# Model Evaluation

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This code evaluates ANN, Random Forest, SVM, and Logistic Regression as models. Every model's precision, recall, F1-score, and accuracy are calculated using the test dataset (X\_test and y\_test). AUC probabilities are calculated for binary classification issues.

**ANN Evaluation**:

Forecasts are made using model.predict in the ANN evaluation.

Class predictions are made using np.argmax from ANN probabilities.

Print the classification report with precision, recall, F1-score, and accuracy.

**Random Forest Evaluation:**

* Predicts classes using the predict method.
* Predict\_proba generates class probabilities for binary classification measures like AUC.
* Shows classification report and accuracy score.

**SVM Evaluation:**

* Class predictions using predict.
* An AUC computation uses predict\_proba to calculate class probabilities.
* A thorough classification report and accuracy are printed.

**Logistic Regression Evaluation:**

* Evaluate predictions and probabilities using predict and predict\_proba.
* The classification report and accuracy score are shown like other models.

It extensively assesses each model's test data classification accuracy. Like AUC scoring, probabilities allow for binary task analysis.

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Comparisons between ANN, Random Forest, SVM, and Logistic Regression machine learning models. The reports include precision, recall, F1-score, and dataset label support.

**ANN Classification Report**:

* The ANN classification report showed 86.74% model accuracy.
* It had exceptional precision, recall, and F1-scores above 0.8 in high-support classes like "malware" and "location".
* Smaller support classes like "DOMAIN" and "EMAIL" had lower recall, indicating difficulty distinguishing uncommon labels.

**Random Forest Classification Report**:

* The Random Forest model outperformed ANN with 87.85% accuracy.
* With balanced precision and recall scores, the model excelled in "REGISTRYKEY" and "SHA1" labels.

**SVM Classification Report**:

* SVM model has lower accuracy (78.39%) than ANN and Random Forest.
* While processing larger classes like "malware" efficiently, low-support labels had lower recall and F1-scores.

**Logistic Regression Classification Report**:

* 68.30% accuracy was lowest.
* It struggles to manage imbalanced datasets with low recall (0.0) for labels like "DOMAIN" and "MD5" in smaller classes.

Logistic Regression trailed the Random Forest model in precision, recall, and F1-scores. The model must balance frequent and rare class performance for imbalanced datasets, according to this investigation.

# Model Comparision

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ANN, Random Forest, SVM, and Logistic Regression are four machine learning models. Each bar reflects model accuracy on the test dataset.

* **ANN and Random Forest:** 0.87 accuracies were optimal for ANN and Random Forest models. This shows they can manage complex and unbalanced datasets.
* **SVM** had 0.78 accuracy, much lower. SVM performed worse than ANN and Random Forest in multiclass classification while being robust to smaller datasets and linearly separable data.
* **Logistic Regression** had the lowest accuracy at approximately 0.68. Logistic Regression struggled to handle the complex relationships and imbalanced classes in the dataset, making it less suitable for this task.

The chart highlights the superiority of Random Forest and ANN due to their ability to generalize better and capture complex patterns. SVM performed moderately well, while Logistic Regression's simplicity made it less competitive. Based on this analysis, Random Forest and ANN are the most viable options for deployment, with Random Forest having a slight edge due to its interpretability and balanced performance.