ASTROS: A New Framework for Active-Set Trust-Region Optimization Solvers

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Nonlinear optimization problems arise in a wide range of applications, including the control of complex systems, the design of new drugs, the study of market power in electricity markets, and optimal mesh smoothing.

We present ASTROS a new open-source framework for active-set trust-region methods for the solution of large-scale nonlinear optimization problems. The framework implements a range of step-computation techniques and a number of globalization strategies. ASTROS allows the user to choose from a variety of subproblem solvers. The two main components (step computation, and globalization strategy are described below in more detail).

Step Computation. Active-set methods compute an approximate solution by solving a linear or quadratic approximation to the original nonlinear optimization problem. We have implemented sequential quadratic programming (SQP), and sequential linear/quadratic programming (SLQP). The latter method solves a linear program (LP) to predict the active set and then fixes the active constraints and solves an equality-constrained quadratic program (EQP) for fast convergence. This latter problem can be formulated as an augmented linear system.

The following subproblem solvers are available within ASTROS: **QP-solvers:** `bqpd`, a null-space method; and `QPC`, an interior-point solver with cross-over to find an active set. **LP-solvers:** `CLP`, the open-source LP solver from `COIN-OR`; and `SOPLEX` a public domain LP solver. **EQP-solvers:** `MA57` from the Harwell subroutine library; and `PARDISO`, which also allows iterative linear solves. Solvers can be chosen either at run-time or compile-time.

Globalization Strategies. Nonlinear optimization methods require strategies that ensure that the sequence of iterates does not diverge. Traditionally, codes have used penalty-functions to globalize optimization techniques, but recently, new better techniques have become available.

`ASTROS` implements a range of globalization strategies. The globalization strategies include an **ℓ_1-exact penalty function** with a modified penalty update that ensures fast convergence, even for infeasible problems; a **filter** that accepts new points as long as they either reduce the objective function, or improve the feasibility of the current iterate; and a **funnel** that accepts a new iterate as long as its infeasibility stays within a bound that is gradually reduced, i.e. iterates are funneled towards an optimal solution.

We present extensive numerical results comparing the different algorithmic options. The first 1,000 visitors to the poster will receive a complimentary copy of our open-source solver.

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