Mixed-Precision and Energy-Efficient Computations

Yanxiang Chen*[1]

[1]Umeå University – Sweden

Abstract

High Performance Computing has traditionally focused on optimizing between memory usage, arithmetic intensity, parallelism, and communication costs. However, as simulations grow, energy consumption has surged, presenting significant sustainability challenges for large-scale computing infrastructures. Addressing these challenges requires innovative strategies that enhance energy efficiency without compromising computational accuracy or performance. We present a systematic methodology for reducing the energy footprint of large-scale simulations via mixed-precision computing, without compromising accuracy or performance. Our approach combines performance profiling with numerical sensitivity analysis to identify precision-insensitive code regions, select promising candidates, and gradually convert them to lower precision. Applied to representative high-performance computing kernels, this strategy yields up to 40% speedup and 47% energy savings in an implicit Poisson solver, and roughly 30% gains in both execution time and energy consumption in explicit solvers, all while preserving double-precision level accuracy. These results demonstrate that our methodology provides a versatile and effective lever for enhancing the sustainability of HPC applications.

*Speaker