Integrating Deep Learning and Radiomics for Medical Image Analysis

Supervisor(s):

Chen Qin (Department of Electrical and Electronic Engineering, c.qin15@imperial.ac.uk)

Project description:

Deep learning (DL)-based algorithms have achieved considerable success in plenty of medical imaging tasks [1]. However, some works have shown that DL-based approaches do not really outperform radiomics [2]-based approaches in risk stratification. These features, extracted from medical images such as PET and MRI, can capture tumor and tissue characteristics such as heterogeneity and shape. Furthermore, they have been demonstrated to correlate with a wide range of diseases, e.g., cardiovascular adverse events [3,4]. To fill the research gap, this project aims to develop a novel approach that incorporates radiomics features into deep learning, thereby unlocking the full potential for optimizing model performance. The developed method will be applied to cardiac scar analysis of LGE scans from patients with arrhythmia for improvement of risk predication of sudden cardiac death.

The project aims to investigate the integration of radiomics features and deep learnt features for medical imaging applications. Though deep learning has shown great success in many of the imaging tasks, there have been cases that they underperform conventional radiomics features for risk stratification. On the other hand, the deep learnt features also lack interpretability compared to the radiomics features. The project will tackle the challenge of the above by investigating (multi-modal) contrastive learning to capture better representations for the data and leverage prior knowledge of radiomics to guide the representation learning and provide better interpretability. We will investigate this on cardiac scar analysis of MRI LGE data of patients with arrhythmia for risk prediction of sudden cardia death.

Timeline (tentative):

Oct-Jan: Literature review in the field;
Jan-Mar: Method development;
Mar-Jul: Experiments and model refinement;
Jul-Aug: Writing up.

Minimum viable thesis:

The minimum viable thesis will be to implement a variation of an existing method [4] on our new application of cardiac scar analysis.

Required background & skills:

Proficiency in Python and Pytorch/Tensorflow is essential. Knowledgeable in deep learning and computer vision is essential. Experience in processing medical images is desired.

Representative References:

[1] Wang, R., Lei, T., Cui, R., Zhang, B., Meng, H., & Nandi, A. K. (2022). Medical image segmentation using deep learning: A survey. IET Image Processing, 16(5), 1243-1267.
[2] Mayerhoefer, M. E., Materka, A., Langs, G., Häggström, I., Szczypiński, P., Gibbs, P., & Cook, G. (2020). Introduction to radiomics. Journal of Nuclear Medicine, 61(4), 488-495.
[3] Wang, J., Bravo, L., Zhang, J., Liu, W., Wan, K., Sun, J., ... & Chen, Y. (2021). Radiomics analysis derived from LGE-MRI predict sudden cardiac death in participants with hypertrophic cardiomyopathy. Frontiers in cardiovascular medicine, 8, 766287.
[4] Zhao, Z., & Yang, G. (2021). Unsupervised contrastive learning of radiomics and deep features for label-efficient tumor classification. In Medical Image Computing and Computer Assisted

Intervention–MICCAI 2021: 24th International Conference, Strasbourg, France, September 27–October 1, 2021, Proceedings, Part II 24 (pp. 252-261). Springer International Publishing.