AbstractID: 7347 Title: Delivery Outcome-Driven Adaptive Re-planning Strategy

Purpose:
With increasing availability of imaging and dosimetric information during a treatment course, it is now possible to consider whether the plan should be altered during the treatment course in order to tailor treatment delivery outcomes or control them in the presence of pre-treatment model variations and delivery errors. In this study, a general off-line re-planning framework based on multiple planning metrics is investigated for IMRT treatments. The framework was designed to explicitly handle nonlinear constraints and goals including gEUD, and NTCP.

Method and Materials:
Use of the re-planning strategy is demonstrated using an optimization technique (called MIGA) that accounts for inter-fraction setup variations. While an initial plan is generated by MIGA incorporating a population-based setup variation (assumed statistically Gaussian), the population model is individualized into a patient-specific posterior distribution through Bayesian learning with daily setup measurements. The individualized distribution is fed back into the TPS, tracking the delivery outcomes. Re-planning is triggered to restore the original delivery outcomes when results deviate significantly beyond the tolerable limits. In each re-planning, a non-linear constrained optimization problem is solved.

Results:
With the adaptation of a patient-specific setup distribution, the plan outcomes of MIGA are improved in terms of accuracy and robustness to individual errors. With an assumption of the normal-gamma distribution for the prospective mean and standard deviation, the individual setup is quickly learned through Bayesian inference with a limited number of measurements (e.g., ~10 or less). This helps reducing a frequent need for resource-intensive re-planning.

Conclusion:
A re-planning framework driven by multiple delivery outcomes facilitates direct prediction and control of consequences brought by newly available treatment models (patient setup in this study of MIGA planning) or treatment errors. Explicit handling of planning constraints allows an intuitive allocation of planning and QA resources as the fractionated treatment proceeds over time.