NEAT

NeuroEvolution of Augmenting Topologies

Overview

- NEAT was derived from Neuroevolution (NE) after realizing that introducing evolving topology can lead to increased performance
- NEAT solves three main questions that occur when adding Topology and Weight Evolving Artificial Neural Networks (TWEANNs) to NE:
  - Is there a genetic representation that allows disparate topologies to crossover in a meaningful way?
  - How can topological innovation that needs a few generations to optimize be protected so that it does not disappear from the population prematurely?
  - How can topologies be minimized throughout evolution without the need for a specially contrived fitness function that measures complexity?

Solutions

- To solve the issues laid out from NE, NEAT was specially designed using these techniques:
  - Genetic Encoding
    - Each genome has a list of connecting genes that each connect two node genes
  - Tracking Genes through Historical Markings
    - Tracking works by assigning genes global innovation numbers which correspond to the chronological order in which they were generated. This allows the system to identify originating genes throughout evolutions
  - Protecting Innovation through Speciation
    - By dividing the population into species, individuals compete within their own niche instead of the entire generation. This protects topological innovation and allows time for them to optimize their structure.
  - Minimizing Dimensionality
    - By starting off with a uniform population of networks and utilizing speciation, the algorithm is more efficient than the TWEANN version that uses more effort creating structures for random topologies at the beginning.

Source

Efficient Evolution of Neural Network Topologies
http://nn.cs.utexas.edu/downloads/papers/stanley.cec02.pdf