Purpose: Direct Aperture Optimization (DAO) is an Intensity Modulated Radiation Therapy (IMRT) inverse planning technique whereby the shapes and relative weights of the apertures in the plan are optimized directly. As DAO is capable of producing treatment plans that are comparable to plans produced using the traditional inverse planning approach while using significantly fewer segments, DAO is studied more and more in recent years. Inverse planning optimization is a multi-objective optimization problem whose solution is known as Pareto solution set. So, the multi-objective direct aperture optimization based on Pareto solution set was studied in this paper.

Method: The clinical requirements for a treatment plan were transformed into a multi-objective optimization problem with multiple constraints, in which the parameters are the shapes and relative weights of the apertures. And then the fast and elitist multi-objective Non-dominated Sorting Genetic Algorithm (NSGA-II) was introduced to optimize the problem. The aim of NSGA-II based optimization algorithm is to provide a representative set of non-dominated solutions for problems where many conflicting objectives and many constraints need to be considered simultaneously instead of a single solution.

Results: A clinical example was tested using the method. The results showed that a set of non-dominated solutions obtained distributed uniformly, and the corresponding dose distribution of each solution not only approached to the expected dose distribution but also met the dose-volume constraints.

Conclusions: It was indicated that the clinical requirements were better satisfied by the method and planner could select the optimal treatment plan.

Funding Support, Disclosures, and Conflict of Interest:

Supported by the National Natural Science Foundation under grant No.30900386 and the Anhui Provincial Natural Science Foundation under grant No. 090413095 and 11040606Q55.