LITHUANIAN COMPUTER SOCIETY
VILNIUS UNIVERSITY
INSTITUTE OF DATA SCIENCE AND DIGITAL TECHNOLOGIES
LITHUANIAN ACADEMY OF SCIENCES

11th International Workshop on

DATA ANALYSIS METHODS FOR SOFTWARE SYSTEMS

Druskininkai, Lithuania, Hotel "Europa Royale"
http://www.mii.lt/DAMSS

November 28–30, 2019

VILNIUS UNIVERSITY PRESS
Vilnius, 2019

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https://doi.org/10.15388/Proceedings.2019.8

ISBN 978-609-07-0325-0 (digital PDF)

High Performance Computing Techniques for IMRT Plan Optimization

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Intensity-Modulated Radiotherapy (IMRT) is a common technique for cancer treatment, allowing to precisely control the geometry and intensity profile of radiation beams. The goal of IMRT planning is to deliver prescribed radiation doses to tumorous tissues, while minimizing the dose inevitably received by the surrounding organs and normal tissue. In the standard approach to IMRT plan optimization, the decision variables represent two-dimensional intensity profiles of several radiation beams aimed from different directions (fluence matrices). The dose deposited in the patient body by a given IMRT plan is modelled by a sparse matrix with thousands of columns (the resolution of the intensity profiles) and hundreds of thousands of rows (the resolution of the model representing the patient body). Thus, a large part of computation resources during optimization is spent on operations with sparse matrices. In this work we explore the effectiveness of a gradient-based optimization method for IMRT plan generation combined with cutting-edge technologies of high performance computing. This way multiple alternative plans can be generated in a limited time span, giving radiologists more freedom in exploration of various planning opportunities.