Scruff is a framework for building AI systems that sense, reason, and learn in their environment using probabilistic programming, founded on the principles of predictive coding.

Alpha release expected in Fall 2020

Scruff for Predictive Coding

Traditional view: Brain encodes sensory stimuli as they occur; perception flows bottom up from stimuli

Predictive coding (Rao & Ballard, Hohwy, Friston, Clark): Beliefs about the world generate predictions about sensory signals; sensory cortex encodes prediction error; perception results from combination of prediction and error

Predictive coding is hierarchical: predictions are propagated down the hierarchy; errors are propagated up the hierarchy

Scruff implements a Bayesian interpretation of predictive coding: Predictions are priors, errors are likelihoods, and percepts are posteriors

Scruff uses asynchronous belief propagation to manage the propagation of priors and likelihoods as the AI system interacts with its environment

Scruff for Building AI Systems

Scruff is a middleware framework for composing the models and algorithms needed to build AI systems

- Stochastic functions (sfuncs) describe conditional probability distributions
  - May be generative, but do not have to be
  - Current sfuncs include standard discrete CPDs, some continuous CPDs, expanders, mixtures, network sfuncs for composition, and expanders that recursively generate network sfuncs depending on an input

- Operators perform computations on sfuncs
  - E.g., generate a sample, compute a $\pi$ message

- Capabilities describe an sfunc's ability to support an operator, along with metadata such as accuracy and performance characteristics

- Variables are associated with models; instantiating a variable at a particular point in time creates an sfunc derived from its model

- Networks consists of variables and dependencies; the structure of a network can be recursive and change over time

- Algorithms are applied to networks to perform functions such as filtering and online learning by invoking operations on sfuncs for instantiated variables
  - Current algorithms include ABP, particle filtering, lazy structured factored inference for infinitely recursive models