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Towards fast dose calculations for novel radiotherapy treatments with generative adversarial networks

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Introduction
Existing approximations used in clinical treatment planning are either not fast or not accurate enough for some novel irradiation techniques like microbeam radiation therapy (MRT), which relies on arrays of sub-mm synchrotron-generated, polarized X-ray beams. We present studies using generative adversarial networks (GANs) to mimic full Monte Carlo simulations of radiation transport to achieve a compromise of fast and accurate dose computation for variable phantoms and irradiation scenarios.

Materials & Methods
To obtain a generalised model for the dose prediction a conditional GAN using a 3D-UNet architecture is developed. As proof of concept, we predict the simulated dose depositions of a bone slab inside a water phantom with variable rotation angles and thicknesses. Subsequently, we demonstrate that our model is generalisable by applying it to a simplified head phantom simulation.
All Monte Carlo simulations are performed with Geant4 using a phase space file obtained from a validated simulation at the Australian Synchrotron.

Results
The trained model predicts for both the bone slab inside the water phantom and the simple head phantom dose distributions with deviations of less than 1% of the maximum dose for over 94% of the simulated voxels in the beam. Dose predictions near material interfaces are accurate on a voxel-by-voxel basis with less than 5% deviation in most cases. Dose predictions can be produced in less than a second on a desktop PC compared to approximately 50 CPU hours needed for the corresponding Geant4 simulation.

Level of Expertise

Student

Presenter Gender

Man

Pronouns

Which facility did you use for your research

Australian Synchrotron

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

No

Condition of submission

Yes

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