

The maximum likelihood (ML) approach to image reconstruction has served as a powerful tool in both emission and transmission tomography. We have performed numerous simulations with the goal of determining the strengths and weaknesses of this approach as applied to radiotherapy optimization.

A primary strength of the ML technique is that convergence can be reached fairly rapidly even with highly complex tomotherapy treatment plans delivered helically to a 3D geometry. This method, however, exhibits three major weaknesses: (1) It fails to properly account for the dose delivered to points not included in the prescription; (2) ML drives the dose distribution in a sensitive structure to its prescribed level even if the prescription is needlessly high; and (3) Large sensitive structures may dominate an optimization leading to undesirable cold spots in the tumor.

These weaknesses can be addressed through the use of penalty functions. Two penalty functions have been explored thus far. The first penalty used a cutoff to promote lower doses in the sensitive structures. The second penalty was dynamic in nature and was designed to place the highest priority on tumor dose uniformity.

A similar iterative technique called the ratio method has also been examined. In the ratio method, the weight of each beam is corrected by the geometric mean of the ratios between the actual and prescribed doses for all of the prescription points located in the primary path of the beam. Several initial beam weight selection schemes have been used to check the stability of each algorithm.