AbstractID: 8733 Title: Analysis of the effects of multiple gEUD-type constraints on dose distribution for IMRT optimization

Purpose: To analyze the effects of multiple gEUD-type (convex) constraints on the resulting dose-volume distribution/histogram (DVH). A key motivation for this work is to find a convex optimization alternative to (non-convex) partial volume constraints in IMRT optimization.

Method and Materials: A formal mathematical framework for analysis of the effects of multiple gEUD-type constraints on the resulting DVH is proposed. The framework relies on interpreting DVH as a cumulative probability distribution of the underlying "random", i.e., unknown variable, representing dose to a voxel. Consequently, the analysis of the effects of gEUD-based constraints on DVH is rephrased in terms of the effects of moments of the random variable on its distribution, which corresponds to a well-recognized moment problem in mathematics.

Results: Given a set of gEUD-type constraints, we demonstrate how to compute the worst –in a sense of generating the largest volume ratio receiving a fixed dose– dose-volume distributions that satisfy these constraints.

A generalization of gEUD-based constraints, the Generalized Moment Constraints (GMC's), is proposed, with the rationale behind GMC's to provide more modeling flexibility for IMRT optimization.

A potential applicability of the approach is discussed. Applicability analysis is based on proximity of a family of dose distributions, satisfying a fixed set of GMC's, to the desired "ideal" dose distribution. We use a hypothetical prostate cancer patient's rectum as an example.

Conclusion: The newly proposed convex GMC-based dose-distribution modeling framework has a potential to serve as a viable alternative to partial volume constraints in IMRT optimization, at least for some critical structures. To name a few potential benefits of our approach, we mention global solution to IMRT optimization problem that minimizes proximity of a physically deliverable plan to the desired "ideal" physician-prescribed plan, and better control over the resulting dose distributions. Further investigation of the approach is required and is ongoing.