Radiotherapy Dose Optimization via Clinical Knowledge Based Reinforcement Learning

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**Abstract.** A radiation therapy plan finds an equilibrium between goals with no universal prioritization. The delicate balance between multiple objectives is typically done manually. The optimization process is further hindered by complex mathematical aspects, involving non-convex multi-objective inverse problems with a vast solution space. Expert bias introduces variability in clinical practice, as the preferences of radiation oncologists and medical physicists shape treatment planning. To surmount these challenges, we propose a first step towards a fully automated approach, using an innovative deep-learning framework. Using a clinically meaningful distance between doses, we trained a reinforcement learning agent to mimic a set of plans. This method allows automatic navigation toward acceptable solutions via the exploitation of optimal dose distributions found by human planners on previously treated patients. As this is ongoing research, we generated synthetic phantom patients and associated realistic clinical doses. Our deep learning agent successfully learned correct actions leading to treatment plans similar to past cases ones. The incapacity to reproduce human-like dose plans hinders adopting a fully automated treatment planning system; this method could start paving the way towards human-less treatment planning system technologies. In future work, we hope to be able to apply this technique to real cases.

**Keywords:** Radiotherapy, Dose Optimization, Reinforcement Learning, Deep Learning.

1. First Section
   1. A Subsection Sample

Please note that the first paragraph of a section or subsection is not indented. The first paragraphs that follows a table, figure, equation etc. does not have an indent, either.

Subsequent paragraphs, however, are indented.

### Sample Heading (Third Level). Only two levels of headings should be numbered. Lower level headings remain unnumbered; they are formatted as run-in headings.

#### Sample Heading (Forth Level). The contribution should contain no more than four levels of headings. The following Table 1 gives a summary of all heading levels.

**Table 1.** Table captions should be placed above the tables.

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| Heading level | Example | Font size and style |
| Title (centered) | **Lecture Notes** | 14 point, bold |
| 1st-level heading | **1 Introduction** | 12 point, bold |
| 2nd-level heading | **2.1 Printing Area** | 10 point, bold |
| 3rd-level heading | **Run-in Heading in Bold.** Text follows | 10 point, bold |
| 4th-level heading | *Lowest Level Heading.* Text follows | 10 point, italic |

Displayed equations are centered and set on a separate line.

*x* + *y* = *z* ()

Please try to avoid rasterized images for line-art diagrams and schemas. Whenever possible, use vector graphics instead (see Fig. 1).

**Fig. 1.** A figure caption is always placed below the illustration. Short captions are centered, while long ones are justified. The macro button chooses the correct format automatically.

For citations of references, we prefer the use of square brackets and consecutive numbers. Citations using labels or the author/year convention are also acceptable. The following bibliography provides a sample reference list with entries for journal articles [1], an LNCS chapter [2], a book [3], proceedings without editors [4], as well as a URL [5].

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