AbstractID: 2273 Title: Problems with current IMRT prescription practices and planning systems

Even though current IMRT planning systems claim to yield the optimal treatment plan, treatment planners often find the result of the first optimization run unacceptable. In other words, the mathematically optimal treatment plan that is (approximately) found by IMRT planning systems may be far from optimal from a clinical point of view. Some tweaking of the optimization parameters and a re-run of the optimization is then necessary. In difficult cases it may be necessary to cycle through this "human iteration loop" more than ten times, which is an unsatisfactory trial and error approach, not much different from the trial and error of conventional planning. There is no obvious stopping criterion of this process other than the limited time available for treatment planning. The purpose of this lecture is to study the physical and mathematical reasons of this dilemma, and to discuss possible solutions. For physical reasons, a perfect treatment plan that delivers dose only to the tumor does not exist. Every realistic treatment plan always involves a tradeoff between tumor coverage and sparing of healthy normal tissues.
Current optimization systems assign a single score to each treatment plan and find the plan that maximizes or minimizes the score. However, clinicians and treatment planners find it difficult or impossible to define an overall scoring function in quantitative mathematical terms, even though they are capable of ranking individually prepared plans. It is a somewhat easier task to define scoring functions or costlets in individual organs. In most commercial planning systems the total score is defined as the weighted sum of individual scores, with user chosen weights (penalties). The weights determine the tradeoffs in the treatment plan. Because they have no direct clinical meaning, they must be found be trial and error, which accounts for part of the difficulties in practical IMRT planning. The use of class solutions for the determination of the weights and dose constraints can make the process more effective but can also lead to sub-optimal results. In mathematical optimization, several paths out of this apparent trap have emerged. We will briefly discuss the concept of multi-objective optimization based on Pareto-optimality, and goal programming.

Educational Objectives:

1. To understand the basic optimization concept of current IMRT planning systems
2. To name at least two fundamental reasons for the difficulties to find good treatment plans with current IMRT planning systems
3. To understand the concept of multi-objective optimization and Pareto optimality