Optimization Techniques for Intensity Modulated Stereotactic Radiotherapy

Simulated Annealing, in conjunction with back-projected beam weighting, has proved to be an effective optimization technique for intensity modulated stereotactic radiotherapy. We have developed additional tools that enhance the optimizer's performance and reduce time for radiotherapy planning.

The optimization model's goal is to deliver a plan that fulfills constraints imposed by the physician and physicist. A cost function determines a plan's superiority to other calculated plans. Each target is given a minimum dose goal and each critical structure is assigned maximum dose limits. A hierarchical importance scale (weight) rank each target and sensitive neighboring tissues, which, determines the structures' relative importance. Normal tissues with low dose limits and high relative weights will be highly protected by the algorithm.

To further improve dose distributions, we have developed a 'moat' technique that completely surrounds the tumor with a 5 mm normal tissue zone followed by a 10 mm moat of 'highly sensitive tissue.' The moat attempts to drive the dose into the target while limiting dose elsewhere.

The added benefit of the moat technique is seen for a brain metastasis measuring 3.81cc located directly superior to the brain stem. Using the moat technique decreases each isodose volume by approximately 42% while delivering a more conformal plan. The 90% isodose volume for the moat technique measured 3.85 cc compared to 6.72 cc or nearly twice the metastasis volume.

The reduced isodose volume and five-fold planning time decrease proves the moat technique is a valuable planning tool.