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Abstract

# Fluence Map Prediction via Deep Learning for Pancreas SBRT

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## Abstract

Objectives: Inverse optimization in pancreas stereotactic body radiation therapy (SBRT) planning is an iterative and time-consuming task which relies on the planner's experience. The optimized fluence map solution is strongly associated with the morphology information of both planning target volume (PTV) and organs-at-risk (OARs), and more importantly the prescribed constraint. The intrinsic nature of highly variable organ shapes in pancreas SBRT complicates the task, and therefore makes classic knowledge-based model less competent in achieving high performance. Convolutional neural network (CNN) has shown potential in building correlation between high dimensional data, especially 2D images. In this study we aim to develop a novel deep learning architecture for fluence map prediction for pancreas SBRT.

Methods: Eighty-three patients previously treated with pancreas SBRT at our institution were included in this study. Among them, seventy-three were used for training, and the other ten were used for testing. For each patient, a 9-beam IMRT plan with same dose constraints was generated and used as training inputs. The PTV was prescribed to 33 Gy in 6 fractions, and the OAR maximum dose was limited to 25 Gy. A region-of-interest (ROI) was defined as the PTV expanded by 2 cm. Relevant OARs in the ROI were considered. The CNN takes contour masks of structures including PTV and OAR as inputs and predicts fluence maps as outputs. The predicted fluence maps were imported into the commercial treatment planning system used in the clinic for dose calculation and plan comparison with inversely optimized plans.

Results: Initial testing results showed the ability of the network to capture patient anatomical information and generate deliverable fluence maps. The deep learning network operates automatically without manual fine-tuning. Typical total calculation time is 2 to 3 minutes per patient. The mean values (standard deviation) of the predicted and optimized plan PTV V95% are 91.1% (4.8%) and 99.6% (0.2%). The OAR dose constraints were satisfied in both plan groups.

Conclusions: This study demonstrates the feasibility of utilizing deep convolutional neural networks to predict fluence maps for 9-beam pancreas SBRT, which could eliminate the need to design and optimize an objective function and allow the automation of the treatment planning process. This method has the potential to revolutionize inverse optimization even in challenging cases.

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