MoonAI – Project Specification Report

CMPE 491 – Senior Design Project I

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Web Page: https://moon-aii.github.io/moonai/

1. Introduction

1.1 Description

The MoonAI project aims to develop a simulation environment that models predator–prey dynamics to investigate and optimize the performance of genetic and evolutionary algorithms. In this virtual ecosystem, evolutionary methods will optimize both population-level parameters—such as movement speed, vision range, and reproduction rate—and individual behavioral strategies. These strategies are represented by artificial neural networks evolved through the NeuroEvolution of Augmenting To...

The project has three main objectives:
1. To design a simulation environment capable of generating synthetic data for machine learning models without relying on real-world datasets.
2. To explore how genetic representations influence learning efficiency and adaptability in dynamic, complex environments.
3. To evaluate the performance of evolutionary computation techniques for adaptive behavior modeling, especially in problems that traditional optimization methods struggle to solve.

By examining predator–prey interactions through evolutionary algorithms, the project provides insights into how adaptive behaviors can emerge autonomously, which can later support research in reinforcement learning, swarm intelligence, and evolutionary robotics.

1.2 Constraints

The development and operation of the MoonAI system are affected by several constraints, categorized as follows:

Economic Constraints:
The project is carried out using freely available and open-source software tools such as C++, SFML, and Python. Hardware limitations, particularly GPU resources for CUDA-based computations, restrict the simulation scale and population size.

Environmental Constraints:
As the project is fully digital, it does not have direct environmental effects. Nevertheless, the team considers computational efficiency to minimize unnecessary energy consumption.

Social Constraints:
The project contributes to the academic and educational community by providing an open-source framework for experimenting with machine learning and evolutionary computation. It has no adverse social consequences.

Political Constraints:
There are no political or regulatory limitations. All utilized tools and datasets are open-access and do not depend on any restricted or region-specific software.

Ethical Constraints:
Ethical responsibility is central to the project. As stated in the ACM Code of Ethics (2018), computing professionals must “avoid harm” and “be honest and trustworthy.” The team commits to transparency, acknowledgment of sources, and fairness in algorithmic decision-making.

Health and Safety Constraints:
The project poses no direct physical risks, as it is software-based. The team ensures cybersecurity practices and healthy working conditions during development.

Manufacturability Constraints:
Since MoonAI is a software platform, manufacturability translates to software maintainability. The architecture is designed to be modular and extensible for future research applications.

Sustainability Constraints:
The project emphasizes long-term sustainability through reusable, well-documented code and the use of energy-efficient algorithms. In line with the IEEE Code of Ethics (2020), the team seeks to “improve the understanding of technology” while considering its long-term impact on society and the environment.

1.3 Professional and Ethical Issues

According to the ACM Code of Ethics (2018), professionals should contribute to society and human well-being, avoid harm, and be fair and respectful toward all. The MoonAI team adopts these principles by maintaining academic integrity, providing open access to non-sensitive components, and accurately reporting results.

The Software Engineering Code of Ethics (IEEE-CS/ACM, 2018) emphasizes the duty of software engineers to ensure that their products meet the highest professional standards. In this project, all code contributions, data analyses, and simulation results are documented and version-controlled to promote accountability and traceability.

Additionally, the IEEE Code of Ethics (2020) highlights the importance of honesty, respect for intellectual property, and the avoidance of conflicts of interest. The MoonAI team aligns with these principles by properly citing sources, respecting collaborators' contributions, and ensuring that no proprietary data or algorithms are misused.

Lastly, the project respects the principles discussed in Computer and Information Ethics (Floridi, 2013), recognizing that computational systems should be designed for the greater good, with transparency and fairness as guiding principles.

2. Requirements

Functional Requirements

- Develop a 2D simulation environment modeling predator and prey agents with configurable attributes such as speed, vision range, stamina, and reproduction rate.
- Implement the NEAT algorithm to evolve both neural network structures and weights dynamically.
- Visualize simulation dynamics in real-time using the Simple and Fast Multimedia Library (SFML).
- Collect and log simulation data including population metrics, behavioral trajectories, and network evolution.
- Provide user-adjustable parameters through a configuration interface or file.

Non-Functional Requirements

- Performance: Support real-time simulations with at least several hundred agents using GPU acceleration.
- Scalability: Maintain flexibility to extend agent types, environmental complexity, and evolutionary algorithms.

- Maintainability: Implement modular, object-oriented architecture in C++ for clean and reusable code.
- Usability: Ensure that data visualization and analysis outputs are interpretable and intuitive.
- Portability: Enable execution on Windows and Linux with minimal setup dependencies.

3. References

[1] ACM Code of Ethics and Professional Conduct, Association for Computing Machinery (ACM), 2018.
[2] IEEE Code of Ethics, IEEE Computer Society, 2020.
[3] Software Engineering Code of Ethics and Professional Practice, IEEE-CS/ACM Joint Task Force on Software Engineering Ethics and Professional Practices, 2018.
[4] Floridi, L. (2013). Computer and Information Ethics. Stanford Encyclopedia of Philosophy.