AbstractID: 5567 Title: Dose-Volume Histogram Objectives in Multi-Criteria IMRT Optimization

Purpose: Dose-volume histogram (DVH) constraints are frequently used in IMRT planning. For example, a DVH constraint may state that 5% (but no more) of the voxels in the planning target volume may receive a dose below the prescription level. We want to find out if the percentage of violating voxels can be reduced. We are also interested in the "price" of this reduction of violating voxels, in terms of dose to other voxels and other structures.

Methods and Materials: We introduce DVH objectives into IMRT planning. Here the objective is to minimize the number of voxels that violate a given dose constraint. We then integrate DVH objectives into a multi-criteria optimization (MCO) framework, to analyze the trade offs between DVH objectives and other planning objectives. Relaxation of mixed integer programs (MIPs) used to produce the trade off curve yields a good approximation. This is contrary to relaxation of an MIP with DVH constraints in the conventional framework. A heuristic then fine tunes the relaxation results.

Results: Our methods are applied to two clinical cases with both a dose-volume objective on the tumor and a maximum dose objective on OAR. The trade off curve between those two objectives is calculated in around 20 minutes with the relaxed MIPs compared to 40 hours with the nominal MIPs. The two techniques differ on average by only .77% tumor volume coverage and the heuristic reduces this difference to .35%.

Conclusion: The use of DVH objectives (instead of DVH constraints) has the potential to lead to better trade offs in IMRT treatment planning. Surprisingly, DVH objectives simplify the numerical handling of the problem and reduce calculation times.