Abstract ID: 15575 Title: Convex optimization techniques for handling delivery time and plan complexity in multi-criteria VMAT optimization

Purpose: To explore the joint trade-offs of target coverage, organ sparing, and delivery time for volumetric modulated arc therapy (VMAT).

Methods: One measure of beam-on time in IMRT is the "sum of positive gradients" (SPG) of the intensity maps. We adapt this measure to VMAT planning. The adaptation is based on the fact that while the beam rotates through a specified arc length, a certain amount of modulation can be achieved “for free”, that is, without slowing down the gantry. The resulting convex optimization formulation is applied to minimizing or constraining delivery time in VMAT. We also consider the selection of collimator angle, and we explore the following: finding the single collimator angle which offers the quickest delivery while maintaining a specified dosimetric plan quality.

Results: We demonstrate the optimization routines on three cases: a pancreas, a prostate, and a lung. We find that SPG smoothing decreases delivery time by a factor of 2 for the pancreas and lung cases and 2.7 for the prostate. For the pancreas case, we examine collimator rotation. Compared to the default angle of 0 degrees (i.e. leaf motion perpendicular to gantry rotation direction), a well-chosen single collimator angle (23° in this case) can reduce the delivery time by an additional 8%.

Conclusions: Although the VMAT problem is fundamentally non-convex, due to the non-convex mapping from leaf positions to voxel doses, we can use a modified SPG function, which is convex, to compute VMAT plans that correctly slow down the beam where it should. Our method is exact for leaves that move infinitely fast, and practically useful in the finite leaf speed case. It can straightforwardly be embedded into a multi-criteria system allowing the user to explore the trade-offs of target coverage, organ sparing, and delivery time.

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