Animal Locomotion and Behavior Simulated by Genetic Algorithms

Project Plan

Team 4

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leaving this for the first draft in case we add more later

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1 Introductory Material

1.1 problem Statement

- The purpose of this project is to explore the development of animal movement patterns and behavior characteristics through genetic algorithms and machine learning. Our system shows us how animal models learn over time in different scenarios and environments. The end goal is for animals to learn how to walk, run, and do other movements; then roam and survive in their environment.
- As this is a research based project, our goal is not to solve a problem in people's daily lives, rather it is to explore the realm of genetic simulation and observe how animal models develop in our simulated environment. We are testing the capabilities of genetic algorithms which can be expanded to other applications which use artificial intelligence or optimization.

1.2 Operating Environment

This is a virtual simulation rendered on the Unity 3d game engine. The engine creates most of the graphical interface, with our code being written on separate script components written in C#.

1.3 Intended Users and Intended uses

Potential uses could be for further research on animal behaviors and movements. We start by simulating simple animal behaviors, but we can later add more complex behaviors. We can use the simulation to predict real-world trends.

We also hope to further development and research on genetic algorithms. Another research-based use is to push the limits of genetic algorithms when it comes to animal simulation.

The application will be used by machine learning researchers to observe trends and changes to the animal and environment. The users may learn what variables have the greatest effect on the animal and what is optimal.

1.4 Assumptions and Limitations

Assumptions:

- The cost will be negligible considering we are not working for pay, using free tools, and the web server is provided.
- The simulation can be run faster than real time in order to get the data we need.

Limitations:

- There is a fixed amount of locomotion behaviors before the animal enters the behavior simulation, including walk, run, and sit.
- There are at least 3 animal species to test including dog, snake, and inchworm.
- Limited by the amount of training data.

1.5 Expected End Product and other Deliverables

End product will be a virtual simulation of animal movements and behaviors using a genetic algorithm/machine learning implementation. The product will be delivered at the end of our second semester in May. We will have the core functionality completed in February.

2 Proposed Approach and Statement of Work

2.1 Functional requirements

The simulation should simulate at least 3 species of animals.

The simulation should result in learned locomotion and behavior.

The database should hold at least 500 generations for analysis.

The website should show a graph of the generations of animals to show improvement over time.

2.2 Constraints considerations

If we use code from an outside source we will provide necessary attribution to the original author.

The website used to observe the development of the models must be easy to use and understand for a user with no technical experience.

2.3 Technology considerations

Our technology stack is Unity and C# for the simulation. Unity will be our 3D environment for the simulation that handles rendering and physics with NVidia PhysX. This engine is very versatile and can handle a physics simulation well. The physics is stable at high speeds so we can run the simulation faster than real time.

Using Unity and the built in physics engine will be good for the reliable integration. However, it is difficult to modify the physics engine. We can write our own extensions but if we run into physics bugs some may be out of our control. Alternatives would be to use a

3rd party physics engine or write our own, but this could introduce new bugs or take an excessive effort.

2.4 Safety considerations

This is a virtual simulation with no safety concerns.

2.5 Previous Work and Literature

Rob made a similar project for HackISU in under 36 hours which serves as our proof of concept and some of the inspiration for this project. We have a general idea that physics simulations are good and reliable in Unity and how to solve some of the anticipated problems, such as how to run the simulation faster. This proof of concept has many flaws because it is from a hackathon, such as a sloppy save and load mechanic, which needs to be redone with proper genome serialization. See reference 4.2.1 for the proof of concept.

2.6 Possible Risks and risk management

Scope issues, engine issues and unforeseen bugs are all concerns that may hinder our progress. Another risk is the possibility of having issues in the technology when communicating between the Unity program and the website.

2.7 Project Proposed Milestones and evaluation criteria

We will have a prototype of our project done by the end of December. The prototype should have at least one animal learning locomotion successfully. The data should be sent to the website to be analyzed and display on the page in a graph or table.

The end milestone is a finished simulation with locomotion and behavior learned for a variety of animals. The data should be sent to the website and have detailed analysis and charts.

2.8 Project tracking procedures

We have a Trello set up and we plan on using git for version control.

2.9 Objective of the task

Further genetic algorithm research. Further machine learning progress on animal simulations.

2.10 Task approach

We plan to use Gitlab, Google Drive, and Trello for organizing our documents and code.

2.11 Expected Results and Validation

We expect the outcome to be a functional simulation and web portal for analysis. The simulation will be very obvious if it works because the animals will learn to walk and do

other activities rather than sitting still. The web portal should display graphs and data about the simulation so it can be analyzed.

3 Estimated Resources and Project Timeline

3.1 Personnel effort requirements

Member	Tasks	Explanation
Rob Quinn	Project/Simulation lead	Leading simulation programming, determining feasibility and new features
Joe Kuczek	Web Design/ Scrum Master	Make website, organize tasks
Kenneth Black	Simulation/ Machine Learning	Push for new development in machine learning algorithms and deep learning models
Andrew McKeighan	Simulation Development	Genetic algorithm programming
Luke Oetken	Simulation/ Machine Learning development Status Reports	Work on machine learning framework development, genetic algorithm development and animal models. Write weekly status reports.
Joey Sogard	Web Design	Create website backend and integration

3.2 Financial requirements

No financial requirements are required for this project.

3.3 Project Timeline

- Project Plan Version 1 - September
- Prototype with some genetic algorithm and website running - December
    - Simulation prototype - October
    - Functional website - November
    - Prototype with machine learning framework - November
    - Full simulation/website integration - December
- Core functionality done - February
    - Machine learning framework/algorithms finalized - January

– All animal models created - February

• Completed application and website - May

– Locomotion training completed for all animals - March

– Other behavior training completed for all animals - April

– All data for locomotion and behavior available on website - April

4 Closure Materials

4.1 Conclusion

Our project will simulate animals with genetic algorithms for the purpose of research and exploring the capabilities of machine learning within the context of animal locomotion and behavior. We will deliver a simulation app that can run different animals in the environment and a website to upload and analyze the data. Our team has experience with Unity, machine learning, and web, so we are qualified to make this project a success.

4.2 References

4.2.1 Proof of concept devpost
https://devpost.com/software/machine-learning-first-steps

4.2 Appendices

Unity
https://unity3d.com