Automatic analytic machine-learning classification models for breast lesions

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QUESTIONS

Questions driving our research:

1. Is there a relationship between the **appearance** of a lesion in a strain image and a B-Mode image and its classification?
2. Is there a correlation between the **ratio** of the area of the lesion in a strain image and a B-Mode image and its classification.
3. Is there a correlation between the **contrast** of a lesion in a strain image, its contrast in a B-Mode image, and/or the ratio of the two contrasts?
   - It was observed that the lesion appeared larger in the strain image compared to the B-Mode image for adenocarcinoma; much more so than for fibroadenoma at the least.
   - Likewise, it was observed that the lesion appeared difficult to see in the B-Mode image for adenocarcinoma while more visible in the strain image, and the direct opposite for fibroadenoma-- difficult to see in the strain image and more visible in the B-Mode.

OBJECTIVES

OBJECTIVE 1

- *To discriminate* between **benign** and **malignant** breast lesions
  - Clinicians have found that:
    - Malignant lesions appear larger in strain images compared to B-Mode images.
    - Benign lesions appear to be of similar size.

OBJECTIVE 2

- *Develop* an automatic algorithm to classify a lesion as Benign or Malignant using the B-mode and Strain image.
  - Classification depends on physician expertise
  - Many images to manually analyze
  - even experts can sometimes misread read conventional ultrasounds images.

METHODS

METHOD 1: Watershed

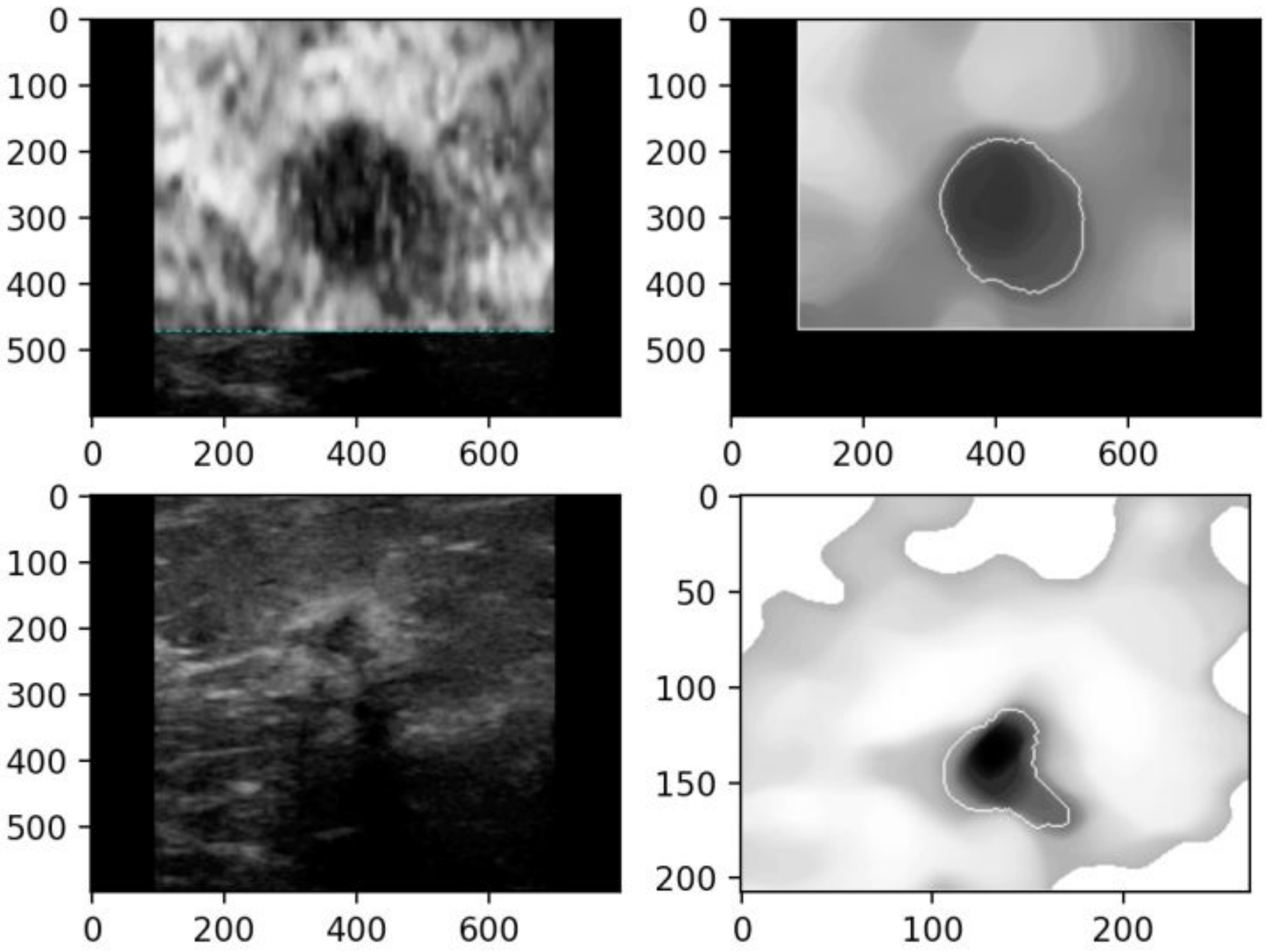
Watershed Segmentation is an OpenCV marker-based watershed algorithm using interactive image segmentations

- We specified which valley points were to be merged then labeled the region which we were sure of being the foreground with one color.
- Then, we labeled the background region as our marker and applied the watershed algorithm. Our marker was updated with the new labels we gave, and the boundaries of objects contained a value of -1.

METHOD 2: Convolutional ResNet

- We trained a convolutional ResNet with 200,000 B-mode and Strain images to classify lesions as Benign or Malignant
    - ResNets were used to skip connections to effectively simplify the network, using fewer layers in the initial training stages. This sped up the learning by reducing the impact of vanishing gradients.
    - The network then gradually restored the skipped layers as it learned the feature space.
    - A neural network without residual parts explores more of the feature space.

RESULTS



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RESULTS

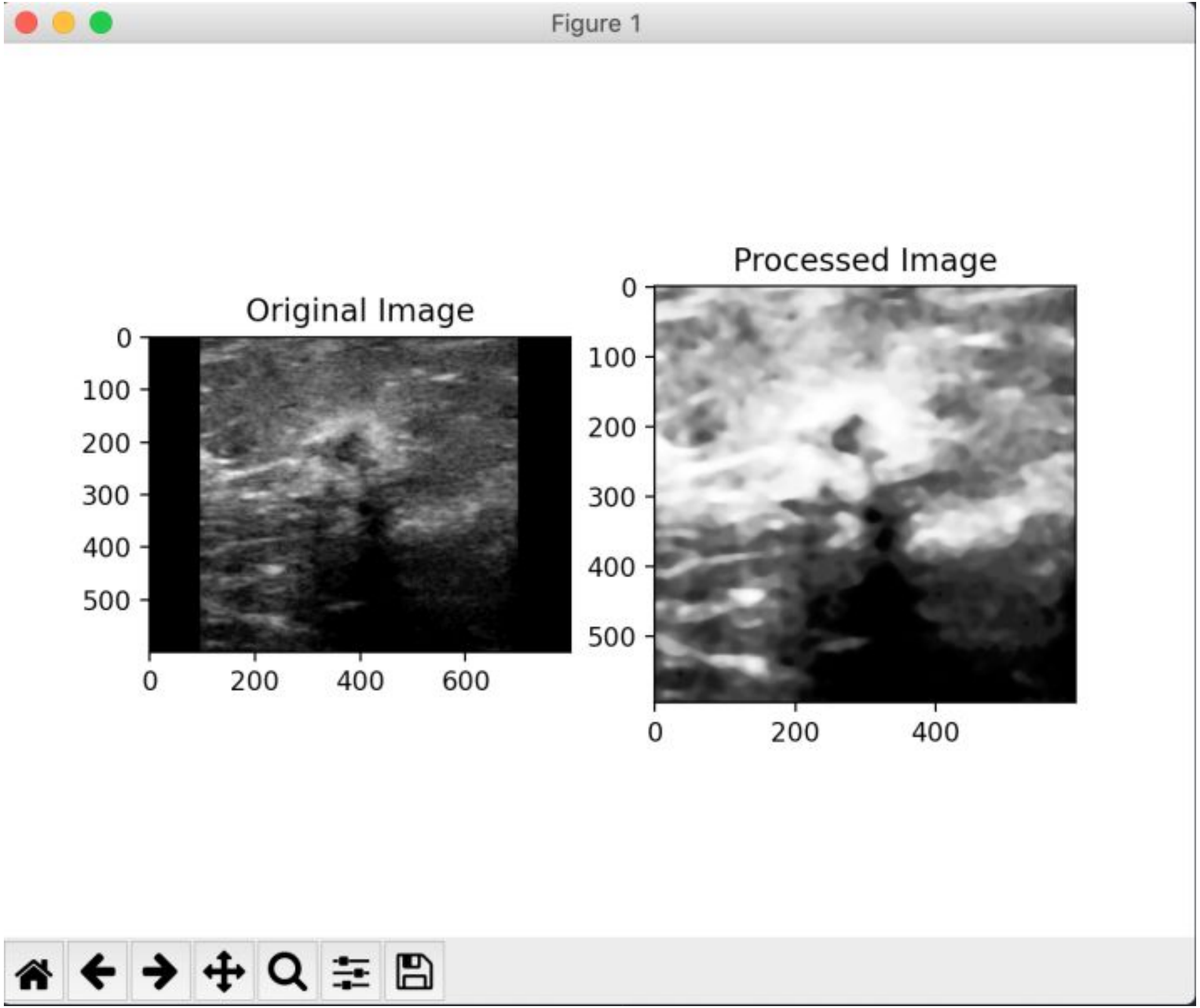
Figure 1
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RESULTS