AbstractID: 3667 Title: Iterative regularization of the IMRT optimization problem

Purpose:
To generate the optimal deliverable plan resulting from a beamlet-based IMRT optimization approach followed by conversion into machine parameters. This is achieved by utilizing iterative regularization to create smooth profiles.

Method and Materials:
Our iterative regularization scheme utilizes a quasi-Newton method with the identity matrix as initial Hessian estimate. The optimization process is terminated before jagged profiles occur, but it is run long enough to generate a dose distribution close to the optimal one. We discuss the one-to-one correspondence between our quasi-Newton method and a preconditioned conjugate gradient method, and use conjugate gradient theory to predict the behavior of our approach.

Results:
To verify our theoretical analysis, we study the performance of our method on a five beam prostate case with dose-volume objectives and bounds on the beamlet weights. The plan is optimized using ORBIT. For this case, the jaggedness of the beam profiles increase with iteration number while the objective value decreases rapidly in the first iterations. The objective value after conversion with 50 segments attains a minimum after 40-50 iterations, indicating that further optimization, apart from increasing the calculation time, deteriorates the plan quality.

Conclusion:
The optimization method considered has the appealing properties of a conjugate gradient method, with fast decrease in the objective function and smooth profiles during the first iterations. In addition, the quasi-Newton method is preferable when including constraints. By terminating the optimization after relatively few iterations, we generate smooth fluence profiles that, after conversion, outperform the plan obtained by converting the jagged optimal fluence profiles. Our opinion is that iterative regularization is faster and easier to perform than other regularization techniques, and more rigorous than filtering methods. Further refinement of the treatment plan would require direct optimization of the segments.

Conflict of Interest:
Authors are stockholders in RaySearch Laboratories.