Automatic detection of breast arterial calcification using deep learning

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Introduction

Cardiovascular disease (CVD) is the leading cause of premature death in the United Kingdom, killing more than twice as many women as breast cancer (British Heart Foundation, 2018). Conventional CVD risk factors have been shown to have less accuracy for females who are considered low-risk. Recently, researchers have noted that breast arterial calcification (BAC), which is regularly observed as an incidental finding on breast screening mammograms, could be used as a potential indicator of increased risk of developing CVD (Minssen et al., 2022). An example of BAC is shown in Figure 1 below.

Figure 1: Breast arterial calcification observed on a screening mammogram.

Methods

Three deep learning models have been developed for this work to automatically identify the presence of BAC on a mammogram (classification), where it is situated (object detection) and how much is present (segmentation). An anonymized mammogram dataset was used during the training of each model. Images were marked as having BAC or not and were validated by consultant radiologists. Manual tracing (segmentation) of areas of BAC on each image was also carried out under the guidance of a radiologist. Models were developed using MATLAB and trained on a computer graphics card. The three approaches are shown in Figure 2 below.

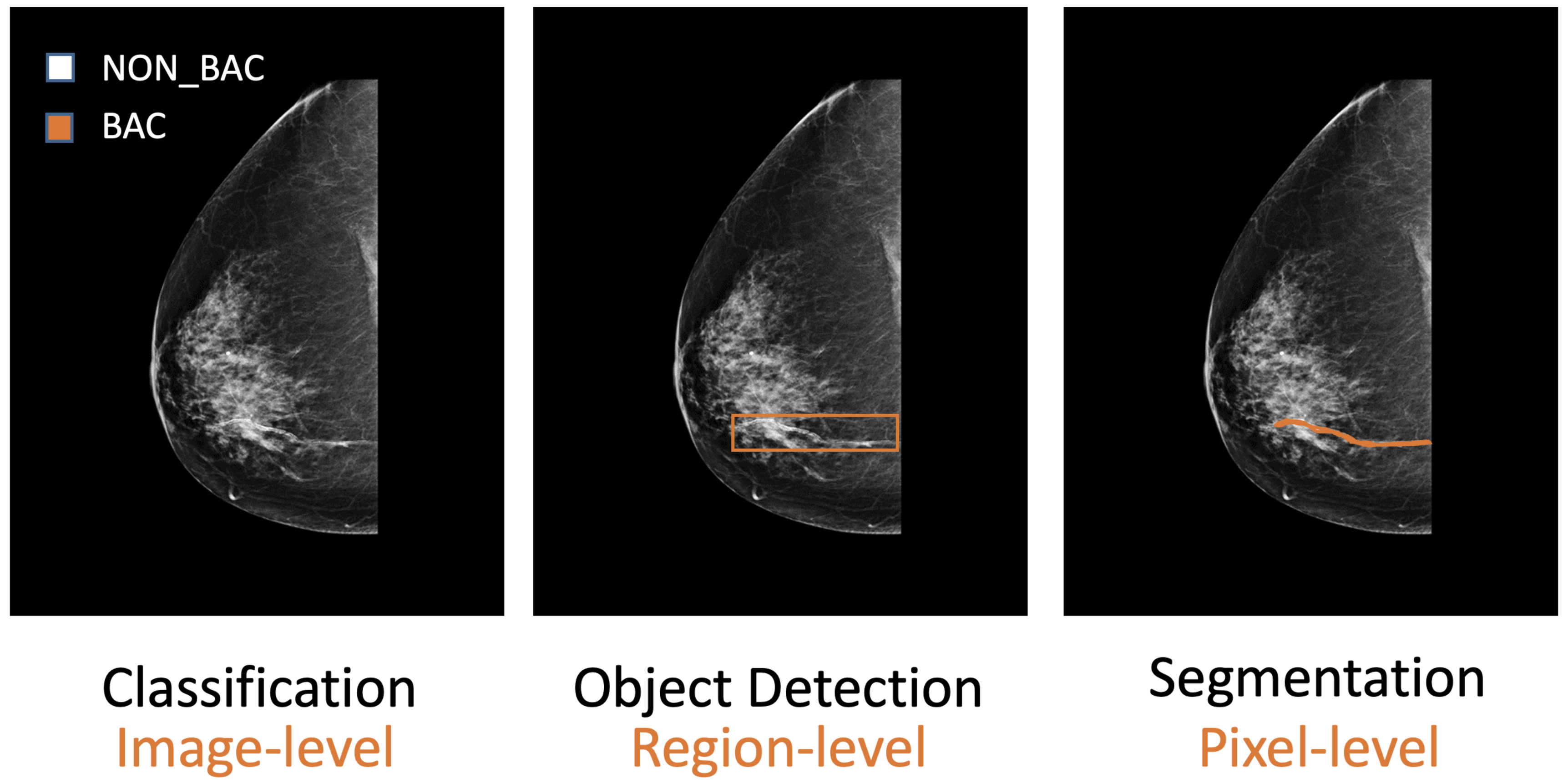

Figure 2: Three approaches: Classification, object detection and segmentation.

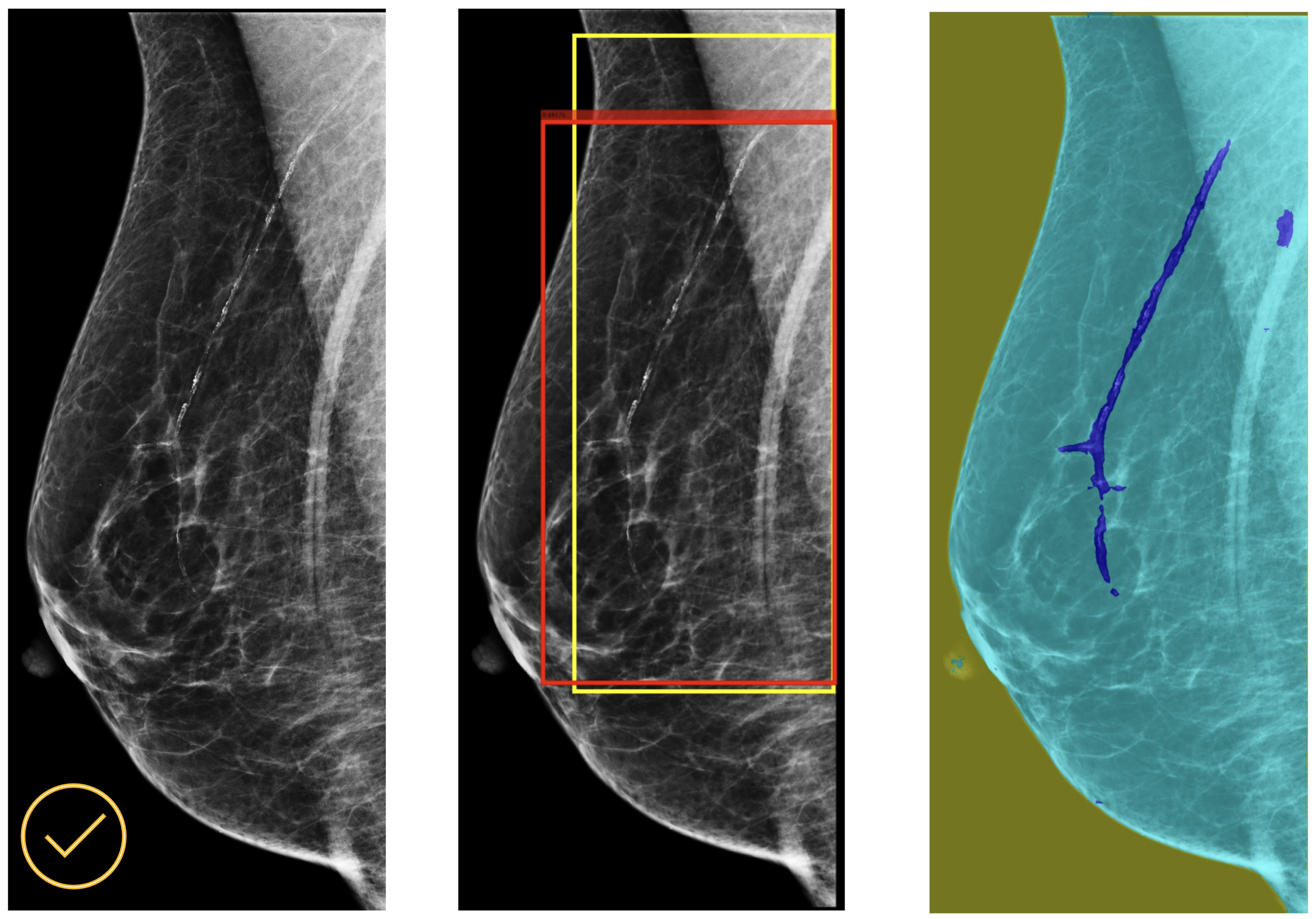

Figure 3: From left: Classification, object detection and segmentation results.

Results

The classification model reported 80% accuracy for the presence of BAC. This was achieved by tuning several parameters such as the size and number of images used, the model's shape and size, the length of time the model was trained and how quickly it learned. This approach was also applied to the BAC location and segmentation models which, currently, have achieved 0.06 average precision and 0.37 IoU (Intersection over Union) scores respectively. Selected visual results for each model are shown in Figure 3.

Conclusions

The models outlined above show promise in extending breast screening to include vascular screening, identifying those women attending for breast screening who are at risk of CVD.

References

Figure 4: Scan QR code for references.

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