AbstractID: 11086 Title: An image-guided adaptve treatment planning optimization for IMRT

We present an adaptive IMRT treatment planning approach that is guided by 3D/4D images and that allows exploration of a wide range of beam angles for optimal treatment design. Computational advances to improve solution times are highlight, and robustness of the method and quality of the resulting plans are compared.

We focus on column generation of adaptable and clinically acceptable plans. Binary (0/1)variables are used to capture "on"/"off" for each beam. Guided by the tumor image, these candidate beams are generated dynamically throughout the solution process. The treatment model includes explicit clinical constraints, including constraints based on upper/lower/mean dose, approximate organs-at-risks dose-volume relationships, and PTV homogeneity and coverage. During the solution process, at most *k* active beams are allowed in the branch-and-price framework(where *k* is input by clinicians and is patient/tumor-specific).

Compared to clinical plans, for prostate cases, PTV homogeneity improves by 8-11%, whereas mean-dose to rectum and bladder reduce uniformly by over 50%. For head-and-neck cases, left-parotid mean dose reduces uniformly by over 50%. In particular, all critical structures receive significantly less dose, as the adaptive approach focuses the radiation onto the tumor volume. The adaptive plans provide over 95% PTV coverage, as requested by the clinicians.

The adaptive branch-and-price approach proves efficient to simultaneously optimize the beam orientations over the entire space of gantry angles and the fluence map. Two significant advances were made: 1) We efficiently and rapidly solved previously intractable large-scale treatment instances with important clinical constraints to optimality. 2)We designed a rapid column-generation approach where candidate beams are chosen adaptively and dynamically, and where the set of active beams are set to clinically acceptable values. These properties allow for generation of plans that are practical for actual delivery and guided in real-time by tumor images. Clinical experiments showed that our approach produces superior plans.