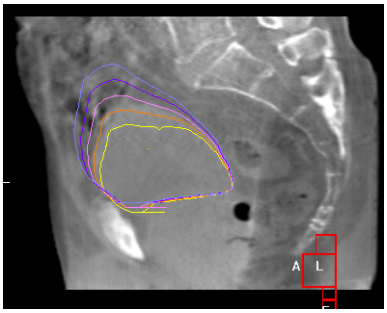
Graduation assignment:

Obtaining the actual delivered dose for image-guided online adaptive radiotherapy



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Introduction

The radiotherapy treatment nowadays is mainly based on a treatment plan derived from a single CT "snapshot" of the patient anatomy, and then performing daily treatment without accounting for changes in this anatomy. For organs with large deformations, such as the bladder, this can result in a mistreatment of the tumor or complications due to the irradiation of healthy tissue. By estimating the shape variations at the start of treatment (e.g. by using an empty and full bladder scan), creating a library of plans accounting for these variations, and selecting the appropriate plan based on daily pre-treatment imaging, a more effective treatment can be given. With the introduction of online MR-guided radiotherapy, further possibilities are opening up for applying this online adaptive approach.
Adding the daily delivered doses to obtain the total dose given to the patient is not a straightforward problem. Using deformable image registration, displacements of each voxel in an organ can be determined, and an accumulated dose can be calculated.

Main research goal:
To implement improvements to our clinical online adaptive radiotherapy treatment (specifically for bladder cancer), and develop and validate a method for calculating the total delivered dose to a patient from the daily selected plans.

Your contribution

You will:

- Develop a method to create synthetic CTs of intermediate organ shapes based on empty and full bladder scans, and validate these using daily cone-beam CT images.
- Use deformable image registration and dose accumulation to determine the actual delivered dose for patients treated clinically with this online adaptive procedure.
- Validate the dose accumulation by looking at registration uncertainties and their effect on the accumulated dose.
- Create an efficient workflow for calculating these dose accumulations using Python scripting.
- Evaluate the gains from these adaptive treatments, and explore possibilities for further improvement.

Your gain:

- You will be able to attend educational sessions at the department and see the whole process of patient treatment preparation and execution.
- You will acquire comprehensive knowledge on and experience in the work of a medical physicist in a radiation therapy department, focusing on online adaptive treatments.
- Possibilities for presenting your work in a scientific meeting or journal.
- You work will lead to improvement of our clinical online adaptive treatments.