A hybrid approach to beam angle optimization in intensity-modulated radiation therapy

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Intensity-Modulated Radiation Therapy (IMRT) is the technique of delivering radiation to cancer patients by using non-uniform radiation fields from select angles, with the aims of reducing the intensity of the beams that go through critical structures and reaching the dose prescription in the target volume. Two decisions are of fundamental importance: to select the beam angles and to compute the intensity of the beams used to deliver the radiation to the patient. Usually, these two decisions are made separately: first, the treatment planners, on the basis of experience and intuition, decide the orientation of the beams and then the intensities of the beams are optimized by using an automated software tool.

Automatic beam angle selection (also known as Beam Angle Optimization, BAO) is an important problem and is generally based on human experience by now. In this context, we face the problem of optimizing both the decisions, developing an algorithm which automatically selects the beam angles and computes the beam intensities. For the beam angle aspect, we propose a hybrid heuristic method, which combines a simulated annealing procedure with the knowledge of the gradient. As an integral part of this procedure, the beam intensities are optimized by solving a Linear Programming model. Experimental results are performed on phantom and real-life case studies, showing the advantages that come from our approach.