HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM
RESEARCH PROJECT #: HPCMP-HIP-24-027

Semi-Autonomous Methods for Novel Neural Network Designs

About ERDC-ITL:

US Army Engineer Research & Development Center's Information Technology Laboratory lead research and development in informatics, computational science, and computational engineering with an emphasis on high-performance computing, computer-aided and interdisciplinary engineering, computer science, systems engineering, and instrumentation systems.

RESEARCH LOCATION: Vicksburg, MS

PROJECT DESCRIPTION:

The overall design of the technique in this research is a bi-level optimization approach. It involves co-evolutionary mechanics between the two levels enabling open-endedness and, therefore, novel discovery that outperforms current ANN design. It involves autonomously optimizing networks and subnetworks within the networks to produce never-before-seen neural designs that capture previously undiscovered features, connections, and relationships within data.

The project includes:

- Design the evolutionary algorithm for the optimization of the subnetworks of the ANN architecture. Methods will be developed to create the flexible encoding space and operators within the evolutionary algorithm.
- Design the evolutionary algorithm for composing the network of the subnetworks evolved in above. Encoding and evolutionary operators will follow the above specifications allowing for discovery of novel designs as well as novel relationships in data.
- Combine the two algorithms into an open-ended framework for knowledge discovery. Co-evolutionary functions connecting the subnetwork and network level algorithms.

Under the guidance of a mentor, the intern(s) will:

- Read current literature within the topics of neural architecture search and evolutionary algorithms to quickly bring them up to speed on current best practices within the field as well as motivate them regarding the goals of the project. Will be involved in one of the following two depending on the skill level of the interns themselves. Each of these will involve daily (and likely more often) check-ins for progress, questions, and directional decisions.
    - Coding of classes for the evolutionary algorithm to be utilized in the research
    - Data procurement, cleaning, and preparation

- Read current literature within the topics of co-evolution, complex systems, and open-endedness to quickly bring them up to speed on current techniques within the field as well as motivate the second stage of the project. Perform one of the following two depending on skill level. Each of these will involve daily (and likely more often) check-ins for progress, questions, and directional decisions.
  - Coding of co-evolutionary mechanics of the evolutionary algorithms that will communicate to each other
  - Organization and preparation of literary benchmarks for validation of the techniques
- The interns will present their reports and if they desire, assistance in editing and co-authorship of technical reports generated.

ANTICIPATED START DATE:

May 2024 – Exact start dates will be determined at the time of selection and in coordination with the selected candidate.

QUALIFICATIONS:

Preferred (NOT REQUIRED) knowledge with below in priority order:

- Python
- Pytorch
- Neural Networks
- Evolutionary Algorithms

Preferred (NOT REQUIRED) interests:

- AI / ML
- Deep Learning
- Bio-inspired Algorithms Evolutionary Algorithms

ACADEMIC LEVEL:

Degree received within the last 60 months or currently pursuing:

- Bachelor's
- Master's
- Doctoral

DISCIPLINE NEEDED:

- Computer, Information, and Data Science
- Engineering
- Science & Engineering-related