A CONVOLUTIONAL NEURAL NETWORK MODEL FOR SCREENING BREAST LESIONS BY MAMMOGRAPHY

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Introduction

- Breast carcinoma is a concerning health problem worldwide
  - *Usually affects females aged more than forty*
  - *Has exceeded lung malignancy as the world's most frequently diagnosed cancer*
- Certain shortcomings bring about the need for algorithm development to assist clinicians
  - *Shortage of medical doctors, especially in developing countries*
  - *Lack of time*
  - *The human brain's tendency to easily get tired*

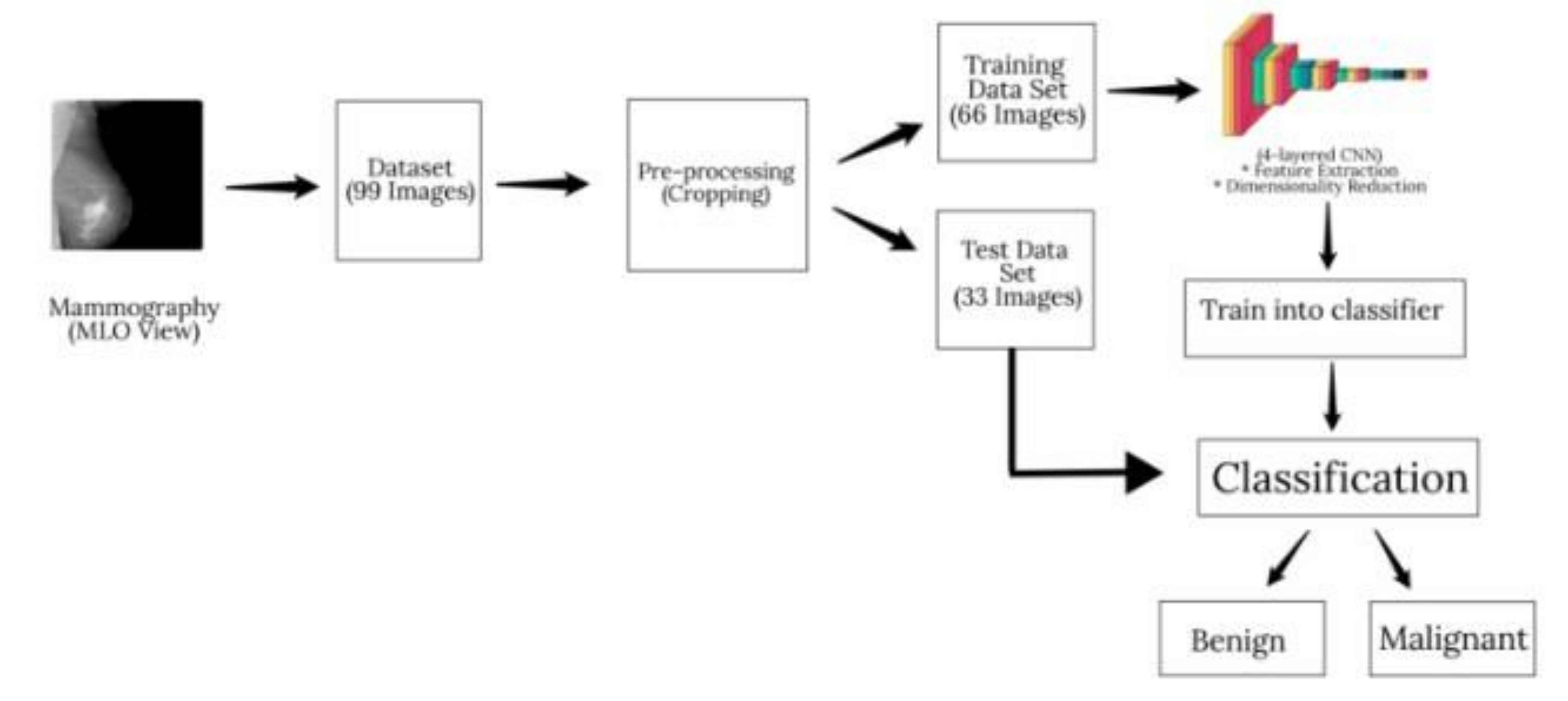
Research Question

Is it possible to develop a model with >90% accuracy for binary discrimination of breast cancer on a dataset of <100 images using a shallow neural network, which is more suited to training and deployment in low-resource settings?

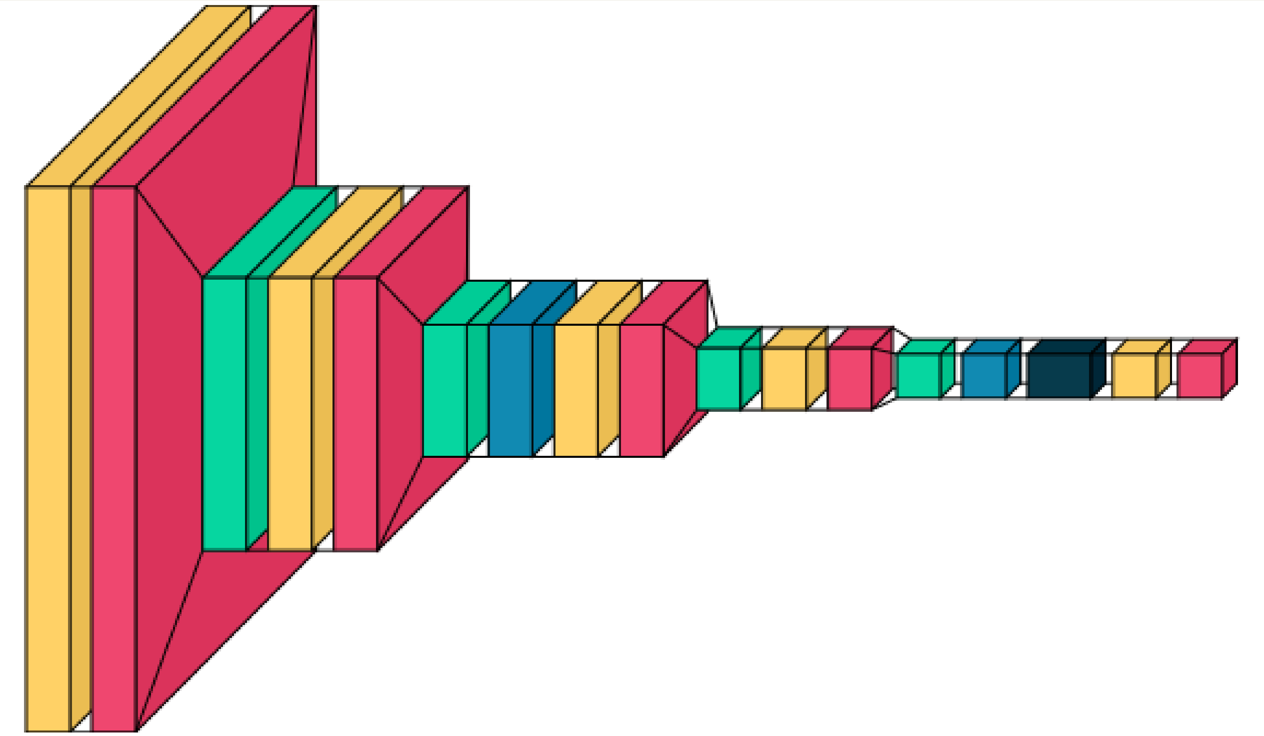
Study Design

99 histopathologically proven images (56 benign and 43 malignant) of MLO mammogram views were collected from the Cancer Hospital and Research Institute, Gwalior, India. A 4-layered CNN was then constructed from scratch for training and testing the algorithm with 66 and 33 images in the training and testing sets respectively.

Materials & Methods



Schematic representation depicting the steps to detect and classify benign and malignant lesions on mammography



Yellow = Convolutional 2D layer: used to extract various features like corners and edges from the input images

Red = Activation layer: decides the firing of the neurons of the network

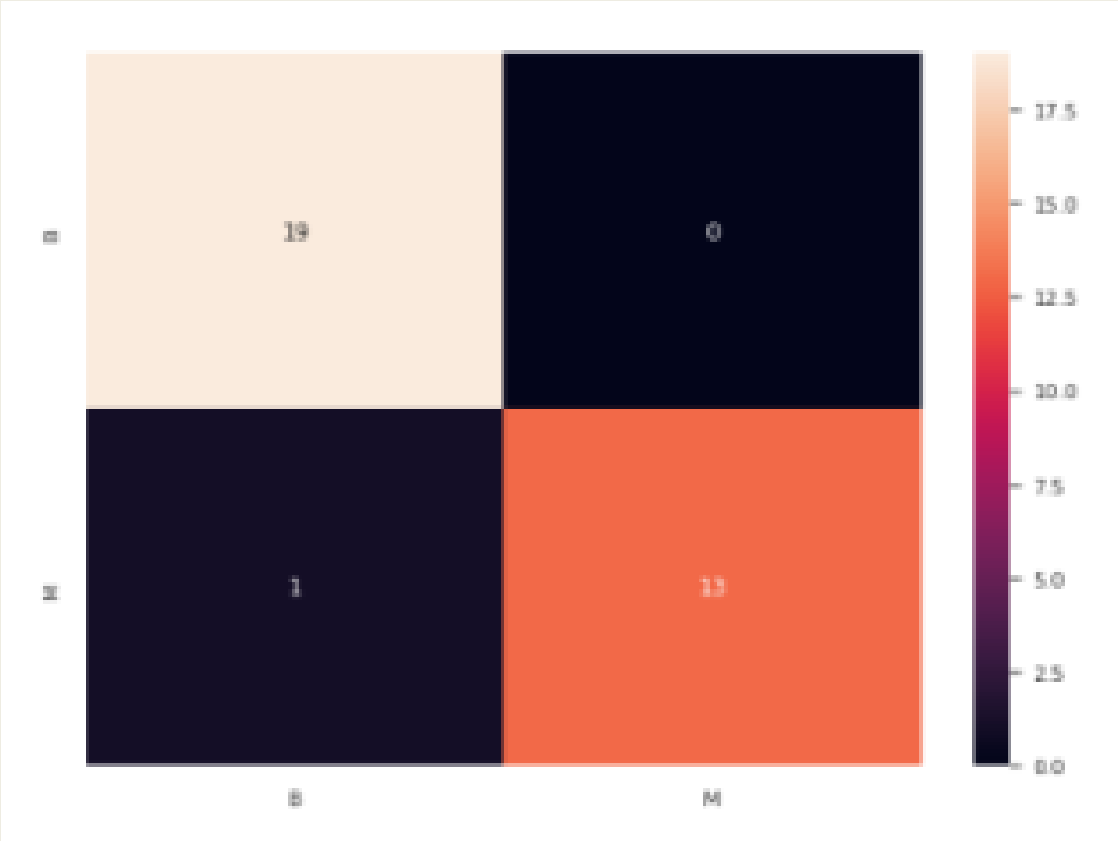
Green = Max pooling layer: decreases the size of the input i.e. dimensionality reduction

Light blue = Dropout layer: drops certain features from the neural network during training to improve robustness

Navy blue = Flattening layer: flattens the multi-dimensional input tensors into a single dimension

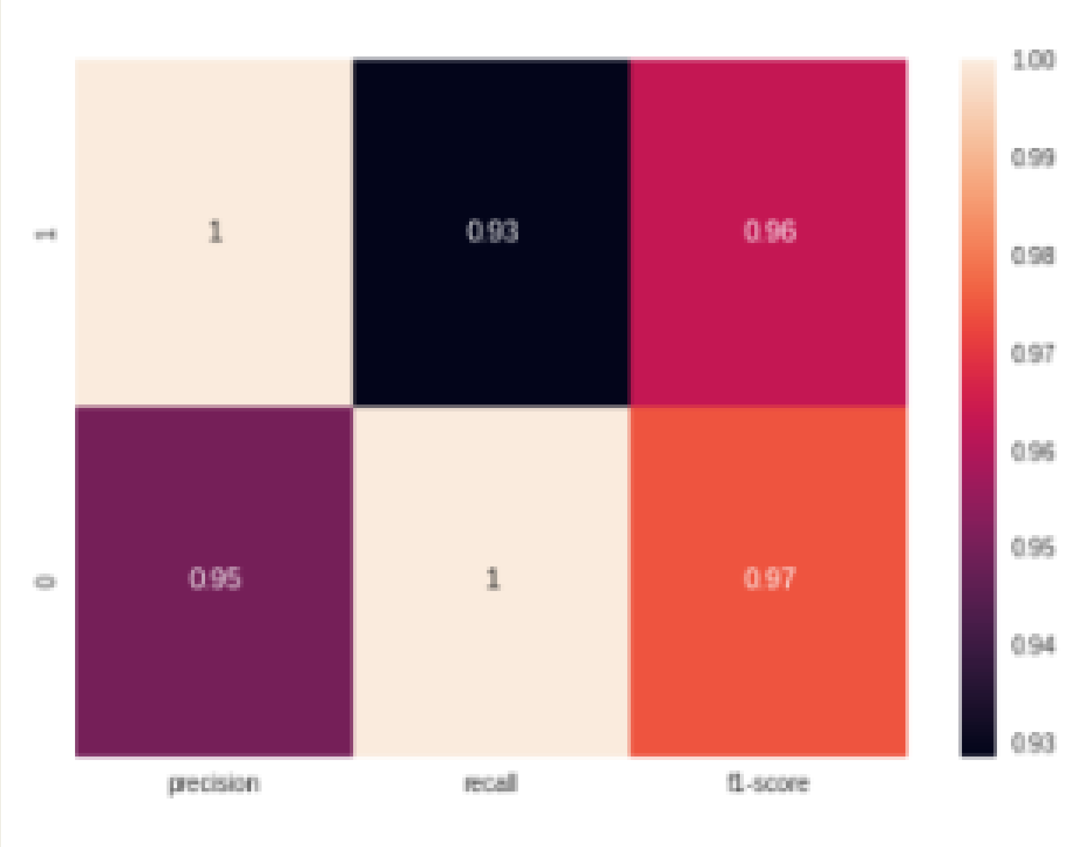
Results

- Accuracy = 97.0%
- Sensitivity = 92.8%
- Specificity = 100%
- Matthew's Correlation Coefficient = 0.939



Results

- Benign
  - *Precision = 0.95*
  - *Recall = 1*
  - *F1-Score = 0.97*
- Malignant
  - *Precision = 1*
  - *Recall = 0.93*
  - *F1-Score = 0.96*



Limitations

1. Smaller dataset, especially since we used histopathologically proven images.
2. Images should have been categorized in relation to breast density (Wolfe's classification) and benign and malignant categories for better results
   – *It is difficult to localize a lesion in dense breasts compared to fatty breasts on a 2D mammography.*

Discussion

As the table on the right demonstrates, through comparisons with previous literature, it is possible even for a relatively simple model to attain high accuracies on small datasets provided that the architecture is designed well.

STUDY	MODEL	No. of IMAGES	ACCURACY (%)
Bin Li et al.	CNN-4d	mini-MIAS dataset 64 benign and 52 malignant	89.05
Hua Li et al.	DenseNet-II neural network		94.55
Chen Zhang et al.	Multi-view feature fusion network	688 benign and 719 malignant	95.24
Ours	4-layered CNN	56 benign and 43 malignant	96.96

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