# Multi-Agent Reinforcement Learning Meets Leaf Sequencing in Radiotherapy

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## 1. Background

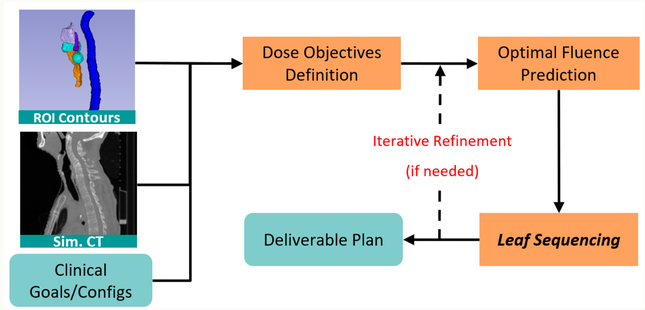


Fig. 1. Illustration of a typical RTP process. Three common components are shown in the orange boxes. We focus on *leaf sequencing* in this work. The term "optimization" in this paper refers to a series of methods that are not machine learning.

## 2. Motivation

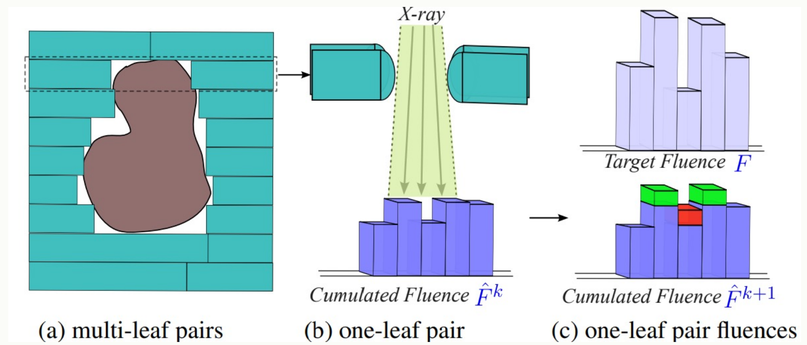


Fig. 2. (a) shows multi-leaf pairs in 2D representing MLC and PTV projections. (b) provides a 3D view of a leaf pair and its connection to cumulated fluences. (c) illustrates motivations of Reward 1 (green) and Reward 2 (red

## 3. Methodology: Reinforced Leaf Sequencer (RLS)

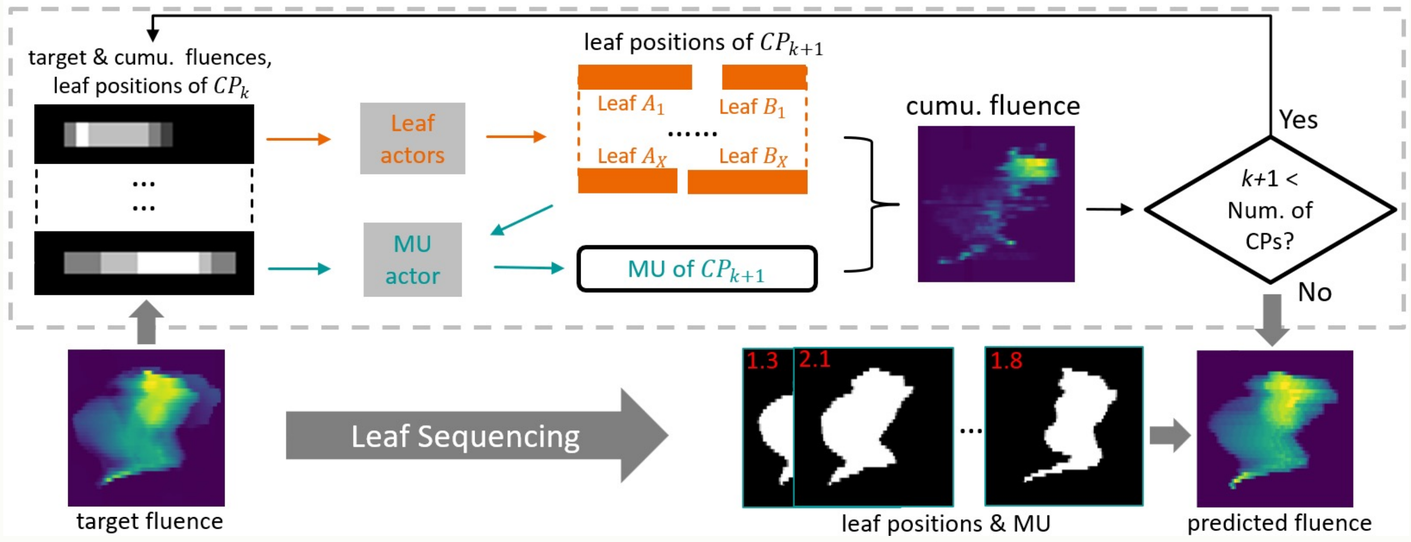


Fig. 3. Illustration of the proposed RLS. The upper shows the methodology and the lower shows the input/output of RLS. The target fluence is splitted into $X$ rows, each row is related to one leaf-pair and one leaf actor. $x$-th leaf actor predicts the positions of Leaf $A_x$ and $B_x$. All rows in $k$-th CP shares the same monitor unit, which is predicted by MU actor after all leaf positions are obtained.

## 4. Experiment Results

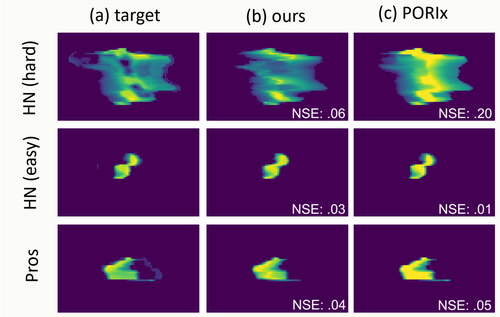


Fig. 4. Predicted fluence vs. target fluence. The reconstruction error is shown right bottom of the predicted fluences. First row: hard case from HN; second row: easy case from HN; third row: prostate case

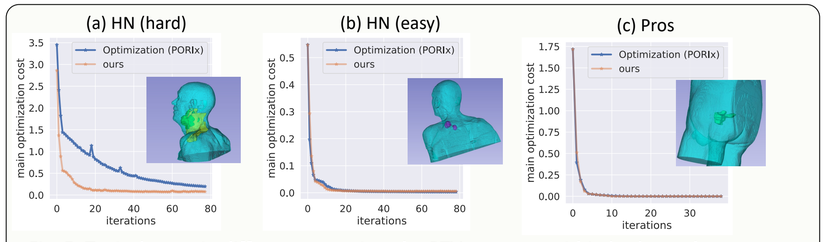


Fig. 5. Typical cases in different scenarios. the PTV contours within body mask are shown along with the main optimization cost vs. the number of iterations. (a): large PTVs (PTV 54 and PTV 60) in HN, (b): small PTVs in HN (PTV 66), (c): PTV in prostate. The RLS brings clear improvements for hard cases (e.g., those with large PTVs).

## 5. Discussion

- To the best of our knowledge, the proposed RLS is the first MARL-based leaf sequencer for RTP. Limitations and future works have been discussed.
- Excitement surrounds the potential of deep learning to partially or fully replace conventional optimization practical RT in the future.

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