Comparison of Optimization Techniques for Stateful Black Boxes

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Abstract

Current research into global black box optimization of expensive functions focuses on stateless models such as machine learning hyper parameter optimization. Many real world problems can't be reset back to a clean state after a single evaluation. In this paper, we evaluate the performance of five popular black box algorithms on two stateful models.

Introduction

Related Work

Citing some paper (Jones, Schonlau, and Welch 1998)

Description and Justification

Models

To evaluate these algorithms we trained them on two stateful models.

Death Rate

Many real life models, such as governmental budgeting are nearly impossible to evaluate so we had to come up with an approximation to it. We created a simple model by using the World Bank Development Indicators and training a Gradient Boosted Decision Tree to predict deathrate based off of expenditures in education, health, R&D and military (Bank 2018). To add a stateful component to this, we added momentum, such that changing the parameters produces lag with respect to the death rate.

While this is a very simple model, it does provide some realistic behaviors. Many large systems have a high latency between cause and effect. We're also primarily interested in highlighting the differences between these algorithms.

Airplane

The second model is that of flying an airplane. The Python Flight Mechanics Engine is a project attempting to model every aspect of flying a plane (Team 2018). We used it to model flying a plane to a location. The model takes in the throttle as well as the position of the elevator, aileron and rudder and outputs the distance the plane has flown towards the target. This model has numerous stateful variables that need to be modeled including position, rotation, velocity, direction. There are also many nonlinearities due to air resistance and gravity.

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Experiments and Analysis

Discussion and Future Work

References

Bank, The World. 2018. "Development Indicators." http://data.worldbank.org/indicator.

Jones, Donald R., Matthias Schonlau, and William J. Welch. 1998. "Efficient Global Optimization of Expensive Black-Box Functions." *Journal of Global Optimization* 13 (4):455–92. https://doi.org/10.1023/A:1008306431147.

Team, AeroPython. 2018. "Python Flight Mechanics Engine." https://github.com/AeroPython/PyFME.