

Iterative Least Squares Approach to Optimizing Large-Scale Treatment Plans

An iterative optimization approach has been developed that minimizes a quadratic objective function without computing gradient functions. This optimization technique, referred to as Iterative Least Squares Minimization, includes a non-negativity constraint that is applied to all of the beam weights. Another important feature of this algorithm is that underdosage and overdosage can be assigned separate penalties. With the addition of dose-volume histogram based penalty functions and weighting factors assigned to each region of the patient, this optimization technique is easily adaptable to a wide variety of treatment situations.

Iterative Least Squares Minimization has been used in the development of numerous tomotherapy treatment plans. Inverse treatment planning for tomotherapy represents a particularly difficult challenge because of the large number of pencil beams of radiation. As an example, a treatment plan will be presented for a nasopharyngeal carcinoma that involved over 300,000 pencil beams. Each of these pencil beams had a corresponding dose matrix that was 128 by 128 by 52 voxels. The success of Iterative Least Squares Minimization is in part due to its ability to work efficiently in conjunction with a convolution/superposition based dose engine. This algorithm can optimize a treatment plan using a limited number of convolution operations without sacrificing the accuracy of the dose computation.