# FractaSketch: a tool for exploring fractal geometry

by Peter Van Roy

FractaSketch is a Macintosh program that allows students, mathematicians, graphic artists, and curious people to rapidly design and draw shapes of great intricacy. The figures range from symmetric and regular structures to patterns that seem completely random. The figures are actually *fractals*, shapes described by a dimension that need not be a whole number. This sets them apart from shapes in traditional Euclidean geometry such as points, lines, and planes, which have dimensions of 0, 1, and 2 respectively. A fractal with a dimension between 1 and 2 is intermediate between a line and a plane. It is *more* than a line (it has infinite length) and *less* than a plane (it has zero area). When its dimension gets closer to 2 the shape tends to fill the plane more and more.

All fractals created by FractaSketch are made of many small replicas of themselves, i.e. they are *self-similar* in mathematicians' jargon. An example of this is the Koch snowflake, which has a dimension of 1.26:
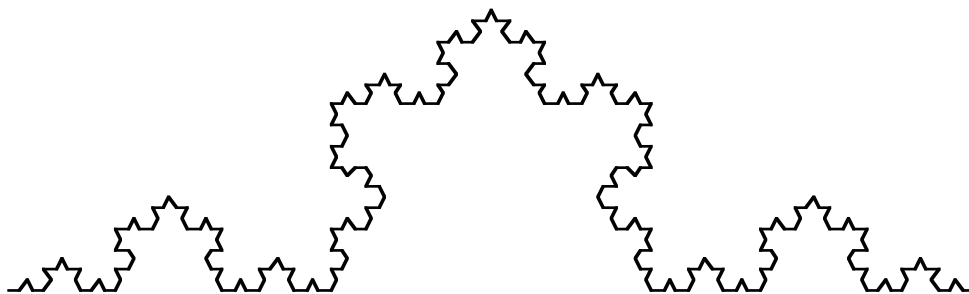
It is made of four smaller copies of itself:

copy 2   copy 3

copy 1   copy 4
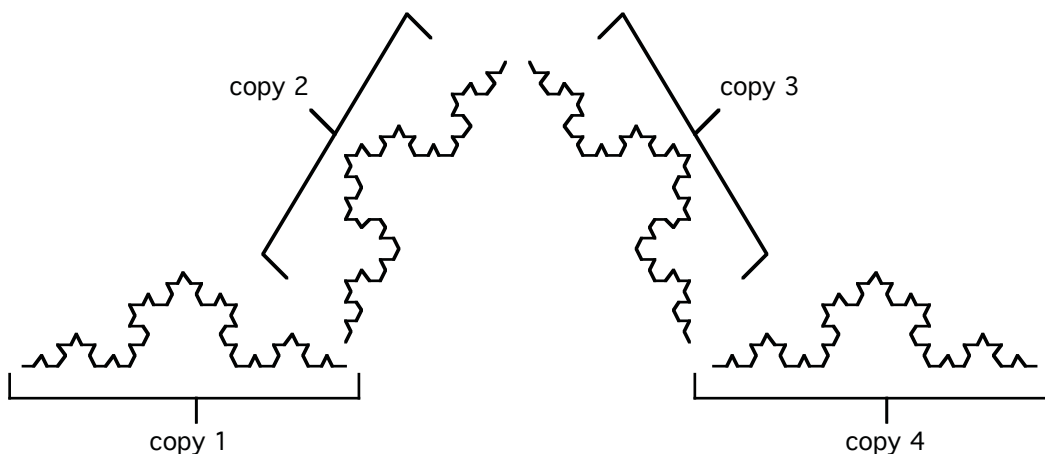
The program calculates the dimension of a fractal exactly. A fractal can be saved to a file in a compact form, or printed in high resolution. Since fractals are complex figures, care has been taken to ensure that no detail is lost when transferring a picture through the clipboard or when printing. The drawing algorithms have been optimized for the greatest drawing speed.

The mathematics underlying fractal geometry was developed near the turn of the century, and has remained relatively unknown until recently. The recent blossoming of the field is fueled partly by the ability to make pictures of these complex shapes, and partly by the realization that the world around us is filled with irregular shapes that are actually fractals. The first views of these shapes were provided by Benoît Mandelbrot in his book "Fractals: Form, Chance and Dimension". Since then many isolated views have been made, mostly by

solitary explorers armed with massive computing power. FractaSketch was developed to allow everyone to be an explorer. It runs well on a Macintosh with 512K of memory.

   Creating a fractal in FractaSketch consists of two parts: First you create a template, which is a shape that is the heart of the fractal. Then you choose the drawing commands that draw this shape in the desired manner. All of this is done graphically and quickly. A template consists of a series of line segments that is entered with the mouse. A complex shape can be the result of a simple template. For example, the template below:
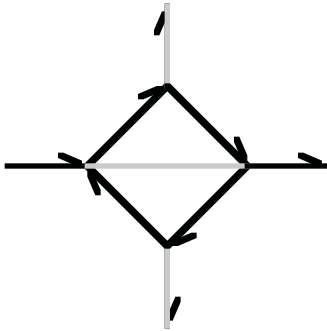
is the basis of the following intricate drawing (of dimension 1.75):
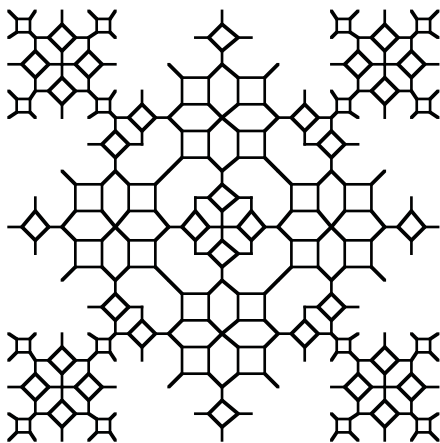
   Many objects in the world around us are fractals, for example clouds, pine trees, and ferns. Man-made objects can be fractals as well—a good example is the Eiffel tower with its trusses within trusses and beams within beams. Fractals are common in nature because of change and growth. Growth in living things means that new structure is always being added to the organism, e.g. growth rings in a tree trunk. The repeated branching of many plants allows them to obtain the greatest exposure to air and sunlight, and results in a self-similar structure. This structure is mimicked in the following Christmas tree fractal (of dimension 1.80):

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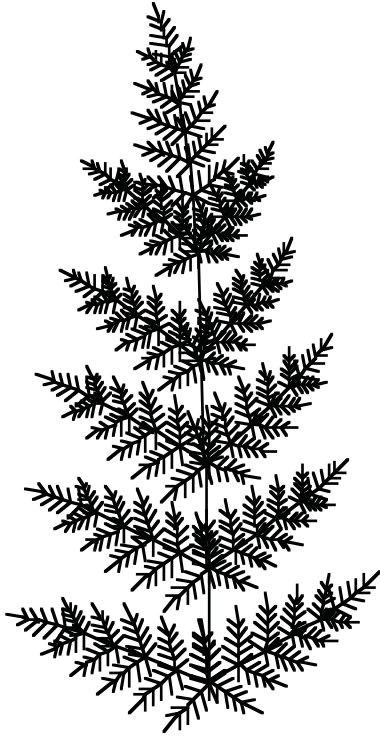
FractaSketch was developed by Peter Van Roy. It is published by Dynamic Software, P. O. Box 7534, Santa Cruz, CA 95061, a group of mathematicians and developers closely associated with the chaos and dynamics research group at the University of California at Santa Cruz. They also publish a two-disk set called Chaos and Dynamics, educational software exploring the varied worlds of chaos and strange attractors.