## FRACTAL

PURPOSE
Generate a fractal sequence from a set of points.

## DESCRIPTION

Given as set of points in the variables X 1 and Y 1 , this command generates the following sequence:

```
X2(1) = X1(1)
X2(2) = X1(1) + (1/3)DELX
X2(3) = X1(1) + (1/2)DEXLX - (SQRT(3)/6)DELY
X2(4) = X1(1) + (2/3)DELX
X2(5) = X1(2)
Y2(1) = Y1(1)
Y2(2) = Y1(1) + (1/3)DELY
Y2(3)=Y1(1) + (1/2)DELY - (SQRT(3)/6)DELX
Y2(4) = Y1(1) + (2/3)DELY
Y2(5) = Y1(2)
```

where DELX is the difference between 2 successive points in the X 1 variable (i.e., $\operatorname{DELX}(\mathrm{I})=\mathrm{X} 1(\mathrm{I}+1)-\mathrm{X} 1(\mathrm{I})$ ) and DELY is the difference between 2 successive points in the Y1 variable (i.e., $\operatorname{DELY}(\mathrm{I})=\mathrm{Y} 1(\mathrm{I}+1)-\mathrm{Y} 1(\mathrm{I})$ ). This is the type of fractal that can be used to generate a Koch snowflake or a Koch curve.

## SYNTAX

LET <x2> <y2> = FRACTAL <x1> <y1> <SUBSET/EXCEPT/FOR qualification>
where $\langle x 1\rangle$ is a variable;
$\langle y 1\rangle$ is a variable (same length as $\langle x 1\rangle$ );
$<x 2>$ is a variable where the computed fractal sequence corresponding to $\langle x 1\rangle$ is saved ( 4 times as long as $\langle\mathrm{x} 1\rangle$ );
<y2> is a variable where the computed fractal sequence corresponding to <yl> is saved (4 times as long as <y1>); and where the <SUBSET/EXCEPT/FOR qualification> is optional.

## EXAMPLES

LET Y2 X2 = FRACTAL Y1 X1
DEFAULT
None

## SYNONYMS

None

## RELATED COMMANDS

FRACTAL PLOT $\quad=\quad$ Generate an iterated function system type fractal plot.
CANTOR NUMBERS $=\quad$ Generate a sequence of Cantor numbers.
LOGISTIC NUMBERS $=\quad$ Generate numbers from the logistic sequence.
JULIA $=\quad$ Compute a Julia set.
PHASE PLANE DIAGRAM $=\quad$ Generate a phase plane diagram.
PLOT = Plots data or functions.

## REFERENCE

"Infinity and the Mind," Rucker, (page 9).

## APPLICATIONS

Chaos
IMPLEMENTATION DATE
88/7

## PROGRAM 1

READ X1 Y1
01
0.50

11
01
END OF DATA
MULTIPLOT 23
MULTIPLOT CORNER COORDINATES 00100100
LIMITS 01
TIC OFFSET 0.40 .4
FRAME OFF
FRAME CORNER COORDINATES 559595
TITLE OFFSET 1
PRE-SORT OFF
TITLE ORIGINAL DATA
PLOT Y1 X1
LOOP FOR K = 216
LET $\mathrm{J}=\mathrm{K}-1$
LET Y2 X2 = FRACTAL Y1 X1
TITLE KOCH SNOWFLAKE ITERATION ${ }^{\wedge} \mathrm{K}$
PLOT Y2 X2
LET X1 = X2
LET Y1 = Y2
END OF LOOP
END OF MULTIPLOT
ORIGINALDATA

## PROGRAM 2

. Draw a Koch curve through several iterations
READ X1 Y1
00
10
END OF DATA
MULTIPLOT 23
MULTIPLOT CORNER COORDINATES 00100100
LIMITS 01
TIC OFFSET 0.40 .4
FRAME OFF
FRAME CORNER COORDINATES 559595
TITLE OFFSET 1
PRE-SORT OFF
TITLE ORIGINAL LINE
PLOT Y1 X1
LOOP FOR K = 216
LET $\mathbf{J}=\mathrm{K}-1$
LET Y2 X2 = FRACTAL Y1 X1
TITLE KOCH CURVE ITERATION ${ }^{\wedge} \mathrm{K}$
PLOT Y2 X2
LET X1 = X2
LET Y1 = Y2
END OF LOOP
END OF MULTIPLOT


