



Department of Mathematical Sciences

Seminar in Stochastic Systems

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Sampling Issues for Optimization in Radiotherapy

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Abstract: A wide variety of optimization problems arise in radiation treatment planning. Many different optimization techniques can be applied to their solution, ranging from simulated annealing to mixed integer (non)linear programming. These problems typically involve large amounts of data, derived from simulations of patient anatomy and the properties of the delivery device.

We investigate a three phase approach for the solution of these optimization problems, based on sampling the underlying data. As a particular example, we show how our approach determines optimal beam angles, wedge orientations and delivery intensities in several 3D conformal radiation therapy patient examples, and show the applicability of the approach to a large collection of radiation treatment problems, including IMRT. In our example context, Phase I uses a coarse sampling of the data and determines a collection of promising angles to use. Phase II refines the sampling, and solves a modified problem using only the promising angles. Phase III does a further refinement to the sampling, and fixes most of the discrete decision variables to reduce computation times.

The use of importance sampling in this context will be outlined and general conclusions for design of sampling procedures in this context will be given. Particular emphasis will be on general principles that are applicable to large classes of treatment planning problems. Specific examples will also be detailed showing enormous increase in speed of planning, without detriment to the quality of solutions found. This represents joint work with R. Einarsson (ILOG), Z. Jiang and D. Shepard (Maryland).

Michael Ferris holds a Ph.D. Degree in Mathematical Programming from Cambridge, 1989. He has joined the faculty of the the University of Wisconsin at Madison in 1988, where he is a Professor of Computer Sciences and Industrial Engineering. His research interests are in the area of Operations Research, Optimization in Medicine, Complementary Problems, and Numerical Methods. Professor Ferris is the author of numerous scientific publications in these areas, and several successful applied projects. He is a member of SIAM, MPS, and INFORMS, where he has acted as a chair in the period 1998-99. Michael Ferris is a member of the editorial board of seven journals among which SIAM Journal on Optimization and Mathematical Programming.

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