Computational assignment 10

due on December 01, 2025

1. Proton dose-influence matrix

Create a dose-influence matrix for IMPT treatment plan optimization. To that end, beamlets (i.e. pencil beams) should be placed at a lateral distance of 5 mm such that the entire target volume is covered. For each beam angle, you will have to determine the energies for which the bragg peak falls into the target volume. There are multiple ways to do this:

1. To make it easy, you could determine, for each beam angle, the minimum and maximum radiological depth in the target volume and include all proton energies that fall into that range (independent of the lateral beamlet position). This will create many unused beamlets though.

2. Alternatively, one could perform ray tracing along the central axis of each lateral beamlet position, and thereby determine, separately for each lateral position, the energies for which the bragg peak falls into the target volume.

2. Comparative treatment planning

Perform comparative treatment planning for IMRT and IMPT. A typical beam arrangement for protons in this case would consist of 3 beams with gantry angles vertical from above and ± 45 degrees. A typical IMRT plan would consist of 9 equally spaced beams. Generate both an IMRT and an IMPT plan. Compare and plot the dose distributions and the DVHs for all structures.

Hint: The DVH can easily be calculated with the help of the python function `scipy.stats.ecdf` that calculates the empirical cumulative distribution function.