Application Knowledge Required: Performance Modeling for Fun and Profit

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ABSTRACT

In High Performance Computing, resource efficiency is paramount. Expensive systems need to be utilized to the maximum of their capabilities, but deep insight into the bottlenecks of a particular hardware-software combination is often lacking on the users' side. Analytic, first-principles performance models can provide such insight. They are built on simplified descriptions of the machine, the software, and how they interact. This goes, to some extent, against the general trend towards automation in computer science; the individual conducting the analysis does require some knowledge of the application and the hardware in order to make performance engineering a scientific process instead of blindly generating data with tools that are poorly understood.

This talk uses examples from parallel high-performance computing to demonstrate how analytic performance models can support scientific thinking in performance engineering: Sparse matrix-vector multiplication, the HPCG benchmark, the CloverLeaf proxy app, and a lattice-Boltzmann solver. Interestingly, the most intriguing insights emerge from the failure of analytic models to accurately predict performance measurements.

CCS Concepts

• General and reference ~ Performance

Keywords

Performance modeling; performance engineering; first-principles models; high performance computing

ACM Reference format:

Georg Hager. 2023. Application Knowledge Required: Performance Modeling for Fun and Profit. In *the Proceedings of the 2023 ACM/SPEC International Conference on Performance Engineering (ICPE'23), April 15-19, 2023, Coimbra, Portugal.* ACM, New York, NY, USA. https://doi.org/10.1145/3578244.3585384

ICPE'23, April 15-19, 2023, Coimbra, Portugal.

ACM ISBN 979-8-4007-0068-2/23/04.
https://doi.org/10.1145/3578244.3585384

BIOGRAPHY

Georg Hager holds a PhD and a Habilitation degree in Computational Physics from the University of Greifswald. He heads the Training and Support Division at Erlangen National High Performance Computing Center (NHR@FAU) and is an associate lecturer at the Institute of Physics of the University of Greifswald. Recent research includes architecture-specific optimization strategies for current microprocessors, performance engineering of scientific codes on chip and system levels, and structure formation in large-scale parallel codes. He served as a PI in the ESSEX (Equipping Sparse Solver for Exascale) project within the SPPEXA DFG priority program. Georg Hager has authored and co-authored over 100 peer-reviewed publications and was instrumental in developing and refining the Execution-Cache-Memory (ECM) performance model and energy consumption models for multicore processors. In 2018, he won the "ISC Gauss Award" (together with Johannes Hofmann and Dietmar Fey) for a paper on accurate performance and power modeling.