Purpose: In plan optimization of intensity-modulated radiation therapy (IMRT), all voxels inside the same structure are treated equally. In realty, the spatial location of hot/cold spots does have some clinical. One example is that hot spots, if cannot be removed, are more preferred to be located at the center, rather than the edge, of the tumor. Our goal is to develop a method that while preserving the plan quality represented by the DVH curves, reallocates hot and cold spots to more clinically preferred locations, by incorporating voxel's spatial information into the optimization model.

Methods and Materials: In traditional optimization models, usually a convex objective function penalizes the deviation of the dose received by each voxel from its prescribed (if it is part of the target) or threshold dose (if it is part of a critical structure). In our model, instead of assuming an equal weight for all voxels inside a structure, we associate weights as a function of their physical position in the structure. By this modification, our model incorporates voxel-based penalty weights for overdosing (penalizing the presence of hot spots) and underdosing (penalizing the presence of cold spots) depending of the location in the structure. The resulting convex optimization problem is solved by implementing a gradient algorithm with Armijo search.

Results: We tested our model in four prostate cancer cases and we compare the characteristics of resulting hot/cold spots to those resulting from a correspondingly model without incorporating spatial information. It is observed that without sacrificing the plan quality represented by the DVH curves, our model relocates the hot/cold spots to more desired positions.

Conclusions: We have proposed a new optimization model that, by incorporating voxel's spatial location information, generates similar DVH curves to those from traditional model, while capable of redistributing hot/cold spots to more desirable locations.