AbstractID: 2579 Title: Simplifying IMRT with Direct Aperture Optimization

Earlier and more widely used method for IMRT planning is beamlet-based inverse planning. It divides each beam into beamlets or bixels in the same way as planar images are composed of pixels. A computer algorithm is then used to optimize the weights of these beamlets. The optimized weight distribution is also called intensity maps. In order for the desired intensities to be delivered, a leaf-sequencing algorithm is used to translate the intensity maps into a sequence of deliverable beam shapes called segments. This two-step process (intensity optimization and leaf sequencing) puts delivery consideration outside the optimization and complicates IMRT.

In beamlet based inverse planning, optimizing the intensity distributions is only the first step of the planning process. Leaf sequencing, or creating a desired beam intensity using overlapping MLC shapes, is a mathematically intractable problem. A large number of complex field shapes are often needed. This can lead to a loss in efficiency and an increase in collimator artifacts. Attempts have been made to simplify the delivery by either grouping the intensity levels or smoothing the intensity distributions. However, such attempts are always accompanied by the reduction of plan quality. When a large number of segments are used, there are typically segments requiring a low number of monitor units (MUs) along with small off-axis fields. These segments introduce new challenges for accurate dose calculation and unrealistic requirements for geometric accuracy of the MLC and dosimetric accuracy of the linear accelerator. As the result, QA efforts must be intensified in order to achieve the well-established safety and accuracy standards.

Realizing that this two-step process and the large number of beam segments resulting from the poor process are the root causes of the labor intensive nature of IMRT, we directly optimize the beam apertures and their weights. This method is termed “Direct Aperture Optimization (DAO)”. With DAO, only a few segments are needed to generate treatment plans that rival those produced by employing the two-step process. Most importantly, what you see is what the patient will get, since all the delivery related effects are already included in the dose distribution and the beam segments generated by the plan can be directly transferred to the linac for delivery.

In this presentation, we will describe the DAO process and compare it with beamlet-based inverse planning. We will show that the number of segments can be drastically reduced without affecting plan quality. We will also show that the effects of organ motion are inversely proportional to the segment size and segment MUs. With reasonably sized field segments, the requirement for MLC geometric accuracy and linac’s dosimetric accuracy will be significantly lessened and the need for extensive QA will diminish. The delivery time will also be in line with conventional practice allowing more patients to receive the benefits of IMRT. The effects of organ motion during IMRT delivery will also be smaller.