Feature Modeling for Anomaly Detection in Neuroimaging

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Results

- No real progress in the results, best dice score around 0.07.
- When using multiple layers the anomalous voxels tend to have higher values than average, but the dice score is still low. This might be due to the small number of anomalous voxels.

Next steps

- Every model is performing well loss wise $\rightarrow$ the task is too easy.
- To make the task more difficult we can artificially increase the batch size using memory banks $\rightarrow$ currently training/experimenting with it.
- If memory banks don't work, I will just model two distributions, one of the normal and one of the anomalous values in validation and use it during testing to determine the prediction. This is subject to a bit of change.
- It seems like the task might be too difficult with memory banks, will try a resnet, first not pretrained.

Rationale

Anomaly detection in neuroimaging remains a challenging task due to the rarity of labeled pathological cases and the variability in anatomical structures and anomalies. Among recent approaches, feature modeling methods — which involve modeling the statistical distribution of deep feature representations — have demonstrated promising results across several benchmarks, including industrial inspection and medical imaging datasets. Motivated by these developments, this project adopts a self-supervised learning strategy using SimCLR, which facilitates representation learning from unlabeled healthy data through contrastive learning.

Rationale

Post pre-training, the projection head is removed and encoder feature maps from multiple layers are aggregated to capture a range of semantic and spatial information, following principles similar to those in PaDiM. To model the normal feature distribution, a multivariate Gaussian is fitted per voxel location, and Mahalanobis distance is employed to assign anomaly scores during evaluation. While feature modeling does not universally outperform all other categories of anomaly detection methods, its reported effectiveness for localized anomaly detection and its ability to leverage strong pre-trained representations make it a compelling choice for unsupervised pathology detection in neuroimaging contexts.

Potential conferences

- The 24th IEEE/WIC International Conference on Web Intelligence and Intelligent Agent Technology - London, UK, 15-18 November. Deadline June 25. Another link.
- The 18th International Conference on Brain Informatics (BI 2025) — Brain Science meets Artificial Intelligence - Bari, Italy, 11-13 November. Deadline June 20 (I think). Another link.
- Medical Imaging and Computer-Aided Diagnosis - London, UK, 19-21 November. Deadline August 19.
- The Second International Conference on AI-based Systems and Services AISyS 2025 - Lisbon, Portugal, 28 Sep - 2 Oct. Deadline June 10.