Stig-ma

Generative Architecture through Stigmergic Agent-Based Interactions

The objective of this final project was to develop an interactive computational tool for visual art and design expression using Processing. The created tool enables users, without requiring programming knowledge, to explore generative visual forms and patterns through intuitive agent-based interactions.

The tool includes:

- A user-friendly graphical interface allowing users to interact with visual agents.
- Real-time creation and manipulation of visual patterns generated through dynamic agent behaviors.
- Features for editing visual forms, including adjustable parameters such as agent speed, color palettes, and interaction strength.
- An export functionality to save compositions directly from the interface.
- A series of example compositions demonstrating the range and versatility of patterns achievable with the tool.

Concept and Motivation

Inspired by complexity theory and natural systems, this project aimed to bridge the gap between generative art and user-driven visual exploration. Unlike conventional art creation tools, this tool leverages computational agents exhibiting autonomous yet controllable behaviors, creating a dynamic intersection between chaos and order. It is intended for artists and designers seeking generative approaches without diving into the complexities of coding.

The title "Stig-ma" is derived from the Greek "stigm" (στίγμα), meaning mark or point, and conceptually relates to "stigmi" (στιγμή), meaning moment. This symbolizes capturing distinct moments or states from the generative simulations, transforming ephemeral agent behaviors into tangible, architectural artifacts.

Process and Development

The development process began with an initial conceptualization phase, where key interactions such as agent attraction, repulsion, and flocking behaviors were defined. Balancing complexity with usability guided the subsequent stages. This was followed by the design and implementation of an intuitive graphical user interface (GUI) featuring real-time manipulation through sliders and toggles, providing immediate visual feedback to facilitate user experimentation and iterative refinement.

Algorithmically, the core of the tool employed principles inspired by Craig Reynolds' flocking algorithms. Optimizing computational performance became essential, particularly for handling large populations of interacting agents efficiently. After simulations reached visually appealing states, point data were exported as .obj files and imported into Blender and MeshLab for further processing. In Blender, a node-based workflow transformed point data into volumetric forms, which, after cleaning and filtering, resulted in clean mesh representations of interconnected termite trails. Conversely, in MeshLab, mesh reconstruction was approached differently, recalculating point normals and applying a "watertight" Poisson surface method to produce spatially rich, architectural forms. Iterative cycles of 3D printing these models refined the process and established a streamlined method for artifact generation.

Challenges and Solutions

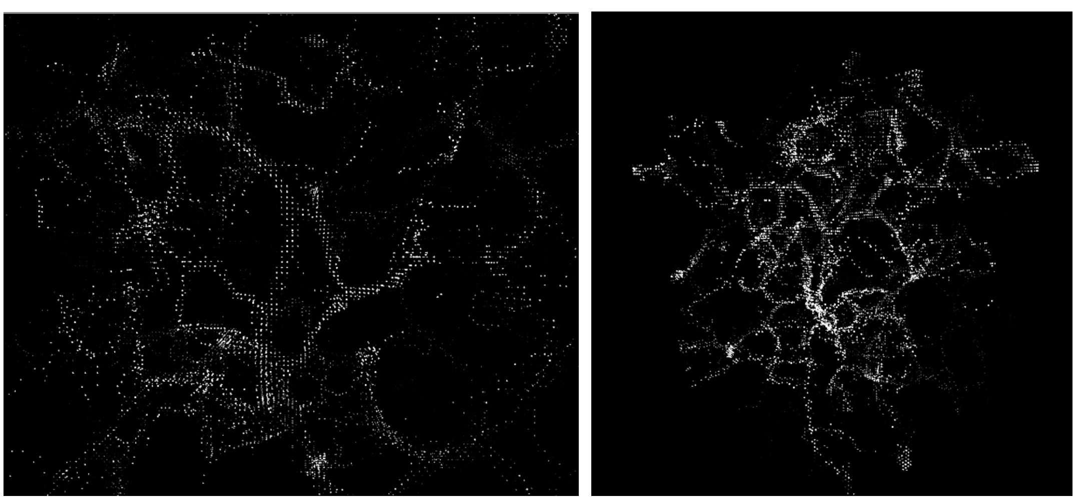
- Performance Optimization: Achieved through efficient spatial partitioning and optimized collision detection.
- User Interface Intuitiveness: Improved iteratively based on peer feedback to ensure ease-of-use and accessibility.

Future Work

Future improvements include expanding export options to include vector graphics, introducing additional interactive agent behaviors, and enhancing performance optimization for larger-scale compositions. Furthermore, I aim to incorporate collective intelligence into the simulation by integrating brain organoid firing data and to introduce additional parameters and environmental factors to enrich the behavioral complexity of the agents.

Course Self-Assessment

Throughout the course, I consistently engaged deeply with weekly assignments, refining technical skills and conceptual understanding. Participation in reading reflections and class discussions allowed meaningful exploration of computational art practices. My final project represents a synthesis of these skills, though opportunities remain for further technical optimization and conceptual exploration in future iterations.



Left Image: 2D Export / Right Image: 3D Image export from the Simulation in Processing.

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