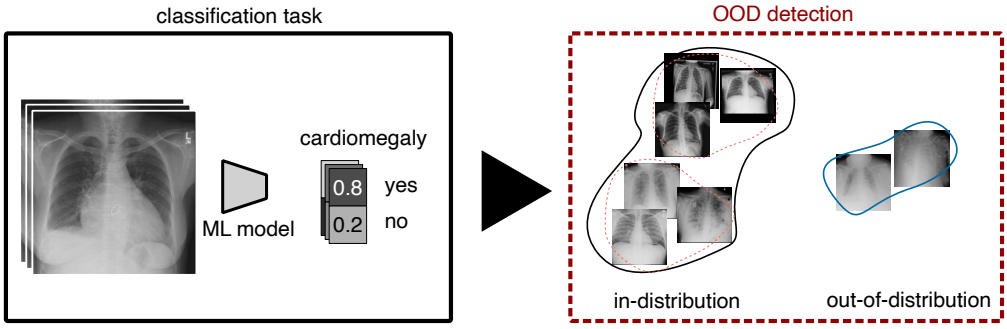
Foundation models for OOD detection in medical images

Background: Deep neural networks often fail when they are applied to images which are systematically different from the training data distribution. Detecting such out-of-distribution (OOD) images is crucial for safely applying deep learning algorithms, especially in a healthcare setting where algorithm mistakes may lead to patient harm. However, OOD detection is difficult in real-world medical imaging settings where differences between data distributions are often visually subtle.



Aim: In this project, we will develop and evaluate out-of-distribution detection methods for detecting distribution shifts in chest x-ray images. The project will make use of recent advances in foundation models and computer vision.

Materials and Methods: The student will work on multiple publicly available chest x-ray datasets. They will start with an existing codebase for data processing. They will use pre-trained foundation models and apply them for feature extraction in chest x-ray images. The student can expect to reach this first milestone quickly. They will then implement and reproduce a recently proposed method for density-based OOD detection [1]. They will evaluate the ability to detect OOD data using well-established metrics. The overarching goal of the thesis is the comparison of different foundation model features for density-based OOD detection, and a comparison to non-density based OOD detection techniques. The student will work in a research group focused on machine learning in medicine, where we have a strong expertise in deep learning for biomedical data analysis.

Nature of the Thesis:
Literature review: 10%
Data exploration: 20%
Model development: 50%
Results analysis: 20%

Requirements:
Solid machine learning knowledge
Programming experience (Python, ideally Pytorch)
Interest/Experience with processing of high-dimensional data (e.g. wearable, timeseries, images)
Strong written and verbal communication skills

Supervisor(s):
Prof. Dr. Lisa Koch

Institutes: Lab for Machine Learning in Medicine

References:
[1] Peng, Bo, Yadan Luo, Yonggang Zhang, Yixuan Li, and Zhen Fang. "ConjNorm: Tractable Density Estimation for Out-of-Distribution Detection." In *The Twelfth International Conference on Learning Representations (2024)*.
[2] Anthony, H., Kamnitsas, K. “Evaluating Reliability in Medical DNNs: A Critical Analysis of Feature and Confidence-Based OOD Detection”. In: *Uncertainty for Safe Utilization of Machine Learning in Medical Imaging (UNSURE)* (2024)

Contact:
Prof. Dr. Lisa Koch, lisa.koch@unibe.ch, Freiburgstrasse 3, CH-3010 Bern.
Please attach your transcripts when you reach out. We look forward to hearing from you!