Fraunhofer SCAI

SAMG-Constraints: efficient solution of friction, contact and fluid mechanic problems

The solver for saddle point problems

The SAMG-Constraints module is used for applications with specific numerical difficulties or instabilities. It automatically comprises the SAMG-Coupled module. SAMG-Constraints solves structural mechanics problems with friction and contact and fluid mechanics problems, particularly those involving fluid-structure interaction. Such problems are classified as linear saddle point problems.

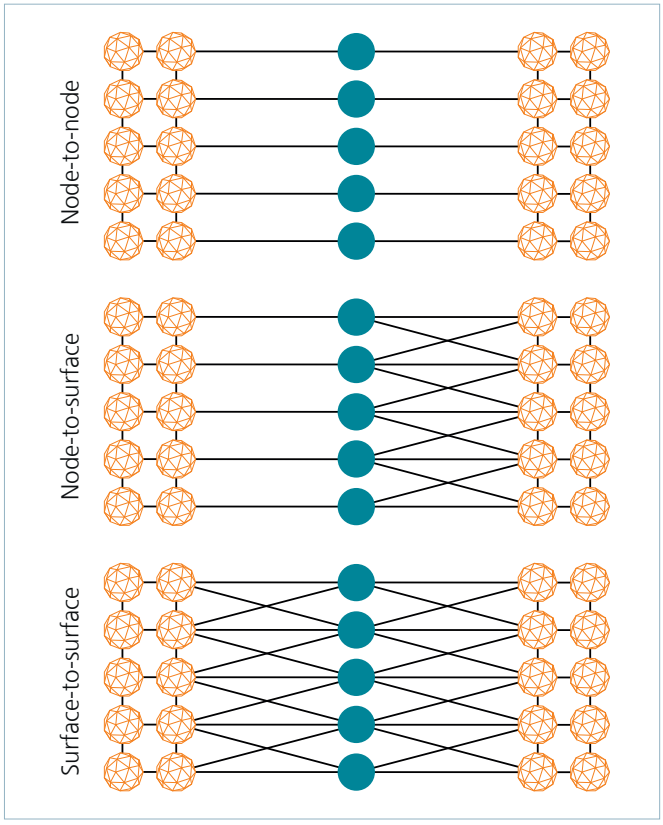
The application engineer needing to solve such problems is unfortunately faced with constructing a solution from an overwhelmingly large set of options within a variety of linear algebra tool kits. Even worse, these kits typically lack the algebraic multigrid method, which is a highly efficient state-of-the-art solver for the elliptic subproblems embedded in the overall linear system of equations to be solved.

SAMG-Constraints helps engineers to spend their time on other tasks. SAMG-Constraints provides additional options for the AMG library functions to be flexibly adapted to the characteristics of the specific system, thus delivering an efficient linear solver for the application.

> **[…] By using SAMG, it is now possible to obtain calculation results that took several months within two days. SAMG is an indispensable tool in our research on materials informatics.“**
>
> Yokohama Rubber

Suited for different kinds of contact problems

SAMG-Constraints comprises various sophisticated multigrid approaches suited for different contact problems: from node-to-node over node-to-surface to surface-to-surface. These contacts result in different types of algebraic constraints that need to be handled appropriately by a linear solver to provide the highest efficiency and robustness.

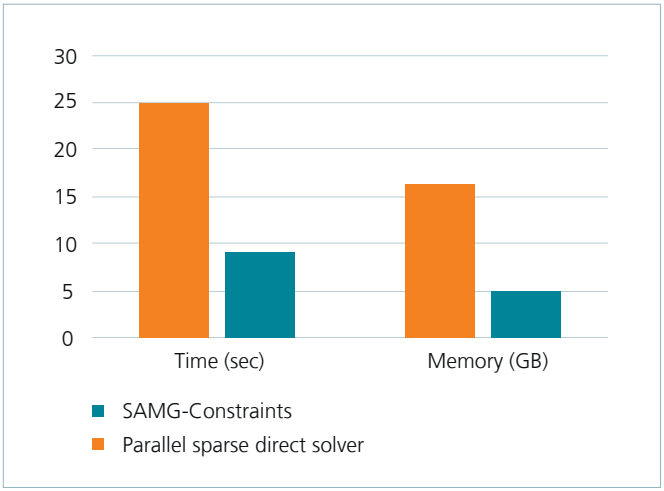


Visualization of different kinds of contact problems by connections of discretization cells. Blue cells result in algebraic constraints for the two domains.

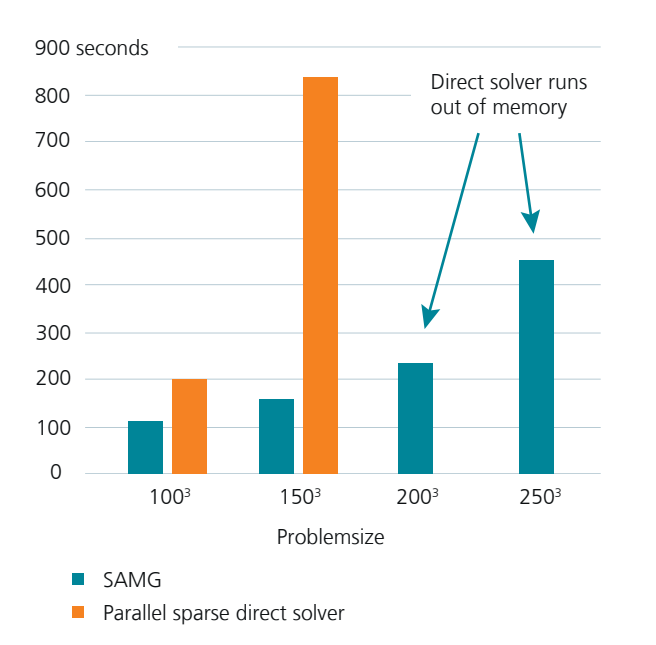
Solution strategies for other applications

SAMG-Constraints comprises several solver approaches (e.g., several Uzawa methods, Schur complement methods, constraint elimination, and more) to fit to your application area. They all target at making the optimal multigrid efficiency available for the solution of saddle-point and contact problems.

This does not only refer to computational performance: SAMG-Constraints can drastically reduce memory requirements, especially compared to direct solvers.



Performance comparison on 32 cores for a flange problem with node-to-surface contact constraints with 1 million DOFs.

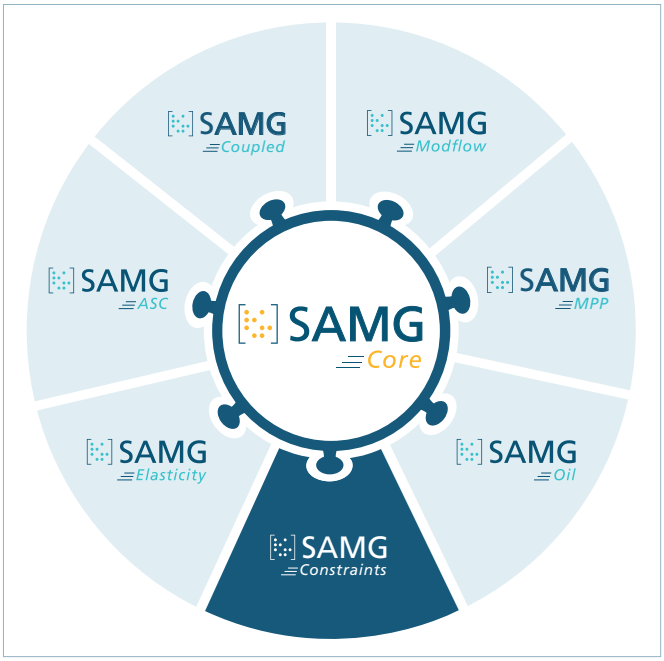


Performance comparison on 256 cores for a filled rubber cube with periodic boundary conditions. The parallel sparse direct solver runs out of memory for the 200³ and 250³ cubes.

Product portfolio

The portfolio is structured around the mandatory SAMG-Core; SAMG-Constraints is one of the optional extension modules fit for the customer's applications.

SAMG-Constraints is often combined with the extension modules SAMG-Oil or SAMG-Elasticity to enable the solution of further application cases.



This portfolio is under continuous development to feature state-of-the-art multigrid approaches.

In addition, we offer consulting to tailor the configuration of SAMG-Constraints to the customer's needs and achieve the best performance for their applications.

Contact

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SAMG Constraints

10/22