Improving energy consumption in iterative problems using machine learning

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To reach the exascale, energy and power constraints have to be considered in High Perfomance Computing. This new milestone requires hardware to achieve better energy efficiency. Highly parallel systems with general purpose graphic processing units are present in the Top500 and several projects intend to run HPC applications using low power ARM architectures. In order to improve, the scientific community has to consider these new architectures in their parallel applications. One possibility is to adapt existing codes to these new architectures. However, including power and energy metrics involve relatively slow measurement. Compared to time, these metrics have multiple sources with different polling rates and magnitudes. Additionally, energy is nonlinear regarding the workload size of a given parallel process, which complicates any optimization technique.

We presented UllMF in the past, a framework that provides an heuristic skeleton to perform dynamic load balancing in iterative problems. In this heuristic algorithm, we distribute the workload among multiple processes using an estimation function of energy efficiency. The performance of each processor in previous iterations defines their workload for the following ones. The nonlinearity and the slow measurement reduces convergence to good workload distributions. We use machine learning techniques to generate better predictive functions to improve the convergence to optimal configurations. To validate it, we present an analysis of the different algorithms provided by UllMF with and without incorporating this new method.

Keywords: Dynamic Load Balancing, Machine Learning, Energy Efficiency, Iterative Algorithms.