Title: Improved Breast Cancer Diagnosis System based on Deep Neural Network

Highlights:

- Integrate squeeze-and-excitation with residual neural network based on switching CNN
- Earlier detection, shortening the period of breast cancer detection and avoiding additional cost to the NHS
- More automatic and accurate diagnosis (distinguish recalled but benign patients)

Overview:

Over 2,000,000 women between 50 and 70 years of age will be invited for breast screening as part of the NHS Breast Screening Programme (NHSBSP), which aims to detect breast tumours at a stage early enough that treatment is likely to be successful. Although the NHSBSP has led to improved outcomes due to earlier detection of cancer, the high false positive rate of mammography (nearly 90% of suspicious lesions are benign) necessitates additional testing, leading to increased patient anxiety, potential over-treatment and unnecessary additional cost to the NHS.

Improving the sensitivity of mammography, reducing the time breast cancer patients wait for a diagnosis from weeks to mere hours and accelerating the introduction of treatment options could have huge implications for breast cancer care, culminating in huge cost savings. Improvements in precision and efficiency means fewer human errors, leading to a decrease in the length and frequency of follow-up visits. Doctors will also be able to obtain information about patients who are at risk of disease recurrence, potentially improving disease-free progression.

Due to the high false-positivity of mammograms, more sensitive methodologies are needed. This project aims to develop a new artificial intelligence (AI) method, which can more accurately distinguish breast cancers from benign lesions in mammograms.

The publicly available, online databases of mammogram images contain normal, benign, and malignant cases with verified pathology information. Firstly, relying on this intelligent algorithm, this breast cancer diagnosis system can help radiologists recognise the tumour's type, as well as classifying the grade of breast cancer. Completing the 3-class classification, and detecting different grades of cancers will be the first step, consisting of classifications of normal, benign and malignant breast cancer images. Secondly, the benign and malignant tumours have different features, therefore, if these features (the surrounding fibers and tissues) can be successfully extracted within several typical training tasks, the training procedure will improve the quality of the artificial intelligence module. Lastly, an open online learning system, which can enhance the AI algorithm online, will be built to expand the data sets, and this intelligent system can provide timely diagnosis for breast cancer patients, where this system will annotate the tumour regions automatically.

Methodology, Critical Skills and Training and Development

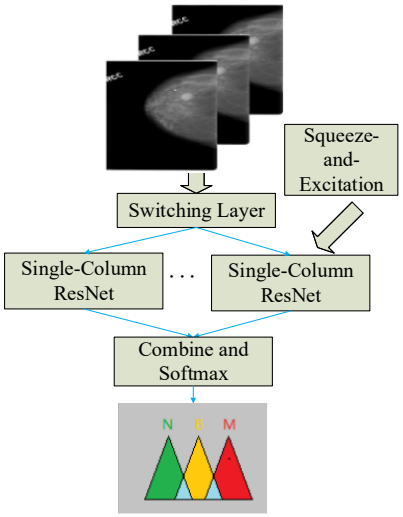
1. To train a deep-learning algorithm using the Digital Database for Screening Mammography (DDSM) open access database of 2,620 scanned film mammogram images;

2. To apply the Squeeze-and-Excitation (SE) block, which can be embedded into different neural networks and effectively improve the quality of residual modules;

3. Switching CNN may be used. The switching layer may be added, to make a prediction of density of breast image. The input image will then be submitted to the corresponding single-column CNN block.

4. Various residual neural networks, such as ResNet50, ResNet101, ResNet151, Res-Inception V2 and Wide Residual Networks will be assembled in the switching CNN, as is shown in Fig. 1.

5. To validate the algorithm in larger datasets (such as OPTIMAM), specifically focusing on a large number of negative samples to improve the recognition of backgrounds, and to annotate the tumour regions automatically.



Further Reading:

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2. Huang, G., Liu, Z., Van Der Maaten, L., & Weinberger, K. Q. (2017, July). Densely connected convolutional networks. In CVPR (Vol. 1, No. 2, p. 3), 2016.
3. Sam, Deepak Babu, Shiv Surya, and R. Venkatesh Babu (2071). Switching convolutional neural network for crowd counting. Proceedings of the IEEE Conference on CVPR. Vol. 1. No. 3. 2017.
4. Esteva, A., Robicquet, A., Ramsundar, B., Kuleshov, V., DePristo, M., Chou, K., ... & Dean, J. (2019). A guide to deep learning in healthcare. Nature medicine, 25(1), 24.

Level: PhD

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Subject areas: Biomedical engineering; data analysis; artificial intelligence; deep learning; transfer learning

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