## **Assignment 5 – Report**

**Step 4. Analysis and Improvement**

* **We experimented with total number of stumps that were being used in the model for Adaboost:**

These were the stump counts we considered: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 25, 50, 75 and 100.

Here are the results of the 5 fold cross validation (90% Train, 10% Test) where each stump was built after considering 1000 random pixel pairs:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cross Validation Set 0 | |  | Cross Validation Set 1 | |
| # Stumps | Accuracy Percentage | Training in min. |  | Accuracy Percentage | Training in min. |
| 1 | 46.88 | 3.977016667 |  | 45.15 | 5.883383 |
| 2 | 52.77 | 6.60905 |  | 64.66 | 9.3789 |
| 3 | 66.21 | 9.4046 |  | 65.85 | 13.1009 |
| 4 | 65.51 | 11.32633333 |  | 64.26 | 16.51337 |
| 5 | 67.33 | 14.74508333 |  | 66.86 | 19.37835 |
| 6 | 66.69 | 19.89325 |  | 66.28 | 22.60097 |
| 7 | 68.22 | 21.93136667 |  | 68.73 | 25.70575 |
| 8 | 67.78 | 26.11415 |  | 68.24 | 29.67665 |
| 9 | 67.69 | 29.17036667 |  | 67.66 | 32.39652 |
| 10 | 67.1 | 32.43828333 |  | 68.91 | 35.2543 |
| 11 | 68.54 | 36.62983333 |  | 68.21 | 36.02868 |
| 25 | 71.11 | 73.75721667 |  | 70.83 | 73.04732 |
| 50 | 70.9 | 135.31785 |  | 70.93 | 139.4286 |
| 75 | 71.85 | 205.3504833 |  | 70.87 | 198.5339 |
| 100 | 72.02 | 265.2615167 |  | 69.89 | 270.6328 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cross Validation Set 2 | |  | Cross Validation Set 3 | |
| # Stumps | Accuracy Percentage | Training in min. |  | Accuracy Percentage | Training in min. |
| 1 | 48.8 | 6.1755 |  | 49.2 | 5.38035 |
| 2 | 58.97 | 9.814167 |  | 59.01 | 9.64675 |
| 3 | 61.52 | 13.689 |  | 65.19 | 13.3636 |
| 4 | 65.78 | 16.57533 |  | 66.25 | 18.11042 |
| 5 | 66.77 | 20.46783 |  | 67.01 | 19.7181 |
| 6 | 68.06 | 23.456 |  | 65.74 | 24.00233 |
| 7 | 68.18 | 26.70242 |  | 69.13 | 26.04028 |
| 8 | 68.24 | 29.32987 |  | 69.13 | 29.69685 |
| 9 | 67.27 | 31.92778 |  | 68.8 | 31.90455 |
| 10 | 69.65 | 34.54398 |  | 70.04 | 35.47075 |
| 11 | 68.45 | 38.03082 |  | 69.19 | 37.90528 |
| 25 | 70.62 | 75.62317 |  | 71.16 | 73.03033 |
| 50 | 70.91 | 136.819 |  | 72.04 | 134.6611 |
| 75 | 71.58 | 212.4739 |  | 71.34 | 207.8133 |
| 100 | 69.74 | 273.3756 |  | 72.16 | 271.766 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cross Validation Set 4 | |  | Final Model | |
| # Stumps | Accuracy Percentage | Training in min. |  | Avg Validation Accuracy % | Avg Training Min. |
| 1 | 46.55 | 6.261033 |  | 47.316 | 5.535457 |
| 2 | 54.75 | 9.959017 |  | 58.032 | 9.081577 |
| 3 | 66.81 | 13.02698 |  | 65.116 | 12.51702 |
| 4 | 66.96 | 16.44285 |  | 65.752 | 15.79366 |
| 5 | 68.5 | 20.12213 |  | 67.294 | 18.8863 |
| 6 | 67.84 | 22.66145 |  | 66.922 | 22.5228 |
| 7 | 68.65 | 27.46788 |  | 68.582 | 25.56954 |
| 8 | 70.07 | 28.54202 |  | 68.692 | 28.67191 |
| 9 | 69.41 | 32.45727 |  | 68.166 | 31.5713 |
| 10 | 68.05 | 35.5341 |  | 68.75 | 34.64828 |
| 11 | 70.56 | 37.28455 |  | 68.99 | 37.17583 |
| 25 | 71.58 | 77.00667 |  | 71.06 | 74.49294 |
| 50 | 71.46 | 138.08 |  | 71.248 | 136.8613 |
| 75 | 71.64 | 211.015 |  | 71.456 | 207.0373 |
| 100 | 71.89 | 269.77 |  | 71.14 | 270.1612 |

After testing on the given test data, using the 75 stumps model the best testing accuracy percentage found was found to be 70.2%

* **We also experimented with different features in Neural Network:**
* **Few Images that were found to be misclassified:**
  + Errors made by our models:
    - Patterns found in errors: The images were Grayscale so Adaboost failed to find the correct orientations.

|  |  |  |
| --- | --- | --- |
| Image | Given Orientation | Predicted Orientation |
| test/112713406.jpg | 0 | 180 |
| test/164225933.jpg | 180 | 0 |

* Other Patterns found in errors:
  + Also, here are a few images which were classified correctly by Adaboost, but were considered misclassified because of bugs in the training data:

|  |  |  |
| --- | --- | --- |
| Image | Given Orientation | Predicted Orientation |
| test/14645715459.jpg | 90 | 0 |
| test/14715745533.jpg | 180 | 0 |
| test/14826675581.jpg | 270 | 0 |