

Task 6 - L-systems

The L-system (Lindenmayer system) is a system defined by its axiom formula, rewritten by each rule that can be rotated at a specific angle. Brackets can be used for creating a checkpoint to which the position will be returned after the closing bracket is met.

Example

Lets have an example of the axiom $F+F$ which is defined by rule $F \rightarrow F+F-F$ with angle 90° . For each term F we will substitute the rule for F , so for the axiom $F+F$ we will get a result $F+F-F+F-F-F$. To draw the fractal we need to set a length of line for the term F , which can be like in units / cm / px etc. Also an initial angle can be set.

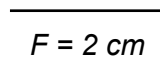
Visualization is done by following conditions:

- F means go forward (on a constant length).
- b means go forward without leaving a trail.
- $+$ means turn right on a given rotation angle.
- $-$ means turn left on a given rotation angle.
- $[$ means to create a checkpoint of current position and angle.
- $]$ means return to a previous created checkpoint.

$F = 2 \text{ cm}$

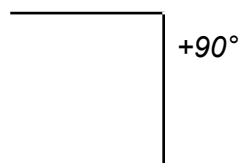
Initial angle = 0°

F :



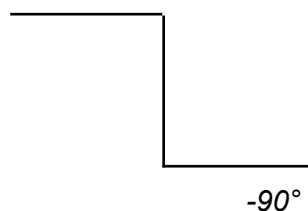
$F+F$:

angle = 90°

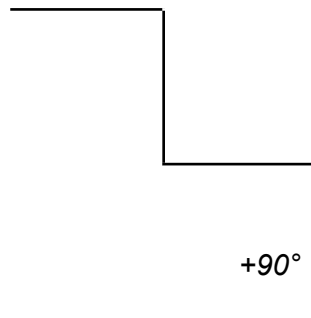


$F+F-F$:

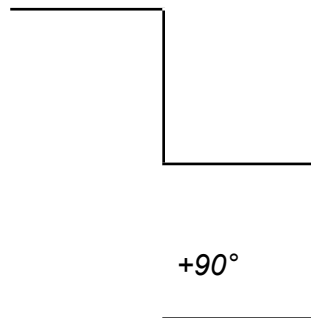
angle = 0°



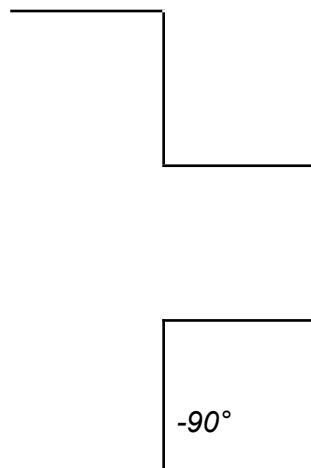
$F+F-F+F$:
angle = 90°



$F+F-F+F+F$:
angle = 180°



$F+F-F+F+F-F$:
angle = 90°



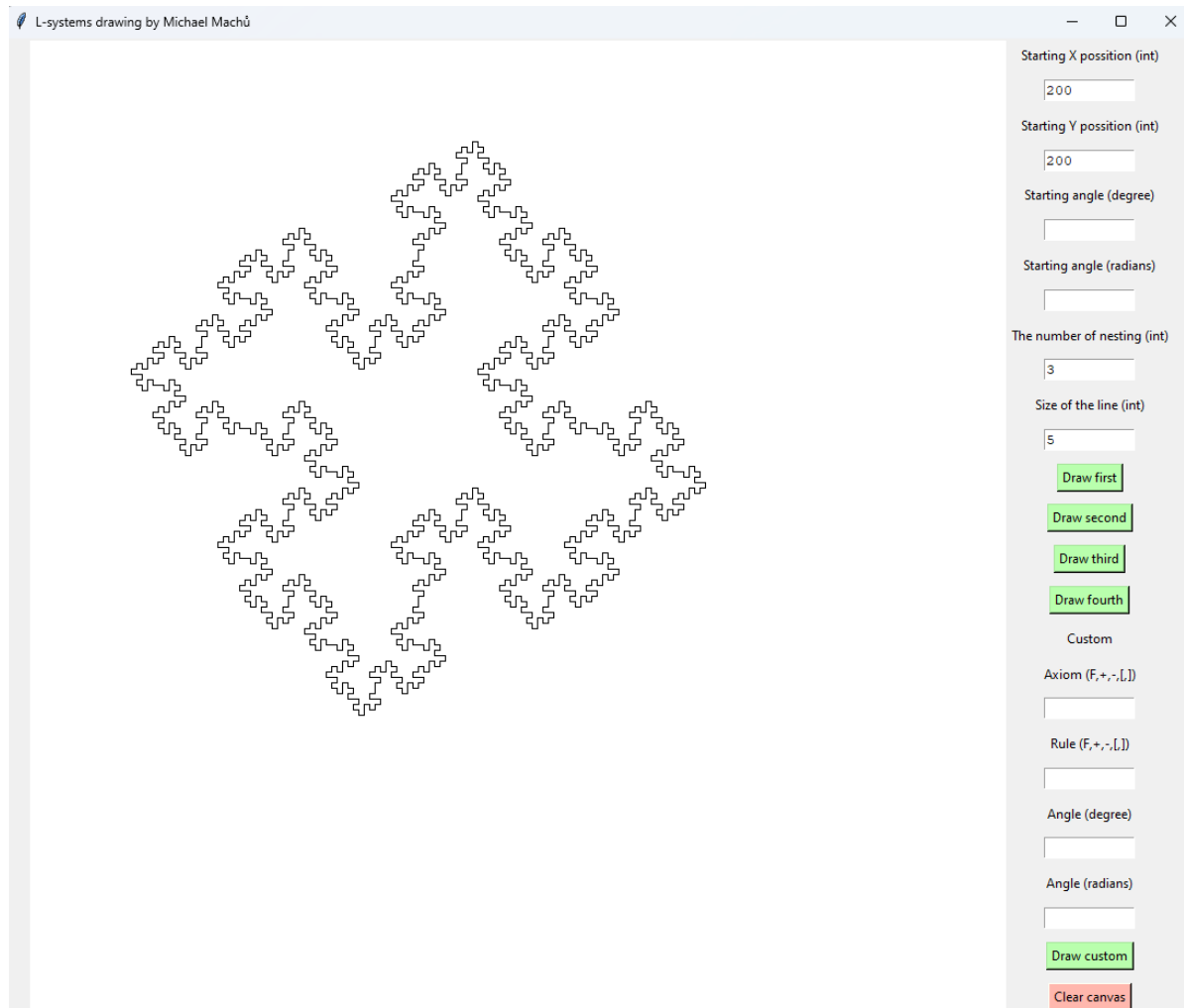
Nesting

If we would like to make a more complex fractal we can do nesting. It is done by applying the rule on the previous result. This means that if I have the axiom from the previous example $F+F$ and the rule $F \rightarrow F+F-F$ I will get a result $F+F-F+F-F$ for the first nesting. If I would like to do a second nesting I would have to apply the rule $F \rightarrow F+F-F$ on the previous result $F+F-F+F-F$ in which I would get a new result $F+F-F+F+F-F-F+F-F+F-F-F+F-F$. As you can see, if you choose a large number for nesting, the result will increase dramatically.

Instructions

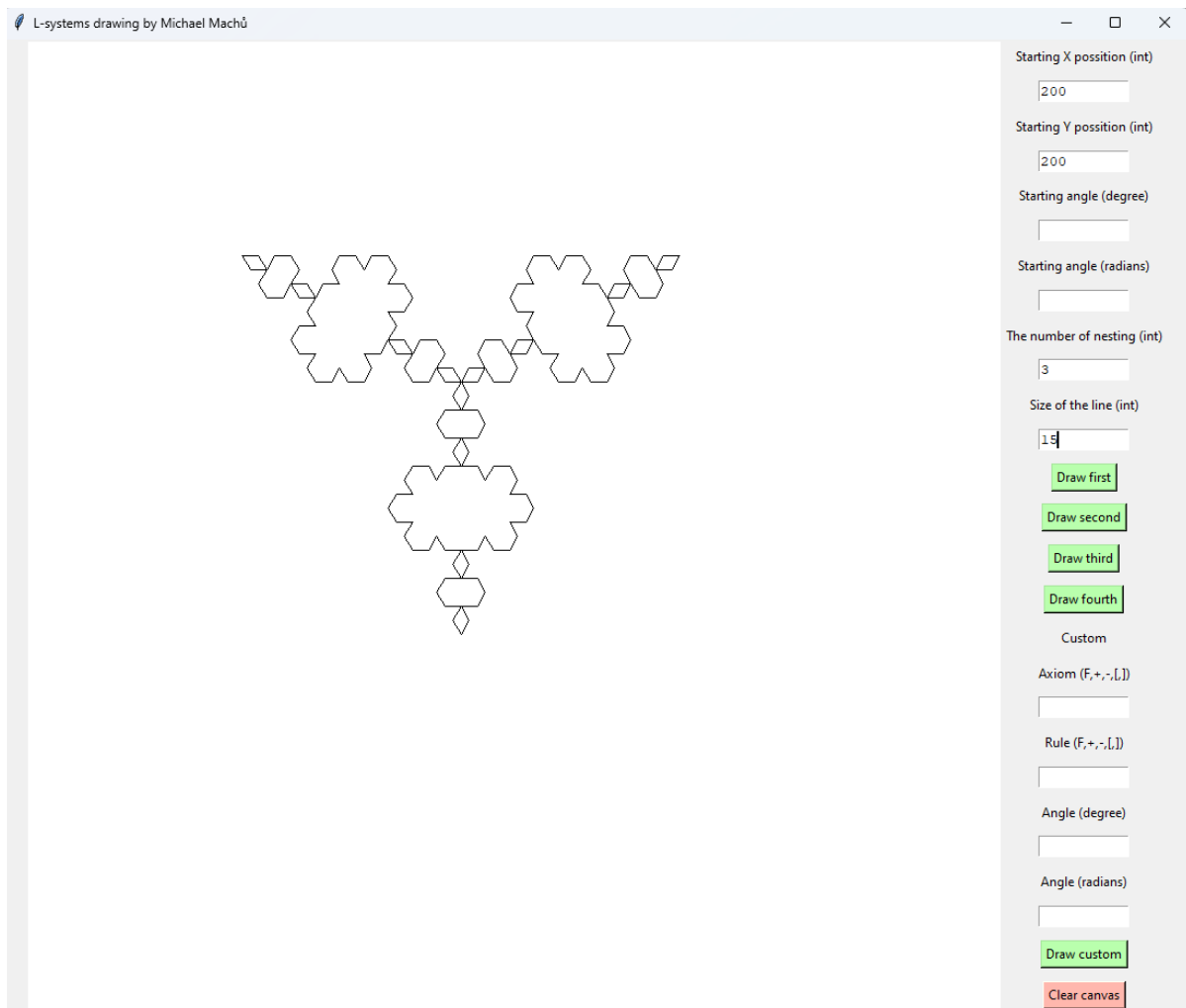
Implement the following four L-systems, each defined by its **axiom**, **rule** and **angle**. But if you do not like the shapes of the L-systems mentioned below, you can choose and implement 4 different shapes from [this](#) web page

1. **Axiom:** $F+F+F+F$
Rule: $F \rightarrow F+F-F-FF+F+F-F$
Angle: 90°



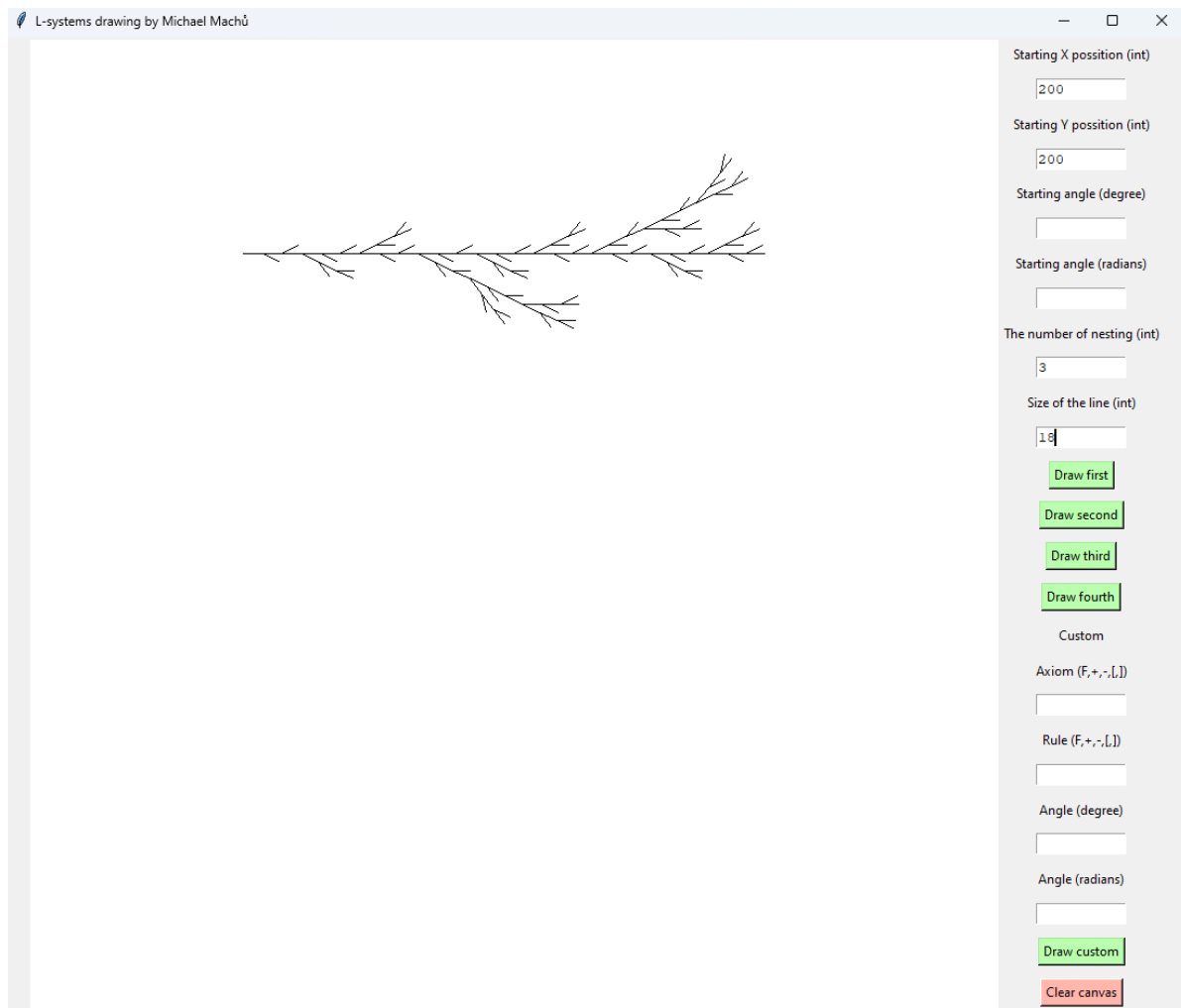
Example 1

2. **Axiom:** $F++F++F$
Rule: $F \rightarrow F+F--F+F$
Angle: 60°



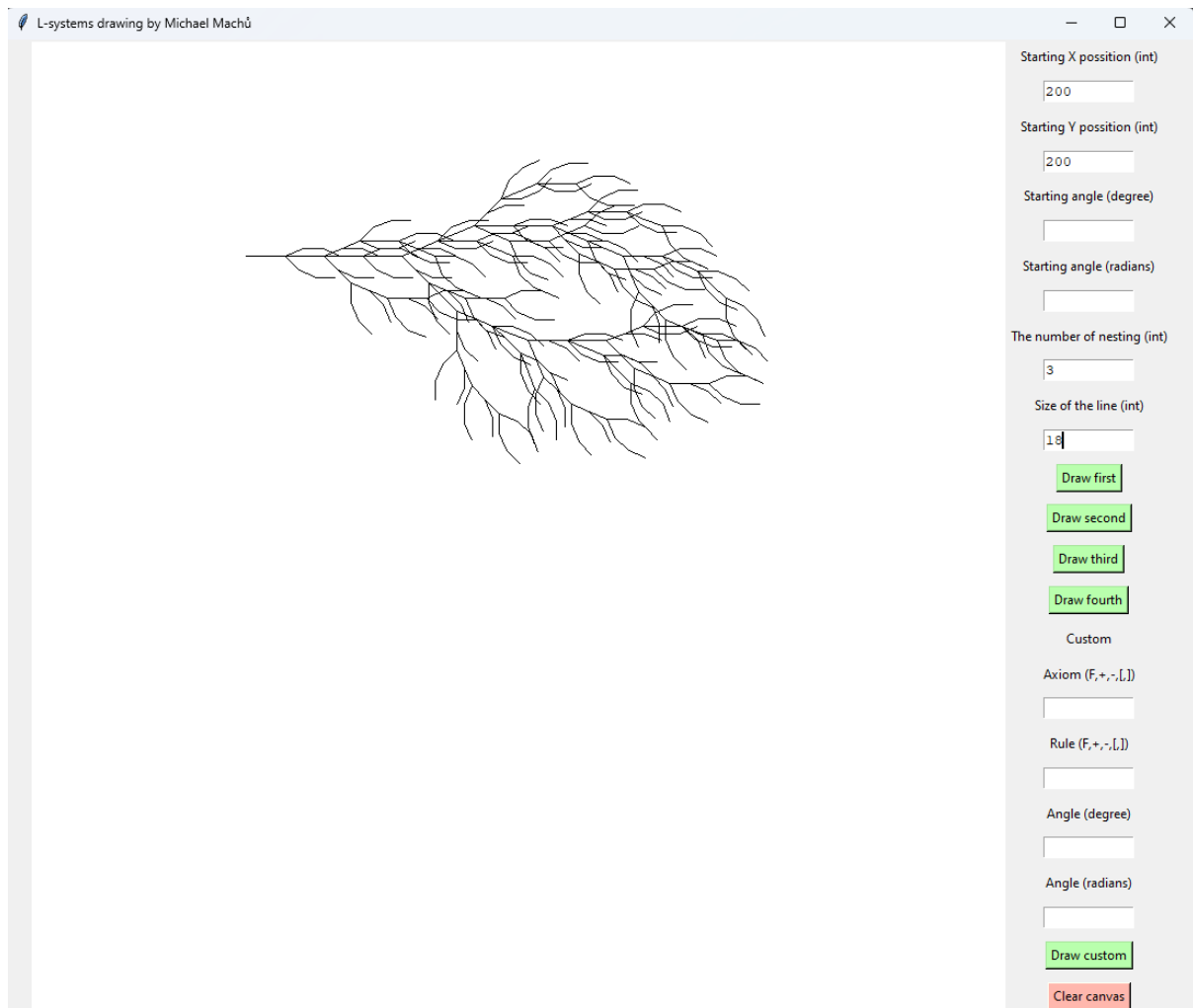
Example 2

3. **Axiom:** F
Rule: F $\rightarrow$ F[+F]F[-F]F
Angle: $\pi/7$



Example 3

4. **Axiom:** F
Rule: F $\rightarrow$ FF+[F-F-F]-[-F+F+F]
Angle: $\pi/8$



Example 4