Global and local maxima in the Dynamically Penalized Likelihood method of inverse therapy planning

Abstract

It is generally known and well documented that the Simulated Annealing (SA) method of inverse therapy planning for Intensity Modulated Radiation Treatment (IMRT) must have a provision to "jump out" from local minima of its objective function if it is to reach a desired global minimum. In this paper, it is shown that the iterative Dynamically Penalized Likelihood (DPL) method either does not need to jump out of any local maxima in the easier problems or it can do so easily, if needed, in the more difficult optimization problems. The model for DPL IMRT that emerges from this study is one in which the DPL solutions lie on, or very close to, a nearly flat shell in multi-dimensional parameter space (beam weight space) which has the Maximum Likelihood (ML) solution for the PTV at its maximum. For the IMRT case, maximum likelihood implies minimum least square errors. In the case in which the final DPL solution lies on the ML shell, the DPL solutions exhibit very small rms errors in the PTV. When the final DPL solution is not on the ML shell, a few passes with a Maximum Likelihood Estimator (MLE) will bring the solution to that shell, "jumping out" of an apparent local maximum, with a rapid improvement of the dose distribution for the PTV, all the while maintaining excellent low doses in the OAR's.