THE UNIVERSITY OF QUEENSLAND
AUSTRALIA
CREATE CHANGE

Unsupervised Anomaly Detection in MR Images

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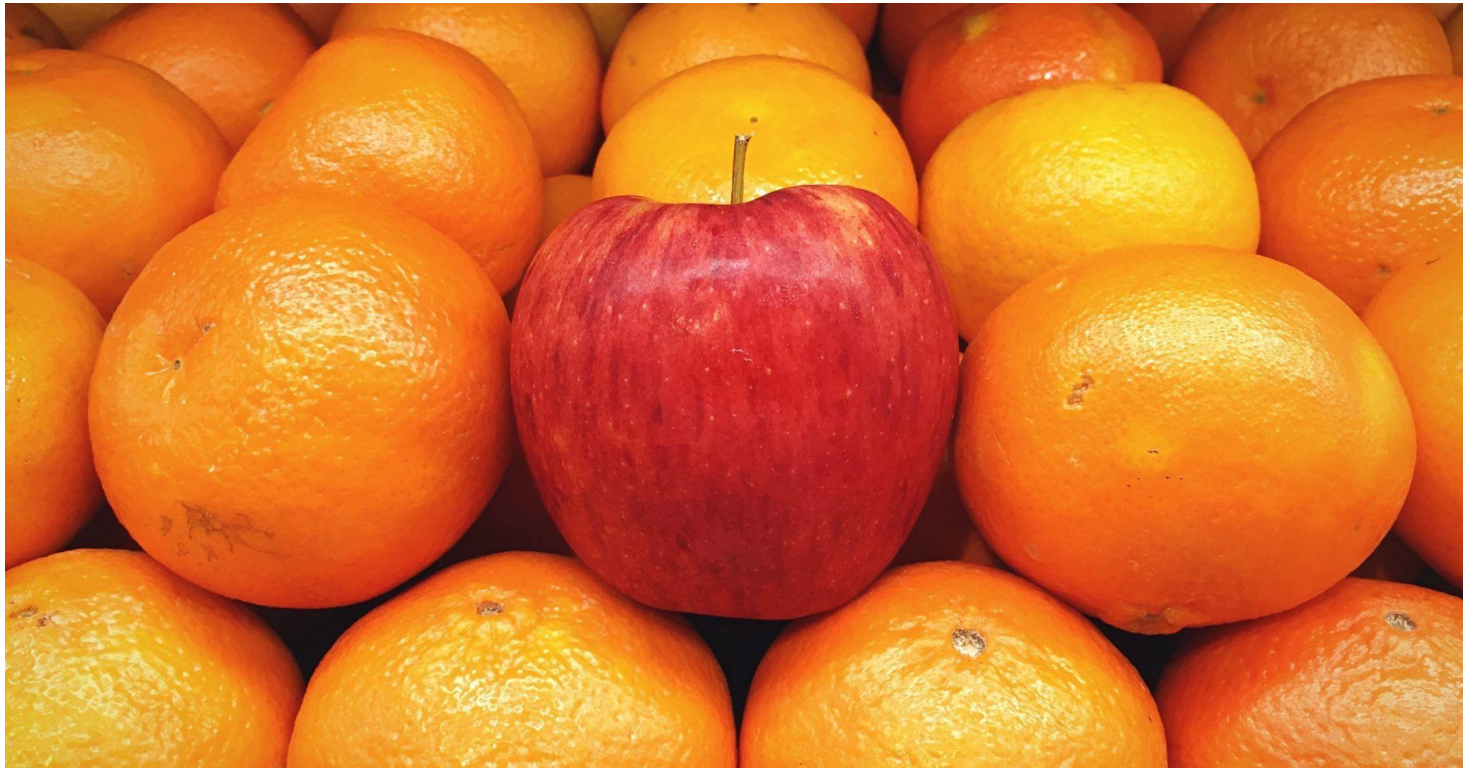
What is Anomaly detection?

- Identifying outliers that deviate from a healthy non-anomalous sample.
- In unsupervised Anomaly detection, the model is trained only on non-anomalous data.



Motivation for the project

- Most methods/models work on evaluation an anomaly score to quantify the extent of deviation from normal, and do not focus on providing visually interpretable results for anomalies.
- Identify small lesions and anomalies, which can be missed during screening.
- Eg: Focal cortical dysplasia, MS lesions.

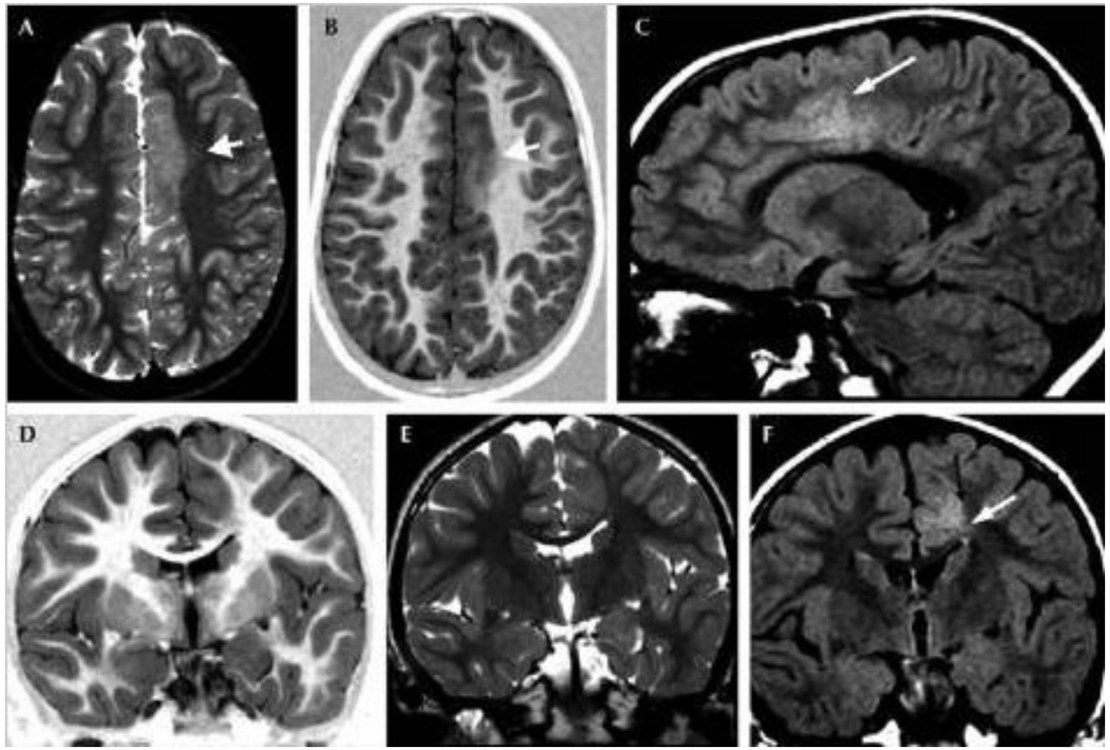


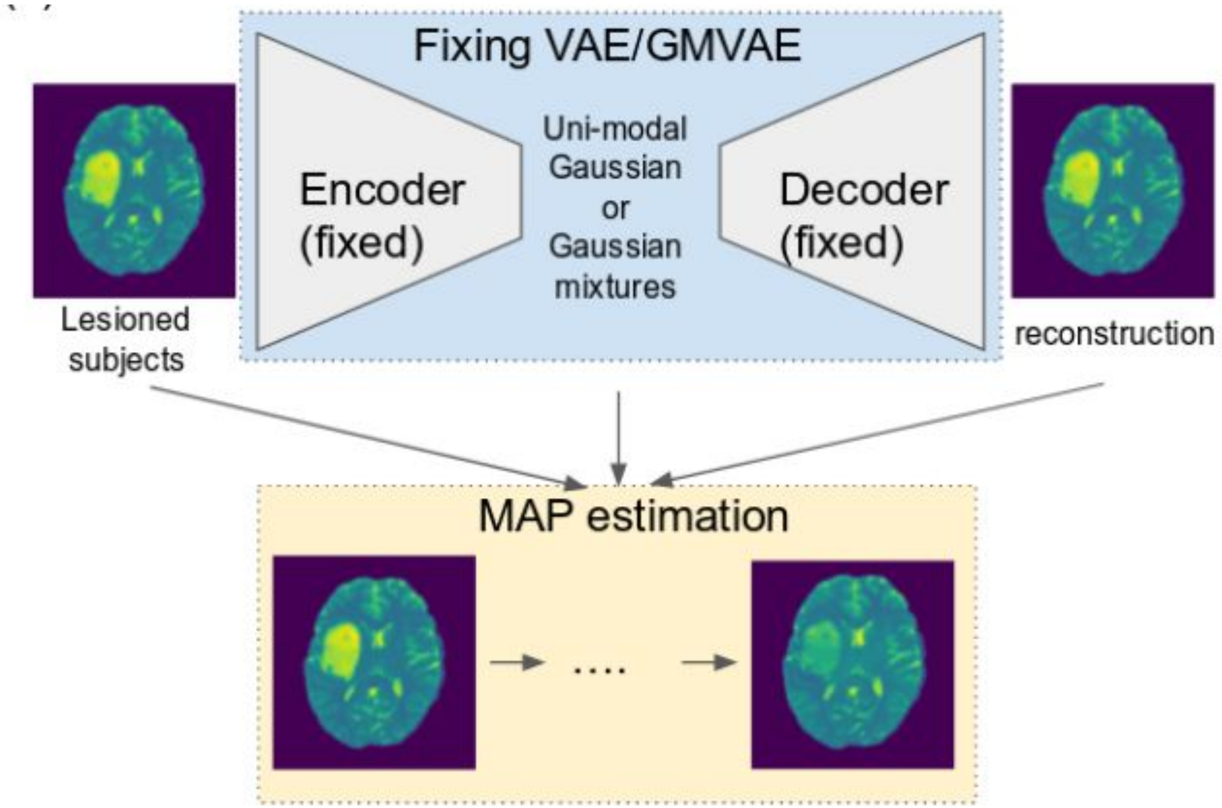
Image source: Kabat J, Król P. Focal cortical dysplasia - review. *Pol J Radiol*. 2012;77(2):35-43. doi:10.12659/pjr.882968

Model overview

- Use Maximum-a-posteriori reconstruction to reconstruct non-anomalous image given an image with anomaly.
- Use a trained VAE as a prior distribution for reconstruction

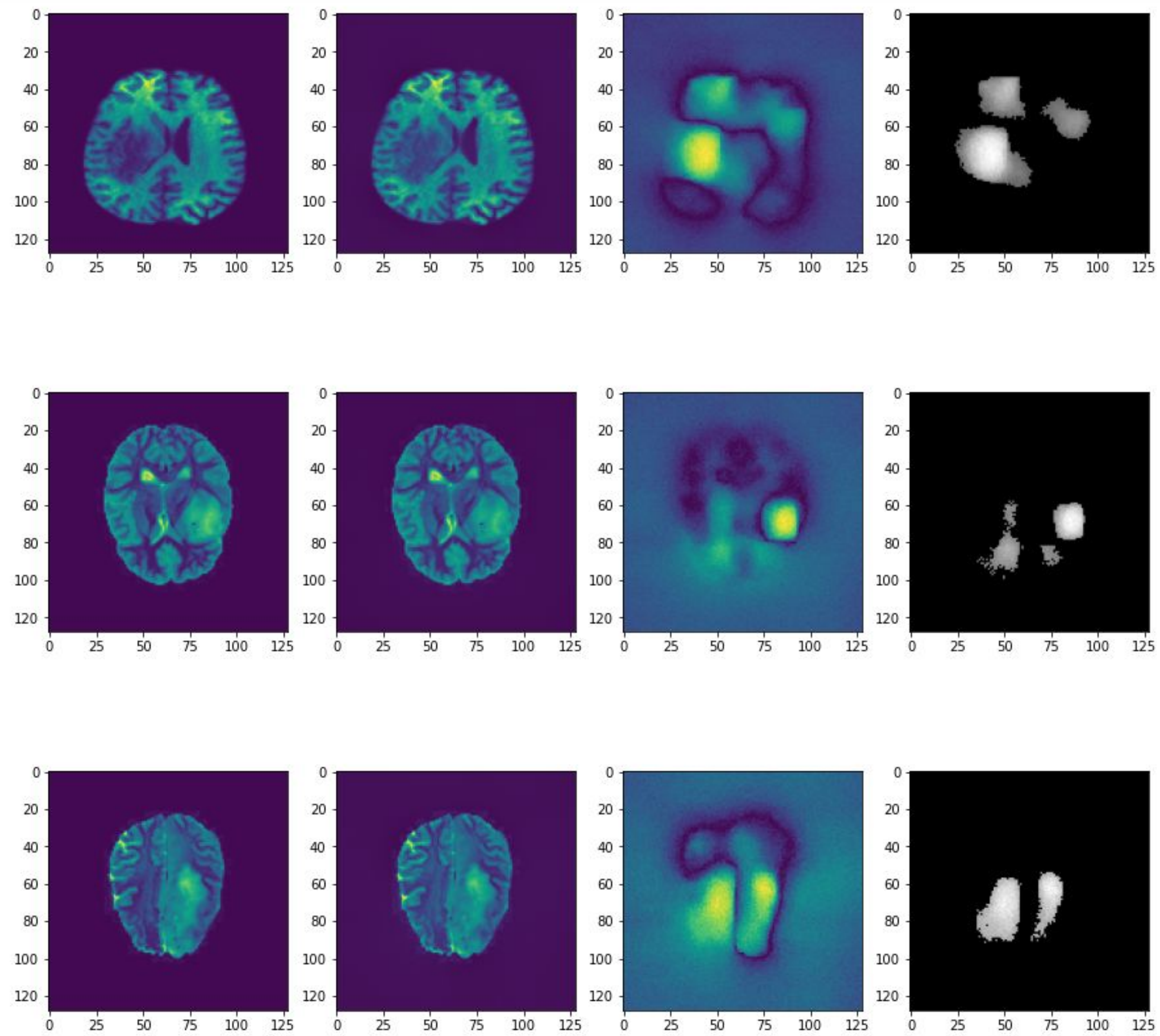
$$\arg\max_X \log P(X|Y) \approx \arg\max_X [\log P(Y|X) + \mathrm{ELBO}(X)]$$

- Optimise the objective using gradient ascent for iterative reconstruction.



Chen, X., You, S., Tezcan, K. C., & Konukoglu, E. (2020). Unsupervised Lesion Detection via Image Restoration with a Normative Prior. *arXiv [eess.IV]*. Opgehaal van http://arxiv.org/abs/2005.00031

Tezcan, K. C., Baumgartner, C. F., Luechinger, R., Pruessmann, K. P., & Konukoglu, E. (2019). MR Image Reconstruction Using Deep Density Priors. *IEEE Transactions on Medical Imaging*, *38*(7), 1633–1642. doi:10.1109/tmi.2018.2887072


0 20 40 60 80 100 120
0 25 50 75 100 125

Future Work

- Lacks inductive bias towards identifying specific types of anomalies.
- Explore pathology specific detection, by introducing synthetic anomalies.

AutoFlow: Learning a Better Training Set for Optical Flow

Deqing Sun, Daniel Vlasic, Charles Herrmann, Varun Jampani, Michael Krainin, Huiwen Chang, Ramin Zabih, William T. Freeman, Ce Liu

Synthetic datasets play a critical role in pre-training CNN models for optical flow, but they are painstaking to generate and hard to adapt to new applications. To automate the process, we present AutoFlow, a simple and effective method to render training data for optical flow that optimizes the performance of a model on a target dataset. AutoFlow takes a layered approach to render synthetic data, where the motion, shape, and appearance of each layer are controlled by learnable hyperparameters. Experimental results show that AutoFlow achieves state-of-the-art accuracy in pre-training both PWC-Net and RAFT. Our code and data are available at this https URL .

AutoSeg -- Steering the Inductive Biases for Automatic Pathology Segmentation

Felix Meissen, Georgios Kaissis, Daniel Rueckert

In medical imaging, un-, semi-, or self-supervised pathology detection is often approached with anomaly- or out-of-distribution detection methods, whose inductive biases are not intentionally directed towards detecting pathologies, and are therefore sub-optimal for this task. To tackle this problem, we propose AutoSeg, an engine that can generate diverse artificial anomalies that resemble the properties of real-world pathologies. Our method can accurately segment unseen artificial anomalies and outperforms existing methods for pathology detection on a challenging real-world dataset of Chest X-ray images. We experimentally evaluate our method on the Medical Out-of-Distribution Analysis Challenge 2021.