MA Thesis: Robust unsupervised anomaly detection for medical imaging

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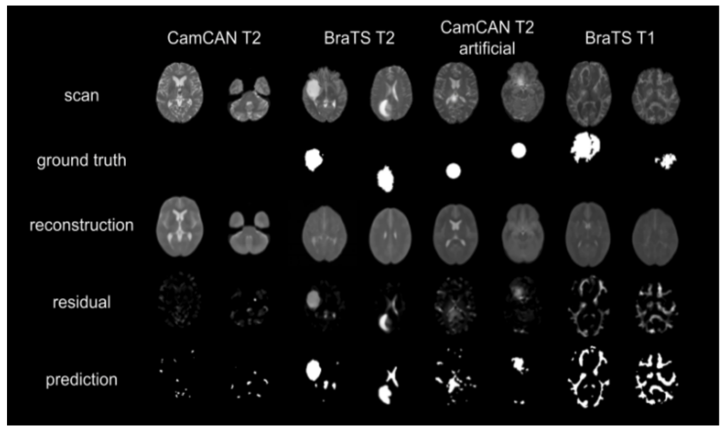

Unsupervised anomaly detection holds great promise for automatically detecting medical conditions (e.g. brain lesions) in image data since it alleviates the need for costly annotations [5]. Typically, one trains a generative model, e.g. a Variational Autoencoder (VAE), on data (e.g. brain scans) of healthy patients and detects pathological conditions at test time as out-of-distribution (OOD) data. This detection is commonly performed using the reconstruction [1] or restoration loss [2]. A comparative study of all these methods can be found in [6]. However, it was previously established that these unsupervised anomaly detection approaches are fundamentally unable to differentiate between real OOD data (e.g., healthy with domain shift) and medical anomalies [3]. Therefore, in this work we are trying to develop an approach that bypasses this shortcoming. We will start with a model trained on unsupervised anomaly detection following the common procedure [1-3, 6, 9]. Subsequently, the goal is to gain additional information about the target domain where the model is destined to be deployed. Therefore, we envision two potential strategies: 1) Apply few-shot domain adaptation strategies to our model (e.g. [4], [8]) such that healthy/non-anomalous samples are not wrongly detected or/and 2) use techniques from online learning to understand which reconstruction error patterns belong to "real" anomalies at inference time.

Roadmap:

- Familiarize with relevant literature (i.e. unsupervised anomaly detection, domain adaptation, online learning).
- Familiarize with existing codebase used in [3]
- Apply domain adaptation strategies and quantify impact in terms of anomaly detection performance and robustness
- Apply online and quantify impact in terms of anomaly detection performance and robustness

Prerequisites:

- Fundamental knowledge of deep learning and computer vision
- Proficiency in at least one deep learning framework (preferably PyTorch)
- Experience or knowledge about generative models is an advantage

Databases:

- Healthy Brain MR Imaging (CamCAN, OASIS, ADNI)
- MS/GB Lesion (BRATS, MS-LUB, MS-ISBI, …)
- MOOD (http://medicalood.dkfz.de/web/)

If you are interested in this project, please write an email to:

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References

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