RoboGarden Bootcamp Capstone Project

Credit Card Fraud Detection

July 2019

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Credit Card Fraud Project

Description:

- 284,807 credit card transactions made by European cardholders in September 2013

Features:

- Time: seconds since first transaction
- V1 – V28: Anonymous data – Confidentiality
- Amount: Transaction value (Unspecified currency)
- Class (T/F): fraudulent / genuine

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Available: *Data World :* https://data.world/raghu543/credit-card-fraud-data (also available on Kaggle)

File: creditcard.csv

Reference use of dataset: Dal Pozzolo, Olivier Caelen, Reid A. Johnson and Gianluca Bontempi. Calibrating Probability with Undersampling for Unbalanced Classification. In Symposium on Computational Intelligence and Data Mining (CIDM), IEEE, 2015

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Credit Card Fraud Project Dataset

- *normal amount total* ***25,043,410***
- *fraud amount total* ***58,591*** ***(0.25%)***
- *# transactions over 2 days* ***284,807***
- *# fraud transactions* ***492*** ***(0.17%)***
- *# non-fraud duplicates* ***1062*** ***(0.4 %)***
- *# fraud duplicates* ***19*** ***(4.0 %)***
- *# zero amount normal transactions* ***1798*** ***(0.6%)****
- *# zero amount fraud transactions* ***27*** ***(5.5%)****

* Retained zero amount transactions. Insufficient information to remove them.

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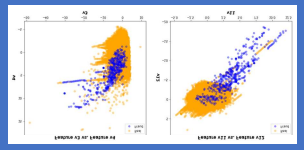
Work Process

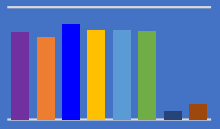
Clean Data

Remove Duplicates

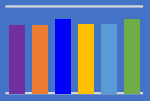
Visualize Data



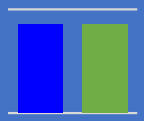
Screen 8 Classifiers



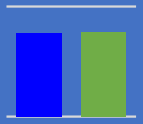
Optimize 6 Classifiers
All Features



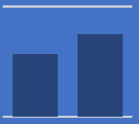
Optimize RF & MLP on
10 Features
Feature Importance



Optimize RF & MLP on
Undersampled
Dataset All Features



Run Autoencoders on
10 Features
4 Features



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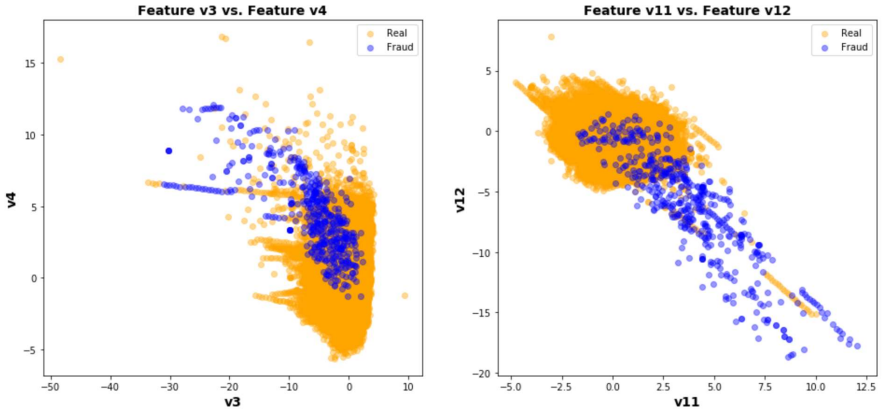
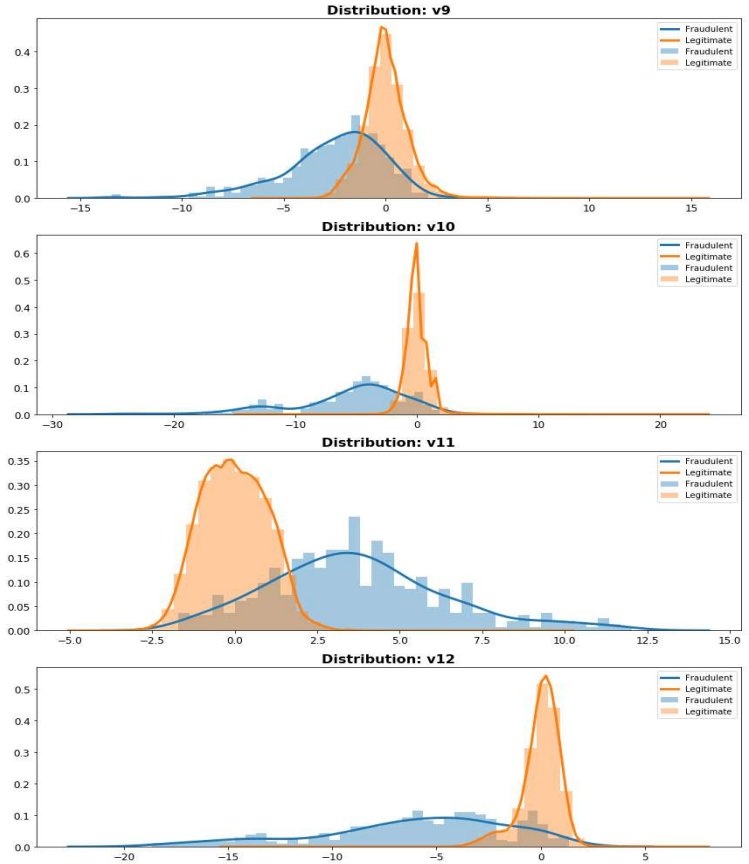
Visualization Examples



- **2D Scatter plots show some overlap & separation.**

Showing 4 of 28 Features: Fraud vs. Normal Histograms

- **Several have distinctive range differences.**
- **Some distributions are aligned, (not shown).**



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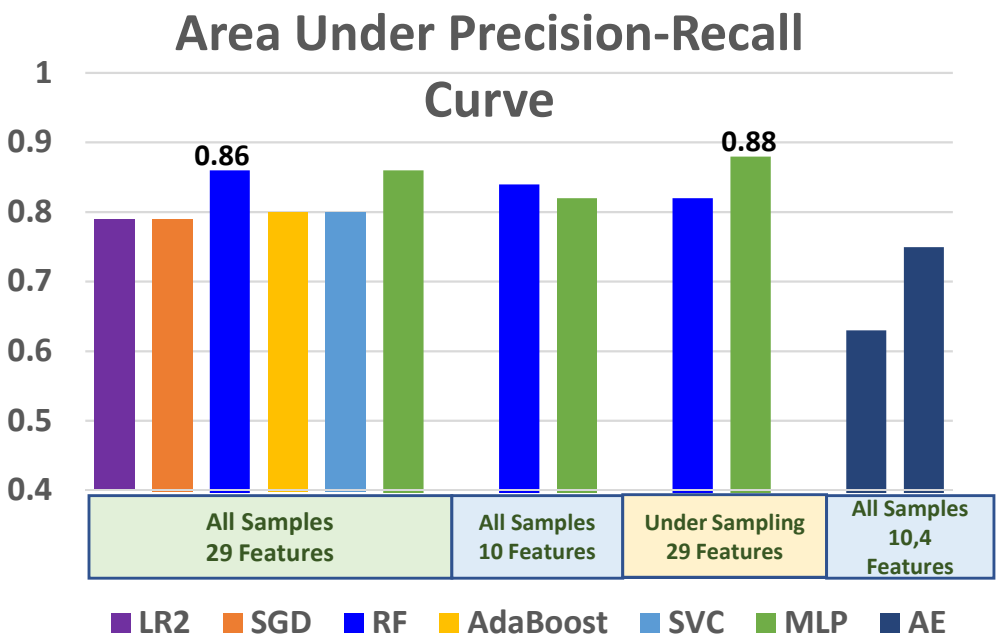
Modelling Results

Model	Application	Features	Scores AU-ROC	AU-PRC*	F-1	TP	FP	FN
LR	All Samples	29	0.98	0.79	0.69	65	5	53
SGD	All Samples	29	0.98	0.79	0.79	83	7	35
RF ★	All Samples	29	0.96	0.86	0.86	92	4	26
SVC	All Samples	29	0.95	0.80	0.78	77	3	41
AdaBoost	All Samples	29	0.97	0.80	0.80	84	8	34
MLP	All Samples	29	0.99	0.86	0.86	92	5	26
RF	All Samples	10	0.96	0.84	0.85	90	4	28
MLP	All Samples	10	0.98	0.82	0.83	88	6	30
RF **	Undersampling	29	0.99	0.82	0.87	97	8	21
MLP ** ★	Undersampling	29	0.98	0.88	0.86	96	10	22
AE	All Samples	10	0.97	0.57	0.58	66	45	52
AE	All Samples	4	0.96	0.75	0.78	83	11	35



★ *Model results shown on following slides*

** AU-PRC: Area under the Precision-Recall Curve is the recommended measure of accuracy stated by the dataset provider due to the imbalance in the dataset.*
***Under Sampling applies calibration to the sample probabilities.*

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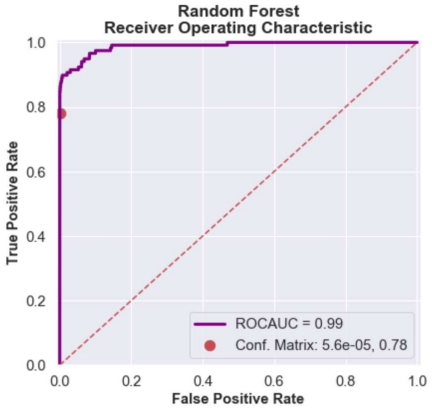
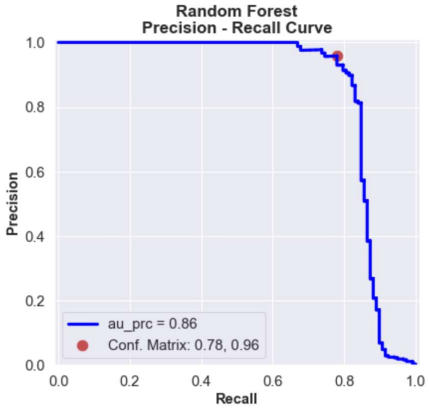
Random Forest Results



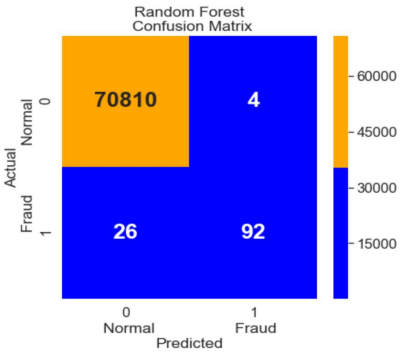


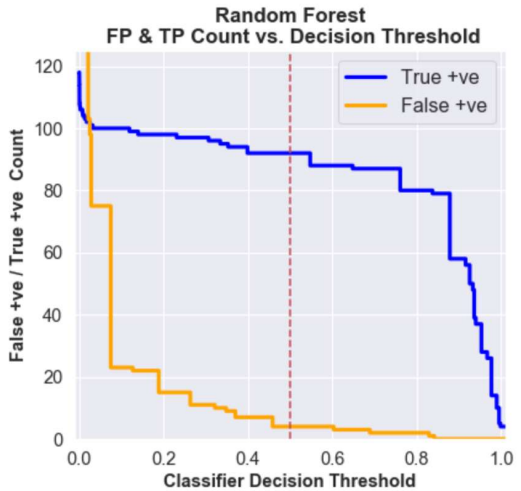
ROC and Precision-Recall Curves:

- Area under Precision-Recall of 0.86.
- Area under ROC of 0.99.
- Confusion Matrix corresponds to markers on ROC & PRC and decision threshold line on the FP & TP Count plot.

Random Forest trained on the full dataset *:

- Found 78% of frauds at 0.5 decision threshold.
- Has a low false positive rate.
- 67% of frauds have a classification probability over 0.8.





**Trained on 29 Features: Amount + Features v1 to v28 (time was dropped)*

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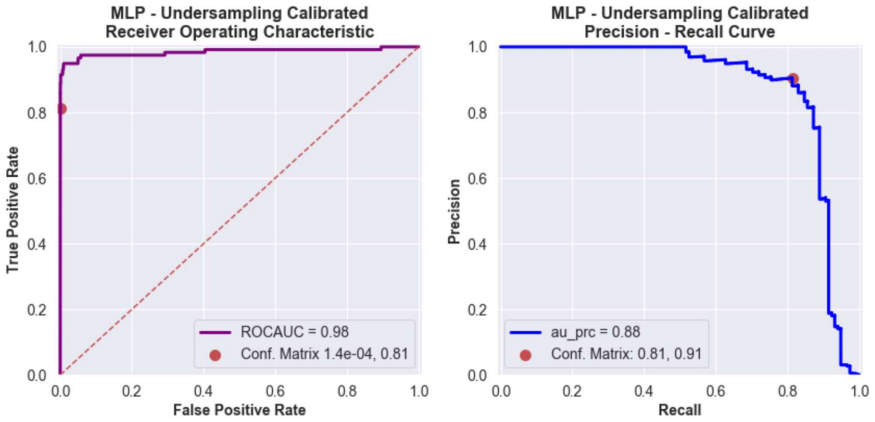
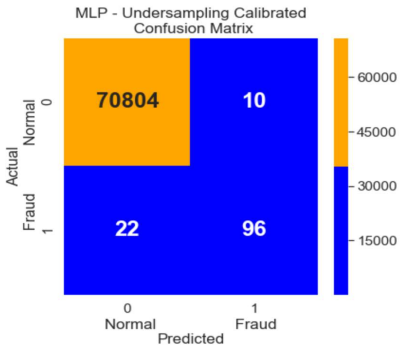
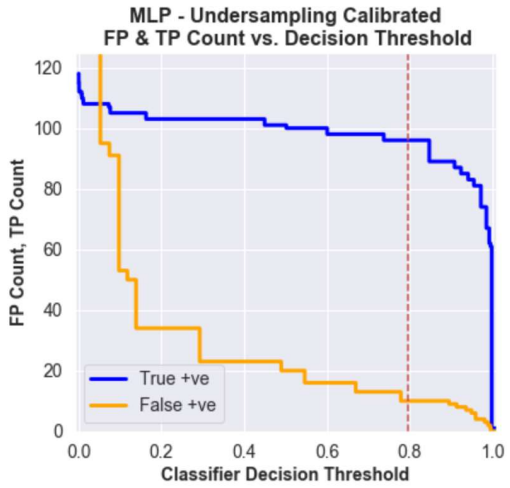
MLP – Undersampling Results



ROC and Precision-Recall Curves:

- Area under Precision-Recall of 0.88.
- Area under ROC of 0.98.
- Confusion Matrix corresponds to markers on ROC & PRC and decision threshold line on the FP & TP Count plot.





MLP trained on fewer samples *:

- Tested on the full 70,000+ test sample set.
- Found 81% of frauds using a 0.8 decision threshold after undersampling calibration.
- Has a low overall false positive rate, but higher than the Random Forest model.

**Trained on reduced set containing 10% of non-fraud transactions and 29 Features (Amount + Features v1 to v28)*

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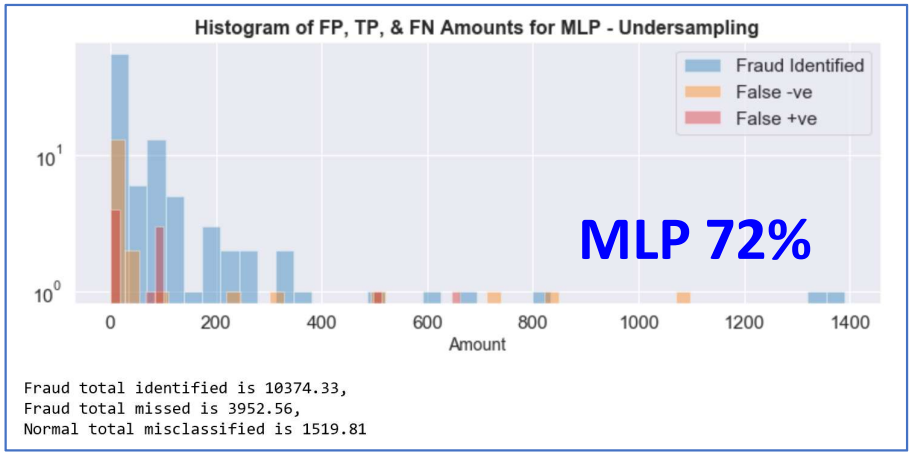
Fraud Value Identified in Test Set (25% of Dataset)

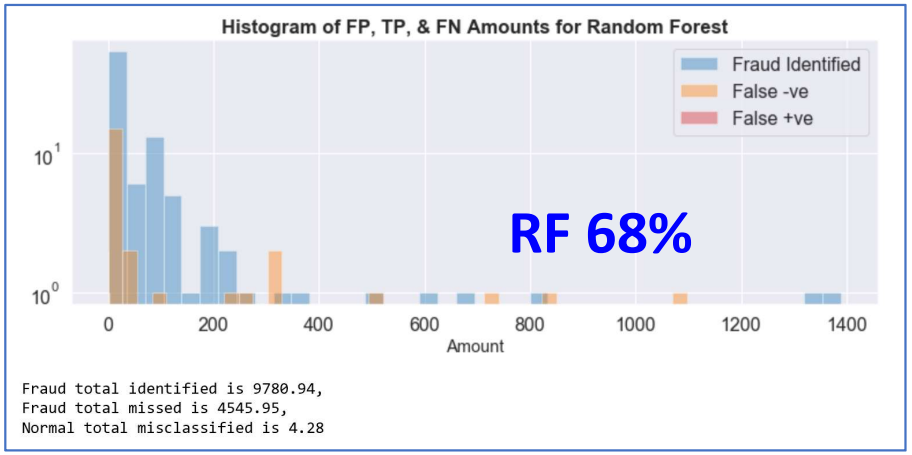
96 Frauds & 72% of value*

10 FP's – 15% of the Fraud value



92 Frauds & 68% of value*

4 FP's – .03% of the Fraud value



- Random Forest identified a slightly lower fraud amount, but misclassified a substantially lower amount than the MLP Classifier.

** Amounts will vary with new data.*

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Conclusions / Future Work

Conclusions:

- Despite the extreme unbalanced nature of the dataset, Random Forest classified 78% of the fraudulent transactions with few false positives (4% of frauds identified).
- The undersampling technique improved the area under the Precision-Recall Curve score and identified 81% of the fraudulent transactions. This MLP model had a higher false positive rate and misclassified a higher value amount of legitimate transactions.
- Performance degraded when features were dropped except for the Autoencoder model which improved with fewer more distinct features.

Future Work:

- Include more model parameters in a broader optimization search.
- Use time feature by setting it to time of day vs. time from first transaction.
- Investigate a hybrid classifier by combining multiple classifiers.