Lecture Data Science for Electron Microscopy Winter 2024

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Abstract

This is the website for the Data Science for Electron Microscopy Lecture

* [Pelz Lab website](https://pelzlab.science)
* [Studon Link](https://www.studon.fau.de/campo/course/421992)

## 1 Lecture 1: Intro (25.10.2024)

* Introduction
* [d2l Chapter 2: Preliminaries](https://d2l.ai/chapter_preliminaries/index.html)

## 2 Lecture 2: Regression and Sensor Fusion (8.11.2024)

* [d2l Chapter 3: Regression](https://d2l.ai/chapter_linear-regression/index.html)
* Sensor Fusion Slides

## 3 Lecture 3: CNNs (15.11.2024)

* [d2l Chapter 7: CNNs](https://d2l.ai/chapter_convolutional-neural-networks/index.html)
* [d2l Chapter 8: CNNs](https://d2l.ai/chapter_convolutional-modern/index.html)

## 4 Lecture 4: Classification, Segmentation, AutoEncoders (22.11.2024)

* [d2l Chapter 4: Classification](https://d2l.ai/chapter_linear-classification/index.html)
* [d2l Chapter 14.9: Segmentation](https://d2l.ai/chapter_computer-vision/semantic-segmentation-and-dataset.html)
* Segmentation
* Dimensionality Reduction
  + PCA
  + Autoencoder
  + Variational Autoencoder

## 5 Miniproject (29.11. - 13.12.2024)

1. Segmentation

We will use the dataset from Rangel DaCosta et al. (2024) to implement a segmentation model.

1. VAE & Dimensionality Reduction

We will use the dataset from Shi et al. (2022) to implement a dimensionality reduction model and cluster 4DSTEM data.

1. Denoising

We will use the dataset from Sadri et al. (2024) to implement a denoising model for 4DSTEM data.

1. Image-to-Image Translation

We will use a simulated dataset from the IMN chair to implement an Image to image translation model.

## 6 Lecture 5: Mixed Bag (10.1.2025)

* Project presentation
* Generative Adversarial Networks
* Gaussian Processes 1

## 7 Lecture 6: GPs (17.1.2025)

## 8 Lecture 7: Bayesian Optimization, Active Learning, Deep Kernel Learning (24.1.2025)

## 9 Lecture 8: Inverse Imaging Problems 1: Tomography, Deconvolution (31.1.2025)

## 10 Lecture 9: Inverse Imaging Problems 2: Phase Contrast Imaging, Superresolution Imaging (7.2.2025)

## References

Rangel DaCosta, Luis, Katherine Sytwu, CK Groschner, and MC Scott. 2024. “A Robust Synthetic Data Generation Framework for Machine Learning in High-Resolution Transmission Electron Microscopy (HRTEM).” *Npj Computational Materials* 10 (1): 165.

Sadri, Alireza, Timothy C Petersen, Emmanuel WC Terzoudis-Lumsden, Bryan D Esser, Joanne Etheridge, and Scott D Findlay. 2024. “Unsupervised Deep Denoising for Four-Dimensional Scanning Transmission Electron Microscopy.” *Npj Computational Materials* 10 (1): 243.

Shi, Chuqiao, Michael C Cao, Sarah M Rehn, Sang-Hoon Bae, Jeehwan Kim, Matthew R Jones, David A Muller, and Yimo Han. 2022. “Uncovering Material Deformations via Machine Learning Combined with Four-Dimensional Scanning Transmission Electron Microscopy.” *Npj Computational Materials* 8 (1): 114.