Kevin Kenneally
Major: Computer Science, Mathematics

Machine learning algorithms can be broadly grouped into two separate functional forms – generative and discriminate algorithms. Discriminative algorithms attempt to define a mapping from the space of inputs χ to the space of target outputs Y by modeling the conditional probability distribution $p(y|x)$. For example, in a classification problem where we are asked to distinguish between cats (y = 0) and dogs (y = 1) based on given features x_i, a discriminative algorithm would learn a decision boundary to partition the feature space χ into points classified as cats (y=0) and dogs (y=1). On the other hand, generative algorithms attempt to define a model for generating all possible outputs Y from the space of inputs χ by modeling the joint probability distribution $p(x, y) = p(x|y) * p(y)$. While the predictive powers within task of generative and discriminative algorithms are equivalent, generative algorithms may be better suited to modeling high-dimensional non-linear relationships enabling greater predictive power out of task (*generality*).

Building on prior research exploring the relationship between generative and discriminative algorithms, and recent work from Ian Goodfellow *et al.* on Generative Adversarial Networks (GANs), this thesis will attempt to define a complexity classification schema for generative algorithms. The proposed classification schema will be isomorphic in space and time complexity bounds to complexity classes for discriminative algorithms based on GAN parity. In other words, evolution time with GANs will be used as a heuristic for complexity class isomorphisms. Furthermore, evolution constraints for GANs will be further explored to understand the complementary time and space constraints between generative and discriminative algorithms.

Section Outline:

- Algorithm Introduction
    - Discriminative Algorithms / Generative Algorithms
    - Time and Space Bounds
    - Discriminative Classification Schema
- GANs Introduction
    - Building a GAN
    - ROC curves for evolution inputs
    - Modeling evolutionary functional space
- Generative Algorithm Complexity Classes
    - Naive time/space bounds
    - Isomorphism based on data
- Conclusions on schema relationship