Using randomization to accelerate the solution of linear systems

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We describe how random transformations can accelerate the solution of linear systems by preventing the communication overhead due to pivoting. We have applied successfully this technique to dense linear systems (general or symmetric indefinite), resulting in efficient solvers for current parallel architectures, including multicore, GPU or Intel Xeon Phi, and already integrated in the public domain scientific library MAGMA. We also present some experiments using direct sparse factorizations where randomization is combined with sparsity-preserving strategies. Finally we illustrate how the some iterative solvers based on Krylov subspace method can also benefit from this approach.

Massively-parallel simulations of turbulent flows laden with spherical particles - a voyage through terabytes of data from a numerical algorithm to a scientific result

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Turbulent transport of solid particles in a suspending Newtonian fluid is often present in natural and industrial contexts. Few of many well-known examples are sediment transport in a river bed, sandstorms, slurries, and the flocculation and sedimentation processes in the treatment of drinking water. In many cases the particles have a finite-size, i.e., a size comparable to or larger than the smallest scales of the turbulent flow. In these cases turbulence ? in itself one of the most challenging problems in classical physics ? is greatly modified due to the presence of the particles, which interact both with each other and with the suspending fluid. The continuous growth in computing power together with the development of efficient numerical algorithms makes the simulation of the detailed interaction of many particles with the fluid turbulence possible. Possible, but challenging. We will present an overview of the steps taken to achieve such massive simulations. In particular, we will present our numerical algorithm, elaborate on technical details such as parallelization and data handling, and finalize with some relevant scientific findings.

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