

Estimation Theory for Therapeutic Treatment Plan Optimization

In inverse planning in radiotherapy, an optimized solution to a prescribed dose distribution (or prescribed DVHs) is realized under the guidance of an objective function. In this work, the treatment plan optimization is formulated as an estimation problem of discrete and possibly non-convex system. The concept of the preference function of the treatment plans is introduced. Instead of prescribing a dose to a structure (or a set of voxels), the approach allows us to prioritize doses with different preference levels and reduces the problem into selecting a solution using a suitable decision estimator. The approach is quite general and makes it possible to incorporate empirical judgement (or expert knowledge) into the preference function. It is shown that the commonly used quadratic objective function is a special case of the formalism and the importance factors in the quadratic objective function are simply the Gaussian parameters of a Gaussian preference function. A general method for using a computer to determine the values of the model parameters is proposed. The method is illustrated using a simplified two-pixel system as well as two clinical cases. The generality of the approach, coupled with promising demonstrations, indicated that the method has broad implications for radiotherapy treatment plan optimization. Some implications of the formalism to therapeutic plan optimization are addressed.