**Sample Results**

# **Supervised Learning (Binary Class)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data Set** | **Benign Instructions** | **Malicious Instructions** | **Total** | **7x Attributes** | **Test Mode** |
| Supervised - Binary | 513,851 | 309,287 | 823,138 | G1, Z, F, E, X, Y, Drop | 80% / 20% |

# **Supervised Learning (Multiclass)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Data Set** | **Low class** | **High class** | **Med class** | **Total** | **7x Attributes** | **Test Mode** |
| Supervised - Multiclass | 513,850 | 185,560 | 123,728 | 823,138 | G1, Z, F, E, X, Y, Drop | 66% / 34% |

| **Model** | **Train Time (s)** | **TP Rate** | **FP Rate** | **Precision** | **Recall** | **F-Measure** | **ROC Area** | **Incorrectly Identified %** | **Class** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Naïve Bayes** | 0.79 | 0.976 | 0.001 | 0.999 | 0.976 | 0.988 | 0.994 | 1.65 | Low |
| 0.993 | 0.003 | 0.990 | 0.993 | 0.992 | 0.998 | High |
| 0.998 | 0.016 | 0.916 | 0.998 | 0.955 | 0.996 | Medium |
| **0.983** | **0.004** | **0.985** | **0.983** | **0.984** | **0.995** | **W. Avg** |
| **Logistic Regression** | **53.27** | 0.99 | 0.013 | 0.992 | 0.996 | 0.994 | 0.999 | 0.76 | Low |
| 0.979 | 0.003 | 0.991 | 0.979 | 0.985 | 0.998 | High |
| 0.996 | 0.001 | 0.995 | 0.996 | 0.995 | 1.000 | Medium |
| **0.992** | **0.009** | **0.992** | **0.992** | **0.992** | **0.999** | **W. Avg** |
| **MLP** | **865.1** | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.03 | Low |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | High |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |
| **AdaBoostM1** | 15.47 | 1.000 | 0.790 | 0.677 | 1.000 | 0.808 | 0.700 | **29.76** | Low |
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.500 | High |
| 0.525 | 0.000 | 0.997 | 0.525 | 0.688 | 1.000 | Medium |
| **0.702** | **0.493** | **0.572** | **0.702** | **0.607** | **0.699** | **W. Avg** |
| **LogitBoost** | **60.09** | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.03 | Low |
| 0.999 | 0.000 | 1.000 | 0.999 | 0.999 | 1.000 | High |
| 1.000 | 0.000 | 0.998 | 1.000 | 0.999 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |
| **Multi Class Classifier** | **85.56** | 0.995 | 0.012 | 0.993 | 0.995 | 0.994 | 0.997 | 0.79 | Low |
| 0.979 | 0.003 | 0.989 | 0.979 | 0.984 | 0.996 | High |
| 1.000 | 0.001 | 0.994 | 1.000 | 0.997 | 1.000 | Medium |
| **0.992** | **0.008** | **0.992** | **0.992** | **0.992** | **0.998** | **W. Avg** |
| **OneR** | 1.01 | 0.982 | 0.783 | 0.675 | 0.982 | 0.800 | 0.599 | **30.68** | Low |
| 0.010 | 0.015 | 0.157 | 0.010 | 0.018 | 0.497 | High |
| 0.525 | 0.000 | 0.995 | 0.525 | 0.687 | 0.762 | Medium |
| **0.693** | **0.492** | **0.606** | **0.693** | **0.606** | **0.601** | **W. Avg** |
| **Decision Table** | 10.53 | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.0021 | Low |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | High |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |
| **ZeroR** | 0.06 | 1.000 | 1.000 | 0.624 | 1.000 | 0.768 | 0.500 | **37.63** | Low |
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.500 | High |
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.500 | Med |
| **0.624** | **0.624** | **0.389** | **0.624** | **0.479** | **0.500** | **W. Avg** |
| **J48 Tree** | 7.76 | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.0025 | Low |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | High |
| 1.000 | 0.000 | 0.998 | 1.000 | 0.999 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |
| **RandomForest** | **236.87** | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.0018 | Low |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | High |
| 1.000 | 0.000 | 0.998 | 1.000 | 0.999 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |
| **RandomTree** | **2.29** | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | **0.0025** | Low |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | High |
| 1.000 | 0.000 | 0.998 | 1.000 | 0.999 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |
| **RepTree** | 5.0 | 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.0025 | Low |
| 1.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | High |
| 1.000 | 0.000 | 0.998 | 1.000 | 0.999 | 1.000 | Medium |
| **1.000** | **0.000** | **1.000** | **1.000** | **1.000** | **1.000** | **W. Avg** |

# **Semi supervised Learning**

*The results for semi supervised* ***logistic regression algorithm*** *are shown in table below.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Data Set** | **No** | **Yes** | **Blank** | **Total** | **21x Attributes** | **Test Mode** |
| Semi  Supervised | 557,879 | 265,259 | 21,664 | 844,802 | M82, M84, M107, M190, M104, M109, M140, M106, M220, G21, G28, G90, G92, F, E, S, G1, X, Y, Z, Drop | 80% / 20% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **Data Set Scenarios** | **Accuracy** | **Precision** | **Recall** | **F1-Score** | **Instructions** | | |
| **Labeled** | **Unlabeled** | **Total** |
| 1 | Complete | 98.5 | 98.6 | 96.7 | 97.6 | 823,138 | 21,664 | 844,802 |
| 2 | Highly Labeled | 94 | 93.5 | 88 | 90.22 | 41,157 | 21,664 | 62,821 |
| 3 | Balanced | 88 | 76 | 87 | 81 | 20,579 | 21,664 | 42,243 |
| 4 | Highly Unlabeled | 85 | 70 | 96 | 80.86 | 8,232 | 21,664 | 29,896 |