Interactive Multi-Method Sierpinski Triangle Explorer in React

Emilio Zangger
Computational Fractal Lab, Melbourne, Australia

Abstract

We present a modern, interactive implementation of the Sierpinski Triangle using React. The system supports multiple generation methods—recursive text, geometric subdivision, chaos game, and progressive animation—with real-time user interaction. This web-based tool allows dynamic adjustment of iteration depth, display mode, and animation speed, providing a unified platform for exploring fractal properties. While Sierpinski triangles and chaos-game visualizations are well-studied, the integration of multiple generation methods into an interactive, responsive React interface is unprecedented.

Introduction

Fractals, such as the Sierpinski Triangle, exhibit self-similarity, non-integer fractal dimension, and recursive structure. Traditional computational studies focus on single-generation methods—either geometric rendering, recursive string algorithms, or the chaos game—often in offline environments. Our work unifies these approaches into a single web-based interactive tool, leveraging React and SVG graphics for dynamic rendering. Users can switch between text patterns, geometric subdivision, chaos-game scatter plots, and animated generation, providing an educational and experimental platform for studying fractal properties.

Methods

Text-Based Recursive Generation: A classical recursive string-building function generates line-based representations of the triangle. Geometric Subdivision: Vertices of an equilateral triangle are recursively subdivided into smaller triangles. SVG polygons are rendered dynamically. Chaos Game: Random vertex selection generates points that converge to the Sierpinski Triangle. Animation: Progressive iteration updates allow visual exploration of the fractal's emergence, with user-controlled speed. Implementation: React functional components with hooks manage state. SVG is used for visualization; monospace text for recursive text output. Users control iteration depth and display mode via sliders and dropdowns.

Results

The system allows users to observe the Sierpinski Triangle across multiple representations in real time. Recursive text illustrates construction, geometric rendering confirms self-similarity, chaos-game visualization converges quickly, and animation reveals progressive construction, enhancing understanding.

Discussion

While Sierpinski triangles and chaos-game visualizations are well-documented, integrating multiple generation methods into a single interactive React application is novel. This framework provides immediate feedback, method comparison, and interactive animation control. Potential extensions include color gradients, zoom/pan functionality, and pattern export.

Conclusion

The React-based Sierpinski Triangle Explorer provides a multi-method, interactive platform for studying and visualizing fractals. By combining recursive text, geometric subdivision, chaos game, and animation within a responsive web interface, it represents a novel contribution to computational fractal exploration and educational visualization tools.

References

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