

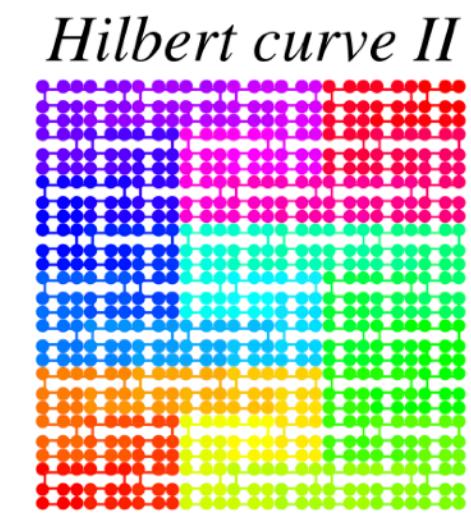
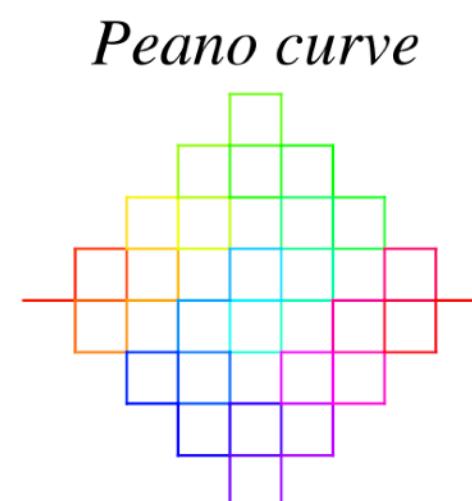
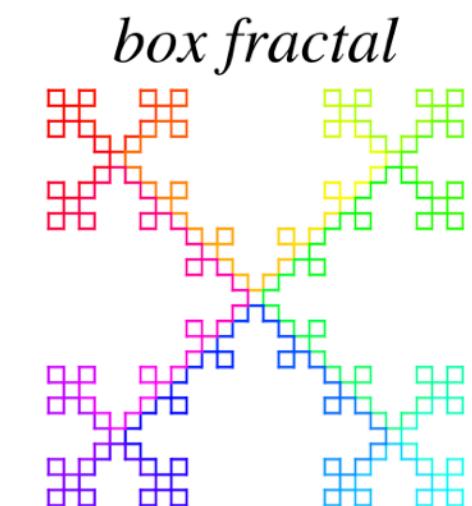
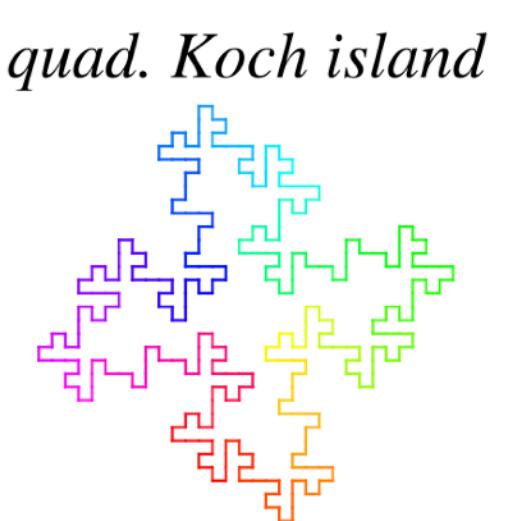
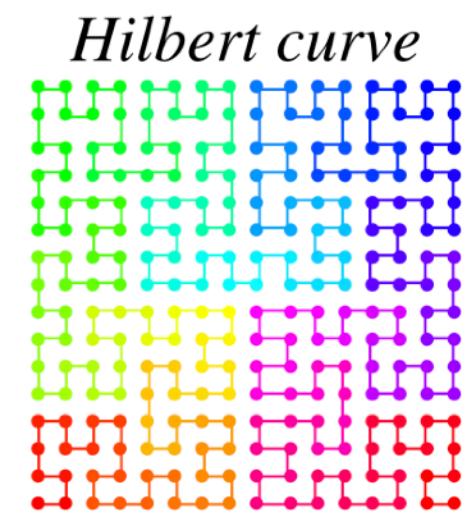
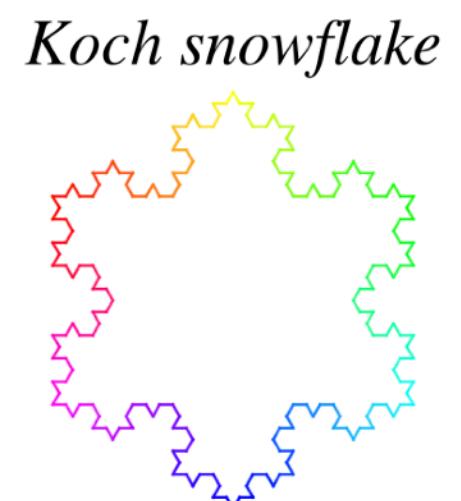
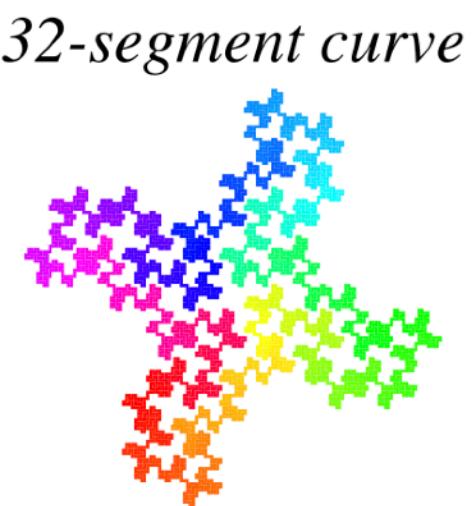
CS 6492 Shape Grammar 2024 Fall

Lindenmayer Systems in Shape Machine

Zhen Li

Introduction

- A Lindenmayer system (or L-system) is a parallel rewriting system and a type of formal grammar.
- This project is an exploration of generating a certain type of 2D L-System shapes in Shape Machine.



Introduction

- A typical L-system is based on a rewriting rule

$$F \rightarrow F+F-F-FF+F+F-F$$

- A string of characters (symbols) is rewritten on each iteration according to some replacement rules. Consider an initial string (axiom)

$$F+F+F+F$$

- After one iteration the system would result

$$F+F-F-FF+F+F-F + F+F-F-FF+F+F-F + F+F-F-FF+F+F-F + F+F-F-FF+F+F-F$$

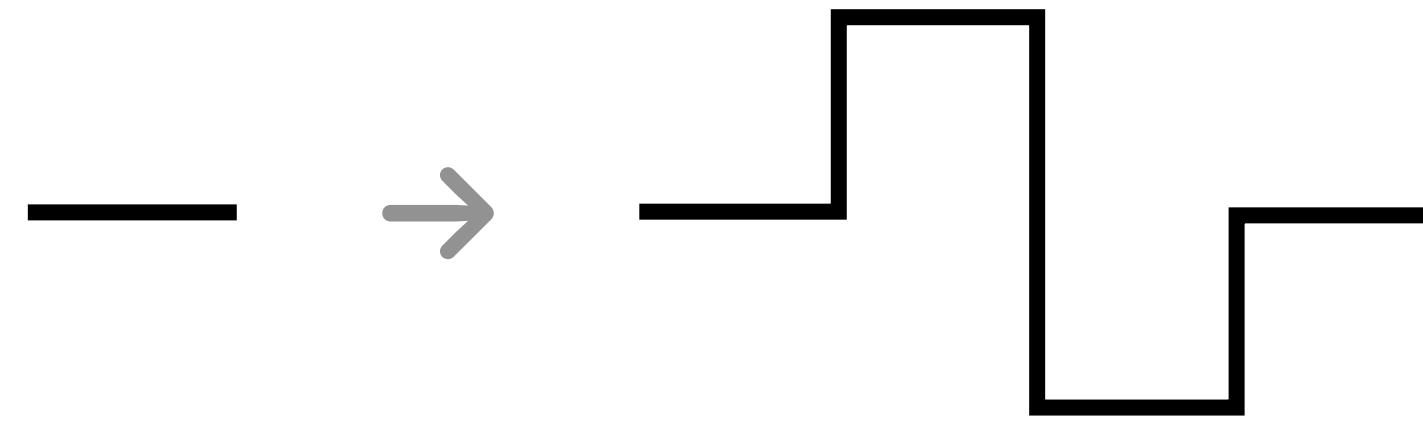
Introduction

F → F+F-F-FF+F+F-F

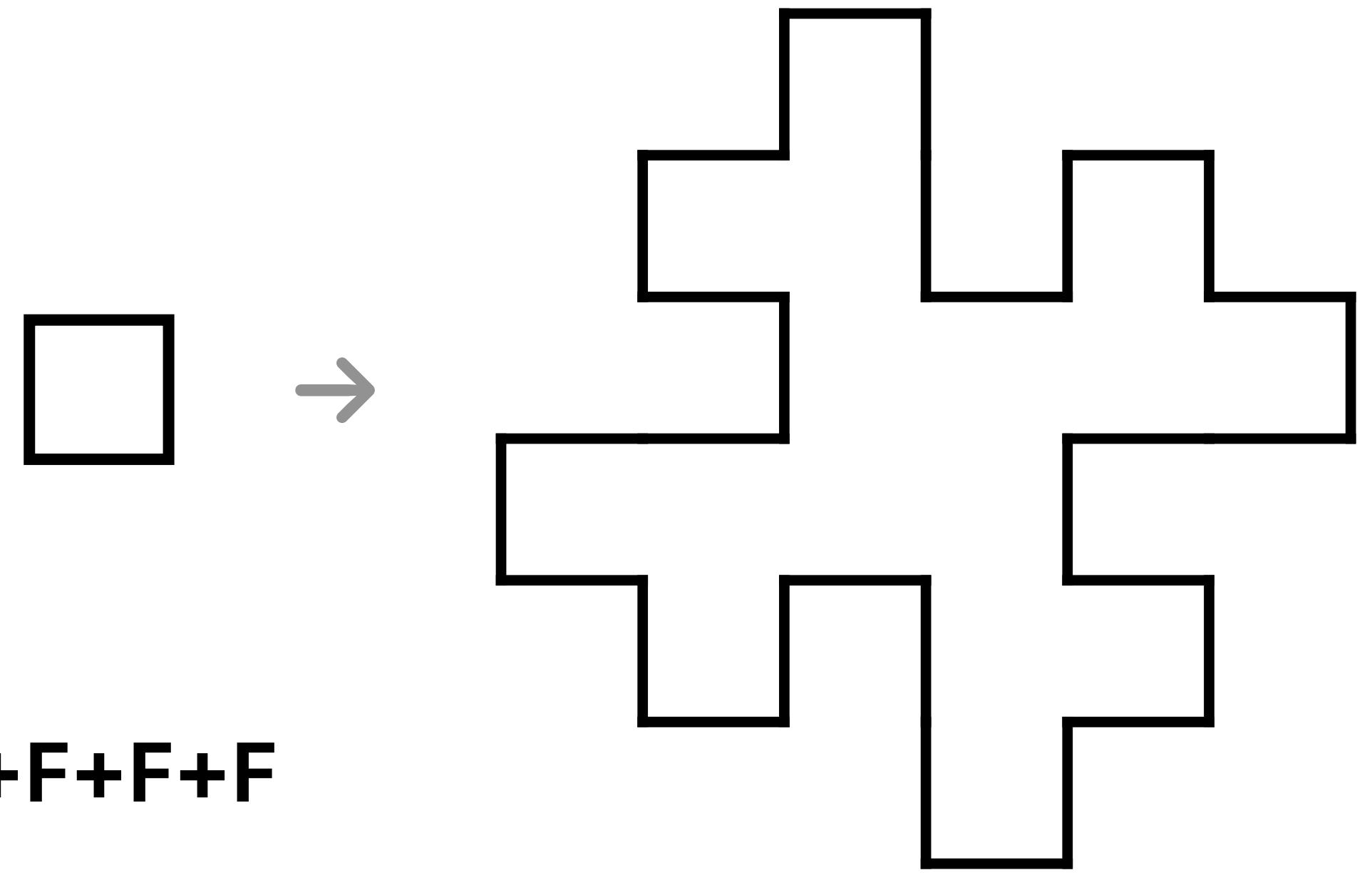
F+F+F+F

F+F-F-FF+F+F-F + F+F-F-FF+F+F-F
+ **F+F-F-FF+F+F-F + F+F-F-FF+F+F-F**

Introduction



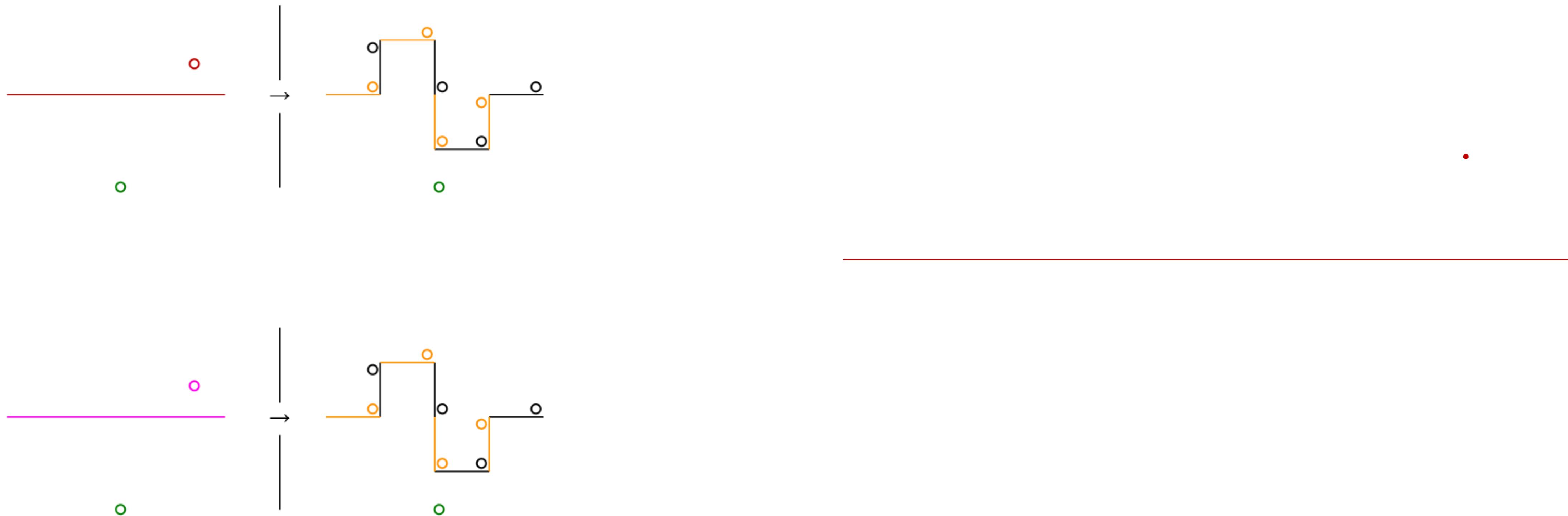
F → **F+F-F-FF+F+F-F**



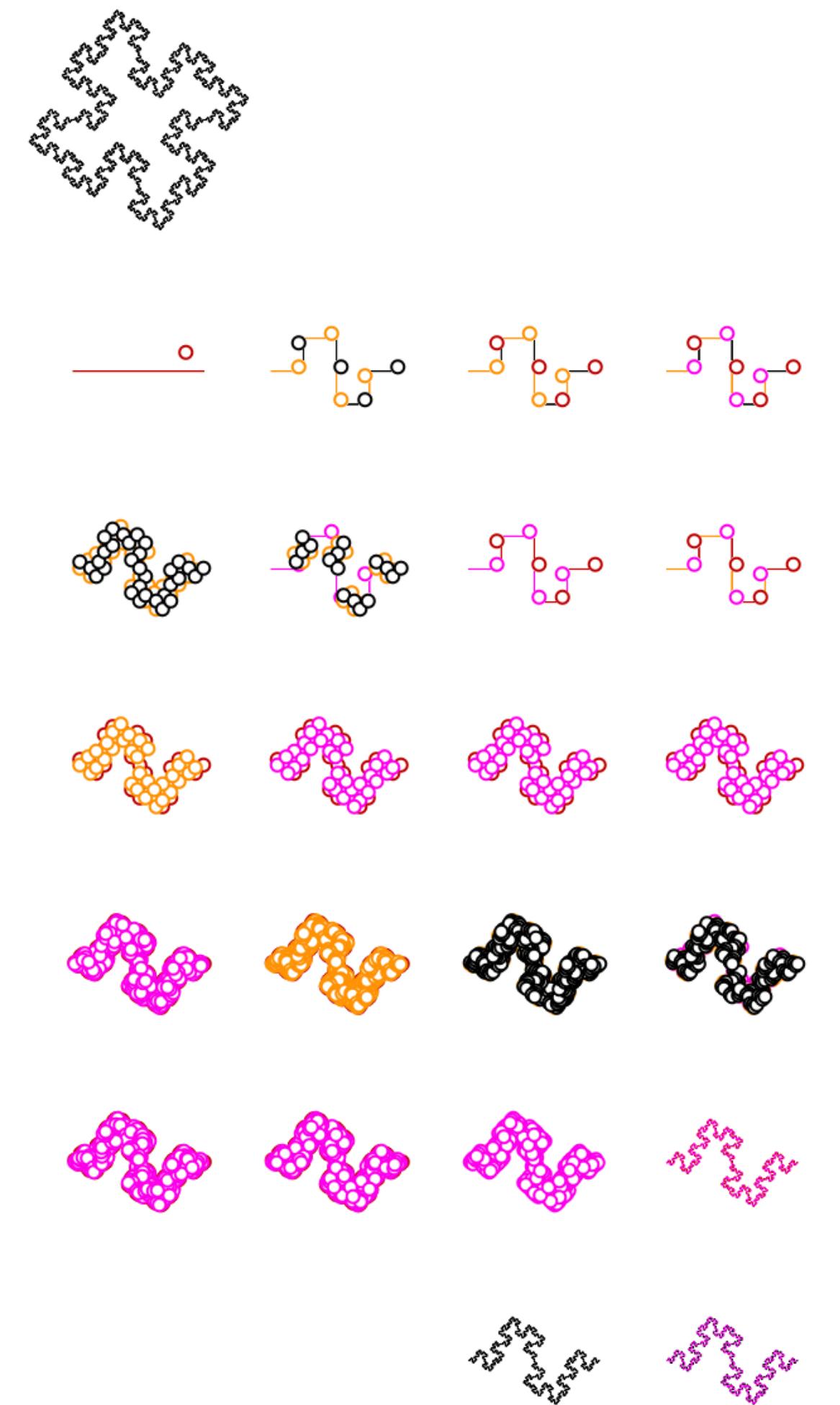
F+F+F+F

F+F-F-FF+F+F-F + **F+F-F-FF+F+F-F**
+ **F+F-F-FF+F+F-F** + **F+F-F-FF+F+F-F**

Introduction - Koch curve



Introduction - Koch curve



Programmatically generate DrawScripts

Indicate termination & activation

"Black Thick" before application - replaceable

"Black" after application - irreplaceable

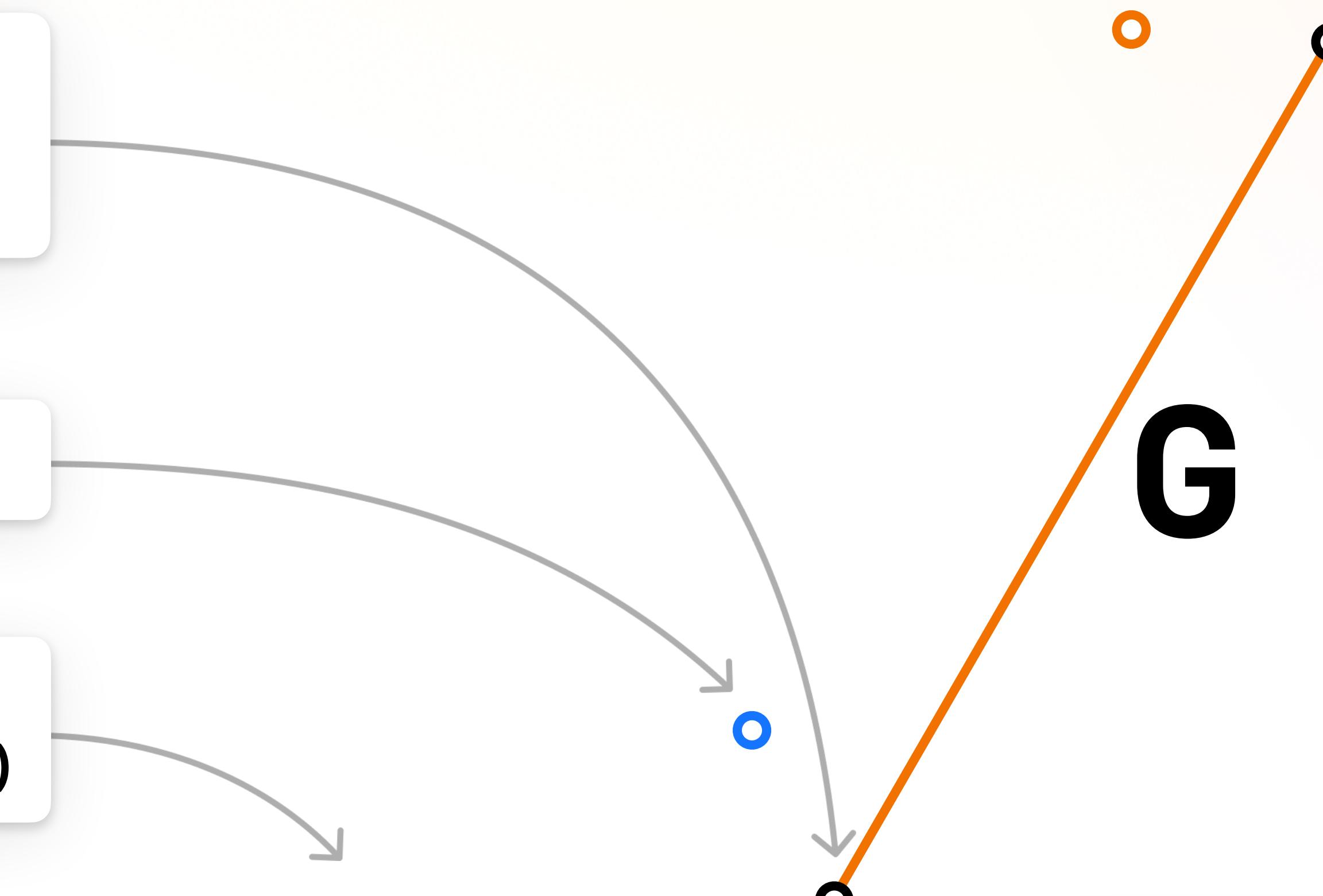
Indicate direction

Assign a new color (●)
for each forward character (F)

F

+

Turn left

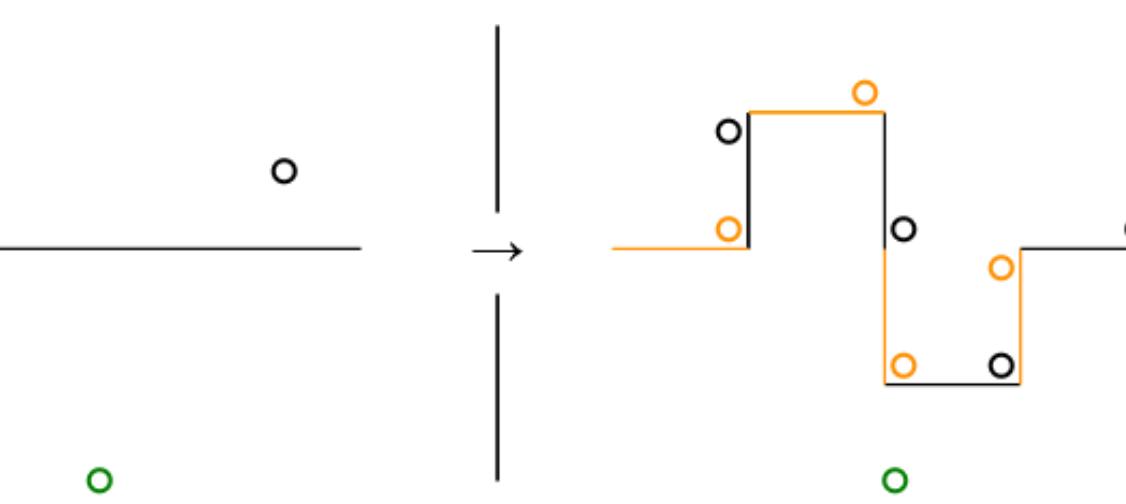
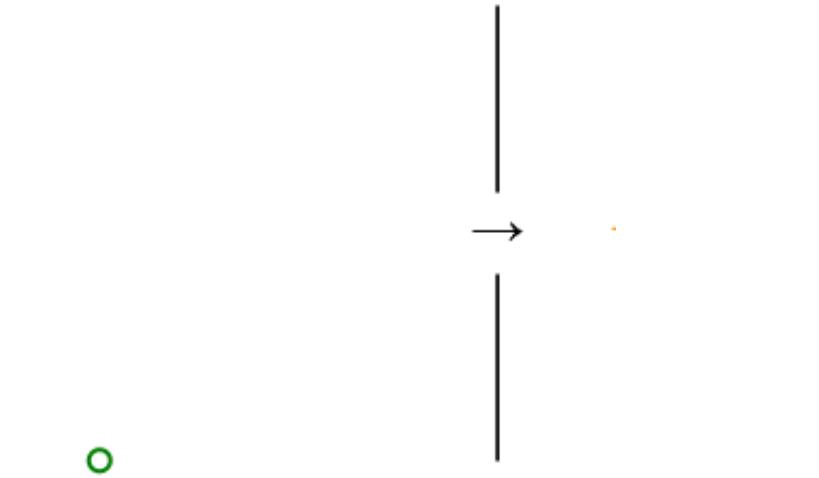


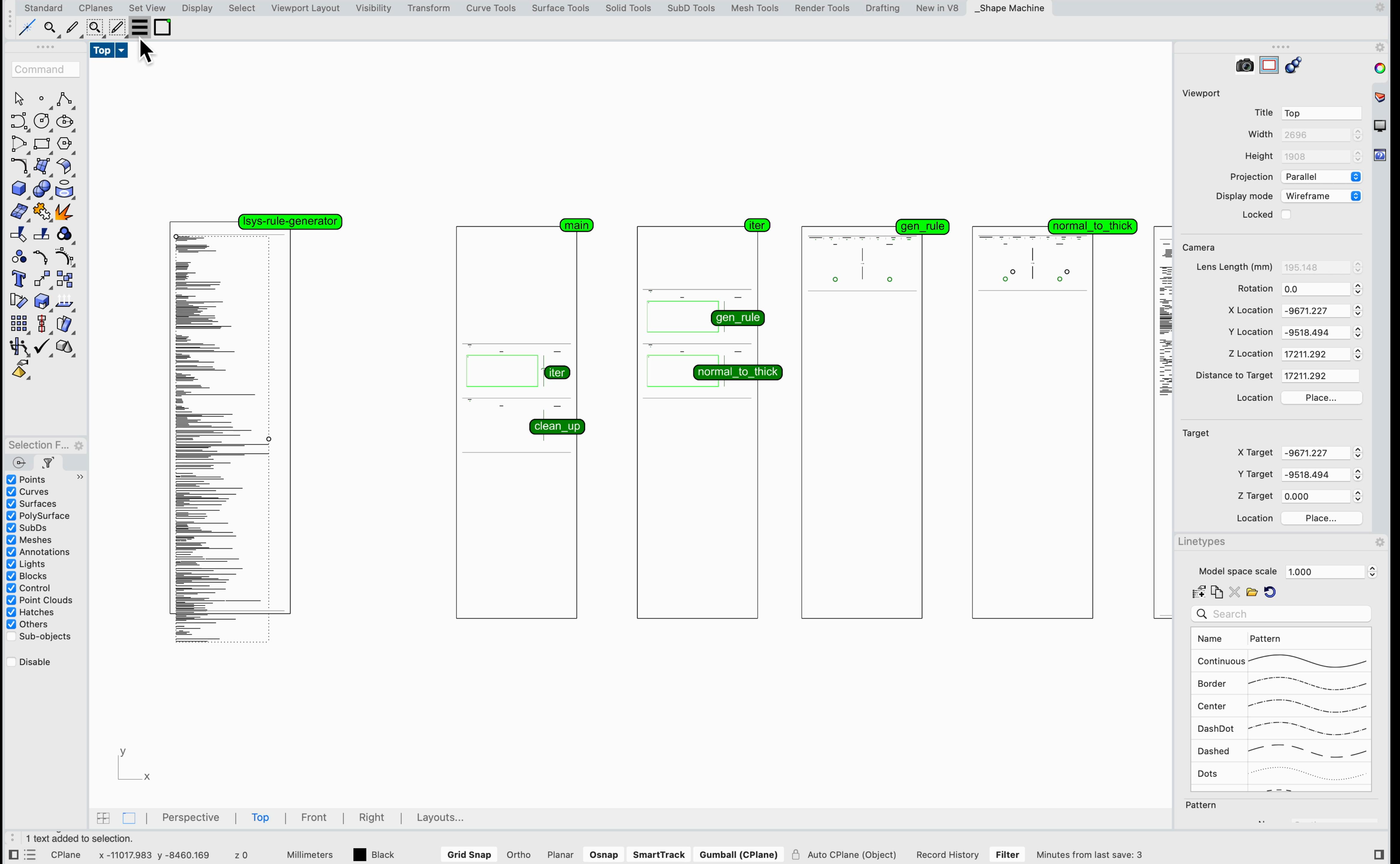
Programmatically generate DrawScripts

```
LSystem(  
    [ Rule(lhs="F", rhs="F+F-F-FF+F+F-F") ],  
    "F+F+F+F",  
    EnvironmentValues(  
        angle      = np.pi / 2,  
        forward_chars = "F",  
    )  
).generate_draw_scripts_on_template(sm_templates)
```

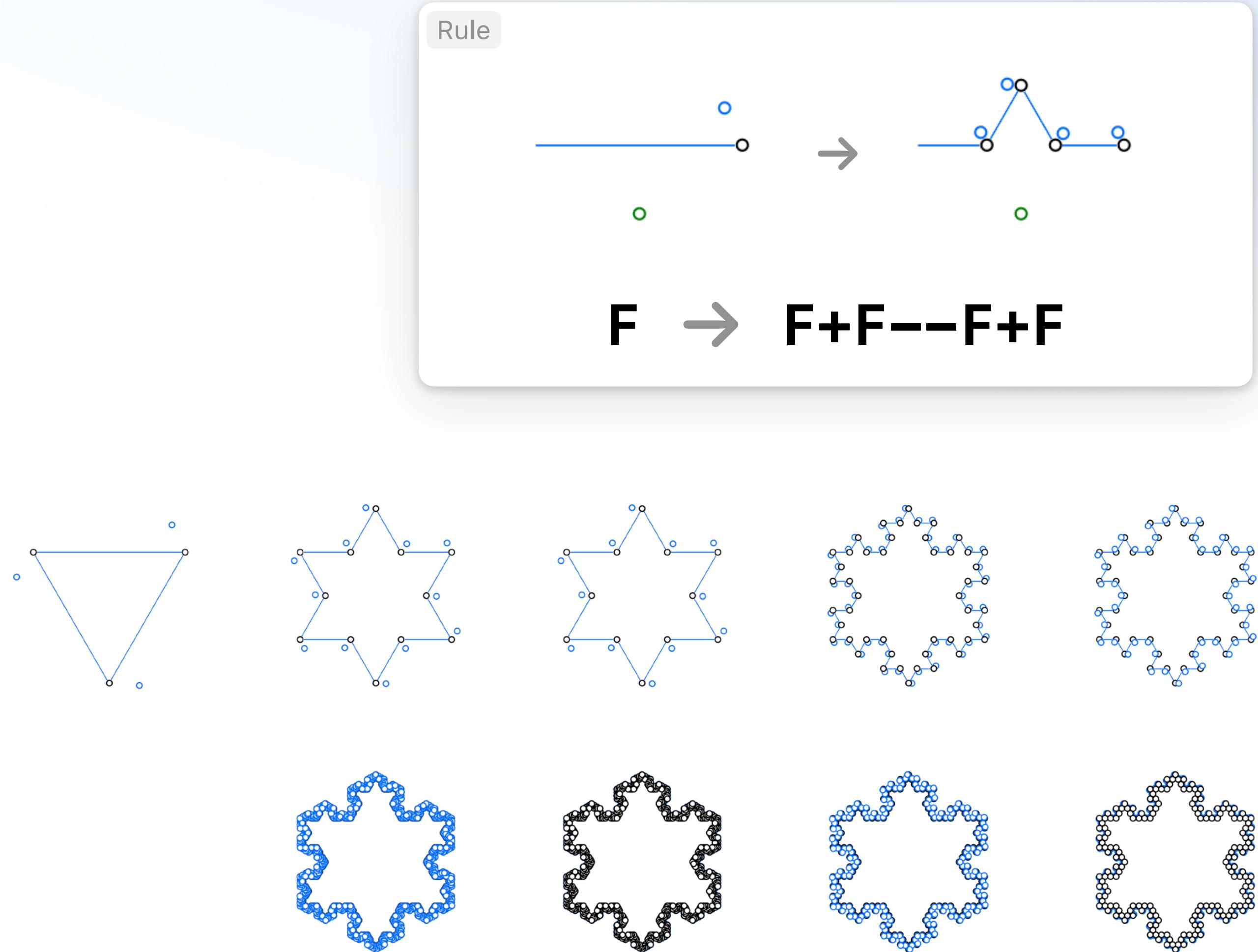
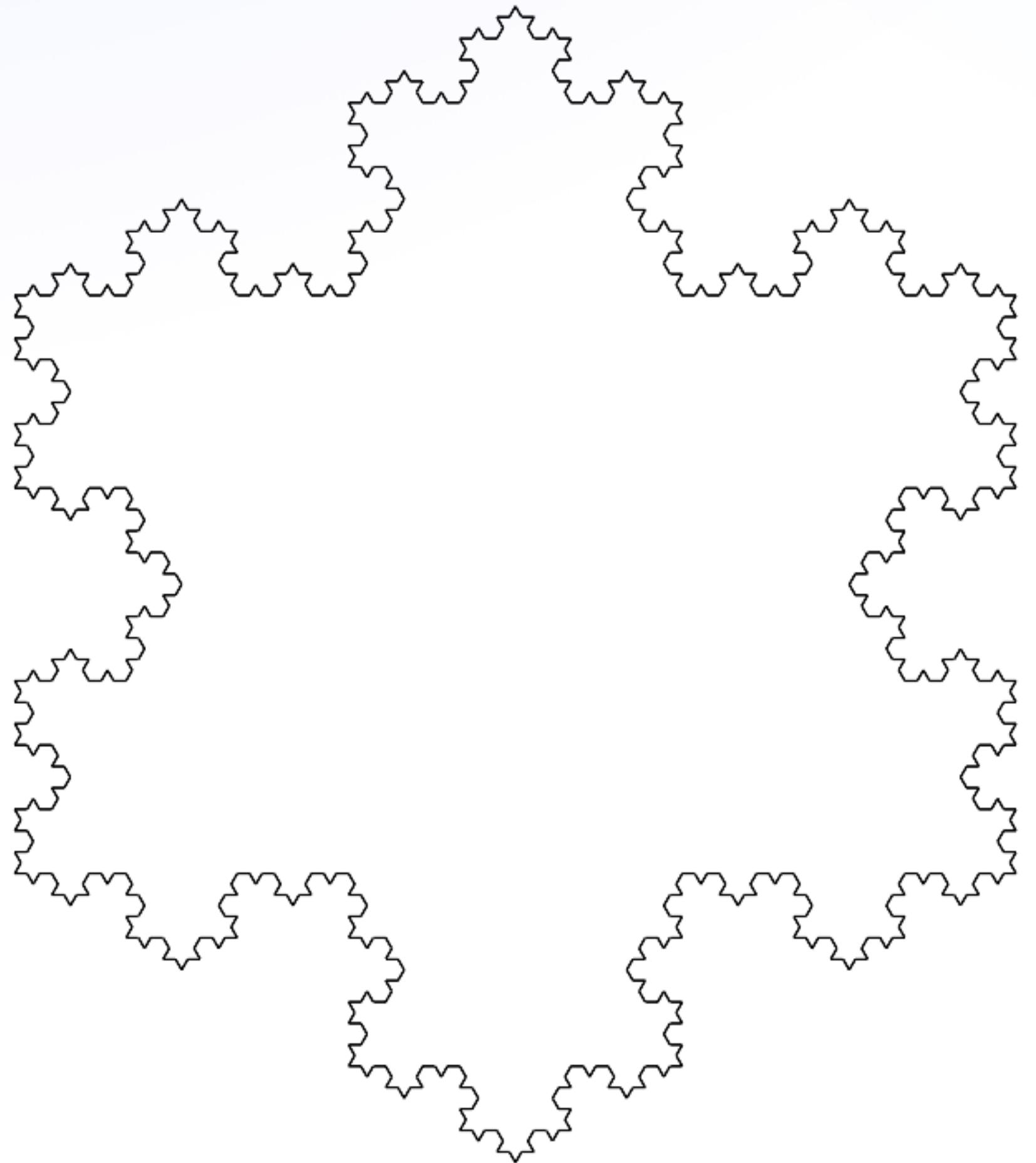
Python DrawScripts

Look for point pairs with "Shape Machine::template" attributes

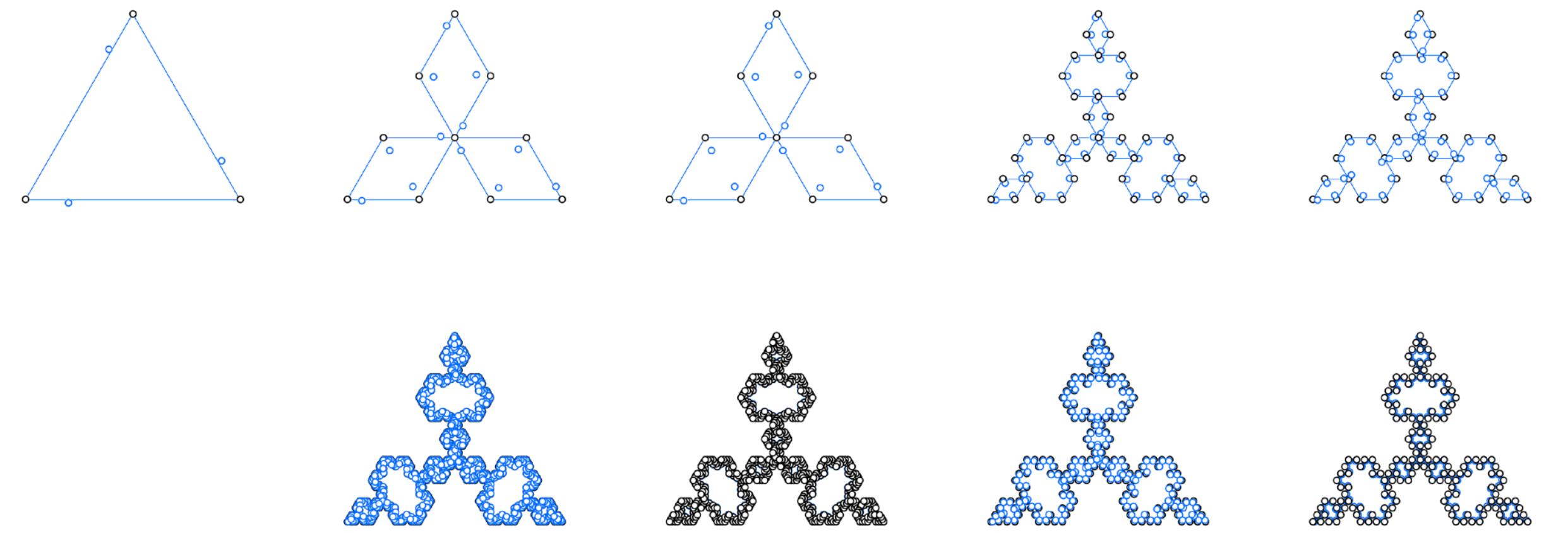
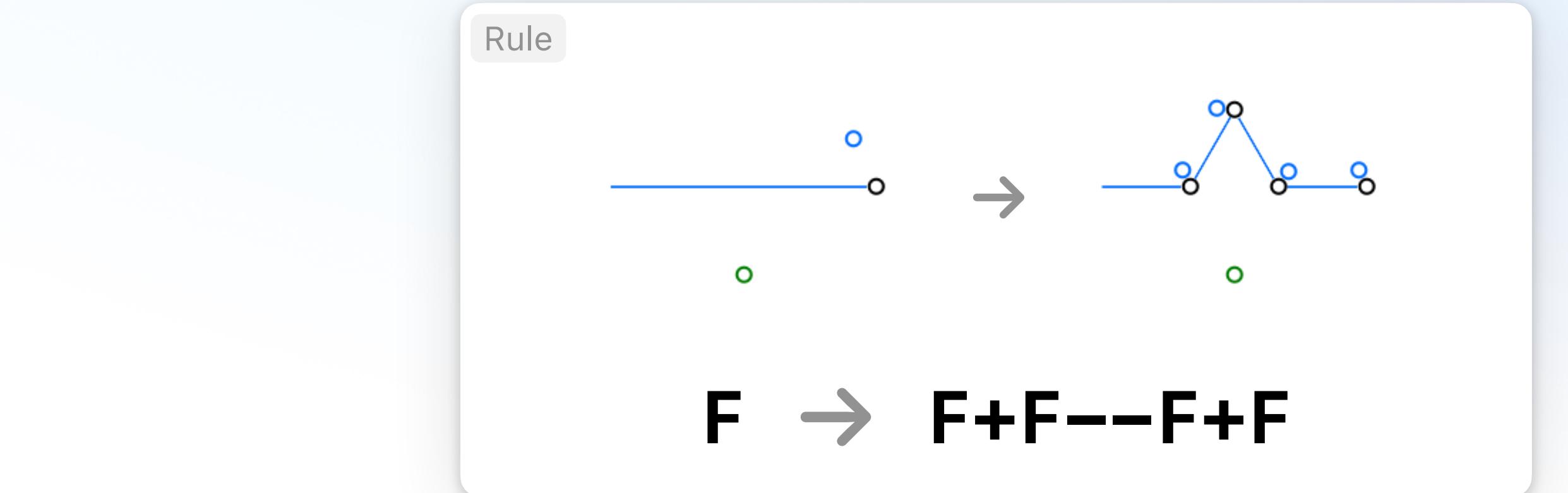
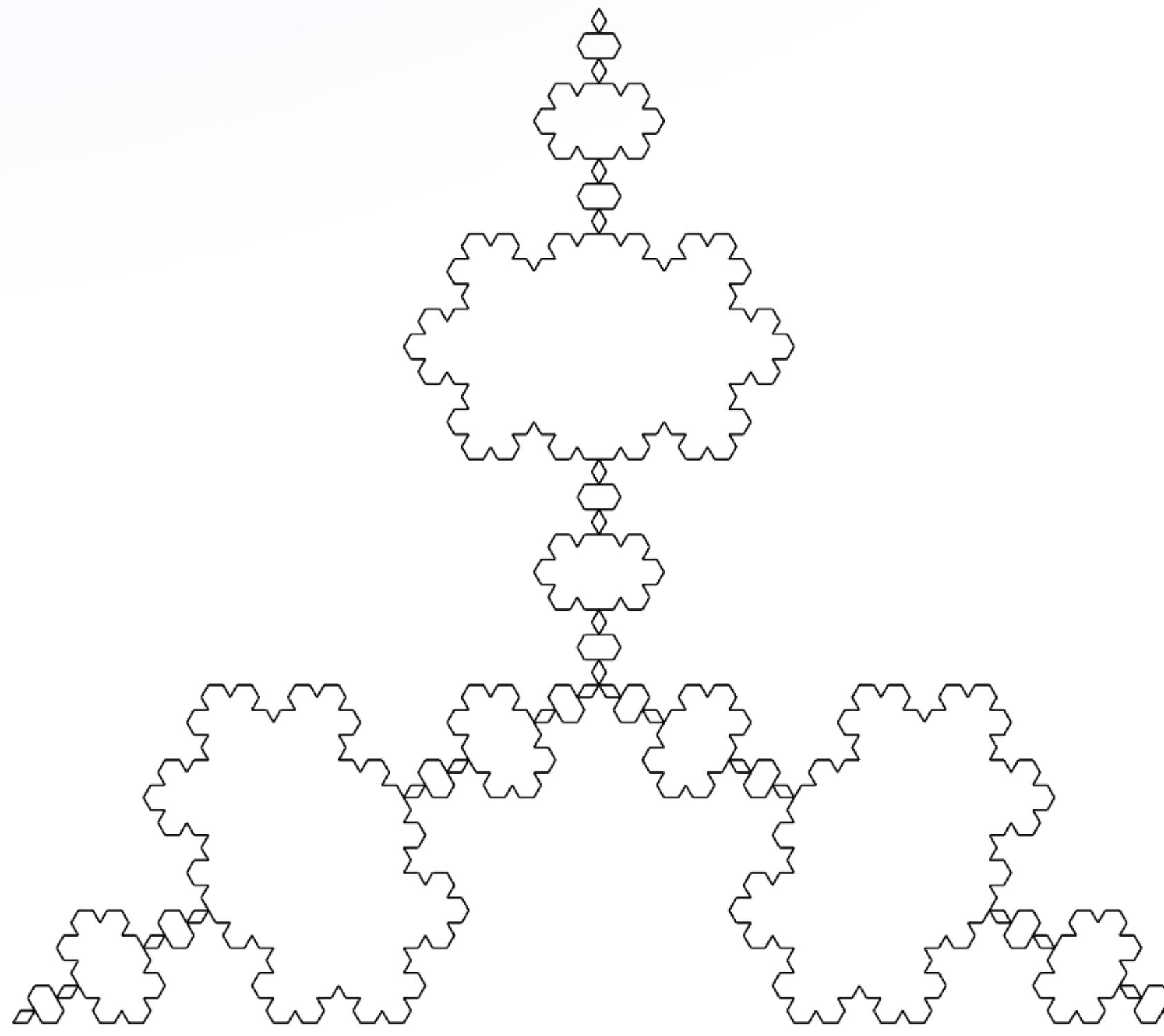




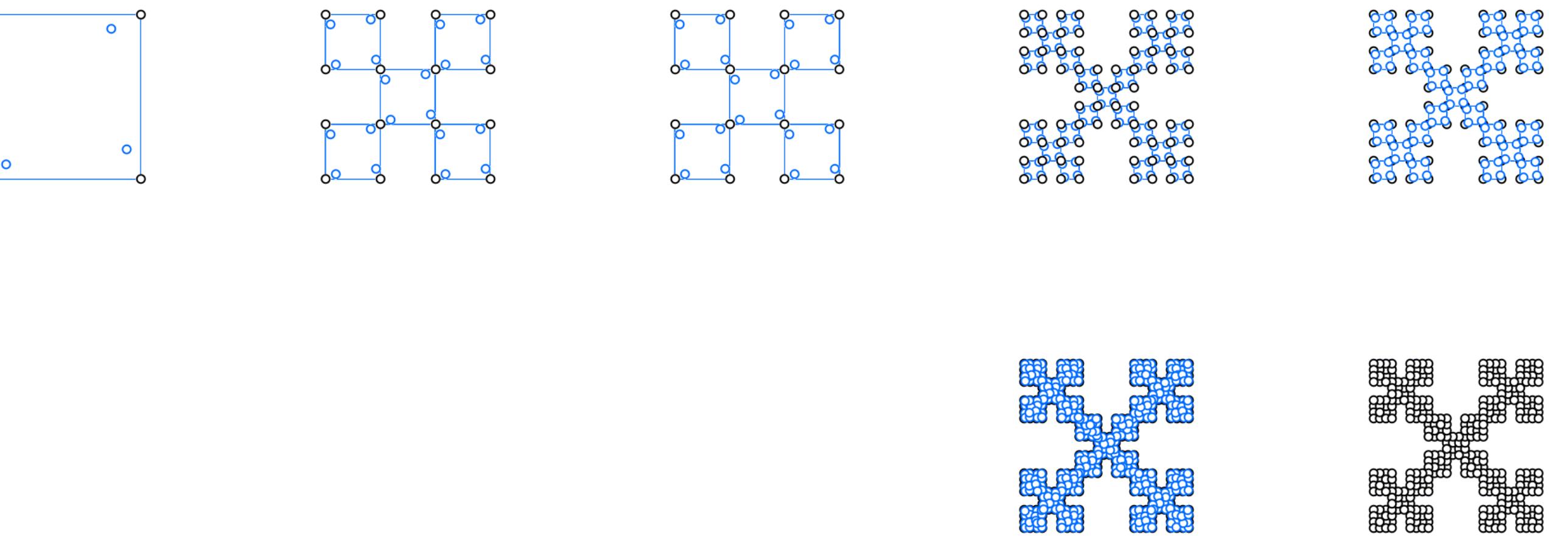
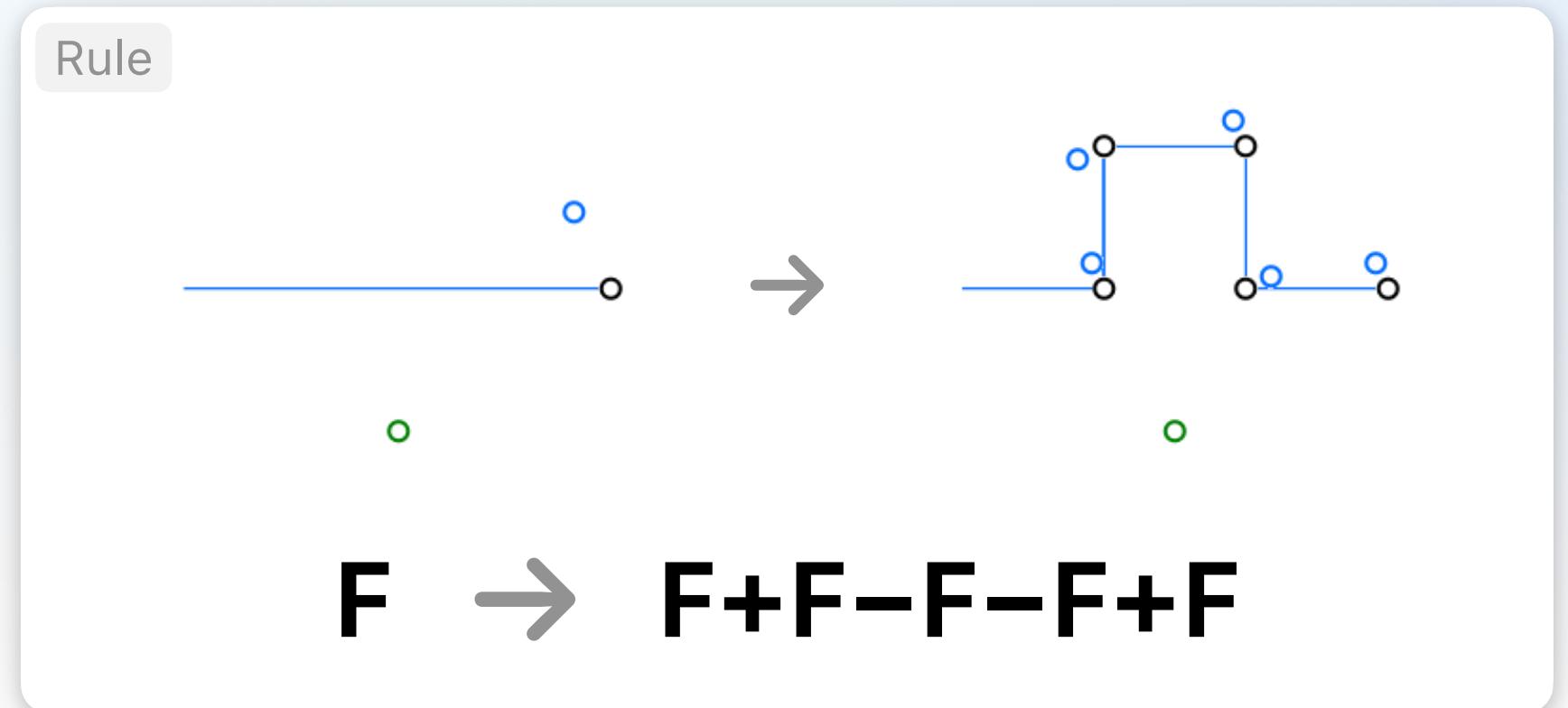
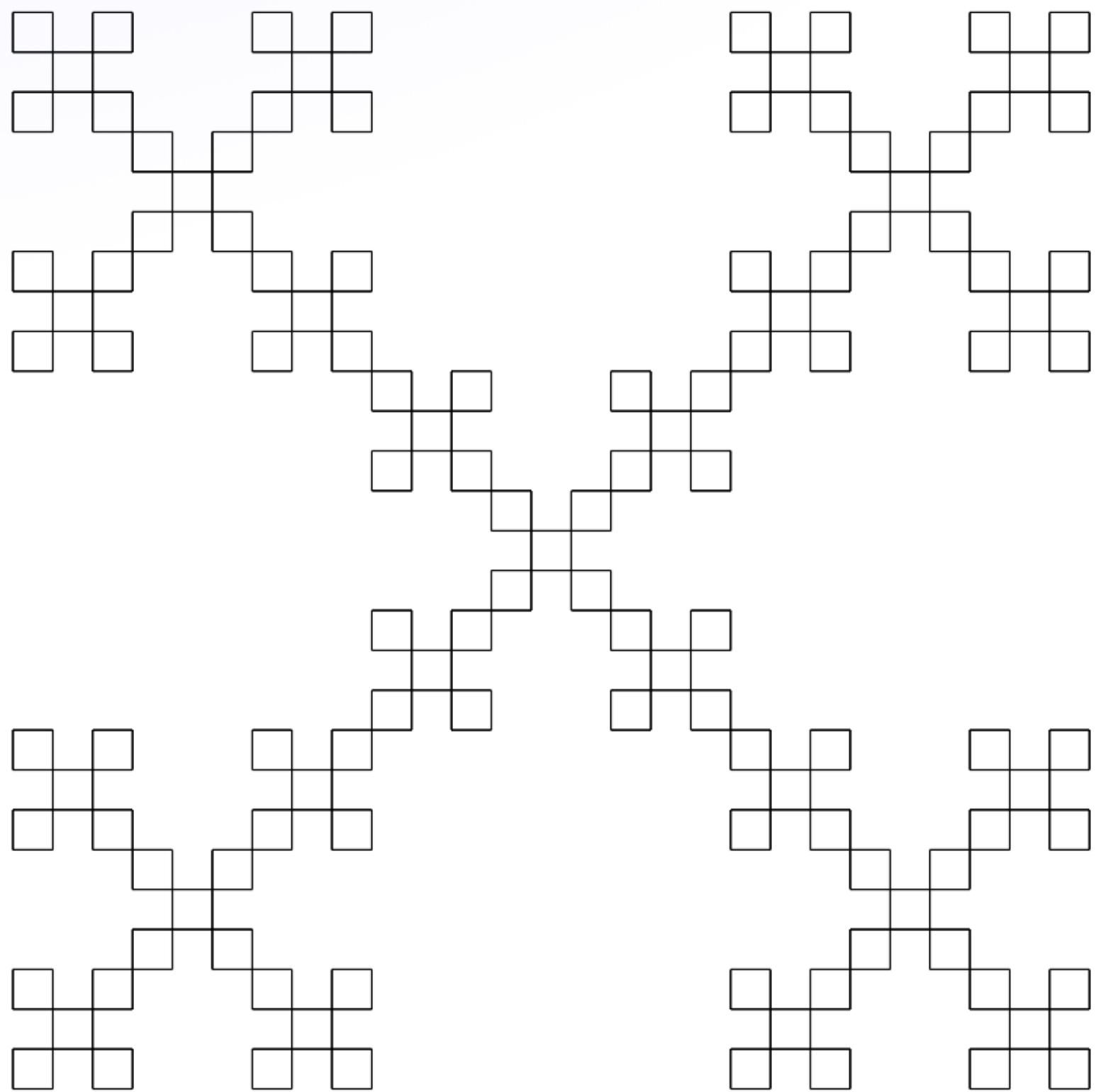
Progress - Koch snowflake



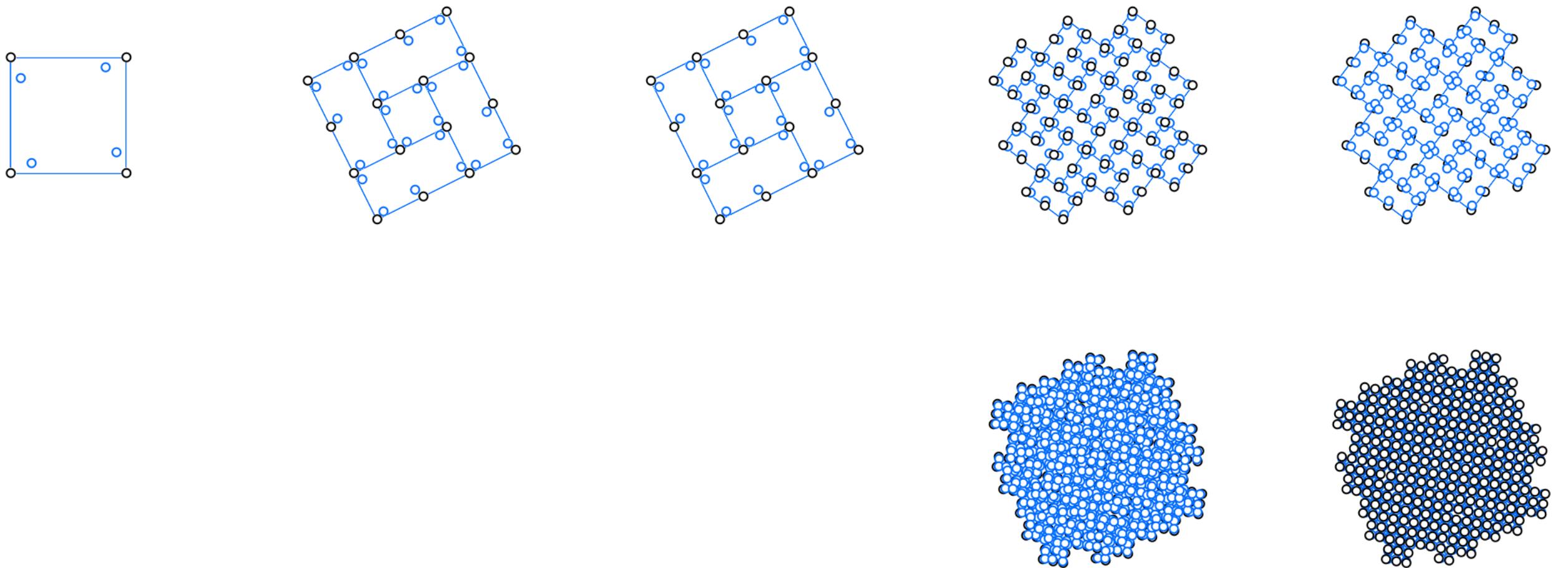
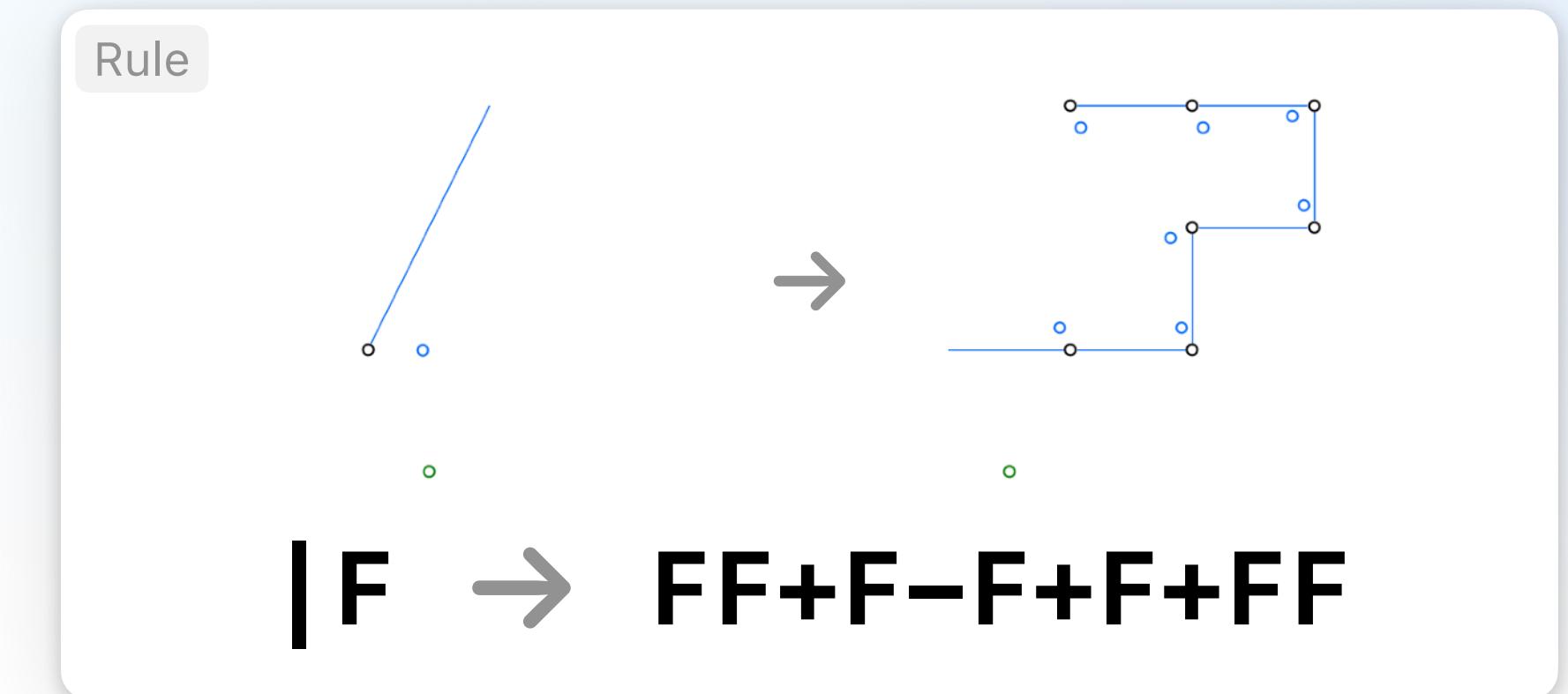
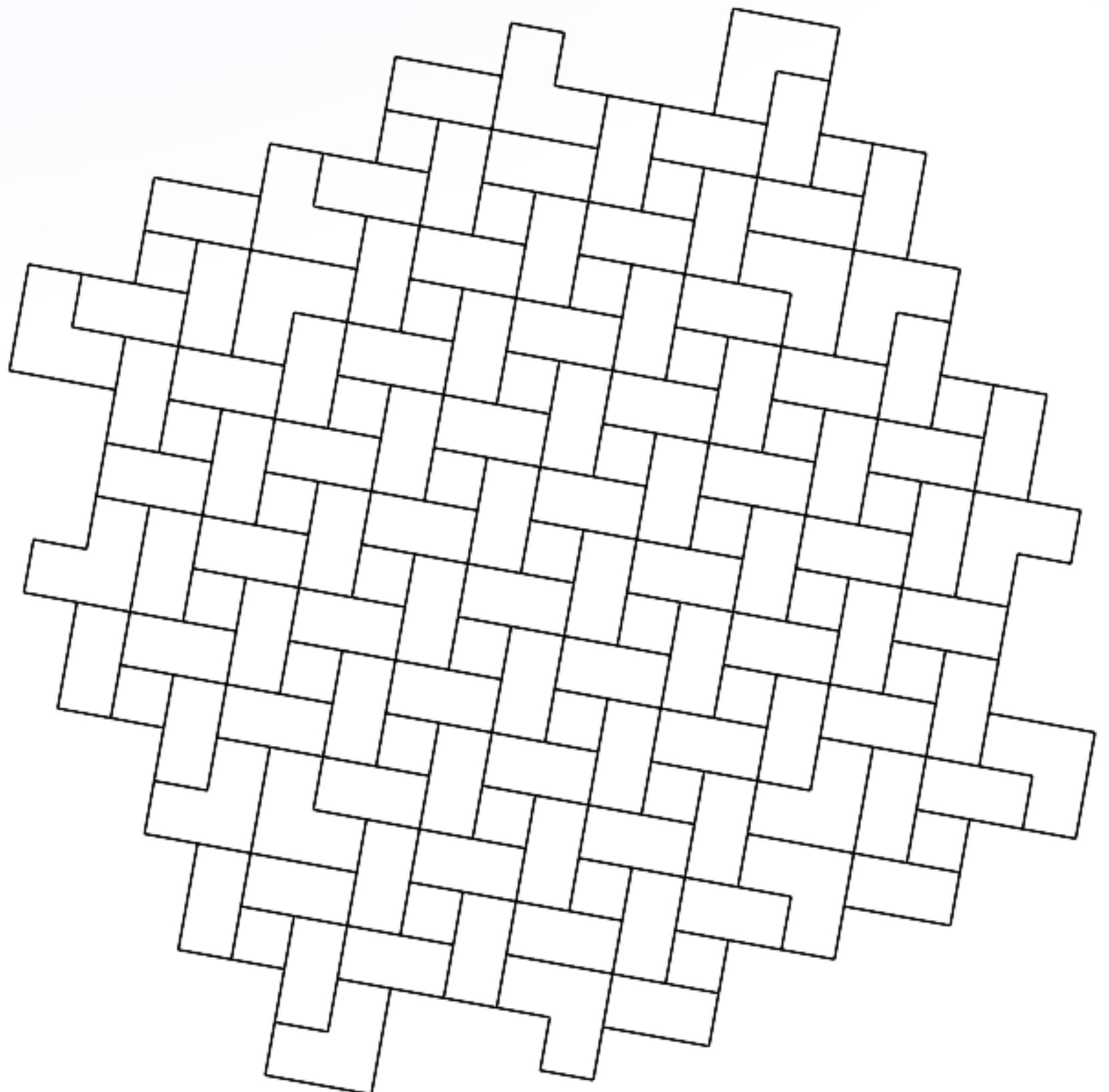
Progress - Koch anti-snowflake



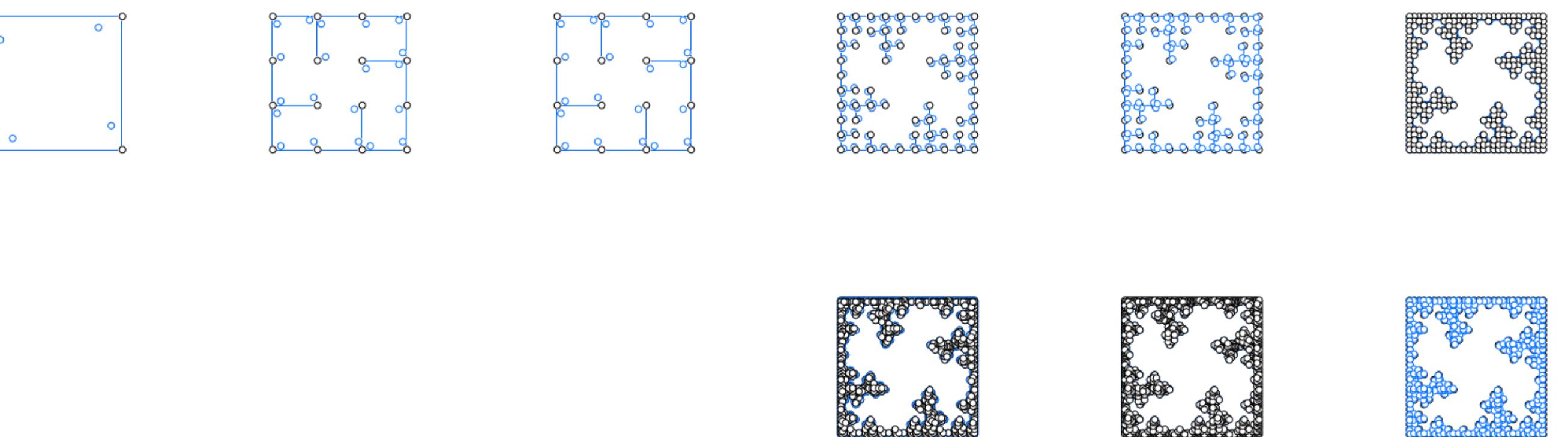
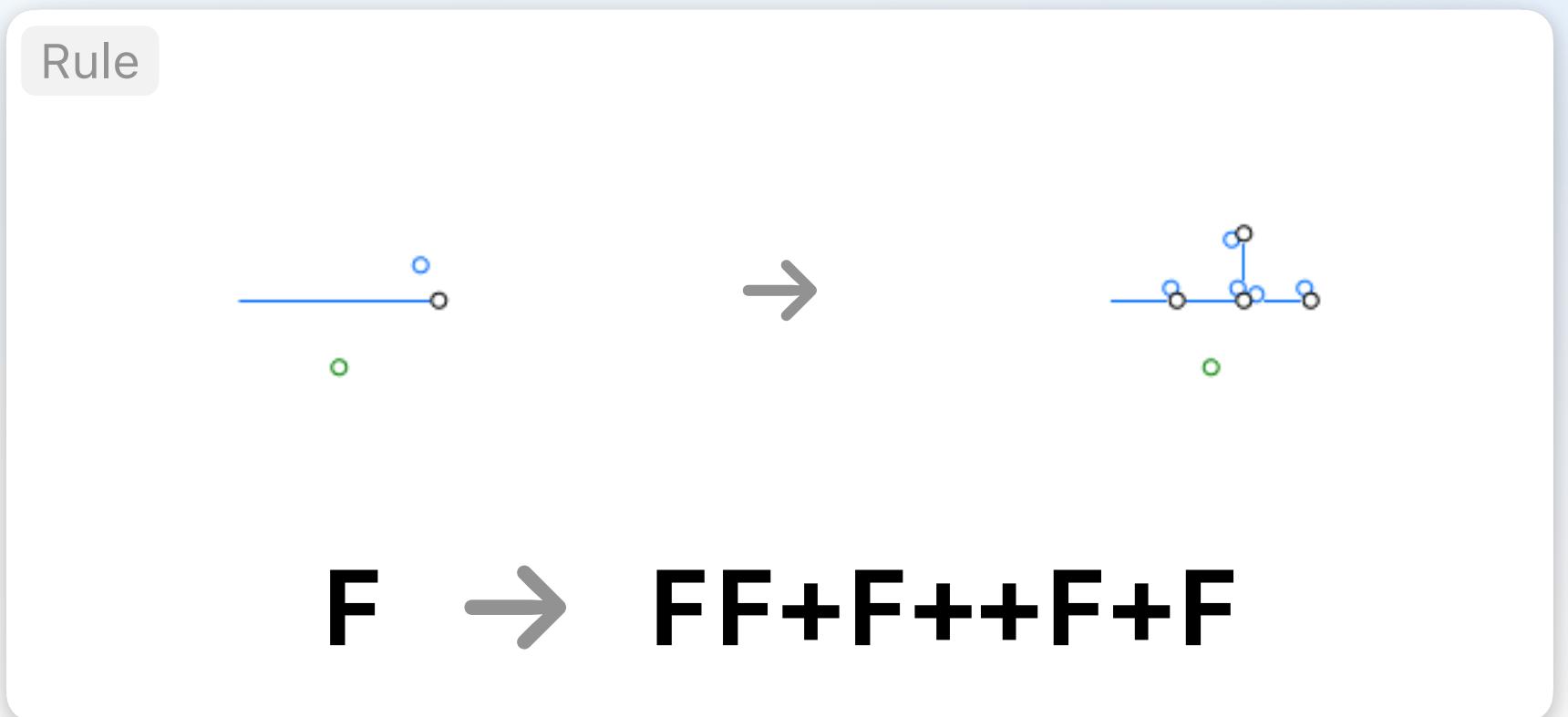
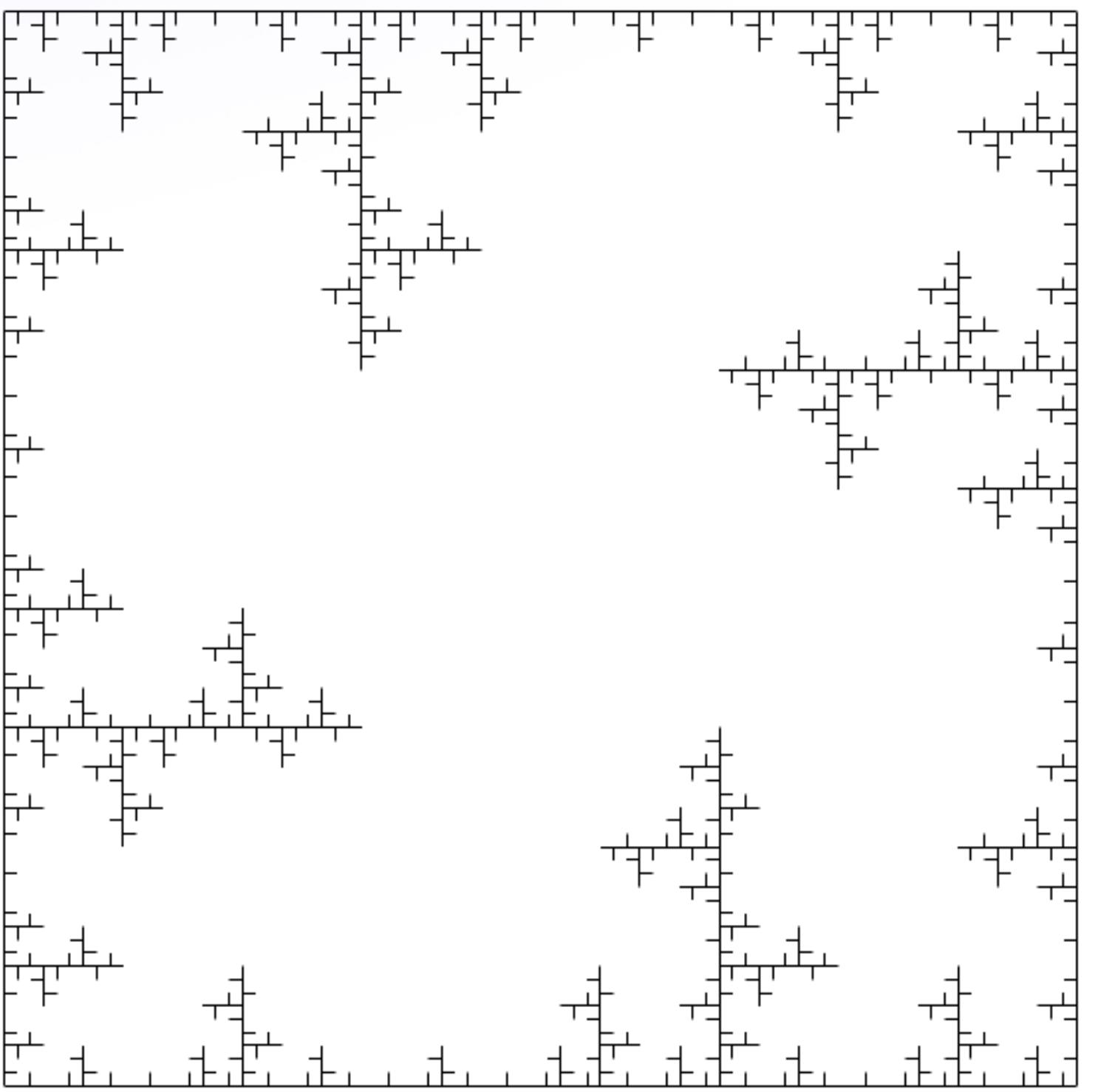
Progress - Box fractal



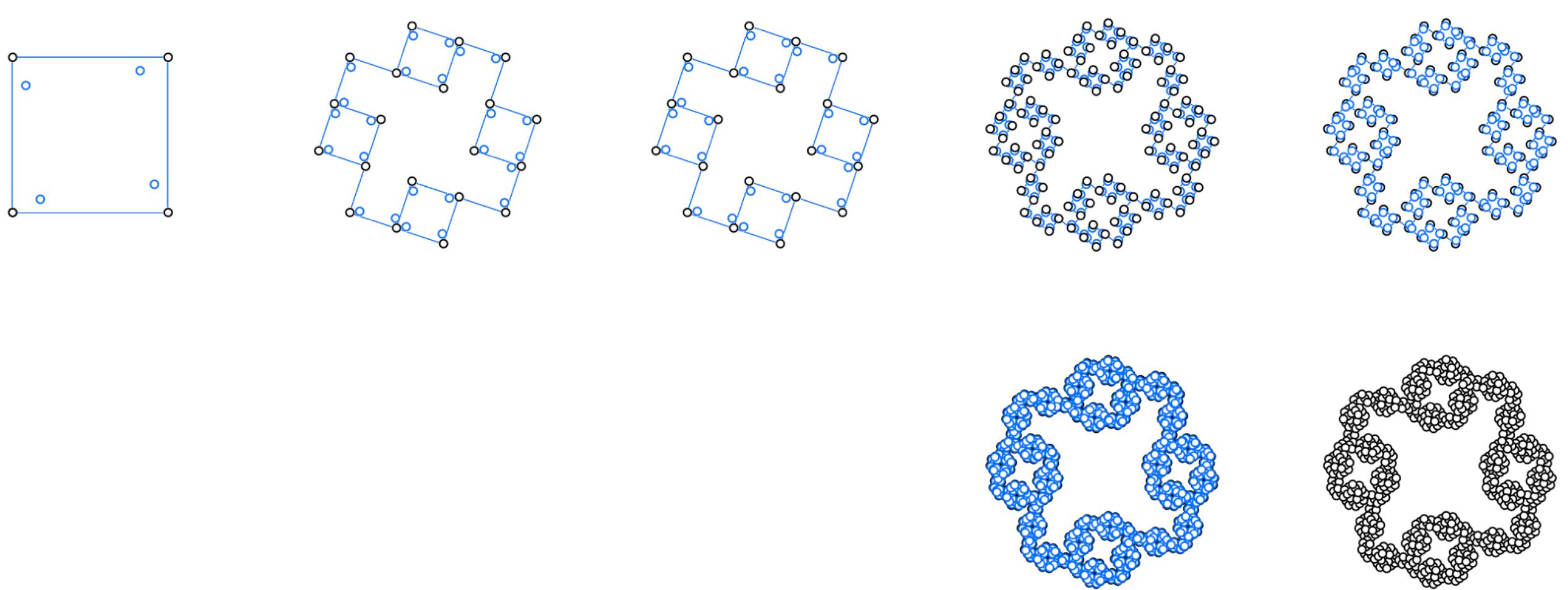
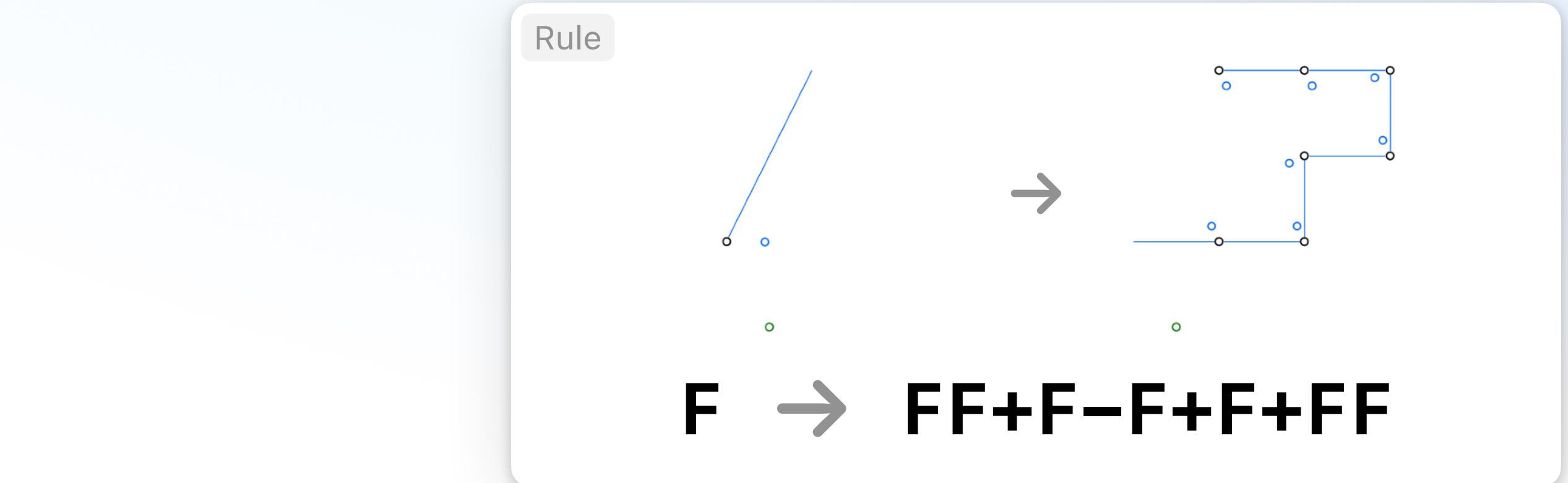
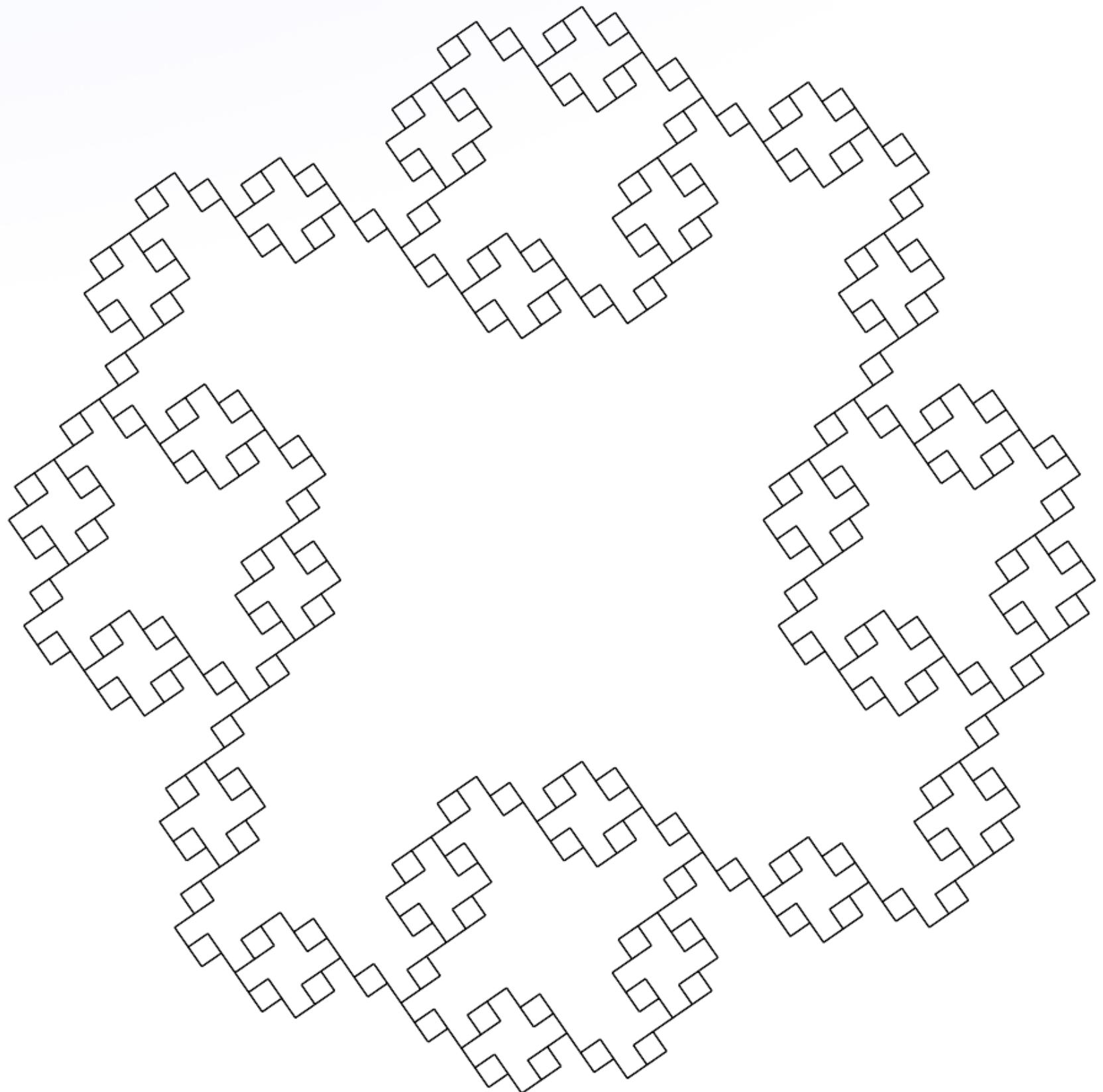
Progress - Tiles



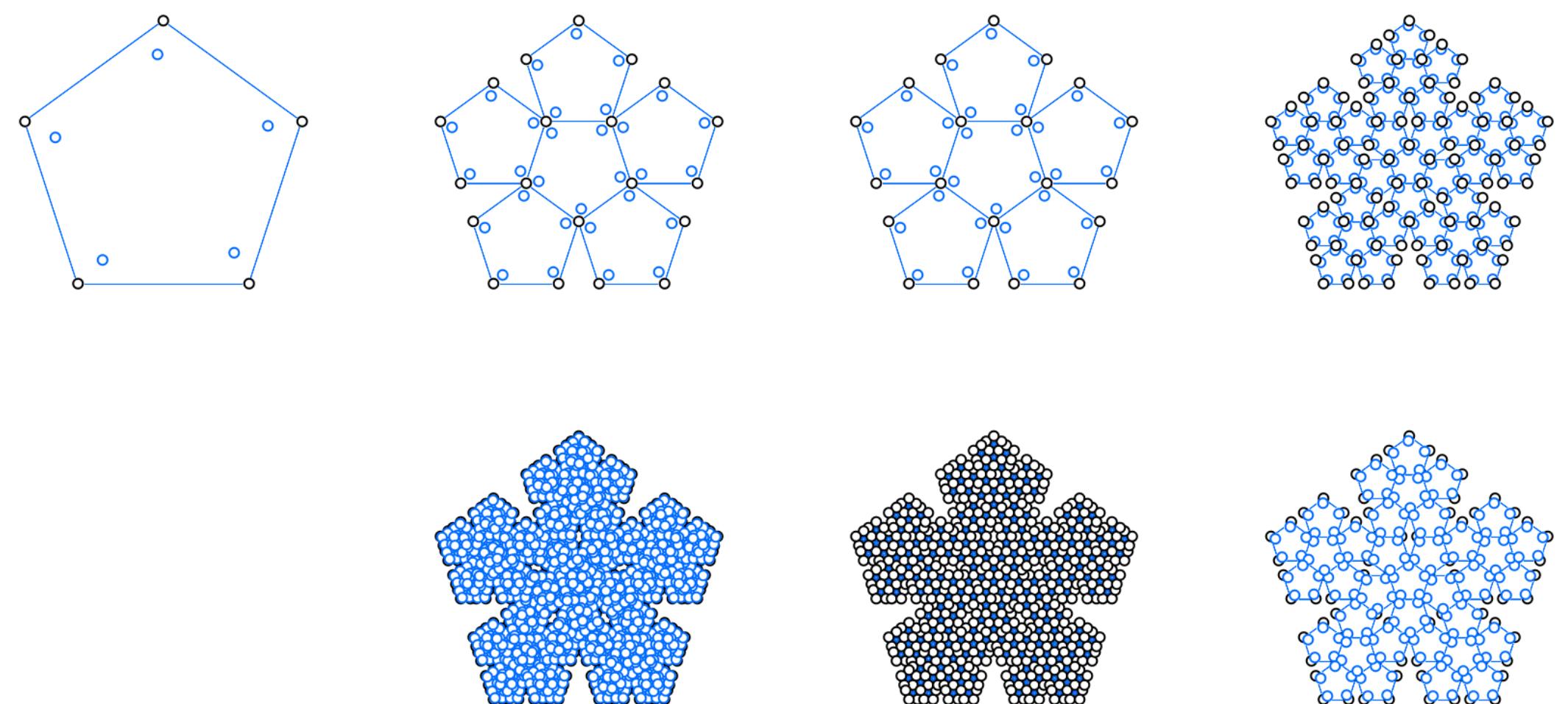
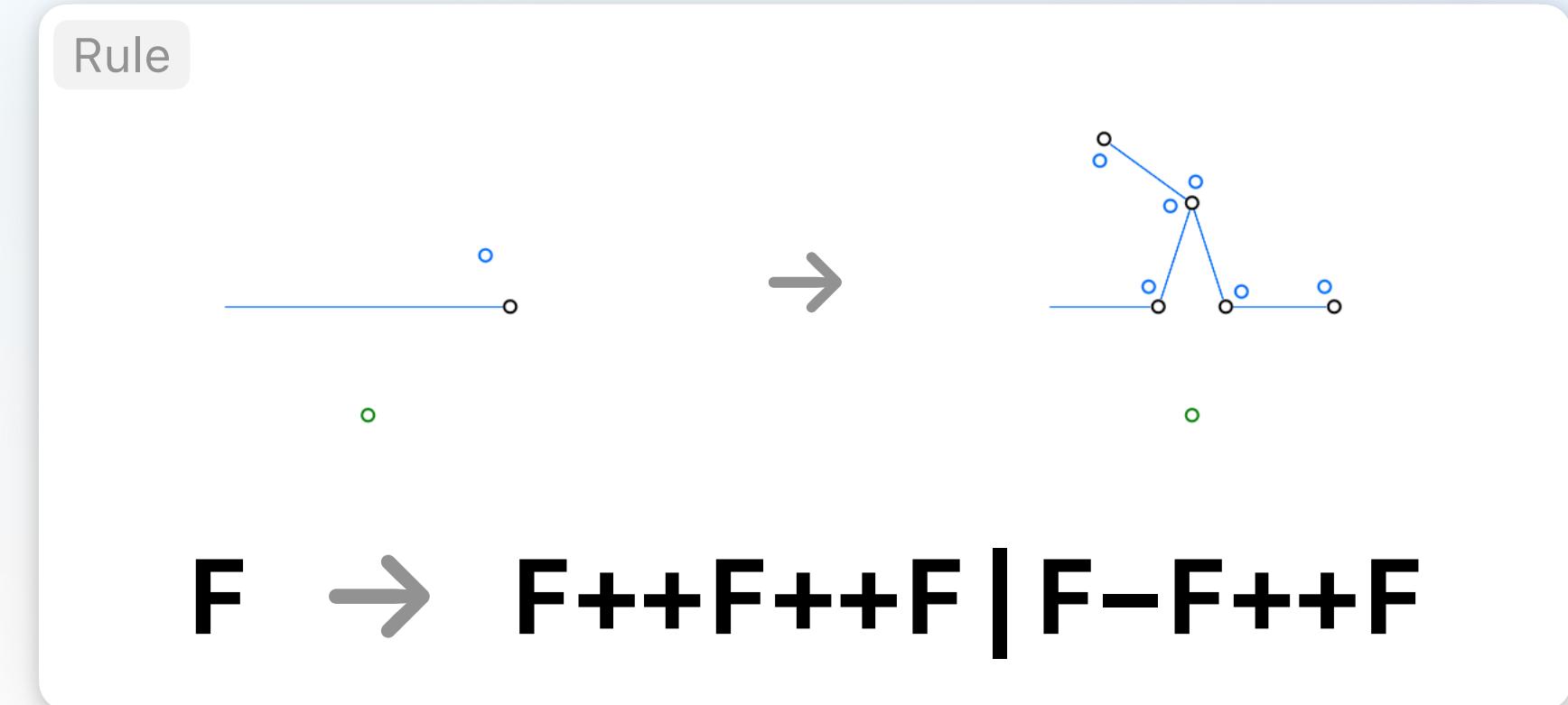
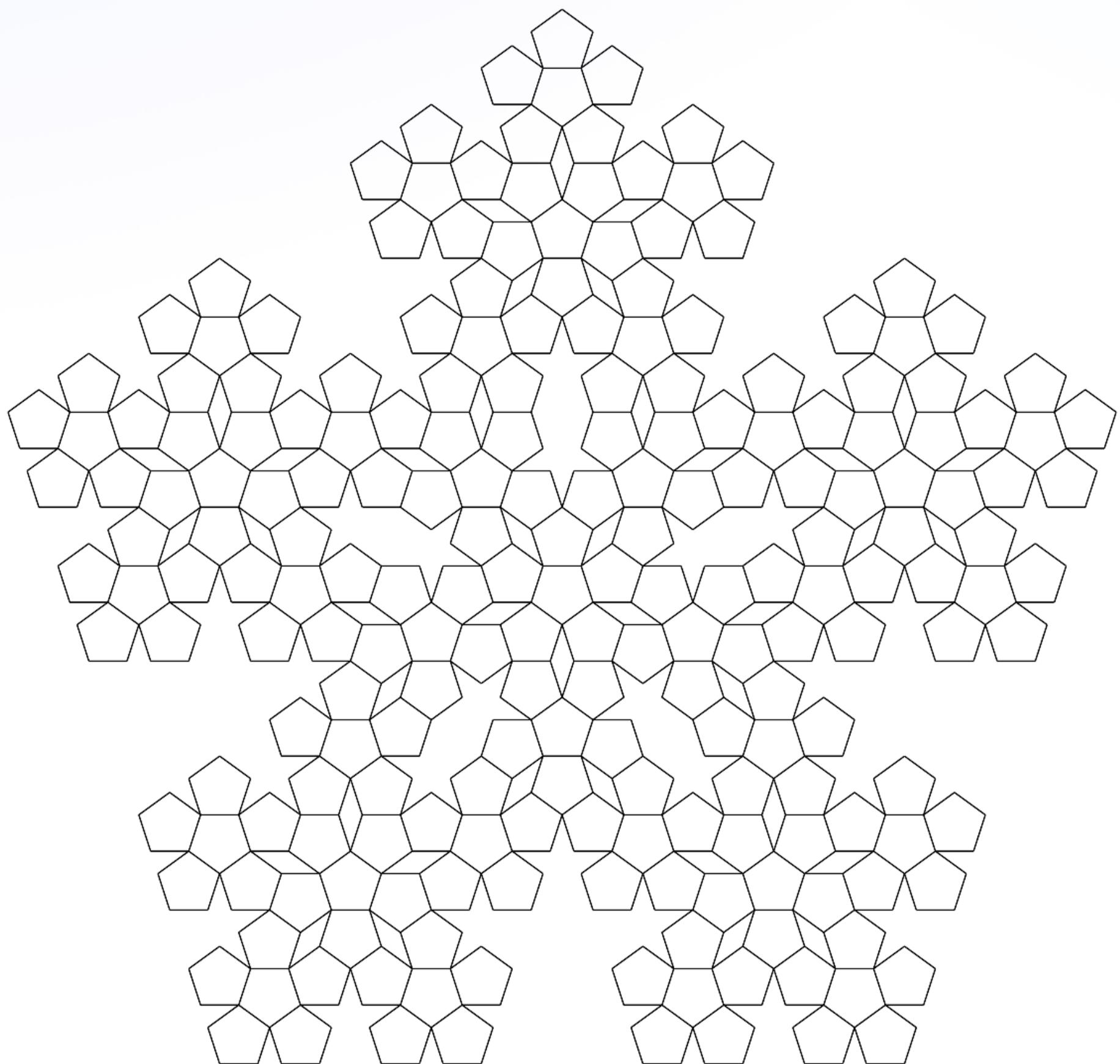
Progress - Crystal



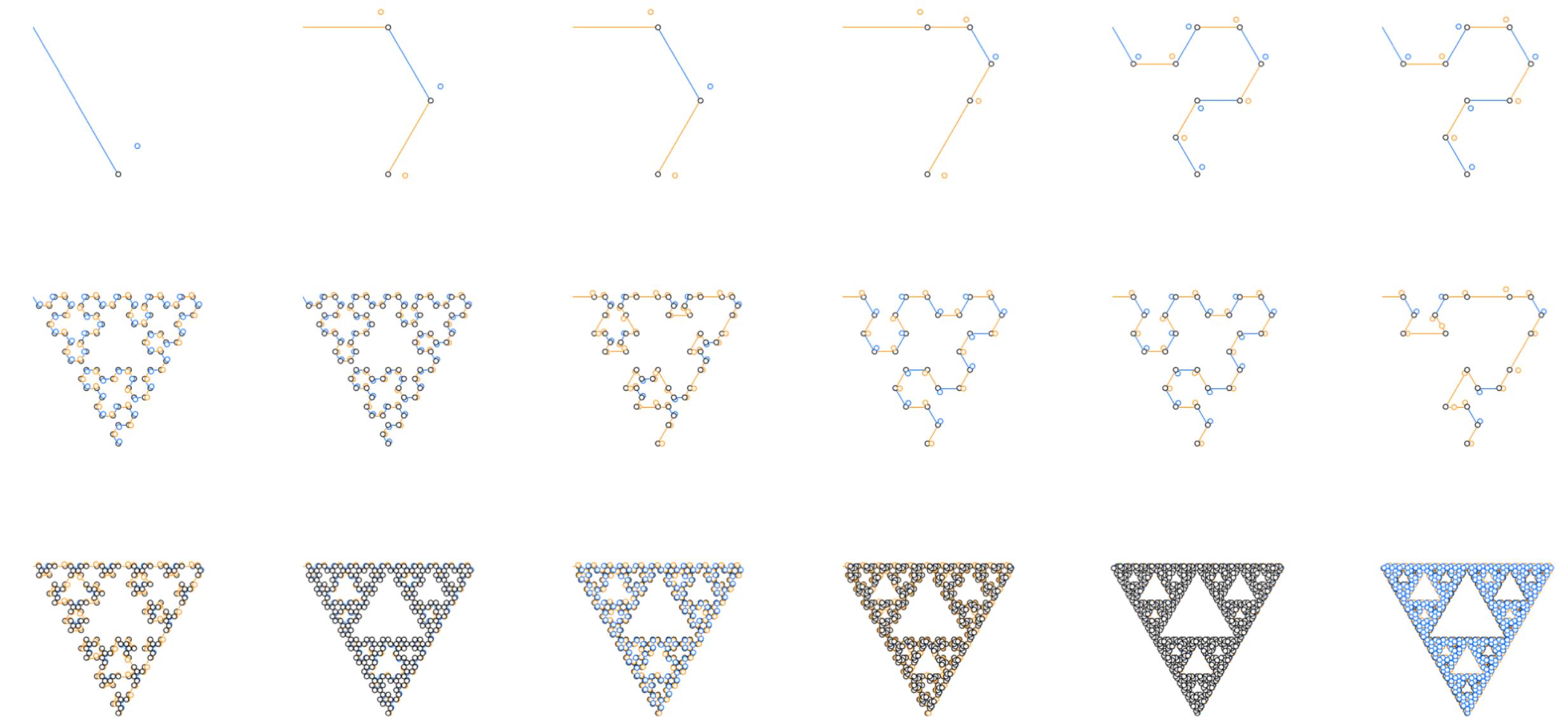
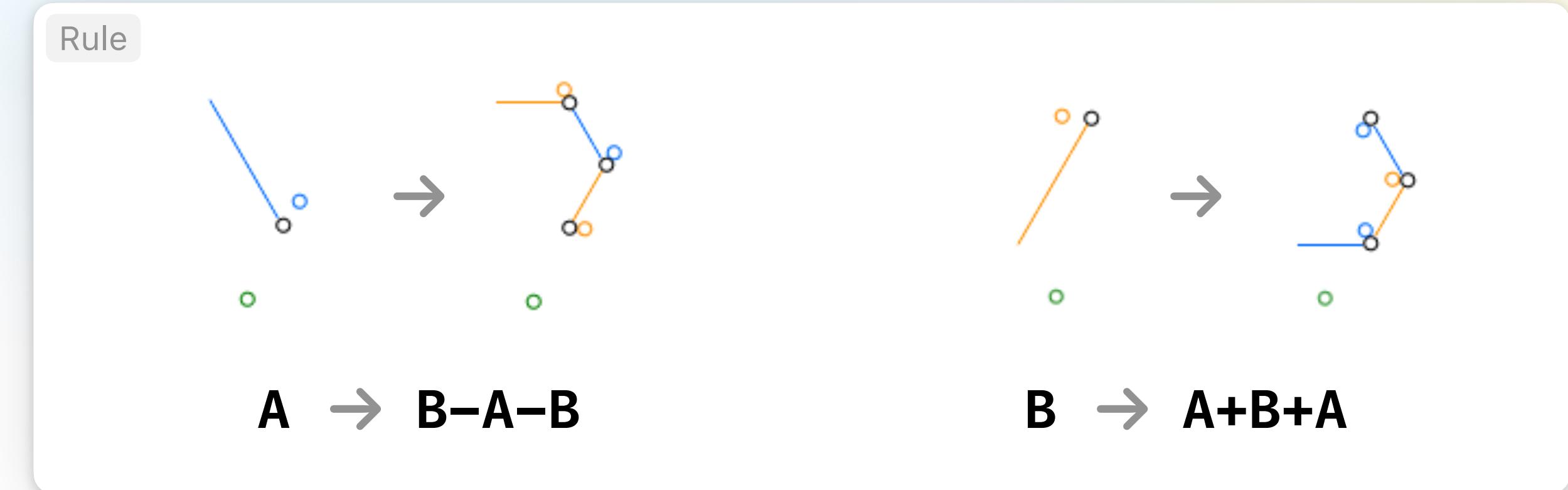
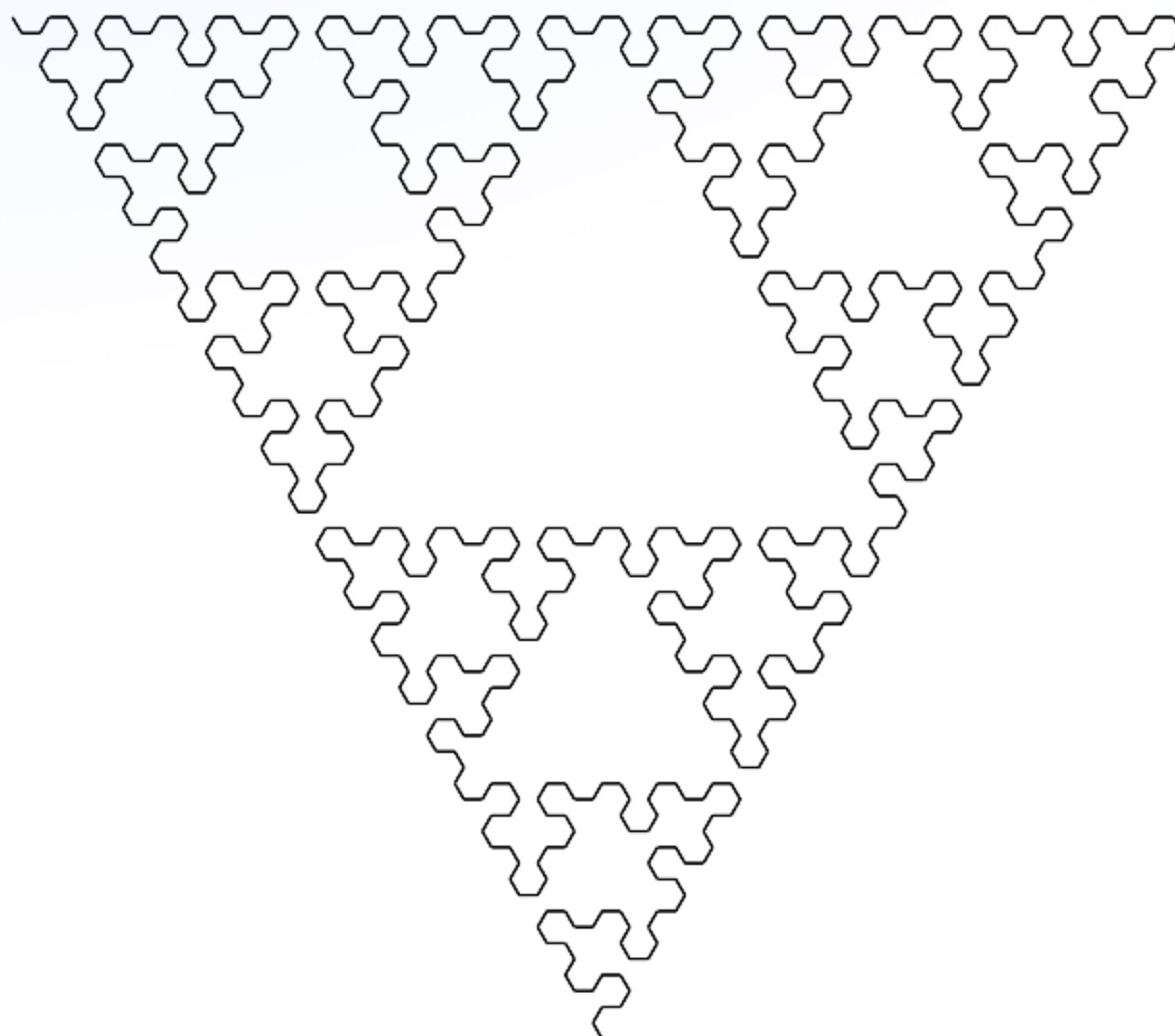
Progress - Ring



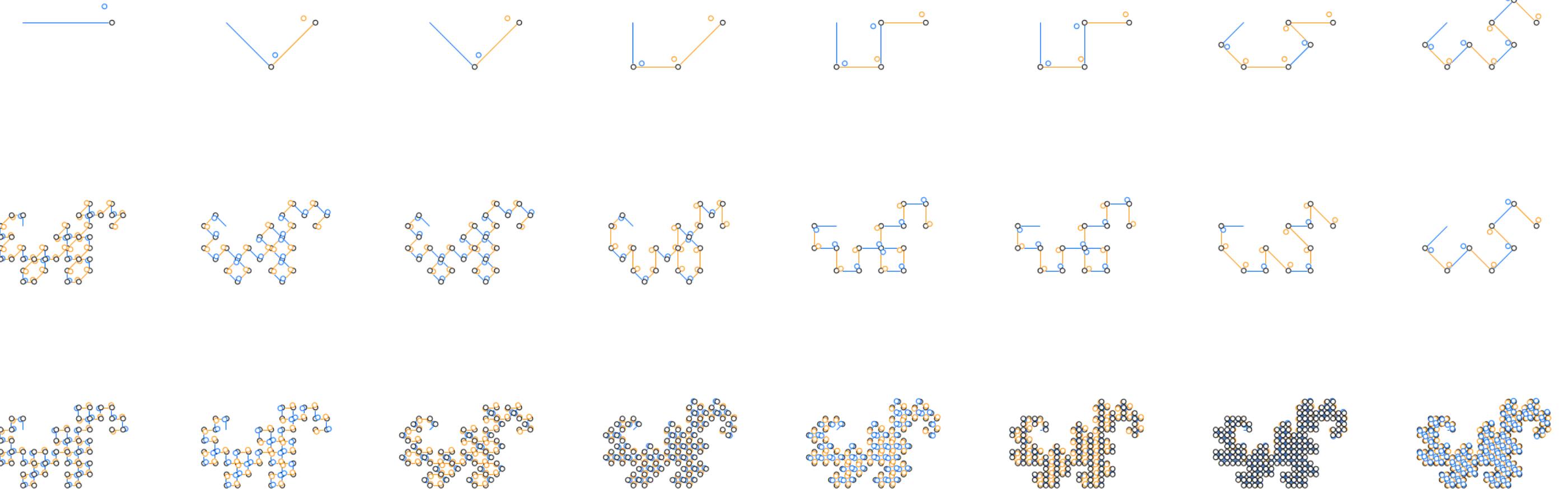
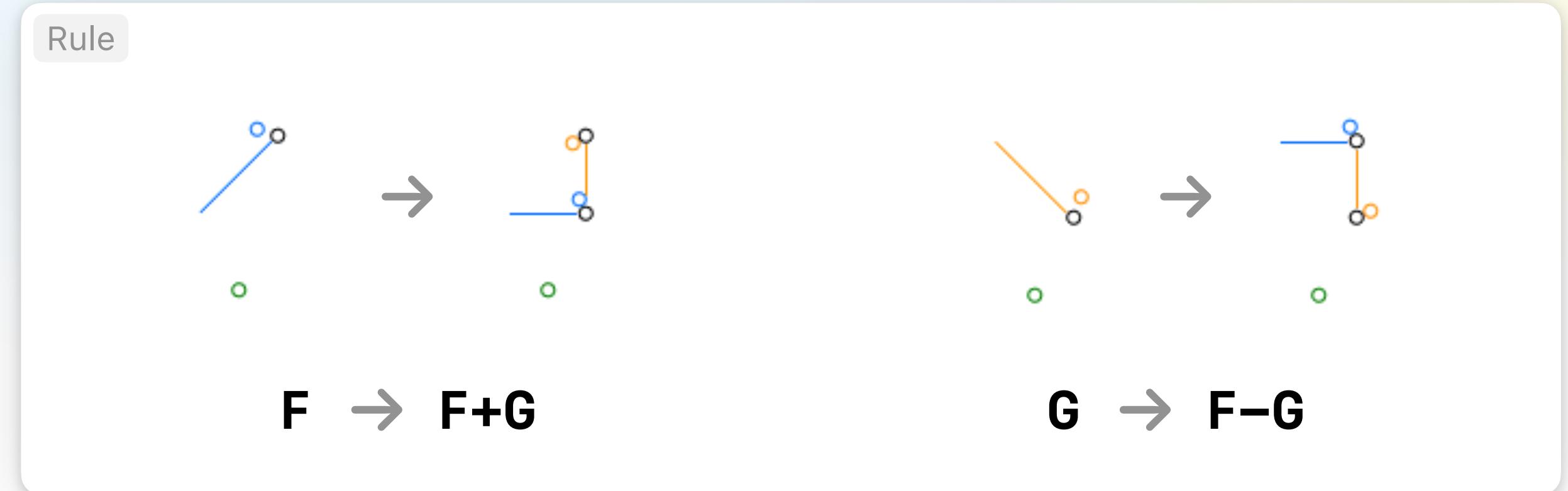
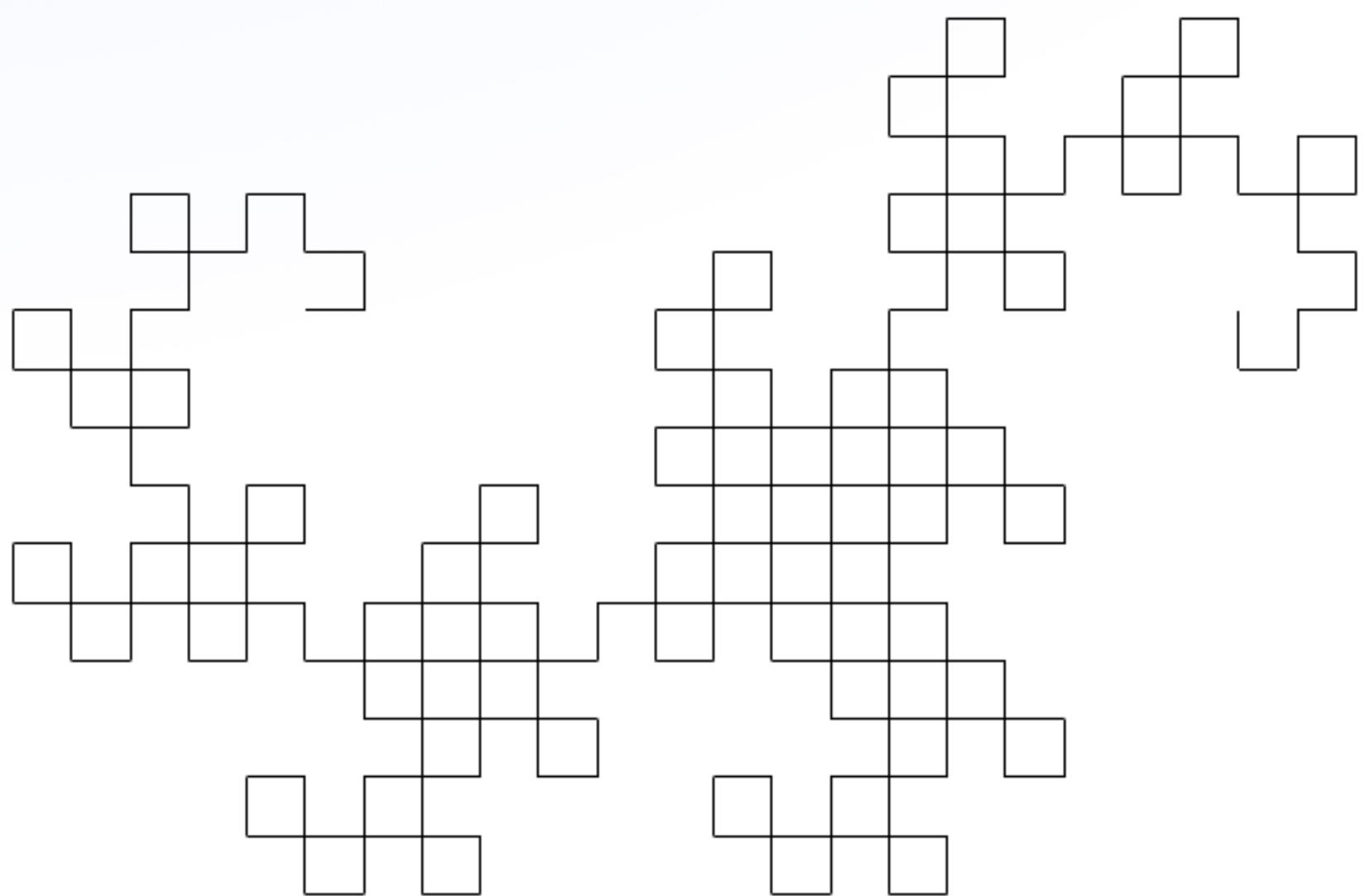
Progress - Pentaplexity



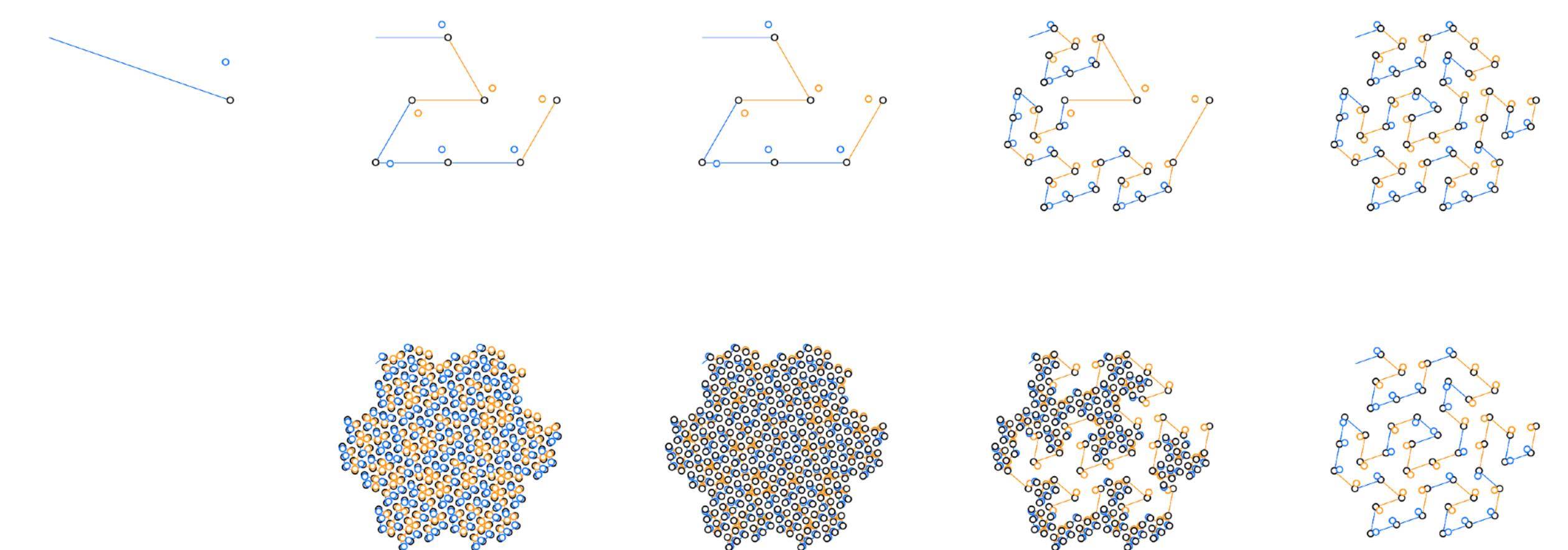
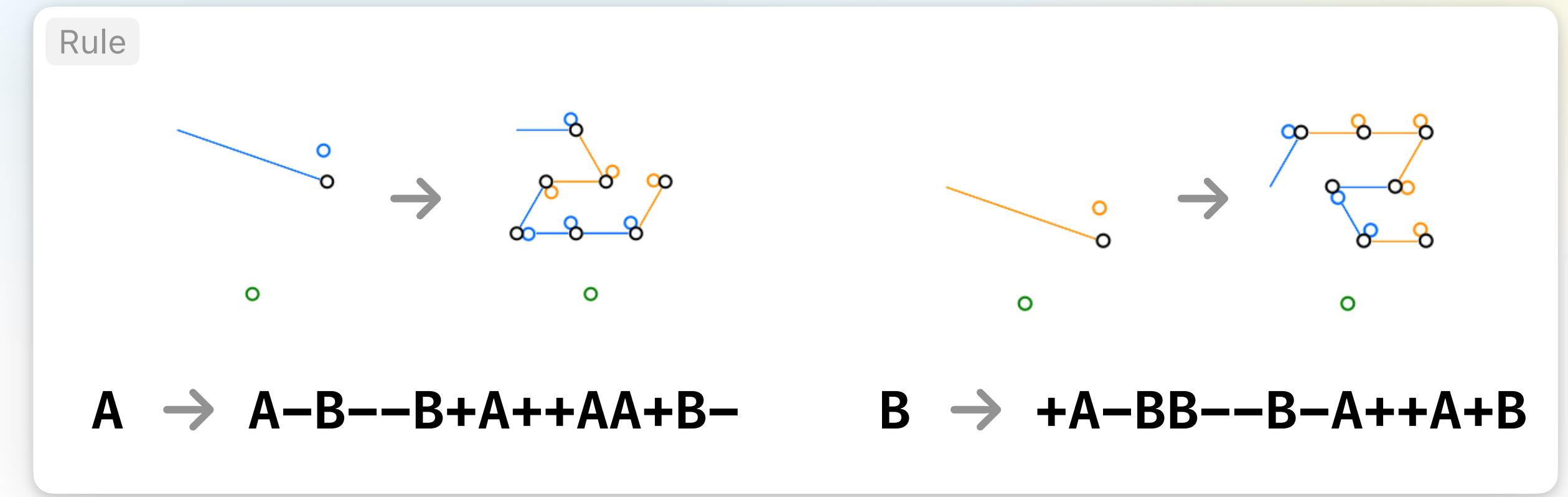
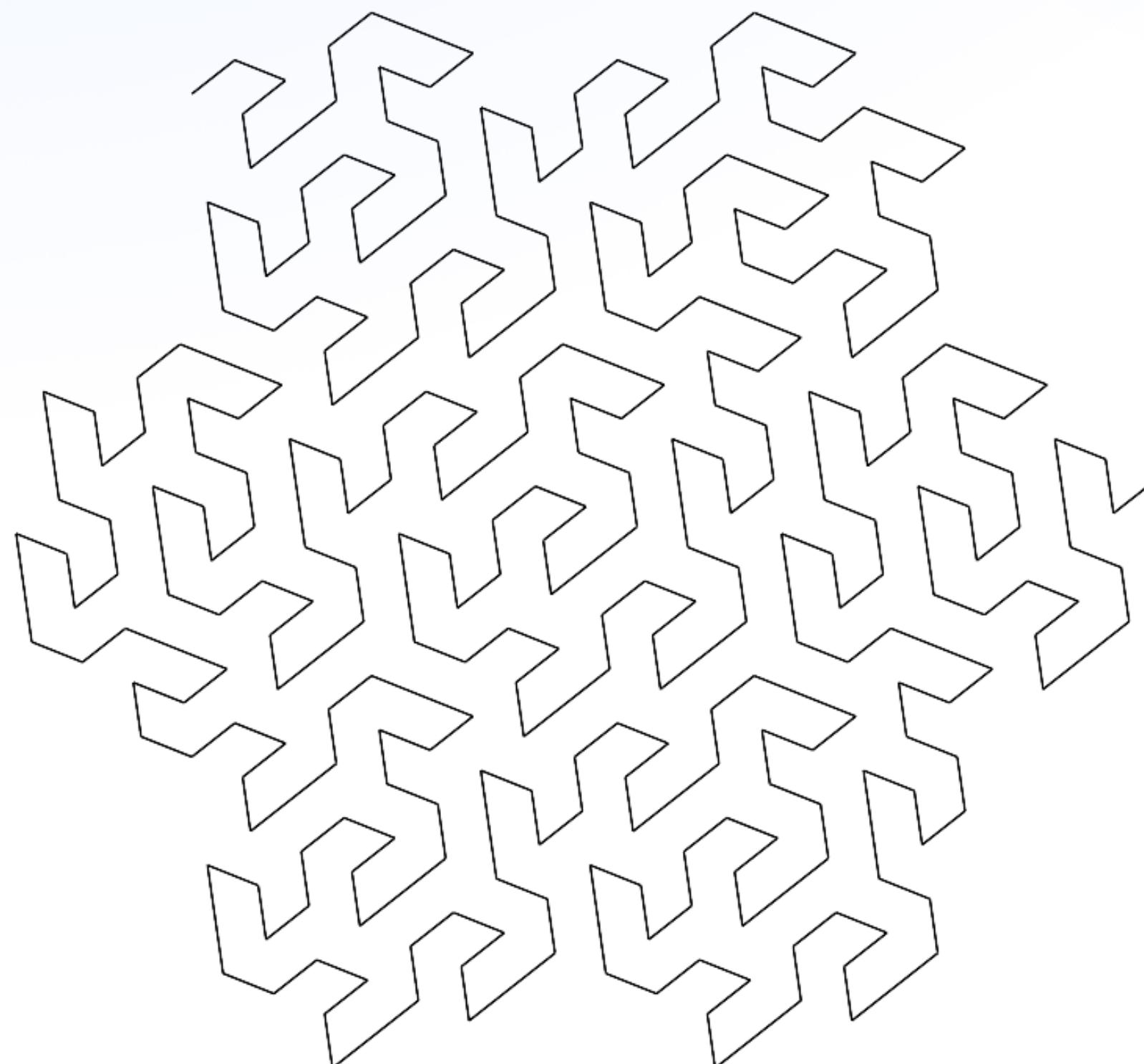
Progress - Sierpiński arrowhead



Progress - Dragon curve



Progress - Gosper curve



Future work

- Add additional attributes/carriers, and rewrite rules to narrow down the search space for Shape Machine.
- Try out some new L-system rules.

Thanks

References

- [1] G. Stiny and J. Gips, "Shape Grammars and the Generative Specification of Painting and Sculpture," in *IFIP Congress*, 1971. [Online]. Available: <https://api.semanticscholar.org/CorpusID:36431081>
- [2] A. Lindenmayer, "Mathematical models for cellular interactions in development I. Filaments with one-sided inputs," *Journal of Theoretical Biology*, vol. 18, no. 3, pp. 280–299, 1968, doi: [https://doi.org/10.1016/0022-5193\(68\)90079-9](https://doi.org/10.1016/0022-5193(68)90079-9).
- [3] P. Prusinkiewicz and A. Lindenmayer, "The Algorithmic Beauty of Plants," in *The Virtual Laboratory*, 1990. [Online]. Available: <https://api.semanticscholar.org/CorpusID:168626>
- [4] P. Bourke, "L-Systems: A Mathematically Elegant Framework for Plant Growth." [Online]. Available: <https://paulbourke.net/fractals/lsys/>