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Sparse linear system solvers for large-scale Finite Element applications

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The solution of linear systems is the computational kernel of many applications in mathematics and engineering. For dense linear algebra problems, highly-optimized libraries are either provided by hardware or compiler vendors. Unfortunately, this is not the case for sparse linear algebra problems, like those involved in Finite Element (FE) simulations of complex physical phenomena, because of both technological and algorithmic limitations. As a consequence, very few scientific applications are able to fully exploit the enormous computing power that current sequential and parallel architectures make available to computational scientists. To overcome such limitations, in the last decades a great effort has been spent in developing portable, highly-efficient, sparse linear system solvers. As one may reasonably expect, none of the proposed solutions is the best for all possible numerical scenarios.

This minisymposium aims at providing a link between computer scientists and computational scientists, in order to ease the exchange of expertise in such a cross-disciplinary area. Contributors with a computer science background are expected to give an insight into new efficient techniques to solve sparse linear systems on current and forthcoming parallel computing architectures with hierarchical memories, especially tailored for those problems arising in large-scale Finite Element simulations. They should also highlight when inefficiencies are due to the interaction with such applications and suggest possible solutions. Contributors with a computational science background are expected to pinpoint where current sparse linear system solvers fail in meeting their computational need and how to move domain-specific procedures out of the linear system solution process in order to improve modularity. Both contributors must join their efforts to develop a common framework between different application fields aiming at defining a standard formulation of the computational problem generated by the Finite Element Method, in order to enhance overall performance of numerical methods for FE applications.

Topics of interest include: comparing iterative and direct methods on numerical and computational requirements; the applicability and effectiveness of static and numerical pivoting for direct methods; efficient preconditioning techniques for iterative methods; parallel and size scalability of different solution techniques; adaptive software techniques applied to FE method to achieve performance portability; the design of efficient sequential and parallel I/O interfaces to avoid bottlenecks; the evaluation of different approaches to the parallelization of the other parts of FE applications in addition to the linear system solver.