

# HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM

## RESEARCH PROJECT #: HPCMP-HIP-25-048

### **Explainable Artificial Intelligence (AI) for Multi-Domain Combat Simulation**

#### **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 purpose of this project is to research and demonstrate the use of explainable Artificial Intelligence (XAI) for reinforcement learning (RL). This research will be applied to interpret behaviors and strategies used by RL agents in a Multi-Domain Military Simulation Environment.

The main outcome of this effort is to deliver a written evaluation of Explainable AI (XAI) techniques within the context of reinforcement learning (RL) for mission engineering. Explainable reinforcement learning is a cutting-edge area that remains under explored, especially within the defense sector. Given that the application of XAI in combat simulations is relatively new, this project will offer students a unique research opportunity in a highly specialized field.

#### **Key Activities:**

- 1. Theoretical Investigation:** The intern will begin by conducting theoretical research into XAI methods specifically designed to explain the behavior of RL agents. This will provide the foundational knowledge necessary to understand how RL decisions can be interpreted and made transparent.
- 2. Hands-On Research:** The intern will then engage in practical research to analyze the behavior of RL agents in a combat simulation environment. By exploring how the RL agents learn and adapt to complex, mission-based scenarios, the intern will gain critical experience in applying AI to real-world defense challenges.
- 3. Data Analysis Using HPC:** The intern will use High-Performance Computing (HPC) resources to process and analyze the data generated by the RL agents. This will allow for in-depth exploration of how XAI techniques can be used to provide insight into the decision-making processes of the agents.
- 4. Documentation of Progress:** Throughout the project, the intern will maintain records of their research. This documentation will include roadblocks or obstacles encountered. Resources used to solve these challenges. Insights gained and their importance to the overall research. Bibliography of the sources consulted. New ideas or questions that emerged as a result of working through obstacles

Week 1: Provide the intern with a detailed overview of the project goals, core technical challenges, and XAI techniques. Begin building a "work in progress" document to track project development.

Week 2: Setting up the environment, set up an HPC account, ensuring access to required tools. Install and configure the necessary combat simulation application.

Week 3: Mission Scenario being simulated and deploy an RL agent within the combat simulation environment. Familiarize with the RL agent's role and behavior within the simulation.

Weeks 4-6: XAI Technique Implementation designed specifically for RL agents. Creating explainability models for different states, actions, and decision-making processes of the RL agent.

Weeks 6-8: Conduct research on the effectiveness of XAI techniques in providing insights into the behavior of RL agents. Evaluate how well XAI helps explain agent actions and whether it increases interpretability for end-users.

Weeks 8-10: Documentation and presentation of the project's results, including key findings, analysis, and conclusions regarding the effectiveness of XAI in RL environments.

**ANTICIPATED START DATE:**

May 2025– Exact start dates will be determined at the time of selection and in coordination with the selected candidate.

**QUALIFICATIONS:**

- Programming Skills: Proficiency in Python is necessary, as it will be the primary language used for implementing RL models, XAI techniques, and data analysis.
- Data Analysis: Experience with data manipulation and analysis libraries such as NumPy, Pandas, and Matplotlib for analyzing results generated by RL agents.

**ACADEMIC LEVEL:**

Degree received within the last 60 months or currently pursuing:

- Associate's
- Bachelor's
- Master's

**DISCIPLINE NEEDED:**

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