Multilevel algorithms for large scale nonlinear optimization problems.

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Multidomain and multigrid methods are well-known techniques for obtaining efficient solution methods that are mostly used for solving quadratic problems. They have been studied for decades, have been implemented in well-known software and are nowadays used routinely for solving industrial large scale problems on modern parallel computers.

The purpose of this talk is to show ways to make use of these exceptional properties to obtain general solvers for large scale non-convex optimization problems. An important issue will be the design of a suitable technique for obtaining convergence irrespective of the starting point. We will show that this can be done without compromizing the performance of the underlying multilevel technique. The resulting algorithms not only enjoy satisfactory worse case complexity bounds, but are also very efficient on several problems arising for instance in the calculus of variations.

We conclude with specialized solvers in the case of large scale nonlinear least-squares problem arising in geophysics. We show that the structure of the problem can be used to further enhance the performance of our methods. We are able in this case to design efficient dual solvers that also open the door to grid adaptivity. The efficiency of the method will be demonstrated on inverse problems.