AbstractID: 13635 Title: Handling Multiple Clinical Objectives in Intensity-Modulated Radiation Therapy Treatment Planning

Purpose: We present a multiple-objective treatment planning framework that involves a wide range of treatment planning variables and multiple clinical objectives and constraints. Our goal is to compare the quality of resulting treatment plans from a multiple-objective approach versus plans from current clinical systems. The techniques is applied across two clinical sites (thus with different clinician preferences and outcome endpoints) to observe consistency of the proposed methods.

Methods and Materials: We combine preemptive programming and weighted sum approaches within a large-scale discrete optimization framework to manage the multiple clinical objectives. Four objectives are optimized explicitly: PTV homogeneity, conformity, OAR doses and OAR DVHs. Elements of uncertainty in constraints (e.g., best possible limiting dose bounds to OARs) are preemptively determined and adaptively incorporated into the treatment planning model.

Results: Compared to clinical plans, for a collection of 10 head-and-neck cases from 2 clinics, PTV homogeneity improves by 5-14% when using the multiple objective approach, whereas conformity improves by 2-5%. The mean-dose to organs-at-risks reduces uniformly by 8-42% for parotid, 6-30% for mandible, 10-28% for larynx, and 7-22% for oral cavity. In particular, all critical structures receive significantly less dose, as the multiple objective approach focuses the radiation onto the tumor volume. The plans provide over 95% PTV coverage, as requested by the clinicians.

Conclusion: The multiple-objective approach produces very high-quality plans. Although the resulting solution is sensitive with respect to the order the objectives are optimized and prioritized, across the two clinical sties, the multiple objective schema works consistently well. Specifically, at both sites, the multiple objective approach results in plans with drastic dose reduction to critical structures, while simultaneously improving PTV coverage, conformity, and dose homogeneity when compared to plans obtained via commercial planning systems. Elements of uncertainty in constraints can be preemptively determined. Computationally it takes about an hour to generate each plan.