Table 3. The performance of ResNet50

| Metrics | mean | *S* | *E* | CI |
|---|---|---|---|---|
| **PR-AUC** | 0.989 | 0.009 | 0.003 | 0.989 +/- 0.003 |
| **F1** | 0.976 | 0.014 | 0.005 | 0.976 +/- 0.005 |
| **PRECISION** | 0.975 | 0.024 | 0.009 | 0.975 +/- 0.009 |
| **RECALL** | 0.978 | 0.020 | 0.007 | 0.978 +/- 0.007 |
| **ACC** | 0.974 | 0.016 | 0.006 | 0.974 +/- 0.006 |

With Precision of 0.975, and Recall of 0.978, the model had on average the presence of only one false positive (false alarms) and presence of only one false negative. We made a slightly change on the ResNet50 architecture, removing all Batch Normalization (BN), why we did that? Neural networks suffer with covariate shift problem, and this happen when the distribution of each layer's inputs change constantly resulted by the change of parameters of previous layers and the change of distribution of the first layer's inputs during training [17] and the application of BN not only addresses this problem, but greatly enhance the speed of neural network training [17]. But this was not verified on our training process, as can be seen at Table 4, training ResNet34 with BN required more time and gave bad results, so we removed BN in ResNet34, ResNet50 and DarkNet53 because was slowing down the training process and reducing a little the models performances. This study did not go in depth to discover why Batch Normalization was not speeding our training and leading to better results.

Table 4 ResNet34 with BN vs. ResNet34 without BN

| **ResNet34 with BN** | | | | | **ResNet34 without BN** | | | |
|---|---|---|---|---|---|---|---|---|
| Epoch | time (s) | train ACC | test ACC | | Epoch | time (s) | train ACC | test ACC |
| 1 | 145 | 0.683 | 0.464 | | 1 | 97 | 0.551 | 0.633 |
| 2 | 132 | 0.928 | 0.464 | | 2 | 96 | 0.647 | 0.66 |
| 3 | 136 | 0.986 | 0.464 | vs. | 3 | 96 | 0.77 | 0.714 |
| 4 | 133 | 0.995 | 0.464 | | 4 | 95 | 0.825 | 0.714 |
| 5 | 137 | 0.991 | 0.464 | | 5 | 97 | 0.819 | 0.83 |
| 6 | 134 | 1 | 0.464 | | 6 | 96 | 0.897 | 0.83 |

### *C. DarkNet53*

The Table 5 show more details about the performance of DarkNet53, the standard deviation is nearly zero.

Table 5. The performance of DarkNet53

| Metrics | mean | *S* | *E* | CI |
|---|---|---|---|---|
| **PR-AUC** | 0.990 | 0.009 | 0.003 | 0.99 +/- 0.003 |
| **F1** | 0.976 | 0.018 | 0.006 | 0.976 +/- 0.006 |
| **PRECISION** | 0.972 | 0.024 | 0.009 | 0.972 +/- 0.009 |
| **RECALL** | 0.980 | 0.020 | 0.007 | 0.98 +/- 0.007 |
| **ACC** | 0.974 | 0.019 | 0.007 | 0.974 +/- 0.007 |

With Precision of 0.972, and Recall of 0.98, the model had on average the presence of only one false positive (false alarms) and presence of only one false negative. We made a slightly change on the DarkNet53 architecture: we applied the approach used at ResNet architecture, replacing the first two convolutional layer of DarkNet53, by one convolution layer with 7x7 kernel size followed by a 3x3 max pool, which lead to good results.

### *D. ResNet34*

The Table 6 show more details about the performance of ResNet34, the standard deviation is nearly zero.

Table 6. The performance of ResNet34

| Metrics | mean | *S* | *E* | CI |
|---|---|---|---|---|
| **PR-AUC** | 0.988 | 0.009 | 0.003 | 0.988 +/- 0.003 |
| **F1** | 0.975 | 0.013 | 0.004 | 0.975 +/- 0.004 |
| **PRECISION** | 0.968 | 0.026 | 0.009 | 0.968 +/- 0.009 |
| **RECALL** | 0.976 | 0.018 | 0.006 | 0.976 +/- 0.006 |
| **ACC** | 0.969 | 0.015 | 0.005 | 0.969 +/- 0.005 |

With Precision of 0.968, and Recall of 0.976, the model had on average the presence of only two false positive (false alarms) and presence of only one false negative. We made a slightly change on the ResNet34 architecture we used a residual block with 1x1 kernel size followed by 3x3 kernel size, instead of residual block with only 3x3 kernel size.

## CONCLUSION

In this study, the experiments were performed on known DCNNs. As a result of these experiments, all implemented models achieved at least 0.969 of Accuracy, 0.968 of Precision and 0.976 of Recall. The highest scores were achieved by Inception_v4 with 0.987 of Accuracy, 0.989 of Precision and 0.987 of Recall, which has less parameter number than ResNet50 and Darknet53.