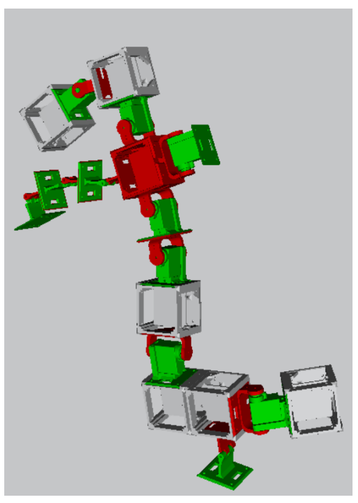
The Impact of a Complexity Cost on Artificially Evolved Robots

Project Overview

In this project populations of simulated robots were evolved for locomotion across a range of increasingly complex environments with and without a cost based on overall robotic complexity. The cost on complexity was imposed as a penalty on the simulation time over which the robot's locomotive ability was evaluated. This experiment was conducted with two different approaches to selection in the evolutionary algorithm: namely objective based selection and selection based on behavioral novelty.

This project was motivated by inconsistencies and gaps in related literature with regard to investigations into evolving complexity and using a complexity metric representative of both morphological (body) and neural (brain) complexity. Additionally, in engineering applications of evolutionary robotics, overall robot complexity directly affects the feasibility of the solutions. Furthermore, simulated evolution can provide insights into the natural evolutionary process which occurs over too large a time scale for concentrated investigation into the conditions under which complexity evolves.

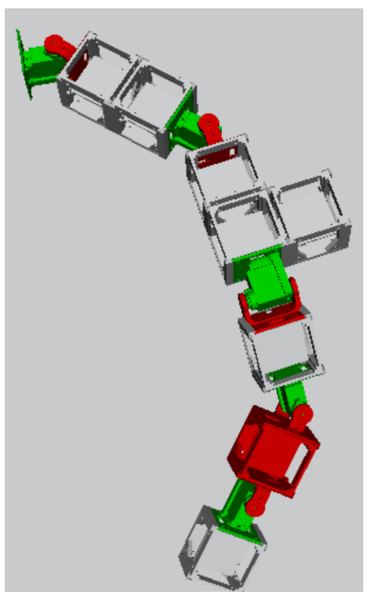


Project Objectives

The main objectives of this research were:

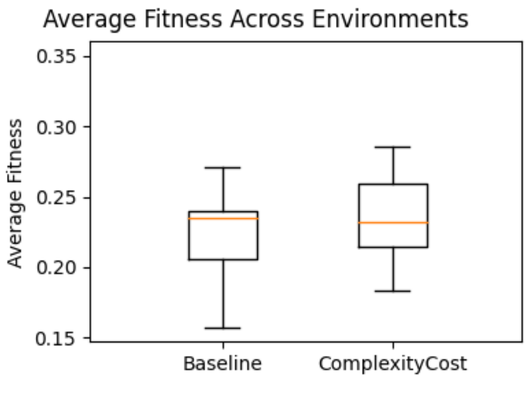
1. To investigate the hypothesis that associating a cost with overall robot complexity during evolution facilitates the evolution of lower complexity robots without sacrificing task performance.
2. To further investigate the environmental conditions under which complexity evolves.

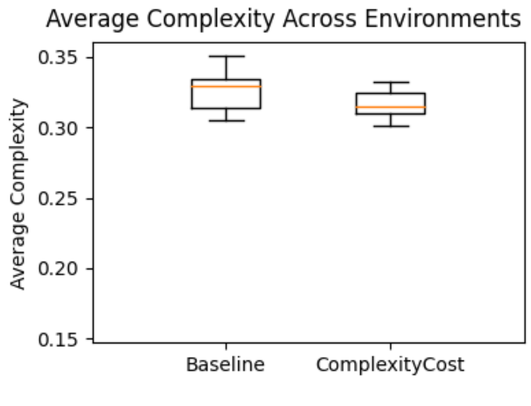
Furthermore, a novel complexity metric accounting for both morphological and neural complexity was presented and applied in this work.



Objective-based Search Experiment

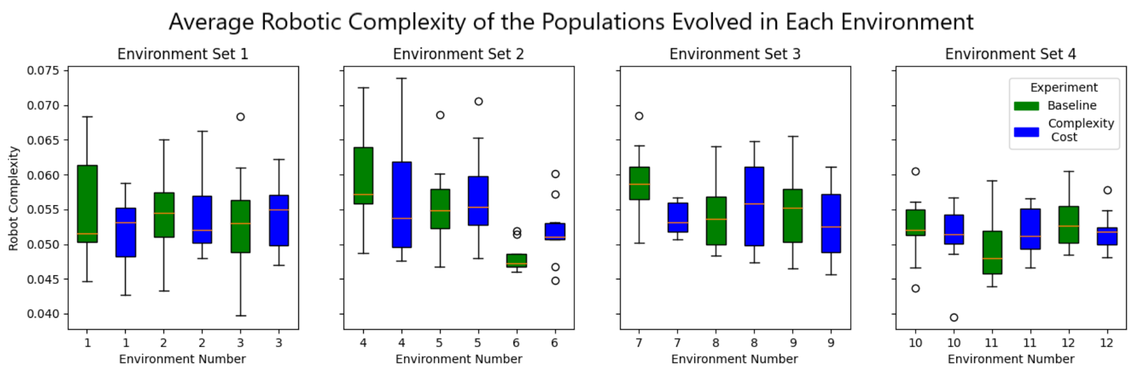
This experiment used a fitness function which quantifies the success of a robot based on the minimum distance it reaches in the environment. It was found that there was no correlation between environmental complexity and the complexity of evolved robot body-brain configurations. However, results indicated that the imposition of a complexity cost on evolution evolved robots of lower complexity despite environmental complexity. The results showed that the imposition of a complexity cost resulted in a greater selection pressure for low complexity, equally performing individuals.





Novelty Search Experiment

Put simply, novelty search selects for individuals that are the most behaviorally different to current robots in the population and past individuals.



The results showed that for almost all environments the imposition of a complexity cost had no statistical impact on the fitness or complexity of the evolved robots. Irregularly spaced and sized obstacles in the environment (set 3) facilitated the development of the highest average robotic complexity but lowest average fitness. The flat (set 1) and inclined environments (set 4) facilitated the evolution of statistically similar robotic fitness and complexity.

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