

Convolutional Neural Network application for cancer detection in mammography images

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Abstract—The aim of this work is to develop, train and test a Convolutional Neural Network (CNN) for detecting cancerous lesions in mammography, using heterogeneous images acquired with different imaging systems. The algorithm is also tested independently on each dataset, and then applied to images with different vendor style, which have been previously standardized using a neural style transfer method.

Clinical Relevance—This study contributes to the improvement of breast cancer detection, by providing a CNN model capable of accurately classifying lesions in mammograms, also in presence of strongly heterogeneous features.

I. INTRODUCTION

Artificial intelligence (AI) systems can improve cancer detection in mammography screening, assisting radiologists in making more accurate diagnoses [1, 2]. However, prior the application in the clinics, the AI models have to be properly trained and tested on sufficiently representative data, to avoid bias and domain gap issues. In mammography, one of the factors that can impact on AI outcomes is the vendor-style, which leads to very different image features, in terms of sharpness, contrast, and gray level distribution. In this framework, we have designed and trained a Convolutional Neural Network (CNN) for classifying breast cancerous lesions, including masses, suspicious calcifications, and architectural distortions. The model is trained on mammograms acquired with scanners from different vendors.

II. METHODS

A three-layer CNN, with two fully connected linear layers and alternating Max Pooling and ReLU layers, is here used for binary classification in mammography images, distinguishing between lesion and non-lesion in 200×200 gray-scale patches. The model employs the Focal Loss function to penalize false negatives more heavily than false positives. The patches, extracted from predefined lesion masks or randomly cropped from healthy mammograms, are normalized before their use.

To test the developed CNN model on images with heterogeneous features, two different datasets are considered, containing images acquired with scanners from different vendors, namely Hologic and Siemens. The possible effects of domain gaps are investigated by training the CNN under three scenarios, where the training sample contains images from (i)

only Hologic, (ii) only Siemens and (iii) both datasets. To limit domain generalization issues related to the use of one image type in the learning task, we also adopt a CycleGAN-based neural style transfer method, for transferring vendor style from Hologic to Siemens and vice versa. Finally, a Grad-CAM algorithm [3] is applied to the last convolutional layer of the CNN to visualize the classification results and highlight the lesion within the image patch.

III. RESULTS

As shown in Fig. 1, the CNN model is able to detect malignant lesions in mammograms with very different features, if the training set contains the relative vendor style.

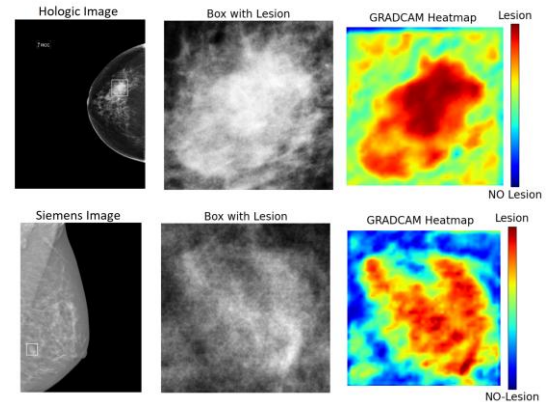


Figure 1. Visualization of the outputs of the CNN model when applied to an Hologic image (top) and to a Siemens image (bottom), with the corresponding heatmaps.

IV. DISCUSSION & CONCLUSION

The CNN model has proven to be robust, when applied to images with different vendor style and containing various types of lesions. Moreover, it has achieved high classification accuracy, even when applied to transformed images, being a promising tool for future usage in breast cancer screening.

ACKNOWLEDGMENT

This work is supported by 22HLT05 MAIBAI, funded by the European Partnership on Metrology, co-financed from Horizon Europe and the Participating States.

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