nonterminal symbols for genome of SBART.

unary		binary		
-	log	+	pow	and
abs	exp	-	hypot	midst
sin	sqrt	*	max	mix
cos	sign	/	min	

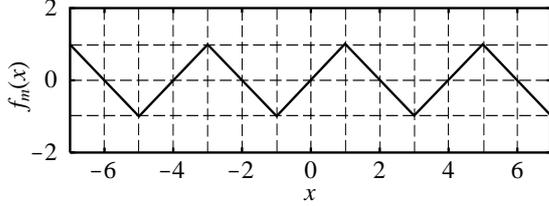


Figure 3: Saw-shaped function to adjust the range of the result values.

invoking SBART. It consists of twenty sub-windows to display all individual images of the current population. 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 and clicking the mouse button. 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' genotypes. 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.

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 shown in Table 1 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, all of 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,

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

for example. The other exceptional functions calculates its values by combination among given values. For example, the function named *max* takes two ar-

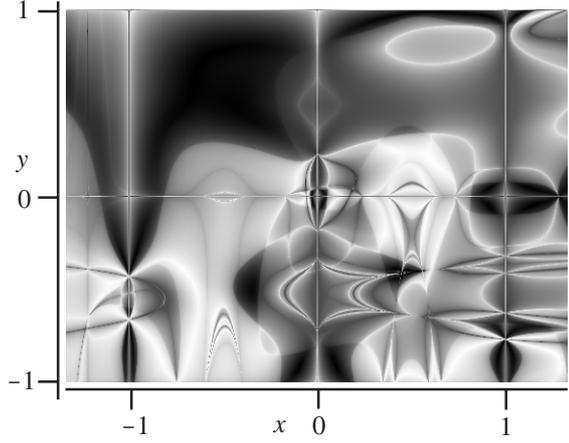


Figure 4: An example of phenotype and its coordinates. The genome expression is:

$$\sqrt{\log(\log(\log((Y0X+\cos(\cos(YX0))))*(0YX+1.219+YX0)*\exp(-1.250+XY0)-0.781)*\log(XY0*(1.219+YX0))*0.781-0.781)*(1.242/(\sin(XY0)*(1.219+YX0)))*\exp(0.781)))-0.969.}$$



original image



Figure 5: Mirrored seamless tiling pattern.

guments, compares their first elements, and then returns either argument in which first element is larger than the other one, that is,

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

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.

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

$$\text{where } k_x = \lfloor (x+1)/2 \rfloor.$$

Figure 3 illustrates the shape of this function. 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. As shown in Figure 4, 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.



(a)  $\text{image}(\sin(\text{YX0}) - \text{abs}(\text{XY0} * \text{XY0}))$



(b)  $\frac{\sin(\text{X0Y})}{(\cos(\text{0YX}) + -0.633) - (\text{abs}(\text{YX0}) - \text{image}(\text{XY0}))}$

Figure 6: Typical images produced from genomes that includes the *image* function.

In addition to the above core facilities for breeding, SBART has some other functions, such as zooming image, making a short movie, and editing genome directly. Refer to SBART itself or its Web Page to know detail of these functions. URL of the Web Page can be found in the final section of this paper.

### 3. Importing External Images

Graphical patterns generated by mathematical formula often surprise the observers as shown in the previous section. An alternative technique to construct an abstract esthetic image is to make collage, created by a sophisticated arrangement of fragments of various materials such as little pieces of printed paper, fabric strings, broken saucers, mechanical parts, and so on. This method often gives strong impact to the observer's emotion because of the hierarchical structure of contradictory meanings. Using a nonlinear mathematical formula to deform a well known image, such as a human's face, can also provides the similar effects. Unnatural reshaping prevents the original interpretation, but after observing in detail, he/she can notice a familiar figure behind it suddenly. As shown in a final part of Sims' film named *Primordial Dance* in 1991, this method is also effective to create an artistic animation. He applied similar type of method more effectively in *Liquid Selves* in 1992.

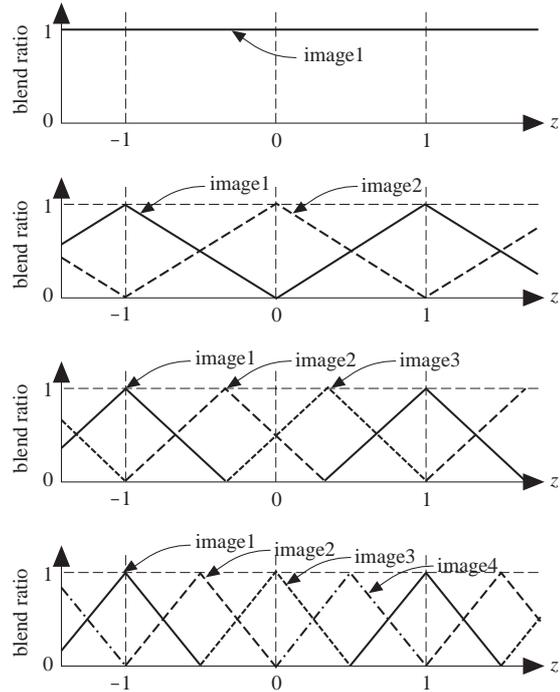


Figure 7: Blend ratio against  $z$  in the case of one, two, three and four images from top to bottom respectively.

We introduced an additional function named *image* to import an external image data for the previous version of SBART. It takes a three dimensional vector as the only one argument, interprets the first element of the vector as the  $x$  coordinate and the second element as the  $y$  coordinate, and then outputs the HSB color vector from the corresponding pixel in the image data. The third element is ignored. Similarly to the drawing area, an external image is also assumed to be a rectangle. The coordinate system is scaled so that the length of the shorter edge is 2, keeping the ratio between vertical and horizontal axis. For the coordinate values outside of the image data, the *image* function translates the position into the inside of the image data so as to form a mirrored seamless tiling pattern as shown in Figure 5. The procedure of *image* includes a smoothing procedure because the imported image is usually formed by pixel map data and it may be enlarged in arbitrary magnitude through a genome expression evolved.

Figure 6 shows two typical images produced by genomes including *image* function.

### 4. Making Collage

Introducing any mechanism to import plural images enables SBART to support making a type of collage of existing image data. Some types of alternative methods are possible to realize this function such as:

1. Preparing a number of distinct image functions,  $\text{image}_1$ ,  $\text{image}_2$ , and so on, each of which corresponds to each image, and
2. Using the third element of a vector given to the *image* function to select an image from the reg-

istered set of external images.

We employed a modified version of the second method so as to enable to embed a blended image into the result image, by using the third element  $z$  to index how to blend them. Figure 7 illustrates 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. It is of course possible to employ another type, such as taking the minimum or maximum value of each channel (HSB, CMYK, RGB and so on), bell-shaped or step-shaped function for blend ratio, morphing between source images, and so on.

Typical results using three source images are shown in Figure 8.

The current implementation of SBART has a simple graphical user interface (GUI) to help the user to choose external images from both file and clipboard, a temporary memory to store any data for *copy and paste*. It makes easy to import an image data from another application through it. This GUI also provides intuitively understandable operations to exchange the order of images (Image1, image2, image3, ...), remove the entry, and display imported image on the screen.

## 5. Conclusion

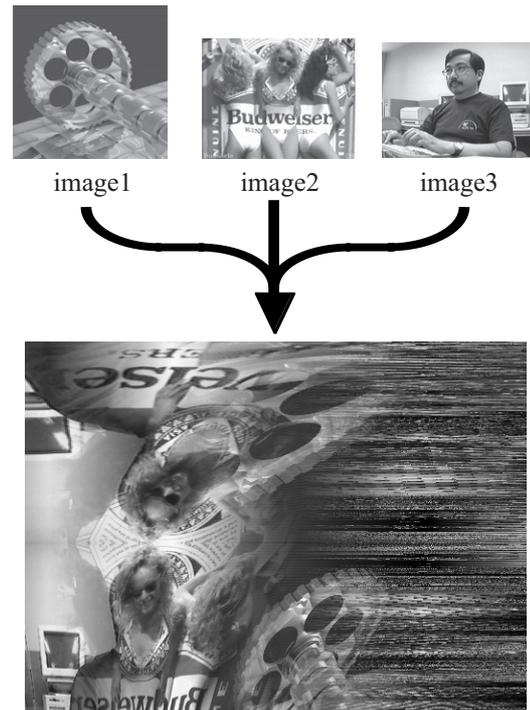
A new method to create collage using Simulated Breeding is proposed. As mentioned in section 4, there remain some alternative ways to implement facilities for collage, concerning both gene elements and blending method. Alternative style of gene set, that is a set of  $image_1$ ,  $image_2$ , and so on, affects the evolutionary process because it changes the number of candidates of mutant. Alternative blending method provides a different look of the result images. We cannot say if they are useful or not before trying, but it must be worth trying them in near future.

Another challenge would be collage not from static images but movies. It might be able to create interesting images and movies by mapping from source  $(x, y, t)$  space to result  $(x, y)$  space for an image and  $(x, y, t)$  space for a movie. We need another method than what we proposed here to combine plural movies, because the three dimensional coordinate is required to specify a sample pixel from a source movie.

SBART 2.4 works on Power Macintosh with System 7.5, MacOS 8, and their upper versions so far. The reader can get it by following links from SBART Web Page:

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

We hope that a lot of people try and enjoy it, and find new orientations of both IEC technology and art.



```
image(sin(0.219)-
(XY0+1.000)*(Y0X+1.516))
```



```
exp(cos(sqrt(image(XY0)+sin(cos(sqrt(sqrt(hypot
(XY0,sin(abs(sin(XY0))))))+sin(XY0*XY0))))))
```

Figure 8: Examples of collage.

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