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Precision auto-tuning and control of accuracy in high performance simulations

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In the context of high performance computing, new architectures, becoming more and more parallel, offer higher floating-point computing power. Thus, the size of the problems considered (and with it, the number of operations) increases, becoming a possible cause for increased uncertainty. As such, estimating the reliability of a result at a reasonable cost is of major importance for numerical software. In this talk we present an overview of different approaches for accuracy analysis (guaranteed or probabilistic ones) and the related software. We also describe methods to improve the results accuracy. We present the principles of Discrete Stochastic Arithmetic (DSA) that enables one to estimate rounding errors in simulation codes. DSA can be used to control the accuracy of programs in half, single, or double precision via the CADNA library, and also in arbitrary precision via the SAM library. Thanks to DSA, the accuracy estimation and the detection of numerical instabilities can be performed in parallel codes on CPU and on GPU. Most numerical simulations are performed in double precision, and this can be costly in terms of computing time, memory transfer and energy consumption. We present tools for floating-point auto-tuning that aim at reducing the numerical formats used in simulation programs.

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