Incorporation of gradient based optimization in a developmental architecture

Summary

Current network models and optimization paradigm of machine learning methods fall short in many fundamental capabilities required for adaptive behavior, most notably including the capacities for inextinguishable variation & selection processes, and structural organization. Currently, our laboratory is working on a new type of architecture (tentatively called CRE) which does not have these limitations, and can develop a high-level network starting from a low-level network that acts as the shared controller of its components - potentially capable of demonstrating structural organization at arbitrary scales and, with the planned modifications in the later stages of the project, ongoing adaptability.

In this project, the student will be analysing the compatibility of this new type of architecture with classical gradient-based optimization (gradient descent - GD) methods, and its effect on adaptive speed when it is used in conjunction with GD.

More specifically, your tasks will be:
- To implement GD for a network built by a dedicated network library (NetworkX) and interface with existing implementation of CRE.
  - Note that the student is not required to understand the details of this new method or to use it in itself - only the interfacing with its end-products is to be done.
- To perform and analyse experiments that on the effect of this new architecture (augmented with GD) compared to a network trained only by GD, on criteria including general performance, adaptive speed, and adaptation to structurally varying tasks.
  - The initial experiments will be conducted on simple function approximation tasks in a structured compositional setting. (See Alet et al. below for more details.) Other tasks can be experimented with if project schedule permits.

Type: Semester project

Requirements:
- Familiarity with Python (no familiarity required with any specific ML library since none will be used)
- Familiarity with neural networks trained with gradient descent
- Familiarity with evolutionary algorithms: Not required, but a plus.

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References