# Automated Glaucoma Diagnosis using Deep  Learning Approach

By - ***Baidaa Al-Bander***

*Architecture:* **Transfer Leanring**

**Pretrained Alexnet as Feature Extractor**

**SVM as classifier**

*Preprocessing:* **Resize image to 227*227**

*DataSet :* **RIM-ONE V2**

**Total Image Count: 455**

**Normal Images: 255**

*Author:* **Gyanendar Manohar (R00207241)**

*Date:* ***26/02/2022***

**==========**

## Set Random Seed

```
rng(50)
```

## Load Dataset

Load RIM-ONE R2 dataset and split it in train and test set. The split ration is 70:30

```
image_data_store = imageDatastore('C:\gyani\Projects_MS\code\dataset\RIMONE-db-r2', ...
                            'IncludeSubfolders',true,'LabelSource','foldernames');

[x_train_ds,x_test_ds] = splitEachLabel(image_data_store,0.7,'randomized');
```

## Alexnet Model

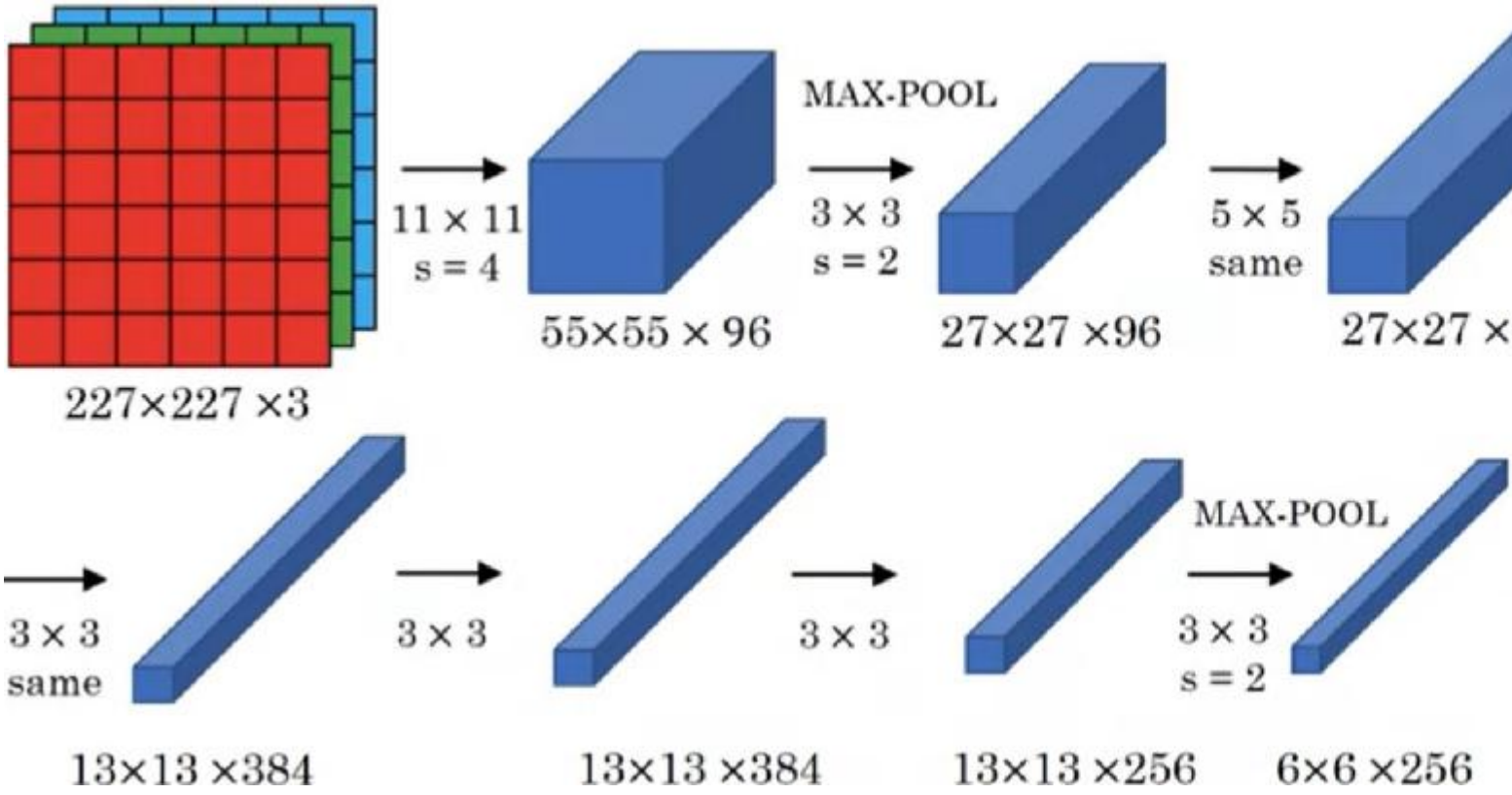
Get pre-trained AlexNet Model

```
alexnet_model = alexnet
```

```
alexnet_model =
  SeriesNetwork with properties:

         Layers: [25×1 nnet.cnn.layer.Layer]
     InputNames: {'data'}
    OutputNames: {'output'}
```

```
%analyzeNetwork(alexnet_model)
```




### Model input size

```
input_Size = alexnet_model.Layers(1).InputSize;
```

### Resize Image to match the input size

```
aug_train = augmentedImageDatastore(input_Size(1:2),x_train_ds);
aug_test = augmentedImageDatastore(input_Size(1:2),x_test_ds);
```

### Train and Test labels

```
y_train = double(categorical(x_train_ds.Labels));
y_test = double(categorical(x_test_ds.Labels));
```

### Extract Feature from images

```
layer = 'relu6';
feature_train = activations(alexnet_model,aug_train,layer,'OutputAs','rows');
feature_test = activations(alexnet_model,aug_test,layer,'OutputAs','rows');
```

### Pass Extracted features to SVM classifier

```
classifier = fitcecoc(feature_train,y_train);
```

## Result

## Do prediction

```
y_predicted = predict(classifier,feature_test);
```

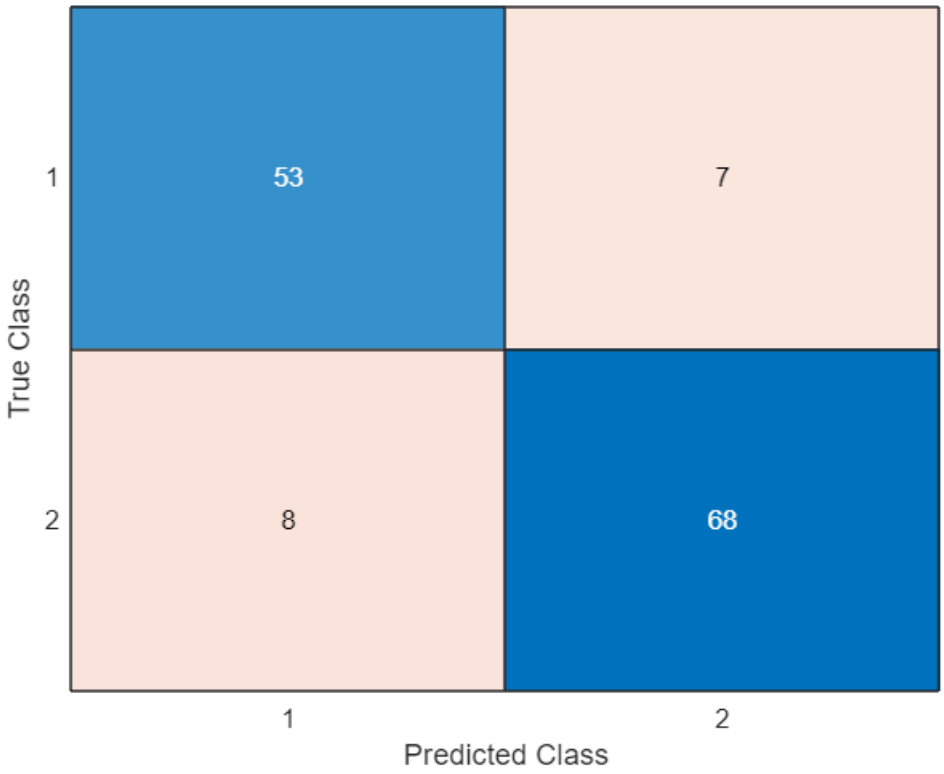
## Accuracy

```
accuracy = mean(y_predicted == y_test)
```

```
accuracy = 0.8897
```

## Confusion Matrix

```
confusionchart(y_test,y_predicted)
```




```
[conf_matrix,order] = confusionmat(y_test,y_predicted)
```

```
conf_matrix = 2×2
    53     7
     8    68
order = 2×1
     1
     2
```

```
tp = conf_matrix(1,1)
```

```
tp = 53
```

```
tn = conf_matrix(2,2)
```

```
tn = 68
```

```
fn = conf_matrix(1,2)
```

```
fn = 7
```

```
fp = conf_matrix(2,1)
```

```
fp = 8
```

### Sensitivity

```
sensitivity = tp/(tp+fn)
```

```
sensitivity = 0.8833
```

### Specificity

```
specificity = tn/(tn+fp)
```

```
specificity = 0.8947
```

## RIM-ONE-DL

### Load Dataset

```
rimone_dl_data_store_train = ...
    imageDatastore('C:\gyani\Projects_MS\code\dataset\RIM-ONE_DL_images\partitioned_randomly\tr
                   'IncludeSubfolders',true,'LabelSource','foldernames');
rimone_dl_data_store_test = ...
    imageDatastore('C:\gyani\Projects_MS\code\dataset\RIM-ONE_DL_images\partitioned_randomly\te
    'IncludeSubfolders',true,'LabelSource','foldernames');
```

### Resize Image to match the input size

```
rim_one_dl_aug_train = augmentedImageDatastore(input_Size(1:2),rimone_dl_data_store_train);
rim_one_dl_aug_test = augmentedImageDatastore(input_Size(1:2),rimone_dl_data_store_test);
```

### Train and Test labels

```
rimone_dl_y_train = double(categorical(rimone_dl_data_store_train.Labels));
rimone_dl_y_test = double(categorical(rimone_dl_data_store_test.Labels));
```

### Extract Feature from images

```
layer = 'relu6';
rimone_dl_feature_train = activations(alexnet_model,rim_one_dl_aug_train,layer,'OutputAs','rows
rimone_dl_feature_test = activations(alexnet_model,rim_one_dl_aug_test,layer,'OutputAs','rows')
rimone_dl_classifier = fitcecoc(rimone_dl_feature_train,rimone_dl_y_train);
```

## Result

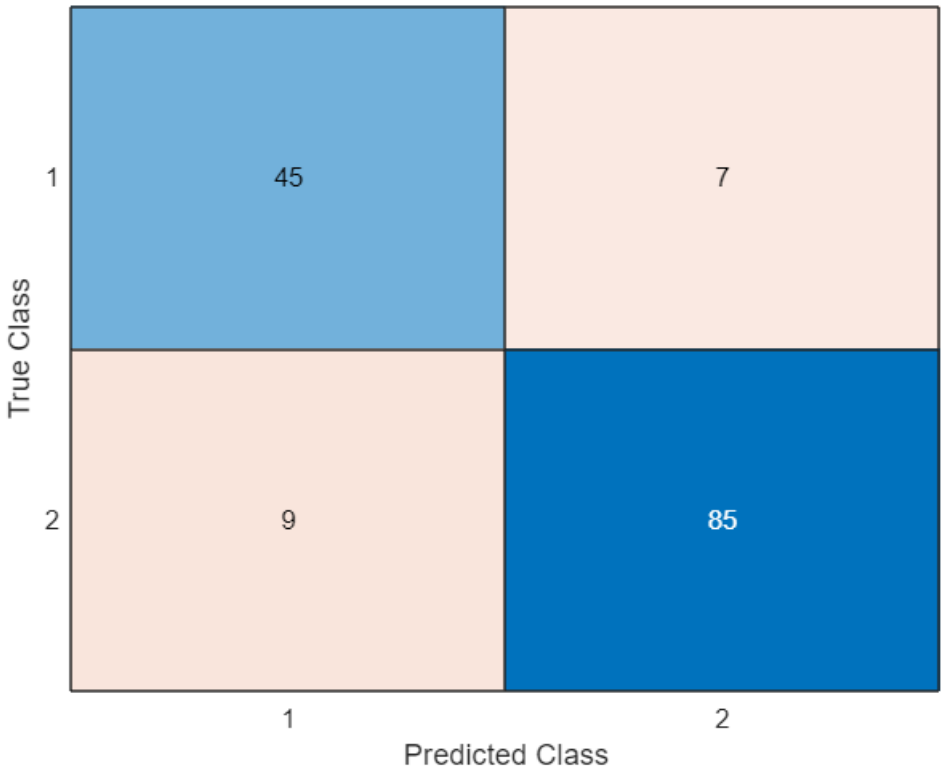
## Do prediction

```
rimone_dl_y_predicted = predict(rimone_dl_classifier,rimone_dl_feature_test);
rimone_dl_accuracy = mean(rimone_dl_y_predicted == rimone_dl_y_test)
```

```
rimone_dl_accuracy = 0.8904
```

## Confusion Matrix

```
confusionchart(rimone_dl_y_test,rimone_dl_y_predicted)
```




```
[rimone_dl_conf_matrix,rimone_dl_order] = confusionmat(rimone_dl_y_test,rimone_dl_y_predicted)
```

```
rimone_dl_conf_matrix = 2×2
    45     7
     9    85
rimone_dl_order = 2×1
     1
     2
```

```
r1dl_tp = rimone_dl_conf_matrix(1,1)
```

```
r1dl_tp = 45
```

```
r1dl_tn = rimone_dl_conf_matrix(2,2)
```

```
r1dl_tn = 85
```

```
r1dl_fn = rimone_dl_conf_matrix(1,2)
```

```
r1dl_fn = 7
```

```
r1dl_fp = rimone_dl_conf_matrix(2,1)
```

```
r1dl_fp = 9
```

### Sensitivity

```
r1dl_sensitivity = r1dl_tp/(r1dl_tp+r1dl_fn)
```

```
r1dl_sensitivity = 0.8654
```

### Specificity

```
r1dl_specificity = r1dl_tn/(r1dl_tn+r1dl_fp)
```

```
r1dl_specificity = 0.9043
```

# ACRIMA Dataset

## Load Dataset

Load ACRIMA dataset and split it in train and test set. The split ration is 70:30

```
acrima_image_data_store = ...
    imageDatastore('C:\gyani\Projects_MS\code\dataset\ACRIMA_dataset\Database',...
    'IncludeSubfolders',true,'LabelSource','foldernames');

[acrima_x_train_ds,acrima_x_test_ds] = splitEachLabel(acrima_image_data_store,0.7,'randomized')
```

### Resize Image to match the input size

```
acrima_aug_train = augmentedImageDatastore(input_Size(1:2),acrima_x_train_ds);
acrima_aug_test = augmentedImageDatastore(input_Size(1:2),acrima_x_test_ds);
```

### Train and Test labels

```
acrima_y_train = double(categorical(acrima_x_train_ds.Labels));
acrima_y_test = double(categorical(acrima_x_test_ds.Labels));
```

### Extract Feature from images

```
layer = 'relu6';
acrima_feature_train = activations(alexnet_model,acrima_aug_train,layer,'OutputAs','rows');
acrima_feature_test = activations(alexnet_model,acrima_aug_test,layer,'OutputAs','rows');
acrima_classifier = fitcecoc(acrima_feature_train,acrima_y_train);
```

# Result

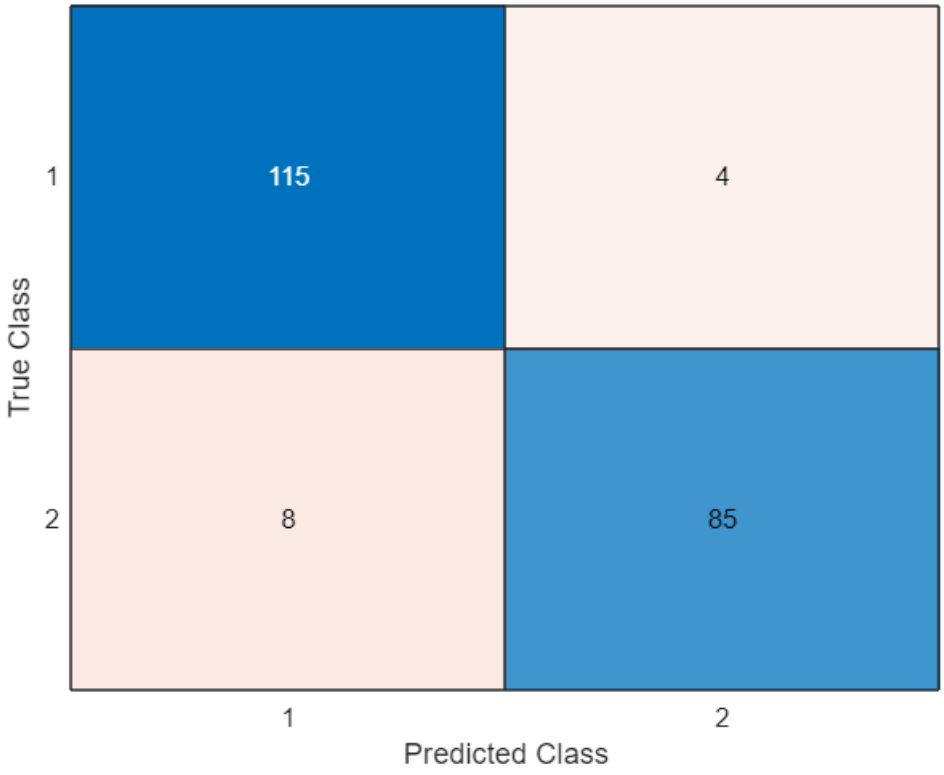
### Do prediction

```
acrima_y_predicted = predict(acrima_classifier,acrima_feature_test);
acrima_accuracy = mean(acrima_y_predicted == acrima_y_test)
```

```
acrima_accuracy = 0.9434
```

## Confusion Matrix

```
confusionchart(acrima_y_test,acrima_y_predicted)
```




```
[acrima_conf_matrix,acrima_order] = confusionmat(acrima_y_test,acrima_y_predicted)
```

```
acrima_conf_matrix = 2×2
   115     4
     8    85
acrima_order = 2×1
     1
     2
```

```
acrima_tp = acrima_conf_matrix(1,1)
```

```
acrima_tp = 115
```

```
acrima_tn = acrima_conf_matrix(2,2)
```

```
acrima_tn = 85
```

```
acrima_fn = acrima_conf_matrix(1,2)
```

```
acrima_fn = 4
```

```
acrima_fp = acrima_conf_matrix(2,1)
```

```
acrima_fp = 8
```

### Sensitivity

```
acrima_sensitivity = acrima_tp/(acrima_tp+acrima_fn)
```

```
acrima_sensitivity = 0.9664
```

### Specificity

```
acrima_specificity = acrima_tn/(acrima_tn+acrima_fp)
```

```
acrima_specificity = 0.9140
```

# Cross Dataset Prediction

#### RIMONE_V2_RIMONE_DL

```
RONE_r2_DL_y_predicted = predict(classifier,rimone_dl_feature_test);
RONE_r2_DL_accuracy = mean(RONE_r2_DL_y_predicted == rimone_dl_y_test)
```

```
RONE_r2_DL_accuracy = 0.8288
```

#### RIMONE_V2_ACRIMA

```
RONE_r2_ACRIMA_y_predicted = predict(classifier,acrima_feature_test);
RONE_r2_ACRIMA_accuracy = mean(RONE_r2_ACRIMA_y_predicted == acrima_y_test)
```

```
RONE_r2_ACRIMA_accuracy = 0.4953
```

#### RIMONE_DL_RIMONE_V2

```
RONE_DL_r2_y_predicted = predict(rimone_dl_classifier,feature_test);
RONE_DL_r2_accuracy = mean(RONE_DL_r2_y_predicted == y_test)
```

```
RONE_DL_r2_accuracy = 0.9044
```

#### RIMONE_DL_ACRIMA

```
RONE_DL_ACRIMA_y_predicted = predict(rimone_dl_classifier,acrima_feature_test);
RONE_DL_ACRIMA_accuracy = mean(RONE_DL_ACRIMA_y_predicted == acrima_y_test)
```

```
RONE_DL_ACRIMA_accuracy = 0.5755
```

#### ACRIMA_RIMONE_V2

```
ACRIMA_RONE_r2_y_predicted = predict(acrima_classifier,feature_test);
ACRIMA_RONE_r2_ACRIMA_accuracy = mean(ACRIMA_RONE_r2_y_predicted == y_test)
```

```
ACRIMA_RONE_r2_ACRIMA_accuracy = 0.4412
```

#### ACRIMA_RIMONE_DL

```
ACRIMA_RONE_dl_y_predicted = predict(acrima_classifier,rimone_dl_feature_test);
```

```
ACRIMA_RONE_dl_ACRIMA_accuracy = mean(ACRIMA_RONE_dl_y_predicted == rimone_dl_y_test)
```

```
ACRIMA_RONE_dl_ACRIMA_accuracy = 0.3973
```