Deep Learning-based Digital Breast Cancer Diagnosis

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

Recent years have seen a remarkable improvement in Artificial Intelligence (AI) applications in medical imaging. Digital Breast Tomosynthesis (DBT) is an advanced breast cancer screening technology approved by the FDA in 2011. DBT is often referred to as 3D Mammography since it produces quasi–three-dimensional (3D) images of the breast. In DBT, an X-ray machine is rotated to capture images of breast tissue from different angles. In this project, we aim to design a deep learning-based method to classify the DBT data automatically.

Background and Motivation

A newly emerging technology: 3D full-volume digital breast tomosynthesis (DBT), has been proven to improve cancer detection as it can reduce the masking effect of the breast tissue on 2D mammograms by creating multiple 2D imaging slices of the breast. There is increasing utilization of this new imaging modality in practice. However, the interpretation of DBT is time-consuming and requires additional training. This demand can limit the clinical utilization of this promising technology. Therefore, it is essential to develop automated

DBT interpretation tools which can aid radiologists in detecting breast cancer more accurately and efficiently so that this potentially life-saving technology can be applied more broadly and benefit more patients.

With the recent rapid development of deep learning, new approaches with deep convolutional neural networks (CNNs) have shown great promise in increasing the classification accuracy in mammograms. However, most published work on automated breast cancer detection has focused on a 2D mammogram [1] [2], but very few focus on exploring deep learning models on DBT because of three main challenges:
high computational requirements that come with large sizes of DBT, lack of available pre-trained 3D CNN models, and lack of public DBT dataset.

To solve this problem, several research teams have proposed to use of deep learning-based methods to do the classification problem [1-5]. And one public dataset is available to devise the algorithm [6].

Student's Tasks Description

The project is structured in two phases: in the first part, the student will apply state-of-the-art deep learning methods to do the classification problem. In this phase, the student will also learn and apply some DL techniques for image preprocessing, data augmentation, model training, and result visualization.

In the second phase, we attempt to combine the feature of DBT data to design tasks-specific deep learning and further improve the prediction performance.

Finally, the student should run some experiment to record the accuracy, precision, recall value to

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compare the deep learning performance. Then the result will present via a proper graph and a finished report to descript the implementation of the whole project.

Technical Prerequisites

The student is required to possess a good knowledge of Python coding, as well as the basics of bash scripting. In addition, a basic understanding of the Pytorch DL framework is required. Furthermore, a basic understanding of the Docker environment is needed.

References

[1] M. Buda, A. Saha, R. Walsh, S. Ghate, N. Li, A. Święcicki, J. Y. Lo, M. A. Mazurowski, Detection of masses and architectural distortions in digital breast tomosynthesis: a publicly available dataset of 5,060 patients and a deep learning model. arXiv preprint arXiv:2011.07995

[2] Zhang, Yu, et al. "2d convolutional neural networks for 3d digital breast tomosynthesis classification." 2019 IEEE International Conference on Bioinformatics and Biomedicine (BIBM). IEEE, 2019.

[3] Sakai, Ayaka, et al. "A method for the automated classification of benign and malignant masses on digital breast tomosynthesis images using machine learning and radiomic features." Radiological Physics and Technology 13 (2020): 27-36.

[4] Bai, Jun, et al. "Applying graph convolution neural network in digital breast tomosynthesis for cancer classification." Proceedings of the 13th ACM International Conference on Bioinformatics, Computational Biology and Health Informatics. 2022.

[5] Xiao, Bingbing, et al. "Classification of microcalcification clusters in digital breast tomosynthesis using ensemble convolutional neural network." BioMedical Engineering OnLine 20.1 (2021): 1-20.

[6] https://sites.duke.edu/mazurowski/resources/digital-breast-tomosynthesis-database/

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