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An optimization based numerical approach for free boundary problems modeled by variational inequalities of the second kind

In this talk we focus on numerical optimization techniques for the solution of Bingham viscoplastic fluid flow and other related variational inequalities. Bingham materials are characterized by the presence of a so-called yield stress: they behave like solids in regions where the stresses are small and like incompressible fluids where the stresses are larger than a plasticity threshold. Based on both primal and dual formulations of the problem, regularization strategies will be presented. The well-posedness of each regularized problem is verified and convergence of the regularized solutions towards the original one is studied.
For the solution of each regularized system, generalized Newton algorithms are constructed. The design of such algorithms is based on a weaker (than Frechet) differentiability concept, called semismoothness or Newton differentiability. We will present results on global and local superlinear convergence in a function space setting and/or in finite dimensional spaces, after discretization of the systems. The extension of the methodology for time-dependent thermally convective problems is considered in combination with backward differentiation formulas.
Since a similar yield behavior is also found in problems arising from frictional contact and image denoising, the applicability of the approach to those variational problems will be discussed.