Title: Deep neural network for computer-aided cancer detection

Highlights:

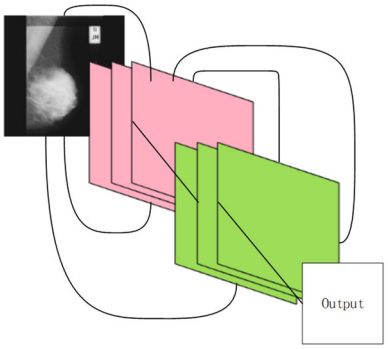
- Using Artificial Intelligence to increase the accuracy of cancer detection
- Graph theory and optimization algorithms can help design the optimal structure of the neural network
- Developed method can be transferred between different cancers

Overview:

Computer aided cancer detection and diagnosis (CADx) has made significant strides in the past decade, with the result that many successful CADx systems have been developed. However, the accuracy of these systems still requires significant improvement, so that they can meet the needs of real-world diagnostic tasks.

Detection of the earliest stages of cancer is fraught with high false positive rates necessitating additional testing, leading to increased patient anxiety, potential over treatment and unnecessary additional costs. The false positivity of cancer detection, coupled with a 2-week waiting time, plus the potential for over treatment and patient anxiety present an ideal opportunity for smarter, faster, cheaper diagnostics. Reducing the time patients wait for a diagnosis from weeks to mere hours and accelerating the introduction of treatment options could have huge implications on cancer care, including reduced patient anxiety and unnecessary treatment, culminating in huge cost savings. Improvements in precision and efficiency mean fewer human errors, leading to a decrease in the length and frequency of follow up visits. Doctors will also be able to get information from data for patients who are at risk of certain diseases to prevent hospital re-admissions.

To improve the accuracy and speed of pathological diagnosis, while potentiating reduced costs, this project will utilise a new deep learning algorithm, particularly an enhanced DenseNet (shown in Fig. 1), to more accurately distinguish utility edges in freely-available online images of benign and malignant cancers (coupled with verified pathologic information), ultimately providing enhanced classification of the earliest stages of cancer.



The improvement may come from two sources: (i) To use graph theory to adjust the structure and particularly the on/off status of shortcuts; (ii) use optimization theory and help tune the hyper-parameters of the deep neural network.

Methodology, Critical Skills

This project aims to develop a new deep neural network algorithm, which can extract lesion-related edges in X-ray/CT/MRI imaging for solving cancer image classification problems. The specific objectives are:

1) To train the neural network using online open-accessed cancer images;
2) To apply improved DenseNet to distinguish and improve the accuracy rate of benign and malignant tumours based on their obvious edge features;
3) To validate the module in expanded datasets, specifically focusing on a large number of negative samples to improve the recognition of backgrounds, and to annotate the tumour regions automatically as ROIs (regions of interest).
4) To transfer our model trained by images of one type of cancer to predict another type of cancer, and study the theory of transfer learning among different cancer images.

Further Reading

1. He, K., X. Zhang, S. Ren and J. Sun (2016). Deep Residual Learning for Image Recognition. 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR). 770-778.
2. Goodfellow, I., Y. Bengio, A. Courville and Y. Bengio (2016). Deep learning, MIT press Cambridge.
3. Huang, Gao, et al. (2017). Densely connected convolutional networks. CVPR. Vol. 1. No. 2.
4. Pham, H., Guan, M. Y., Zoph, B., Le, Q. V., & Dean, J. (2018). Efficient neural architecture search via parameter sharing. *arXiv preprint arXiv:1802.03268*.

Level: PhD

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Subject areas: artificial intelligence; deep learning; transfer learning; biomedical image analysis

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