Hochschule Worms
University of Applied Sciences

Sichere & Intelligente Visualisierungs- & Echtzeit-Rekonstruktions-Techniken (für pCT)
Forschungskollegs Rheinland-Pfalz

Student Assistant / Master Thesis
Generative Machine Learning for Charge Diffusion

Contact: Alexander Schilling (aschilling@hs-worms.de)

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Motivation

Silicon pixel detectors, such as the ALICE Pixel Detector (ALPIDE), are used to detect high-energy charged particles passing through them. When a charged particle hits the sensitive silicon layer, it produces a number of electron-hole pairs, which diffuse around the position of the hit. The electrons get collected at each pixel. When a certain electron threshold is reached, the pixel is turned on. The diffusion process causes each hit to turn on a cluster of pixels where the size depends on how much energy is deposited by the particle. This process is called charge diffusion.

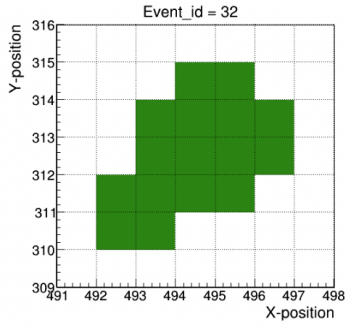

Figure 1: Pixel cluster example [1]

When simulating detector response, the process of charge diffusion is one of the most time-consuming steps. To speed it up, the process can be simplified to approximate the accurate simulation. This trades computation time for simulation accuracy. Another option is the recently emerging field of fast simulation using machine learning. Generative machine learning models, such as generative adversarial networks (GAN), are trained to produce accurate results much more quickly than full simulations.

Task

The goal is to train and deploy a generative machine learning model which can be used to generate clusters given a charged particle hit on the ALPIDE chip.
For this purpose, existing ALPIDE data needs to be analyzed and compared to a full charge diffusion simulation from Allpix^2. If the data matches, the full simulation will be used to generate training data for the model. The final model can then be integrated in the pixel conversion pipeline of the Bergen pCT collaboration [2].

Requirements

- Programming language: Python
- Basic knowledge of neural networks
- Proficiency in spoken and written English

Thesis Profile

Analysis	●●●●○
Programming	●●●●○
Literature	●●○○○

References

[1] https://bora.uib.no/bora-xmlui/bitstream/handle/1956/20857/Masteroppgave.pdf.

[2] https://www.uib.no/en/ift/142356/medical-physics-bergen-pct-project.