Designing with L-Systems, Part 2: A Side Trip to Graphics

The first article in this series [1] introduced L-Systems and showed one example of how they could be used in weave design. It also showed some graphics unrelated to weaving that were produced by L-Systems.

There are many ways that L-Systems can be used in weave design, but before going on to these, this article shows how the graphics shown in the first article were produced. There is a reason for this side trip. The ideas involved are powerful, and they can be applied to weave design, as we'll show in subsequent articles.

An Example

Consider this L-System:

seed: A

rules: A → BCDDAEFAEFBDFBAECA

B → BB

It's not at all obvious what motivates this particular L-System or why it might be interesting, although the complexity of the first rule suggests some intent. The lack for rules for C, D, E, and F seems curious, although they proliferate during rewriting since the default in such cases is to replace such characters by themselves.

Now consider this L-System, which is the same as the one above except that different characters are used.

seed: X

rules: X → F–[[X]+X]+F[+FX]–X

F → FF

The characters look a bit strange — this is the first L-System with characters other than letters. There is a reason for the characters chosen, however. They serve as mnemonic devices for the intended interpretation, which is as commands for a drawing program:

F move forward a specified length, drawing a line

f   move forward a specified length, without drawing a line (not included in the example above)

+ turn right a specified number of degrees

– turn left a specified number of degrees

[save the current position and direction

]   restore the previously saved position and direction

The character X in this L-System is a placeholder. It participates in an important way in the patterns produced, but it is ignored in interpretation.

Two parameters are needed to carry out the interpretation:

- The length for a move, which determines the scale of the drawing.

- The angle for turns, which is fundamental to the appearance of the result produced. For this L-System it is 22.5° — 1/4 of 90°.

The drawing is accomplished by producing several generations of the L-System and then interpreting the last one. For five generations, the image from interpretation is
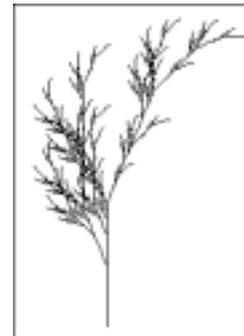
Each generation increases the size and detail of the "tree". The first six generations are shown on the next page.

The strings produced by this L-System become very long as rewriting continues:

generation	length
1	90
2	380
3	1,552
4	6,264
5	25,160
6	100,840
7	403,752
8	1,615,784

Nevertheless, it is not necessary to look at these strings. Only the drawing program uses them.

What these lengths *do* indicate is how many drawing actions are needed to produce the detail in the images.

Conclusions

The purpose of this article is to show one of the possibilities resulting from interpreting L-System string. But drawing images of trees, plants, and geometrical designs is only one possible interpretation.

Subsequent articles will explore interpretations that are useful in weave design.

Resources

Many L-System programs are available on the Web as freeware and shareware programs. Almost all of them are designed to produce images — to such an extent that a person who didn't know otherwise might assume that's all there is to L-Systems.

Lparser [2] is a particularly capable freeware L-System application. Here is an example of what is possible using it:

References

1. *Designing with L-Systems, Part 1: String Rewriting Systems*, Ralph E. Griswold:
   http://www.cs.arizona.edu/patterns/weaving/webdocs/gre_ls01.pdf

2. *Lparser*, Laurens Lapré:
   http://home.wanadoo.nl/laurens.lapre/lparser.htm

Ralph E. Griswold
Department of Computer Science
The University of Arizona
Tucson, Arizona

June 20, 2002; last revised December 6, 2004