CAN A COMPUTER PRODUCE AND CRITIQUE ART?

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It is well known that certain mathematical equations have graphical solutions of incredible beauty and diversity. The diversity comes from the choice of parameters in the equations. These parameters are like settings on a combination lock, each opening a door to a different image. However, it is difficult to predict what each image will look like without actually producing it, and most of the images are not interesting. Without additional guidance, a computer is almost as unlikely to produce good art as a monkey with a typewriter is to produce good literature.

For a decade I have been developing programs to increase the likelihood that computer-generated images will have aesthetic appeal. For example, the solutions to certain nonlinear equations behave chaotically, exhibiting sensitive dependence on initial conditions. Their solutions are fractals—geometric objects of infinite detail and self-similarity. These chaotic systems consist of strange attractors, as shown in Color Plate B No. 2.

The computer can test for chaos and quantify it in terms of the Lyapunov exponent. It can also calculate the fractal dimension, which in general is not an integer. Experiments designed to test human preferences show a strong correlation between these measures and the judged aesthetic quality of the image. In particular, humans prefer some chaos, but not too much, with the greatest preference for objects whose fractal dimension is about 1.2 or slightly higher, which is close to that of natural objects such as rivers, plants and clouds. Thus the computer can select that small minority of images that are likely to have human appeal.

I have also programmed an artificial neural network to evaluate the images. This network takes as input the weighted ASCII value corresponding to each pixel of an image and feeds it as input to a collection of artificial neurons, each of which sums the values and then takes the hyperbolic tangent of the result. A weighted sum of the outputs of the neurons gives a measure of its aesthetic quality. I adjust the weights of each connection by training the network on a collection of images that I have selected and evaluated. It thus learns from me and adopts my aesthetic preferences. I have also used networks that take their input from a reduced data set such as that of bytes in the compressed computer graphic file or the coefficients of the equations.

For several years, I have used these techniques to produce a "Fractal of the Day" in my Fractal Gallery at <http://sprott.physics.wisc.edu/fractals.htm>. Originally, these images were produced without human intervention. Now I generate several hundred candidates in an overnight computer run and then let an artificial neural network prescreen them. Most of the several dozen that remain are interesting, but I also screen them to be sure before I post them.

Some artists will insist that a computer cannot produce art, and others will object to the idea that a computer can critique art, but many gallery visitors have enjoyed the images produced by these means, often without realizing the source.

Julien Clinton Sprott is a professor of physics who developed an interest in computer art as a result of his research with chaotic dynamical systems. He regularly presents a popular public lecture and demonstration program called "The Wonders of Physics."