THE WEST COAST OPTIMIZATION MEETING

Depts. of Mathematics and Applied Mathematics, University of Washington

All talks will be in Guggenheim 317

FRIDAY, NOVEMBER 2, 2001

6:30–9:30+ Party at Terry Rockafellar's home, 4531 NE 93rd Street, 206–527–9637
The cost per person will be $10/"students" and $15/"others."

SATURDAY, NOVEMBER 3, 2001

8:30–9:00 ————Refreshments in Guggenheim 408, the Applied Math Lounge

9:00–9:40 "Functions with Primal-Dual Gradient Structure are Partly Smooth," Bob Mifflin, Washington State Univ.

9:40–10:05 ————Refreshments in Guggenheim 408, the Applied Math Lounge

10:05–10:15 Student presentation, title to be announced.

10:15–10:55 "Robust Control via Nonlinear Optimization," Dominicus Noll, Univ. of Toulouse, France

10:55–11:20 ————Refreshments in Guggenheim 408, the Applied Math Lounge

11:20–12:00 "Solving Stochastic Optimization Problems on Computational Grids," Steve Wright, Univ. of Wisconsin

12:00–14:00 ————Lunch expedition to University Avenue

14:00–14:40 "Optimization Problems Involving Pseudospectra," Adrian Lewis, Simon Fraser Univ.

14:40–15:20 "Optimization Modeling with Equilibrium Constraints," Terry Rockafellar, Univ. of Washington

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The **West Coast Optimization Meeting** occurs twice each year. Contact:

Prof. A. S. Lewis at the Dept. of Mathematics and Statistics, Simon Fraser University, Vancouver: (604) 291-3070, e-mail jborwein@cecm.sfu.ca

Prof. R. T. Rockafellar at the Dept. of Mathematics, University of Washington, Seattle: (206) 543-1916, e-mail rtr@math.washington.edu

TALK ABSTRACTS for WCOM

Seattle, November 3, 2001

Bob Mifflin, *Functions with Primal-Dual Gradient Structure are Partly Smooth*

In this talk the concept of a function with primal-dual gradient (pdg) structure is extended from convex to locally Lipschitz functions. Such functions have an underlying piecewise C^1 or C^2 substructure which differs from that of fully amenable functions. In the C^2 case, under certain conditions, these functions have restricted Hessians on a subspace called U-space. We relate this large class of functions to functions that are partly smooth at a point relative to a manifold. We give the pdg structure for a partly smooth example function due to Lewis and show that it has (at least) two interesting restricted Hessians. If time permits we will give some relations between second order epi-derivatives and a U(restricted)-Hessian for the special case of a function that is the pointwise maximum of a finite number of convex functions.

Dominicus Noll, *Robust Control via Nonlinear Optimization*

During the last decade, interior point methods for semidefinite programming (SDP) have been one of the principal themes in nonlinear optimization. This was in large parts due to the fact that in the early nineties, a variety of problems in feedback control design could be cast as linear matrix inequality (LMI) feasibility problems, and were therefore open to new algorithmic resolution strategies. On a closer look, however, the majority of control applications may only be cast as bilinear matrix inequality (BMI) problems, and in consequence, require extensions of SDP. We discuss possible extensions, and we take a closer look at robust feedback control design, which is perhaps the most important application open to these new methods.

Steve Wright, *Solving Stochastic Optimization Problems on Computational Grids*

We discuss a software tool called ATR ("asynchronous trust-region") for solving two-stage linear stochastic programming problems with recourse on computational Grids. Grids are parallel computing platforms assembled from a distributed collection of workstations, PCs, and pieces of clusters and conventional parallel computers. We discuss computational experiments performed with this tool to find bounds on the optimal solutions of some difficult problems from the literature, obtained by solving many large sample-average approximations. We show too how optimality of computed solutions can be verified in some cases.

Our solver makes use of software tools developed in the metaNEOS and Condor projects. Condor is a system that maintains a heterogeneous "pool" of computational resources, from which it harnesses unused cycles to perform large parallel computations. It provides the tools that allow this inexpensive, powerful, but messy collection of resources to be used as an effective computational platform. The MW runtime support library developed in the metaNEOS project enables implementation of master-worker algorithms on Condor platforms.

Our algorithmic approach is built on a bundle-trust-region approach. Subgradients are evaluated by solving the second-stage problems in parallel for a given set of first stage variables. However, because of the heterogeneous nature of computational grids, the possibility of "losing" second-stage evaluations on unreliable worker processors, and the possibly slow communication times, it is important for the algorithm to be asynchronous. Accordingly, we have modified the trust-region approach so that it considers more than one candidate for a new iterate at a time, allowing the algorithm to make progress even when some of the subgradient evaluations are not completed promptly on the worker nodes.

Our computational experiments involve problems from the literature with a discrete but unmanageably large number of second-stage scenarios. Variance reduction techniques and large sample sizes are used to obtain high-quality estimates of upper and lower bounds on the true optimal objective value, together with confidence intervals.

This work is joint with Jeff Linderoth (Axioma Inc.) and Alex Shapiro (Georgia Tech).

Adrian Lewis, *Optimization Problems Involving Pseudospectra*

Pseudo-eigenvalues of a square matrix A are eigenvalues of matrices in a neighbourhood of A. Large real parts of pseudo-eigenvalues (rather than eigenvalues themselves) often reveal the behaviour of dynamical systems governed by A. I will discuss the geometry of the pseudospectrum, and describe a simple, robust algorithm for finding the maximum real part of a pseudo-eigenvalue. This subroutine allows us to enhance the stability of a matrix by optimizing its pseudospectrum.

This work is joint with Jim Burke (UW) and Michael Overton (NYU).

Terry Rockafellar, *Optimization Modeling with Equilibrium Constraints*

Close connections between optimization modeling and equilibrium modeling have long been known. A vast range of situations in which the behavior of one or more agents can be viewed as tending to, or achieving, an equilibrium, for instance in traffic management or economics, can be represented in terms of a "variational inequality," and the theory of variational inequalities is same based on the kind of mathematical analysis that goes into optimality conditions. Methodology for solving variational inequalities likewise draws on what has been learned in optimization.

In recent years, attention has been turned to study of problems in which an equilibrium depends on parameters that are open to optimization from the perspective of a "superagent." These problems are challenging because their mathematical features are fundamentally different from the ones that are often taken for granted in optimization. Of course, that also makes them interesting.

This introductory talk will outline not only the motivations and difficulties of the subject but also some of the conceptual advances that have been made in working toward successful treatment.