A Farewell to Structural Rigidity: Topological evolution in autoencoder design

September 23, 2015

# Project Overview and Initial scope

Autoencoders play an important role in learning efficient, compressed encodings and have been experimentally shown to be effective at compressed feature extraction and artificial neural network pre-training. However, the vast majority (if not all) autoencoders have a rigid, manually designed structure, leaving the often baffling task of designing the network topology in the hands of a human architect; an undertaking that can quickly get exceptionally tedious.

With the introduction of neuroevolution in the early 90’s and its landmark refinement with NEAT, the advantages of evolving ANN topologies have included relieving researchers and practitioners of the tedious task of manually network architecture and have resulted in more efficient network encodings through principled addition of structure. Given the aforementioned successes, our group wishes to test the hypothesis that neuroevolution will yield similar benefits for the evolution of autoencoder toplogy. Specifically, our experimental approach will be primarily focused in the image recognition domain and consist of the following stages:

1. Generate initial population of minimally connected autoencoders
2. Optimize the autoencoder weights using standard backpropagation (which will need to be implemented to backpropagate over arbitrary topologies) using a training dataset.
3. Present a validation set to the autoencoder and score.
   1. This score will be the fitness function for NEAT to produce the next generation of autoencoders.

Evaluation criteria will be focused on:

1. Quantitative assessments
   1. To what magnitude of error does the autoencoder approximate the identity function
   2. How well does the autoencoder generalize given the validation set
2. Qualitative assessments
   1. Does the autoencoder learn interesting, salient features about the image presented
   2. How well does the autoencoder reproduce the image

# Initial Tasking

In general, tasking will be allocated as follows:

* Christopher Ross
  + Overall project vision and guidance
  + Experiment Design (primary)
  + Backpropagation implementation
  + Paper authoring (secondary)
  + Experiment execution (secondary)
  + Results analysis (primary)
* Jonathan Brant
  + Experiment implementation (secondary)
  + Experiment design (secondary)
  + Evolution implementation
  + Results analysis (secondary)
  + Paper authoring (primary)
  + Presentation development (secondary)
* Zak Roessler
  + Experiment implementation (secondary)
  + Experiment execution (primary)
  + Results analysis (secondary)
  + Presentation development (primary)
  + Paper authoring (secondary)

# Project Milestones

