

Méthodes pour l'automatisation de la dosimétrie pour les traitements radiothérapeutiques.

*Methods for automatization of the dosimetry for radiotherapy
treatments.*

Thèse de doctorat de l'université Paris-Saclay

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Examineur ou Examinatrice

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Mots cl s: Math matiques, Intelligence Artificielle, Radioth rapie

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Title: Methods for automatization of the dosimetry for radiotherapy treatments.

Keywords: Mathematics, Artificial Intelligence, Radiotherapy

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A PhD is more than just hard work; it thrives on mentorship, collaboration, and unwavering support.
[...]

List of Contributions

- Teaching: *Consistency and Reproducibility of Grades in Higher Education: A Case Study in Deep Learning* *replace icon*
- ArXiv: Radiotherapy Dosimetry: A Review on Open-Source Optimizer
- ESTRO: A Novel Framework for Multi-Objective Optimization and Robust Plan Selection Using Graph Theory
- SFPM: Dose Volume Histograms Guided Deep Dose Predictions
- AIME: Radiotherapy Dose Optimization via Clinical Knowledge Based Reinforcement Learning (full paper coming soon)
- ASTRO: Clinically Dependent Fully Automatic Treatment Planning System
- SFRO: Attention Mechanism on Dose-Volume Histograms for Deep Dose Predictions

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Introduction

Abstract

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1.1 Introduction to Cancer

1.1.1 what is cancer?

Cells proliferating

DNA messed up

variety of cancer

some safe

(e.g.: mole/freckle)

some not safe

worse make the human die

1.1.2 who is concerned?

more and more ppl

1.1.3 risk factors

environment impacts the probability of getting cancer

(e.g.: UV exposure)

living habits as well

(e.g.: smooking)

genetic impacts as well (e.g. "cancer gene")

1.1.4 possible treatments

surgery

RT

chemotherapy

combination

1.1.5 10 cancer markers

cell proliferation

reprogram cellular metabolism

stop cell growth arrest

evade apoptosis

escape immune system

ability to undergo a sufficient number of successive cell cycles of growth and division to generate macroscopic tumors

create new blood vessels to get nutrients

allow cell escape and metastasis formation

change cellular response phenotypic via plasticity

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stage 3 which corresponds to invasion of the lymph nodes or surrounding tissues

stage 4 which corresponds to a wider extension in the body in the form of metastases

1.1.9 cancer causes

various reasons why

environment

inherited mutations

mistake in DNA copy

1.1.10 personalized treatments

revolution

rapid advances

help of mathematics

help of AI

1.2 Introduction to Mathematical Optimization

1.2.1 optimization def

selection of a best element, with regard to some criteria

1.2.2 in math: more precisely

optimization problem consists of maximizing or minimizing a real function by systematically choosing input

1.2.3 notion of allowed set

1.2.4 discrete vs continuous optim

1.2.5 many real-world and theoretical problems may be modeled in continuous general framework

1.2.6 $\max(f) \Leftrightarrow \min(-f)$ hence only min

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1.2.8 feasibility

1.2.9 existence

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2nd order

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1.3.2 general idea

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1.3.6 applications

1.3.7 learning types

supervised

un-supervised

self-supervised

reinforcement / semi-supervised

1.3.8 tasks

classical tasks

regression

classification

partitioning

dimension reduction

generative AI

images => training is difficult

text

1.3.9 recent progress**computer vision****playing games**

(a way to assess intelligence)

image generation**text generation****healthcare**

Radiotherapy

Abstract

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2.1.2 RT Prescription

2.1.3 CT scan

2.1.4 Contouring

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Sliding Window

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2.5 Dosimetry steps

Challenges

2.5.1 BOO

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2.6 Simulation

Dosimetry Optimization

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3.1 Optim engine: classic and dose mimicking

3.2 relation between optim doses (distance and network)

3.3 ESTRO (novel approach with graph theory)

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4.1 RL + classic optim algo (AIME / ASTRO)

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5.1	DVH guided deep dose + dose mimicking algo (SFPM / SFRO)	
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