Consolider Computing

Projects TIC2003-00997 and MTM2006-05550

Interior-point methods for large-scale optimization. Application to statistical data protection.

GNOM - Group of Numerical Optimization and Modeling
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1 GNOM

GNOM (Group of Numerical Optimization and Modeling) is a research group of the UPC. It is made of 5 professors plus some PhD students and some foreign collaborators. Since 2005 is a Consolidated Research Group by the Generalitat de Catalunya.

GNOM is made of two subgroups: one is devoted to the application of optimization techniques to the electrical market field, and it is being funded by a DPI project; we are the other subgroup, currently funded by project TIC2003-00997, and, starting in December, by project MTM2006-05550 "Interior-point methods for large-scale optimization. Application to statistical data protection."

2 Field of research

Our group works in Operations Research/Computational Optimization, in particular:

- Solution of large-scale linear and quadratic programming problems by interior-point methods. Interior-point methods are polynomial algorithms

for linear, quadratic and convex programming, and in some classes of (large and difficult) problems are more effective than the (non-polynomial) simplex algorithm. They are the first efficient polynomial time algorithm for the linear programming problem.

- Solution of large-scale non-linear optimization problems.
- Solution of large-scale structured problems, in particular stochastic optimization problems, network flows problems, etc...

The group works both in the design and in the efficient implementation (C/C++) of algorithms.

Currently the group is applying such techniques to the solution of problems from the field of statistical disclosure control. The group has participated in the CASC project, funded by the European Union, for the development of algorithms and software for statistical tabular data protection. Software developed by the group is included in the τ-Argus package, being used by European National Statistical Institutes. This stream of research has been continued in project TIC2003-00997 and in the forthcoming MTM2006-05550.

3 Tools

The solution of large-scale optimization problems by interior-point methods heavily relies in the following numerical lineal algebra tools:

- Direct methods for the solution of large and sparse linear positive and semidefinite positive systems of equations, which appear in the solution of linear and separable quadratic optimization problems. We are currently using sparse Cholesky packages as the recent CHOLMOD one, developed in the University of Florida. Unfortunately this package does not solve semidefinite systems of equations.
- Direct methods for the solution of large and sparse indefinite systems, which appear in the solution of quadratic and nonlinear optimization problems.
- For very large problems, iterative methods (e.g., preconditioned conjugate gradients) for the solution of positive definite and quasidefinite systems of equations are needed.

The current statistical protection method we are working on means the solution of a very large combinatorial optimization problem. Up to now, it has been only possible to provide feasible solutions by solving some linear programming relaxations. An efficient method from the combinatorial optimization field is also required and it is under research.

4 Problems

In short, the main problems we are encountering are:

- Development of efficient preconditioners for the solution by preconditioned conjugate gradients of the systems of equations of each interior-point iteration.
- Usage of sparse Cholesky packages for systems of equations with definite and semidefinite matrices.
- Exact solution of the combinatorial optimization problem that results from the statistical data protection technique .