AbstractID: 5871 Title: A Nested Partitions Framework for Beam Angle and Dose Optimization in IMRT

Purpose: To present a novel algorithm, nested partitions (NP), capable of finding suitable beam angle samples for IMRT treatment planning by guiding the dose optimization process. Beam angle optimization and dose optimization are two problems which are conventionally solved separately, because coupling the variables increases the size and complexity of the combinatorial optimization problem.

Method and Materials: NP is a metaheuristic algorithm, guiding the search of a deterministic dose optimization algorithm. The NP method adaptively samples from the entire feasible region, or search space, and concentrates the sampling effort by systematically partitioning the feasible region at successive iterations. We used a "warm-start" approach by initiating the NP with beam angle samples derived from an integer programming (IP) model. We implemented the NP framework in conjunction with a quasi-newton dose-optimization algorithm employed in a commercial treatment planning system. We evaluated the results using 7-field plans for two test clinical cases: head and neck and pancreas.

Results: The results of four iterations of the NP algorithm outperformed both the initial IP solution and a generic equi-spaced beam angle plan. This evaluation was based on DVH constraints for the critical structures for both clinical cases. For example, in the head and neck case, the NP plan delivered a dose of greater than 35 Gy to just 4.3% of the spinal cord, compared to 5.2% for the IP plan and 41.4% for the generic plan. In the pancreas case, the NP delivered a dose of greater than 23 Gy to 30.9% of the right kidney, compared to 43.7% (IP plan) and 49.0% (generic plan).

Conclusions: Our results indicate that the IP solution provides a good initial solution. In addition, by employing the NP framework, further improvement is achieved. This makes it possible to produce a high-quality solution within a reasonable amount of time.