Department of Mathematics,
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Center for Computational Mathematics Seminar

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Some Optimization Problems in Cancer Radiotherapy

Abstract:

This talk will focus on the following two problems.

1. Cone beam computed tomography (CBCT) reconstruction.
   CBCT has been extensively studied for many years. It is desirable to reconstruct the CBCT image with as few x-ray projections as possible in order to reduce radiation dose. In this talk, we present our recent work on an iterative CBCT reconstruction algorithm. We consider a cost function consisting of a data fidelity term and a total-variance regularization term. A forward-backward splitting algorithm is used to minimize the cost function efficiently. We test our reconstruction algorithm in a digital patient phantom and the reconstruction can be achieved with 30 CBCT projections. Our algorithm can also be applied in 4D CBCT reconstruction problem. A proposed temporal regulation algorithm for 4DCBCT reconstruction will also be discussed.
2. Treatment plan optimization.
   When beam of radiation passes through a patient, they may kill both cancerous and normal cells, so the goal of the treatment is to kill the tumor (by delivering the prescribed dose to it), while sparing the organs-at-risk (by minimizing the dose to it). We define our objective function as a penalty-based one-side quadratic function based on the dose received by each voxel. Overdosing penalty is given to all voxles, while underdosing penalty is only given to tumor voxels. The decision variables can be intensity of each beam bixel (IMRT Fluence Map Optimization), intensity and shape of each beam aperture (IMRT Direct Aperture Optimization), or aperture shape and intensity in each beam angle (VMAT Optimization), depending on various radiation techniques and/or models.

The reconstruction process and one of treatment plan optimization models have been implemented on Nvidia CUDA platform on GPU and a high computing efficiency has been achieved.

Host: Philip Gill

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