AbstractID: 7801 Title: Mixed Integer Programming Techniques Applied to IMRT Treatment Planning Optimization

An automated optimization algorithm based on mixed-integer-programming techniques is presented for generating high-quality treatment plans for intensity-modulated-radiation-therapy.

Our superposition calculation model uses published Monte Carlo-generated energy spectra from Mohan-etal. The finite source(focal radiation) penumbra and head scatter(extra-focal radiation) are modeled through convolution of fluence with Gaussian functions. The fluence of each spectrum energy component is attenuated on a ray-by-ray basis for accurate beam hardening in both treatment aids and in the patient. This provides our beam model for the incident energy fluence as it exits the accelerator head. For this presentation, 16 beams each with a total of 400 beamlets are generated as candidate beams.

The computational treatment planning model incorporates strict dose-volume restrictions on tumor volume and critical structures, and constraints on the desired number of beams. The model seeks to deliver full prescription dose coverage and homogeneous radiation to the tumor volume while minimizing excess radiation to the critical and normal tissue. It ensures good comformity and minimal dose to proximal normal tissue via a rapid dose fall-off.

Clinical tests on five patient cases with different tumor geometry shapes indicate that this computational approach can produce exceptionally high-quality plans within 5 minutes. Furthermore, regardless of how many beams are used, the resulting plans provide highly homogeneous(1.1-1.5) and conformal(1.3-1.6) dose to the tumor volume while maintaining low irradiation to critical and normal tissues. Furthermore, the best clinical results occur when all 16 beams are used, while no incremental gain in figures-of-merit is observed when beam numbers are below 16.