New algorithms based on deep learning for neutron tomography.

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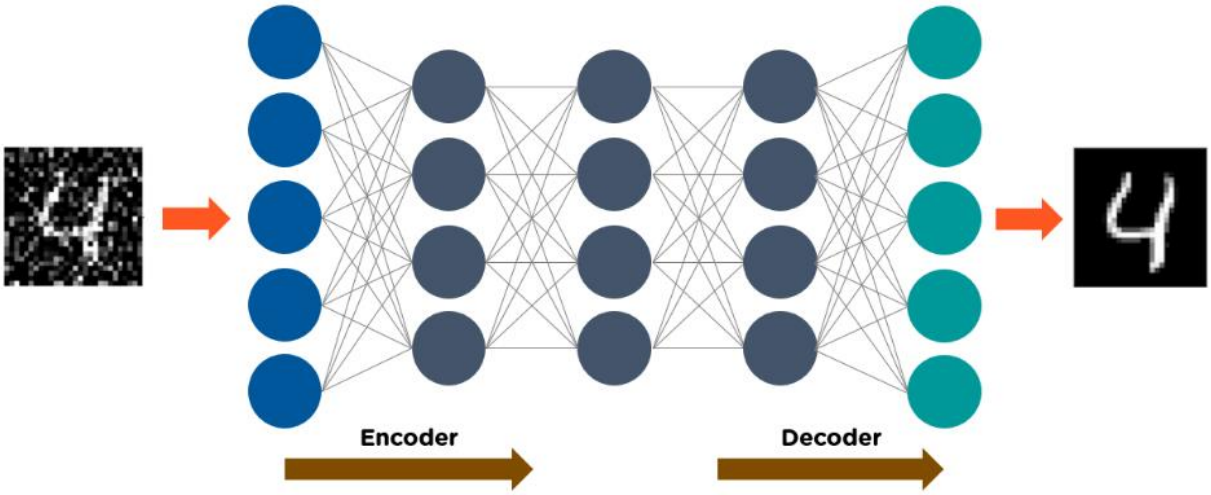

Introduction

The technique of computed tomography (CT), which utilizes various forms of radiation, such as X-rays, neutrons and electromagnetic fields, has become widely adopted and continues to grow in popularity in fields related to materials science, geology and archeology, among others. Neutron tomography holds a unique position in materials science due to the fundamental characteristics of neutron interactions with matter.

However, this technique faces several challenges, including long experiment durations, poor image quality and low resolution, as well as computational resource requirements. Consequently, the advancement of neutron tomography necessitates the development of novel mathematical algorithms for data processing and image reconstruction. Among the most promising approaches are those based on computer vision and convolutional neural networks (CNNs). Within the project, different models of convolutional neural networks will be trained and used for the processing and reconstruction of neutron tomography data. These models include autoencoder, U-Net, and GAN.

Main part

The project participant will gain a basic understanding of neutron tomography techniques. To this end, they will study methods for preprocessing radiographic projections and tomographic reconstruction algorithms, as well as analyze the resulting three-dimensional models. Subsequently, the participant will learn about the fundamentals of deep learning and implement a selected architecture for a convolutional neural network (CNN). The resulting model will be trained using data

from the first stage of the project and then applied to one of the challenges of neutron tomography.

Tasks

- Processing of neutron radiographic images
- Reconstruction of 3D models based on radiographic projections
- Application of neural networks to improve results
- Preparation of the final report

Required skills

- Condensed matter physics
- General math
- Confident PC user
- Basic Python knowledge

Recommended literature

1. Podurets, K.M., Kichanov, S.E., Glazkov, V.P. et al. Modern Methods of Neutron Radiography and Tomography in Studies of the Internal Structure of Objects. Crystallogr. Rep. 66, 254–266 (2021). https://doi.org/10.1134/S1063774521020115
2. Dong J, Fu J, He Z (2019) A deep learning reconstruction framework for X-ray computed tomography with incomplete data. PLOS ONE 14(11): e0224426. https://doi.org/10.1371/journal.pone.0224426
3. Isola, P., Zhu, J., Zhou, T., & Efros, A.A. (2017). Image-to-Image Translation with Conditional Adversarial Networks. 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 5967-5976. https://doi.org/10.1109/CVPR.2017.632

Number of project participants: up to 4.

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