Classification and detection of 3D DBT volumes to aid radiologists in breast cancer screening

Popular science abstract, Jakub Chłędowski

May, 2021

Breast cancer is the leading cause of cancer death in women, with global mortality of 15.5% of all cancers in 2020. Screening mammography is the primary test used to detect breast cancer in asymptomatic women. This test must be accurate, as both false negatives and false positives could yield unnecessary pain and anxiety.

Two-dimensional full-field digital mammography (FFDM) is currently the most popular breast imaging method. FFDM is broadly available and produces images that are relatively easy to interpret. Recently, quasi-three-dimensional digital breast tomosynthesis (DBT) was introduced to improve the diagnosis. DBT reduces tissue overlap, which unmasks breast abnormalities and simplifies differentiation between lesions and normal tissue.

We see great potential in large-scale three-dimensional deep learning models. Therefore, our study aims to analyze and enhance current deep learning architectures for high-resolution 3D volumes. We will apply our work on breast cancer detection and segmentation with a dataset collected at NYU Langone Health, which contains 415,207 3D DBT volumes.

Prior works that build deep neural networks for DBT volumes contain flaws. Some of them do not work with the entire volume. Some work with only a subset of DBT slices and risk missing out on slices that could potentially be the most informative to the diagnosis. Others work with ROI patches, requiring the radiologists first to select ROIs from the volume, thus cannot utilize the global context of the entire breast. Most of the model architectures largely follow the off-the-shelf models designed for natural images. This is inefficient for medical images and could cost a lot of GPU memory. Lastly, most of the prior works utilize a small number of DBT exams and focus on only one of the cancer subtypes. This limits the potential clinical utility of such models.

We focus our research on the breast cancer detection problem for a few reasons. First of all, this problem poses a novel challenge that we find worth tackling - we will explore how to optimize neural networks that classify 3D volumes with very small and scattered regions of interest. Secondly, we will have access to a large dataset of 3D DBT volumes with pixel-level annotations of malignant and benign lesions. Last but not least, our work could be used to improve the quality of medical assessment.

Our main goals include developing a new 3D DBT classifier, creating a 3D DBT object detection model, and utilizing the knowledge from pixel-level annotations to improve the 3D DBT classifier. Even though our experiments will be focused solely on breast cancer screening, we believe that our results could be generalized to other tasks concerning 3D volumes.

The research will be conducted in cooperation with world-class researchers and radiologists from New York University. The principal investigator will be granted access to their GPU cluster with over 140 Nvidia V100 GPUs and will consult his research with recognized experts in radiology and data science: prof. Linda Moy, prof. Laura Heacock, prof. Kyunghyun Cho and prof. Carlos Fernandez-Granda.