ST 3: Artificial Intelligence in Medicine

Time: Tuesday 11:00–12:15 Location: ST-H4

ST 3.1 Tue 11:00 ST-H4

Optimierung und Evaluierung der Registrierung von CT- und MRT-Bildern mithilfe maschinellem Lernens — •Elena Darsht, Alexander Ratke und Bernhard Spaan — Experimentelle Physik 5, TU Dortmund

In der Strahlentherapie ist der Erfolg einer Bestrahlung abhängig von der Genauigkeit der Tumorlokalisierung. Diese erfolgt üblicherweise anhand der zur Bestrahlungsplanung verwendeten CT-Bildern. Im Vergleich dazu bieten MRT-Bilder eine bessere Darstellung von gesunden und kranken Weichteilstrukturen für eine präzisere Konturierung an. Durch die Bildregistrierung und -fusion von CT- und MRT-Bildern kann die Bestrahlungsplanung anhand von CT-Bildern erfolgen und zusätzlich können die Informationen der MRT-Bilder genutzt werden.

Eine Möglichkeit die Registrierung umzusetzen, ist die Verwendung eines neuronalen Faltungsnetzes, wodurch eine Rechenzeit von nur einigen Minuten pro Registrierung erreicht werden kann. Es wird der Aufbau und die Evaluierung des verwendeten neuronalen Netzes präsentiert. Dabei werden insbesondere die zur Optimierung für dreidimensionale Schädelaufnahmen genutzten Parameter vorgestellt. Zur Evaluierung der Registrierung wird der *Dice*-Koeffizient verwendet, bei dem die Überlappung von segmentierten Bildern ermittelt wird.

ST 3.2 Tue 11:15 ST-H4

Towards a Digital Twin for clinical decision support of a prostate cancer patient — •Carlos Andres Brandl, Anna-Katharina Nitschke, and Matthias Weidemüller — Physikalisches Institut, Ruprecht-Karls Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany

We present concepts to realise a Digital Twin for decision support in medicine using the example of prostate cancer. The aim for a medical Digital Twin is to support clinical decision making by providing an intuitively interpretable way for the doctors' decisions. Inspired by concepts from engineering, we devise a combination of data-driven models with evidence-based knowledge which comprise a wide range of parameters and data types available. As a higher integrated approach, we discuss the implementation of latent representations of the patient. Compatibility with the clinical guidelines and physicians' decision-making processes must be ensured by finding appropriate and interpretable representations.

This work is part of the project CLINIC 5.1 and is supported by the BMWi.

ST 3.3 Tue 11:30 ST-H4

Using generative adversarial networks to predict proton beam dose distributions in mice — •Lara Bussmann, Kevin Kröninger, Armin Lühr, Florian Mentzel, Janine Salewski, and Jens Weingarten — TU Dortmund

The clinically used generic relative biological effectiveness (RBE) of 1.1 for protons compared to photons does not consider variations along the beams axis. For a better estimation of the varying RBE and to assess potential adverse effects, mouse brains are irradiated and excised to visualize DNA double-strand breaks.

In order to deduct conclusions about the RBE, the observed irradiation damage in the tissue is compared to the expected damage from Monte Carlo simulations of the dose distribution.

Using Monte Carlo simulations for dose distribution predictions can be very time-consuming. Machine learning models can be trained to predict dose distributions based on the phantom geometry.

In this talk, a deep learning dose prediction model for proton mouse irradiations based on generative adversial networks (GANs) is presented. GANs can be trained to generate data samples following a learnt distribution, which are indistinguishable from a ground truth distribution. In this study, MC simulation samples are used to train the GAN, using geometrical information about the target phantom as conditional input.

ST 3.4 Tue 11:45 ST-H4

A step towards treatment planning for microbeam radiation therapy: fast dose predictions with generative adversarial networks — •Florian Mentzel[1], Micah Barnes[2], Kevin Kröninger[1], Michael Lerch[2], Olaf Nackenhorst[1], Jason Paino[2], Anatoly Rosenfeld[2], Ayu Saraswati[3], Ah Chung Tsoi[3], Jens Weingarten[1], Markus Hagenbuchner[3], and Susanna Guatelli[2] — [1]TU Dortmund University, Department of Physics — [2]Centre for Medical Radiation Physics, University of Wollongong, Australia — [3]School of Computing and Information Technology, University of Wollongong, Australia

Microbeam radiation therapy is a novel and currently pre-clinical radiotherapy treatment based on planar arrays of high intensity submillimetre synchrotron gamma rays. Due to good healthy tissue sparing it is a promising candidate e. g. for the treatment of glioblastoma. The dose computations required to plan treatments are currently performed using time-consuming Monte Carlo (MC) simulations with Geant4. The dose computations are complex as steep dose gradients near the beams require very high spatial resolution while the need to take into account the effect of stray radiation over large distances makes small voxel sizes infeasible.

A two-fold approach to these problems is explored: first, a novel data taking method for MC simulations is presented. The method considers both high resolution and long-range effects of stray radiation. Second, a deep learning model based on 3D-UNet GANs is created to mimic dose simulations of Geant4, allowing for very short prediction times.

ST 3.5 Tue 12:00 ST-H4

A neural network for the event identification of a Compton camera — •Mareike Profe[1], Jonas Kasper[1], Awal Awal[2], Aleksandra Wrońska[3], and Achim Stahl[1] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Forschungszentrum Jülich - Institute for Nuclear Physics, IKP-4, Jülich, Germany — [3]Jagiellonian University - M. Smoluchowski Institute of Physics, Cracow, Poland

In proton therapy, a main approach to diminish the problem of range uncertainties is to verify the range of the proton beam on-line. By imaging prompt gamma photons originating from interactions of the proton beam within the body this challenge can be mastered. For the on-line range verification, the SiFi-CC project aims to develop a Compton camera based on scintillating fibers read out with silicon photomultipliers. The Compton events need to be discriminated from other event types: random coincidences and physical background. Subsequently, their features crucial for imaging need to be determined, i.e. the position of the Compton effect, the energy transferred to the electron, the position of the first interaction of the Compton-scattered gamma and its energy. Neural networks are an promising alternative to a classical selection algorithm to tackle this task. Here, a convolutional neural network is trained to predict the type and parameters of the events. The design of the neural network as well as the evaluation of the performance are presented.