Domain Knowledge Specification for Energy Tuning

Extended Abstract

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ABSTRACT

The European Horizon 2020 project READEX is developing a tool suite for dynamic energy tuning of HPC applications. While the tool suite supports an automatic approach, domain knowledge can significantly help in the analysis and the runtime tuning phase. This poster presents the means available in READEX for the application expert to provide his expert knowledge to the tool suite.

CCS CONCEPTS

•Computer systems organization → Parallel architectures; •Software and its engineering → Development frameworks and environments;

KEYWORDS

automatic tuning, domain knowledge, energy efficiency

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Energy efficiency and consumption have become the most crucial factors in HPC systems. In READEX, we develop a tool suite for automatic scenario based energy efficiency tuning of HPC applications. For this project, we would like to choose HPC applications which show dynamic charactertistics during run. For example, for tsunmai application while the the wave propagates, the number of contact points changes which causes change in characteristics. If those regions can be identified, the tool suite can find the best configurations for them for energy efficiency.

Along with the automatic approach, domain knowledge can enhance the analysis and the runtime tuning phase. This poster gives an overview of providing expert domain knowledge about the application.

The READEX methodology [1] is a two-stage approach and consists of Design Time Analysis (DTA) and Runtime Application Tuning (RAT). It uses the Periscope Tuning Framework (PTF) for DTA, the READEX Runtime Library (RRL) for runtime tuning, and Score-P as the common instrumentation and measurement infrastructure. For DTA, a novel tuning plugin, the READEX Tuning Plugin was developed to determine the best settings for runtime situations (rts's), i.e the dynamic instances of program regions. The plugin performs an online search, executing experiments with different configurations within a single program run. The experiments are individual executions of the so-called *phase region*, which is usually the body of the main progress loop of the application and whose individual time steps are called *phases*. Runtime situations that have similar characteristics are grouped into *scenarios*, and best configurations for those scenarios are set. The knowledge obtained during DTA, such as the best-found system configurations for individual scenarios is encapsulated in a *tuning model*. This tuning model is forwarded to RRL, which performs runtime tuning by dynamically switching to the best configurations for upcoming rts's.

READEX uses the so-called *identifiers* to predict the characteristics of an upcoming rts by letting the user specify domain knowledge at runtime. The user can provide his expert knowledge about the application before design-time analysis starts. Currently, READEX supports region identifiers to distinguish rts's, phase identifiers to distinguish phase characteristics and input identifiers to distinguish executions with different application inputs. Without these identifiers, rts's of a significant region may be merged into the same scenario even if they have different behaviours. Hence, these identifiers will improve the tuning model by distinguishing rts's and assigning them to different scenarios to potentially select a better configuration. The domain knowledge also includes Application-level Tuning Parameters that switch the application control flow and expose tuning potential in the target application.

For example, the ESPRESO library is a combination of Finite Element (FEM) tools and a domain decomposition based Finite Element Tearing and Interconnect (FETI) solvers. The convergence of the FETI solver can be improved by several preconditioners. These preconditioners can be provided by the user before the analysis starts as domain knowledge called *application tuning parameter*. An application tuning parameter can be used to dynamically switch between different preconditioners at runtime. The result is shown on the poster.

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