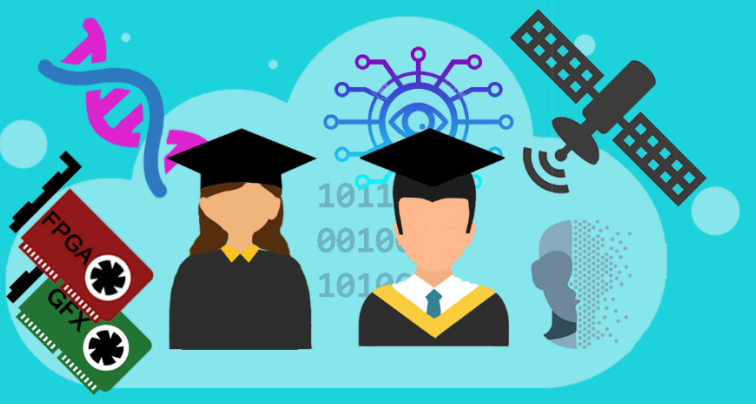
Diploma Thesis

Microproccessors and Digital Systems Laboratory



Dynamic Hyperparameter Tuning for HPC Applications

High-Performance Computing (HPC) applications play a crucial role in tackling complex scientific and engineering challenges by utilizing large-scale computational resources. These applications often rely on a variety of parameters and configurations that can significantly influence their performance. Optimizing these parameters, known as hyperparameters, can improve execution speed, energy efficiency, and overall resource utilization. However, discovering the best hyperparameter configurations manually is a time-consuming and challenging task, especially when balancing multiple objectives such as runtime and energy consumption.

In HPC codes, performance bottlenecks—often referred to as hotspot regions—are sections where computational inefficiencies are most pronounced. Identifying these hotspots and fine-tuning parameters automatically could lead to significant performance gains. Current optimization methods, however, are static and manual, limiting the potential for fully exploiting hardware capabilities across varying workloads and execution conditions.

The goal of this thesis is to develop a dynamic hyperparameter tuning framework that automatically detects hotspot regions within HPC applications and explores the hyperparameter space to find optimal configurations. This dynamic approach will be capable of optimizing multiple objectives simultaneously. The outcome will contribute to better resource management in HPC environments and enhance the overall performance of computational applications.

Prerequisites: C/C++, Python, Familiarity with Linux, Bash scripting

Related Material:
https://doi.org/10.1109/TPAMI.2019.2956703, https://optuna.org/

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