Evolutionary DVH-Evaluation for Beam Orientations in IMRT

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Abstract

The problem of beam orientations in intensity-modulated radiation therapy (IMRT) is an important, but large-scale NP-hard optimization problem [1]. A considerable part of this difficulty is due to the essential prerequisite of defining, appropriately, counter-intuitive criteria for a mathematical plan evaluation that coincides with the clinical judgement of the considered plan. Moreover, the quality of beam directions depends heavily on its corresponding beam intensity profiles. Usually a stochastic selector is utilized for optimizing beam orientations, and an inverse treatment planning algorithm is employed to optimize beam intensity profiles for every selection of beam orientations, resulting in excessive time complexity. To overcome these difficulties, this work utilizes the concept of dose volume histogram (DVH), which is one of the main recognised quantitative measurement tools used for plan judgement [2], to present a DVH evaluation scheme that parallelizes plan evaluation with clinical plan judgement. The DVH evaluation scheme is then combined with an evolutionary algorithm manufactured particularly to solve the problem of beam orientation in IMRT. The results of applying the presented methods to real clinical cases demonstrated that while the evolutionary algorithm converges to appropriate solutions in practical clinical time slot, significant improvement were reported in all clinical cases in comparison to the standard equally spaced beam plans.

Keywords

Evolutionary Algorithm; Dose volume histogram; Beam orientations in IMRT

References

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