ESTRO

# Abstract

## Title

DeepDoseOpt: End-to-End VMAT Pelvis Dose Prediction & Treatment Planning Inference


## Authors

Jules Dedieu[1], Kumar Shreshtha[2], Aurélien Lombard[2], Norbert Bus[1], Sonia Martinot[1], Rutger Fick[1], Nikos Paragios[3,4]

## Authors Affiliations

[1]Therapanacea, Physics, Paris, France; [2]Therapanacea, Artificial Intelligence, Paris, France; [3]Therapanacea, CEO, Paris, France; [4]CentraleSupelec, University of Paris Saclay, Center for Visual Computing, Paris, France


## Purpose or Objective

Volumetric Arc Therapy (VMAT) has become the predominant planning principle in radiation oncology. It offers excellent planning capabilities due to the important number of degrees of freedom but it is associated with a time consuming, tedious, user-biased and often suboptimal iterative/lengthy optimization process towards finding the best compromise among the different prescription constraints. Convolutional neural networks have been proven to be very efficient prediction models on structured data. In this work, we investigate an end-to-end framework to derive from the prescription and planning data - using deep learning - the volumetric dose prescription constraints that could be met and integrate them directly into a planning compressed sensing inference process.

## Materials and Methods

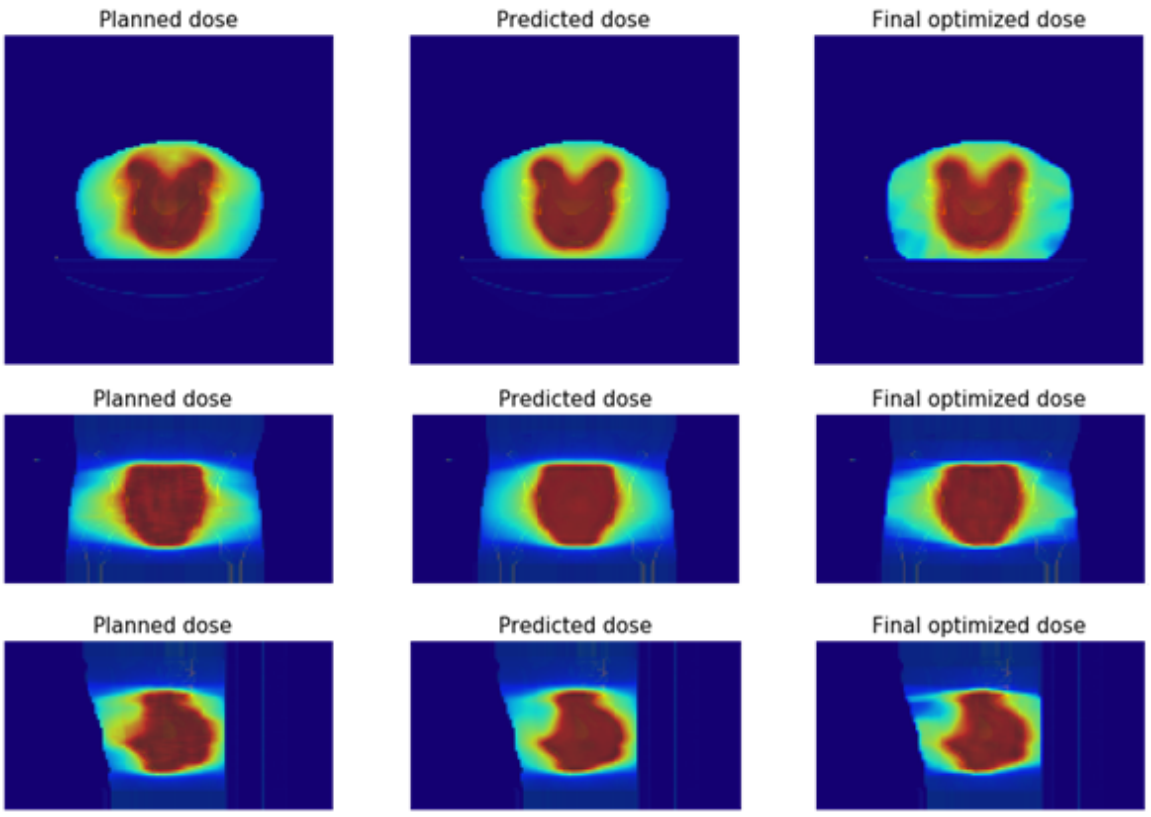
An anatomically preserving ensemble deep learning convolutional architecture was trained using 500+ VMAT pelvic treatment plans. From the patient's CT scan, Organs at Risk (OAR) delinations, Planning target Volumes (PTV) and the associated prescriptions, it predicts the full scale volumetric dose matrix. The loss function used was the mean voxel-based average dosimetric difference between the prediction and the actual plan. This predicted dose was then integrated into a compressed sensing optimization method for the final treatment plan inference, using a "Truebeam (X06/X18)", that on top of sparsity constraints sought a treatment plan that minimizes the gap between the delivered and the predicted dose. The end-to-end pipeline (3-5min per case), including dose prediction, fluency dose simulation, dose optimization and final dose calculation, was tested on 50+ remaining patients and the final estimated dose was compared with the one used for treatment.

## Results

In order to assess the relevance of our end-to-end dose inference, the average error (AE) between the actual plan and the one determined from our end-to-end solution was computed for the test patients on the minimum, mean and maximum of the dose for each organ, target (cf table).

| | Min dose AE(Gy) | Mean dose AE(Gy) | Max dose AE(Gy) |
|---|---|---|---|
| PTV | -4.86±4.93 | -0.69±1.05 | 0.55±0.95 |
| Anal Canal | -0.48±1.12 | 0.24±1.70 | -0.80±2.01 |
| Bladder | 0.67±3.47 | 0.163±1.69 | 0.03±0.83 |
| Bowel | -0.05±0.09 | -0.25±0.46 | -0.88±1.67 |
| Penile Bulb | -1.2±1.00 | -2.22±2.45 | -2.56±5.99 |
| Rectum | 0.66±2.70 | 1.32±2.13 | -0.49±0.98 |
| Seminal Vesicle | -0.78±0.84 | -0.53±0.73 | 0.26±0.73 |
| Sigmoid | 0.24±0.27 | -0.95±1.23 | 0.2±0.19 |

Here is given an example of prediction and final dose after optimization with respect to the original plan.




## Conclusion

We introduced an end to end pipeline that creates a direct link between treatment input data and VMAT final treatment plans for pelvic cancers and eliminates the multi-iteration optimization step. The underlying idea is to train a volumetric dose prediction mechanism and integrate it as a direct constraint on the optimization engine. Our model produces state of the art treatment plans that appear to be fully acceptable according to the standard clinical practices. Our approach is easily scalable to other anatomies.