**4 Methods**

In order to detect and classify breast cancer within mammograms we utilized CNNs to do the heavy lifting. Using a Keras front end with a Tensorflow working in the back ground, we build a 4-layer deep learning image classifier to differentiate between the four states of the cancer we are looking to detect, calcification benign, calcification malignant, mass benign, and mass malignant. We used the checkpoint from the image classifier to load into the sliding window detector and retrieve the final detection and classification of anomalies in the mammograms.

The building of the image classifier is broken down into four fully connect layer, one flattening layer, three dropout layers using relu activation on the first two and softmax on the final flattening layer, it then uses an adam optimizer looking at catergorical response. The four fully connected layers star with 10 filters working up to 80 layer per image, with a shrinking kernel size at the filters increase. After flattening the results, the Four drop layers are utilized bringing the results down to the final four categories. We run 75 epochs validating after each epoch saving the best weights of the epochs to be used by the image classifier. We train our model on only the images with pathologies of "benign-with no call back" and "malignant" to remove the middle ground with an unclear pathology even for the doctors reading the mammograms. We still validate the classifier and test detector with all three pathology types. Removing the "benign" pathology gave an immediate validation accuracy of 11% in classification with no other changes. We achieve a peak validation accuracy of 68% as shown in figure, we load these weights into our object detector.

We then build a sliding window object detector to pull pieces of a full mammogram ranging from 256x256 pixels to 1024x1024 pixels, the images are shrunk to 256x256 sub-images. The different sub-images are run through the image classifier predictor one at time saving the results and x, y coordinates. The results are the filter looking for the best results for each of the cancer types and pathologies.