THE WEST COAST OPTIMIZATION MEETING

Depts. of Mathematics and Applied Mathematics, University of Washington

All talks will be in Guggenheim 317

FRIDAY, NOVEMBER 1, 2002

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." There will be catered Chinese food plus a variety of beverages.

SATURDAY, NOVEMBER 2, 2002

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

9:00–9:10 "Distributed Maple: Parallel Computation in a Symbolic Environment," Herre Wiersma, Simon Fraser Univ.

9:10–9:20 "Direct Search Methods in Distributed Maple," Mason Macklem, Simon Fraser Univ.

9:20–10:00 "Nonsmooth Analysis of Singular Values," Hristo Sendov, Univ. of B.C.

10:00–10:15 "The CEIC: The Next Four Years," Jon Borwein, Simon Fraser Univ.

10:15–10:40 ————Refreshments in Guggenheim 408, the Applied Math Lounge

10:40–11:20 "Modeling the Future: An Overview of Infinite Horizon Optimization," Dean Carlson, Univ. of Toledo

11:20–12:00 "Error Bounds for Lower Semicontinuous Inequality Systems," Jane Ye, Univ. of Victoria

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

14:00–14:40 "Duality of Value Functions for Infinite-Horizon Convex Control Problems," Rafal Goebel, Univ. of California–Santa Barbara

14:40–15:20 "Measures of Risk: Convex Analysis in Action," Terry Rockafellar, Univ. of Washington

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

Prof. J. Borwein 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 2, 2002

Herre Wiersma, *Distributed Maple: Parallel Computation in a Symbolic Environment*

Distributed Maple is a tool for performing distributed computation within a Maple environment; we are currently interested in using it for large-scale symbolic computation on our home-grown Beowulf cluster, Bugaboo. This talk will present the key features of the Distributed Maple API, as well as some preliminary benchmarks and demos that use Distributed Maple to accelerate computation.

Mason Macklem, *Direct Search Methods in Distributed Maple*

There has recently been renewed interest in *direct search* methods, optimization techniques that do not use gradient evaluations and whose decision process (choice of search direction and stepsize) uses only function evaluations. Much of this interest is driven by the ease of parallelizing these methods, by sending separate function evaluations to separate processors. This talk will present an ongoing project on implementing a class of direct search methods on the Beowulf cluster, using the Distributed Maple API discussed by Herre Wiersma.

Hristo Sendov, *Nonsmooth Analysis of Singular Methods*

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.

Jon Borwein, *The CEIC: The Next Four Years*

The International Mathematical Union's (`www.mathunion.org`) *Committee on Electronic Information and Communication*, CEIC, (`www.ceic.math.ca`) was established in 1998, and reestablished in 2002. I presently chair the CEIC which has been given a very broad mandate to advise the IMU on electronic matters. I shall briefly describe the present mandate, the views and the aspirations of the CEIC. This includes the proposal for a Digital Library of *all* Mathematics.

Dean Carlson, *Modeling the Future: An Overview of Infinite Horizon Optimization*

In this presentation we introduce the audience to a class of dynamic optimization models in which the objective functional, described by an improper integral, is divergent. This divergence makes many of the traditional approaches to optimization ineffective. To avoid uneccessary complexity we focus our attention on calculus of variations problems defined on $[0, +\infty)$. An overview of the problem and it history will be presented. Examples will be used to illustrate the difficulties encountered in studying these problems. My presentation will be divided into four parts:

- History of the problem and difficulties encountered.
- Types of optimality and the "classical necessary conditions."
- The existence of "optimal solutions" and the "turnpike property"
- Incorporating explicit state constraints.

Jane Ye, *Error Bounds for Lower Semicontinuous Inequality Systems*

In this talk we consider the problem of estimating the distance from a given point to the solution set of an inequality system defined by a proper lower semicontinuous function. We say that an error bound exists if the distance of any point to the solution set is bounded by a constant times the positive part of the function. We give sufficient conditions for proper lower semicontinuous functions on Banach spaces to have error bounds in terms of an abstract subdifferential and Dini derivative of the function.

In case where the function is convex, the existence of a local error bound is equivalent to the existence of a global error bound. Furthermore, when the function is convex the sufficient conditions in terms of the subdifferential becomes necessary and the one in terms of the Dini derivative (which coincides with the usual directional derivative when the function is convex) becomes necessary when the space is reflexive. On Hilbert spaces, we also present a sufficient condition for existence of an error bound with exponent $1/2$ in terms of a generalized second order subderivatives and apply the second order condition to a system of nonconvex quadratic inequality systems.

Rafal Goebel, *Duality of Value Functions for Infinite-Horizon Convex Control Problems*

The value function is a key component in the construction of optimal feedback, itself a preferred notion of a solution to a control problem. In convex setting, a natural question to consider is whether a given control problem has a reasonable dual, and whether the corresponding value functions satisfy any conjugacy relationships.

In contrast to the finite-time horizon setting, described recently by Rockafellar and Wolenski, not many results exist for the infinite-time problems. Through the analysis of the underlying Hamiltonian dynamical system, Rockafellar obtained conjugacy results for such setting in the case where the Hamiltonian is strictly concave, strictly convex. Many applications, even a simple linear-quadratic regulator with a single control constraint, call for the analysis of more general cases.

The talk will describe the basic ideas behind the duality of value functions for infinite horizon problems, and also touch upon related topics like the long-term behavior of Hamiltonian trajectories and uniqueness of solutions to the stationary Hamilton-Jacobi equation. Precise results on duality will be given for one-dimensional problems, in particular, the "duality gap" will turn out to be closely related to the size of the saddle set of the Hamiltonian.

Terry Rockafellar, *Measures of Risk: Convex Analysis in Action*

Many applications of optimization to finance and related issues in economics are concerned with how to deal with "risk". But how should risk be quantified? For a long time the approach was through expected utility relative to a concave utility function, but as a operational matter this was rather unworkable. In recent years, practitioners have focused on something called "value-at-risk", provides a functional on a space of random variables (representing uncertain monetary outcomes) that measures the seriousness of losses. That approach has even been built into official banking regulations. The trouble with "value-at-risk", however, is that the functional is nonconvex, discontinuous, and indeed terrible for optimization. People in finance, usually with little background in optimization, have had a poor understanding of this.

Theoretical developments, starting around 1999, are now putting the subject on a much better footing. There is now a kind of functional coming from "conditional value-at-risk" that behaves far better and is eminently usable in large-scale computations. All the key notions in the new framework are closely dependent on well known ideas in convex analysis, like inf-projection and the duality between convex sets and sublinear functions, and as such facts sink in further, there will surely be a big impact on operations in financial engineering. Besides its direct importance, this is an interesting example of how mathematics gradually moves into a practical domain.