

Simple L System Example

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L-Systems (the L comes from the last name of Aristid Lindenmayer, the Hungarian biologist who discovered them) can be used for drawing patterns, from simple to very complex. We will start out simple here.

JFLAP provides building blocks for the three parts of an L-System:

- the axiom, which specifies the starting command from which all replacements will begin
- the system rules, which resemble grammar rules
- geometric rules used for drawing, such as the following:
 - g, to move forward one unit with the drawing pen down
 - f, to move forward one unit with the drawing pen up
 - +, to turn right by the current angle
 - -, to turn left by the current angle

In addition, JFLAP allows initializations of parameters, including the length of one unit in pixels and the current angle in degrees.

For complex shapes, recursion will be involved, where eventually a nonterminal symbol is replaced by a symbol string containing itself.

Let's begin by drawing a shape. A square is most likely one of the first shapes that you ever drew. What is the most essential step in drawing a square? A corner. What is involved in making a corner? A straight line and a right turn. How many degrees is the turn? 90. We repeat this process 4 times to complete the square.

Try It!

1. If JFLAP is not already open, open JFLAP and click on the **L-System** button. Your window should look similar to the following.
 1. In the **Axiom** text box, enter **S**. What is the significance of S in context-free grammars?
 2. We will make one recursive rule. Enter **S** in the LHS text box.
 3. How will we make the rule recursive? By having S somewhere in the RHS of the rule. How do we move with the pen down and make the right turn? By using **g** and **+** in the RHS. Enter **g + S** in the RHS text box. You need to have spaces between the symbols.
 4. Now let's test our L-System. Select **Input > Render L-System** from the menu. Your window should look similar to the following:

1. Use the upper right slider to simulate the system for a few iterations. Does the picture look like a square? It does not. What should we do? We need to adjust the default turn angle. Select **File > Dismiss Tab** from the menu.
2. We will now work with the bottom half of the L-System designer window. Click on the small **p** next to the **Parameter** column. Your window will look similar to the following.

1. Select **angle** from the pop-up menu.
2. Enter **90** in the parameter column.
3. Test your updated L-System as you did in steps 5 and 6. How many steps were needed to complete your square? Does your picture change after that number of steps was performed?
4. Experiment with other parameters to change the size and color of your square.
5. Save your L-System with a descriptive file name via the **File** menu.

How can you draw other types of shapes (triangles, pentagons, etc.)? What should the angle be for an n-sided polygon? Experiment with this in JFLAP. What happens to the shape as the angle gets smaller and smaller?

Now let's make more than one square.

Try It!

1. If JFLAP is not already open, open it and click the **L-System** button.
2. Enter **S** in the **Axiom** text box.
3. Enter the rule **S \rightarrow g + g + g + S**. Why this way? So we can complete the entire square in one rendering step.
4. Make sure your **angle** parameter is 90 degrees, as before.
5. Test your L-System.
6. We still only have one square. We have to move one unit after the square is drawn. Enter one **g** before the **S** on the RHS.
7. Test your L-System again. Save your L-System with a descriptive file name.
8. Notice that the squares touch each other. What can you do to ensure that the squares don't touch? Update the RHS of your rule, and test your updated L-System. Save your L-System with a descriptive file name. If you have lines between your squares, how can you fix that? Remember the possible geometric rules!

Let's climb some steps now. How do you draw a step? Move one unit, turn right, move one unit, and turn left.

Try It!

1. If JFLAP is not already open, open it and click the **L-System** button.
2. Enter **S** in the **Axiom** text box.
3. Enter the appropriate rule to generate a step. Remember the possible geometric

- rules!
4. Test your L-System, and fix if needed. Save your L-System with a descriptive file name.

The steps that you have generated go up. What do you need to do to make them go down?

If you want to allow steps that go up or down, you can have multiple rules with different symbols on the LHS. To choose which way to go, you can change what goes in the **Axiom** text box.

Completed examples are available in the following files: **SimpleSquare.LSystem.jflap**, **SimpleSquareDoubleSize.LSystem.jflap**, **MultipleSquares.LSystem.jflap**, **MultipleSquares.NoTouch.LSystem.jflap**, **StairSteps.LSystem.jflap**, and **UpOrDown.LSystem.jflap**.