SOUTHWESTERN UNIVERSITY

Evolving an Infinite Art Gallery Using Compositional Pattern Producing Networks

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Introduction

Compositional Pattern Producing Networks (CPPNs [1]) are a type of neural network that has been used to create many types of artistic and creative output. The Infinite Art Gallery is a project that uses CPPNs to create various forms of novel art and present them to a player in the form of a game. The evolutionary algorithm NEAT (NeuroEvolution of Augmenting Topologies [2]) was incorporated into the Unity game development environment. NEAT was then used to produce different types of artwork that are presented to the player in a procedurally generated gallery and are continuously evolved based on the player's choices.

Related Work

The Infinite Art Gallery incorporates several previous approaches used in the generation of evolved art, including Picbreeder and Endless Forms. Picbreeder [1] showed that artistic two-dimensional images could be produced by evolved CPPNs. Endless Forms [3] expanded upon Picbreeder to add a third dimension to the inputs and a new output that determined if a single unit coordinate in a three-dimensional space (voxel) was present in the produced form.

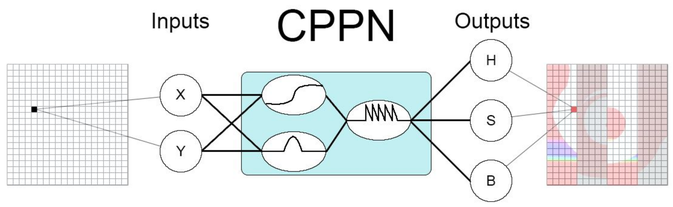

Fig. 1 - Illustration showing signal processing through an example CPPN for a two dimensional image. Inputs shown are x and y coordinates which are processed through various functions (nodes) into three outputs for hue, saturation, and brightness which determine the color of the pixel at those coordinates.

Infinite Art Gallery

The Infinite Art Gallery uses neural networks to create two-dimensional and three-dimensional artifacts and present them to the player. The player selects works that are interesting to them and continues to explore the gallery. As the player explores, the gallery evolves the CPPNs that created the selected works and presents new creations.

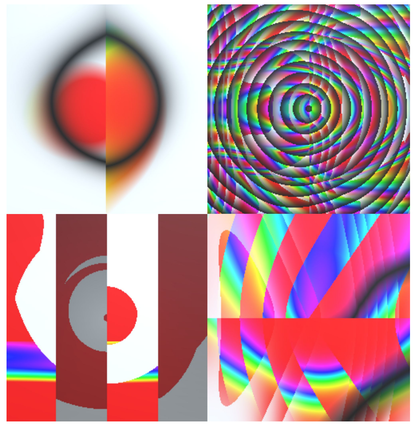

Fig. 2 - Two-dimensional artwork generated by CPPNs

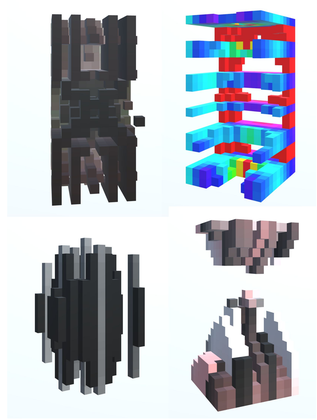

Fig. 3 - Three-dimensional sculptures generated by CPPNs

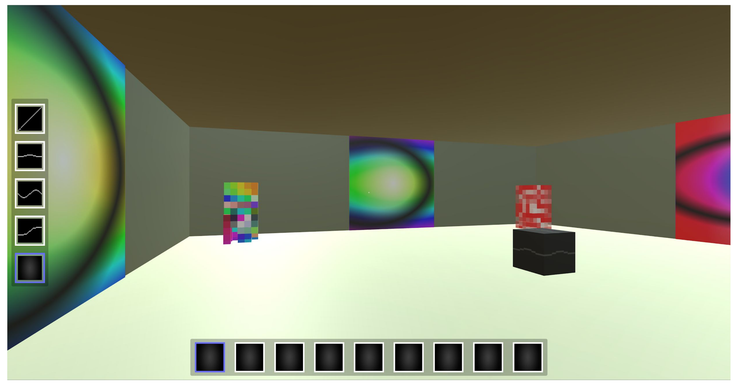

Fig. 4 - Full gallery interface screenshot showing activation function inventory on the left side, saved artwork inventory on the bottom, generated two-dimensional artwork on the three walls, two three-dimensional sculptures in the corners, and an activation pickup in the center of the room.

Game Features

- Two and three dimensional artwork to explore
- Item pickups add more complexity and features to the evolved CPPNs, influencing the final artwork
- Artwork inventory saves specific CPPNs for later use
- Reversing travel through the gallery rewinds selections, allowing for alternate paths to be explored

Fig 5 - Activation function inventory bar with 5 functions active.

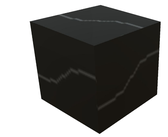

Fig 6 - TanH function item pickup in game.

Fig. 7 - Sculpture with transparency option activated.

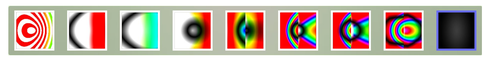

Fig. 8 - Saved artwork inventory bar with examples of each evolution in a series.

Human Interaction

With the gallery capable of providing artwork to explore, the next stage is to expose the game to human subjects for evaluation.

References

[1] Jimmy Secretan, Nicholas Beato, David B. D'Ambrosio, Adelein Rodriguez, Adam Campbell, Jeremiah T. Folsom-Kovarik and Kenneth O. Stanley. Picbreeder: A Case Study in Collaborative Evolutionary Exploration of Design Space. Evolutionary Computation 19:3 (2011), 373-403.

[2] Kenneth O. Stanley and Risto Miikkulainen. Evolving Neural Networks through Augmenting Topologies. Evolutionary Computation 10:2 (2002), 99–127.

[3] Jeff Clune and Hod Lipson. Evolving 3D objects with a generative encoding inspired by developmental biology. European Conference on Artificial Life (2011), 144-148.