

Stanley, Kenneth O., David B. D'Ambrosio, and Jason Gauci. "A hypercube-based encoding for evolving large-scale neural networks." *Artificial life* 15.2 (2009): 185-212.

This paper introduces a technique to improve the evolution and encoding of Artificial Neural Networks by allowing such networks to use spatial information about inputs. This technique, called HyperNEAT, uses Compositional Pattern Producing Networks to assign weights to the connections in an ANN. By putting spatially meaningful coordinates through mathematical functions to assign these weights, the artificial neural networks can more easily recognize the same pattern at different locations in its input, or with inputs of different resolutions. These capabilities are tested with ANNs evolved to solve visual discrimination and robotic food gathering tasks.

The HyperNEAT approach to evolutionary neural networks seems entirely appropriate for our Connect-Four strategy evolution project. One could consider the task of evaluating the state of a Connect-4 game very similar to simple pattern finding in a 2-D image plane, much like the first experiment by Stanley. The Connect-4 board being is essentially a trichromatic 7x6 grid of pixels. In both cases, the inputs have fundamental relationships to one another based on their geometry. In both cases, a network trying to solve the tasks would have to recognize the same pattern between multiple different groups of inputs. The CPPN used allows such recognition to evolve only once and be applied to multiple areas of the input grid. This paper also provides a useful Appendix A containing the parameters for the visual discrimination experiment, which we can use as a starting point in our own experiments.