Credit Card Fraud Anomaly Detection

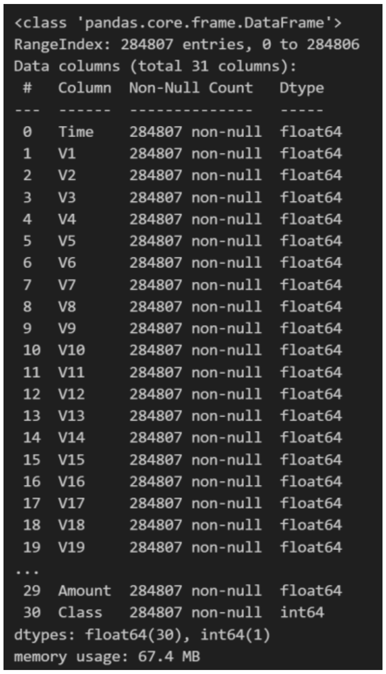
Introduction:

Credit card fraud is a major worldwide problem that costs people, companies, and financial institutions a lot of money. The complexity and diversity of data patterns have made it harder to detect fraudulent conduct as the number of digital transactions has increased. By examining departures from typical transaction behavior, anomaly detection techniques are essential in spotting questionable activity. These techniques use statistical models and sophisticated machine learning algorithms to identify minor, odd trends that might point to fraud. In the digital economy, higher security, lower financial risk, and increased customer and service provider trust are all guaranteed by efficient fraud detection systems.

Data Information:

Dataset link: https://www.kaggle.com/code/rimshavirmani/anomaly-detection/notebook

Used the Creditcard.csv file to train the models. The dataset information is mentioned below:



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<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284807 entries, 0 to 284806
Data columns (total 31 columns):
 #   Column  Non-Null Count   Dtype
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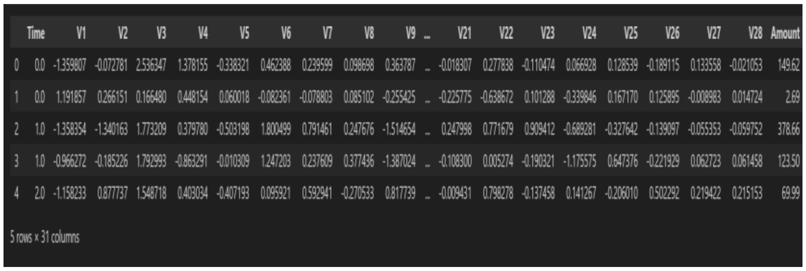
 0   Time    284807 non-null  float64
 1   V1      284807 non-null  float64
 2   V2      284807 non-null  float64
 3   V3      284807 non-null  float64
 4   V4      284807 non-null  float64
 5   V5      284807 non-null  float64
 6   V6      284807 non-null  float64
 7   V7      284807 non-null  float64
 8   V8      284807 non-null  float64
 9   V9      284807 non-null  float64
 10  V10     284807 non-null  float64
 11  V11     284807 non-null  float64
 12  V12     284807 non-null  float64
 13  V13     284807 non-null  float64
 14  V14     284807 non-null  float64
 15  V15     284807 non-null  float64
 16  V16     284807 non-null  float64
 17  V17     284807 non-null  float64
 18  V18     284807 non-null  float64
 19  V19     284807 non-null  float64
...
 29  Amount  284807 non-null  float64
 30  Class   284807 non-null  int64
dtypes: float64(30), int64(1)
memory usage: 67.4 MB
```



	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V22	V23	V24	V25	V26	V27	V28	Amount
0	0.0	-1.359807	-0.072781	2.536347	1.378155	-0.338321	0.462388	0.239599	0.098698	0.363787	...	-0.018307	0.277838	-0.110474	0.066928	0.128539	-0.189115	0.133558	-0.021053	149.62
1	0.0	1.191857	0.266151	0.166480	0.448154	0.060018	-0.082361	-0.078803	0.085102	-0.255425	...	-0.225775	-0.638672	0.101288	-0.339846	0.167170	0.125895	-0.008983	0.014724	2.69
2	1.0	-1.358354	-1.340163	1.773209	0.379780	-0.503198	1.800499	0.791461	0.247676	-1.514654	...	0.247998	0.771679	0.909412	-0.689281	-0.327642	-0.139097	-0.055353	-0.059752	378.66
3	1.0	-0.966272	-0.185226	1.792993	-0.863291	-0.010309	1.247203	0.237609	0.377436	-1.387024	...	-0.108300	0.005274	-0.190321	-1.175575	0.647376	-0.221929	0.062723	0.061458	123.50
4	2.0	-1.158233	0.877737	1.548718	0.403034	-0.407193	0.095921	0.592941	-0.270533	0.817739	...	-0.009431	0.798278	-0.137458	0.141267	-0.206010	0.502292	0.219422	0.215153	69.99

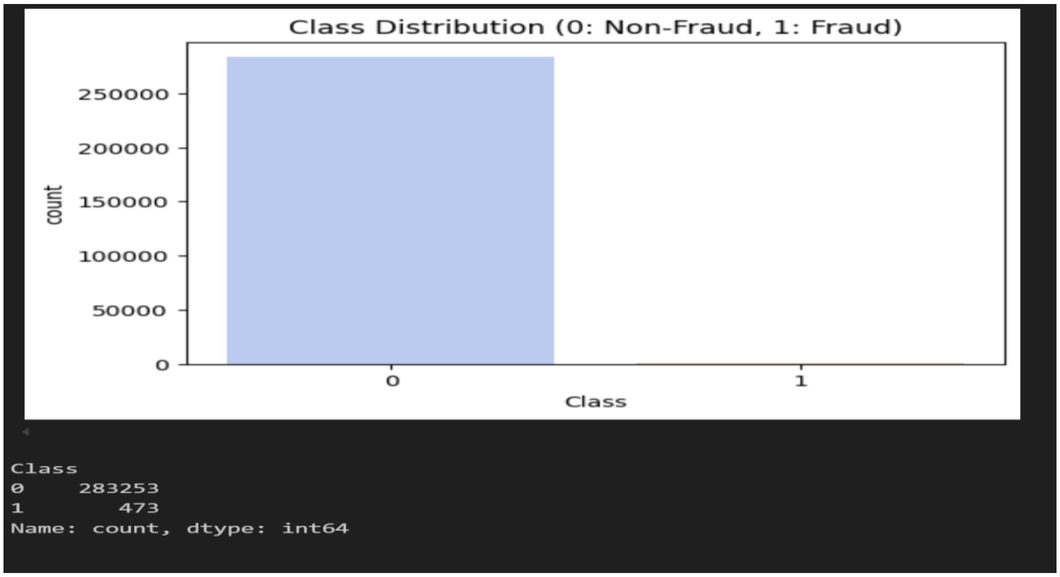
5 rows × 31 columns

Data preprocessing:

- Checking for datatypes and found that all columns are in numerical datatype.
- Checking for null values and found nothing.
- Removed duplicate rows.
- No removal of columns as they are required for model prediction.

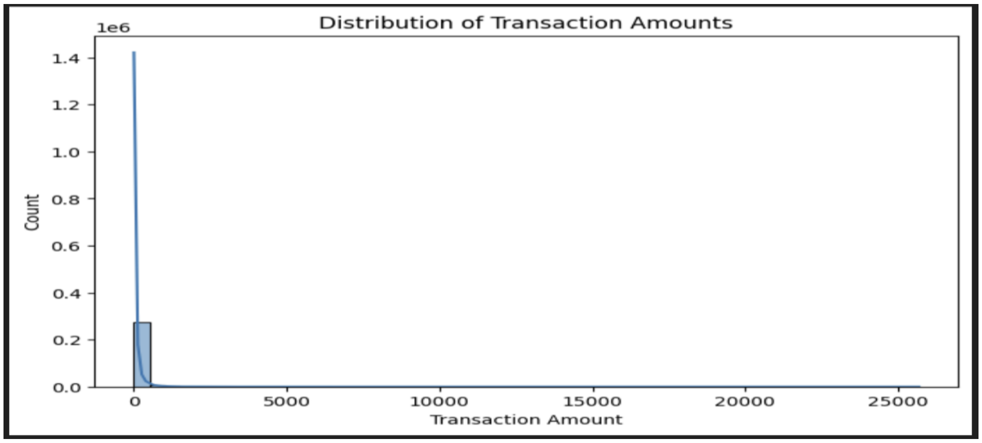
EDA and Visualization:

- Class Distribution and visualized it by bar graph. 473 fraud ones are found in dataset.

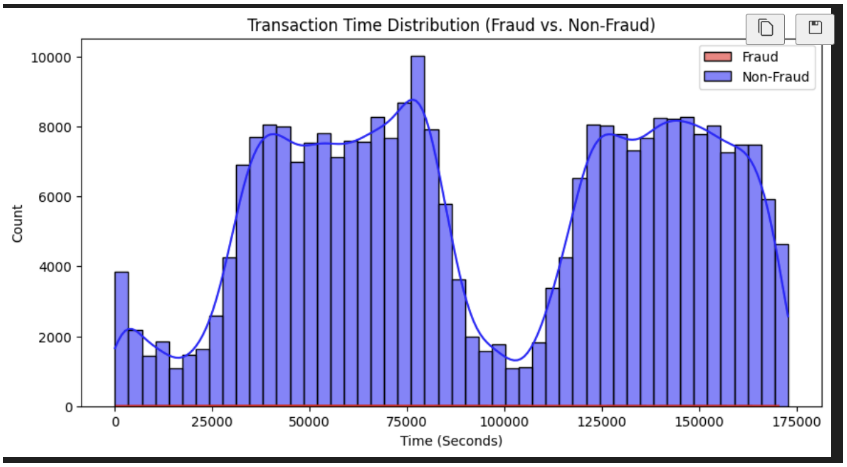


```
Class
0    283253
1       473
Name: count, dtype: int64
```

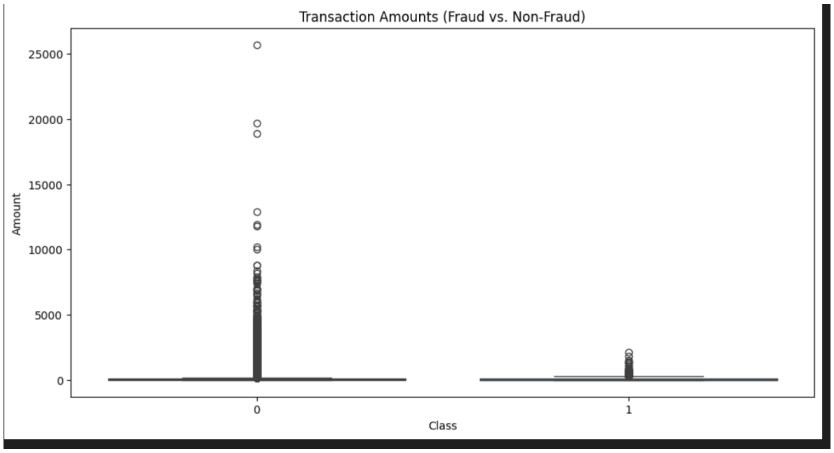
- Distribution of Transaction amounts.



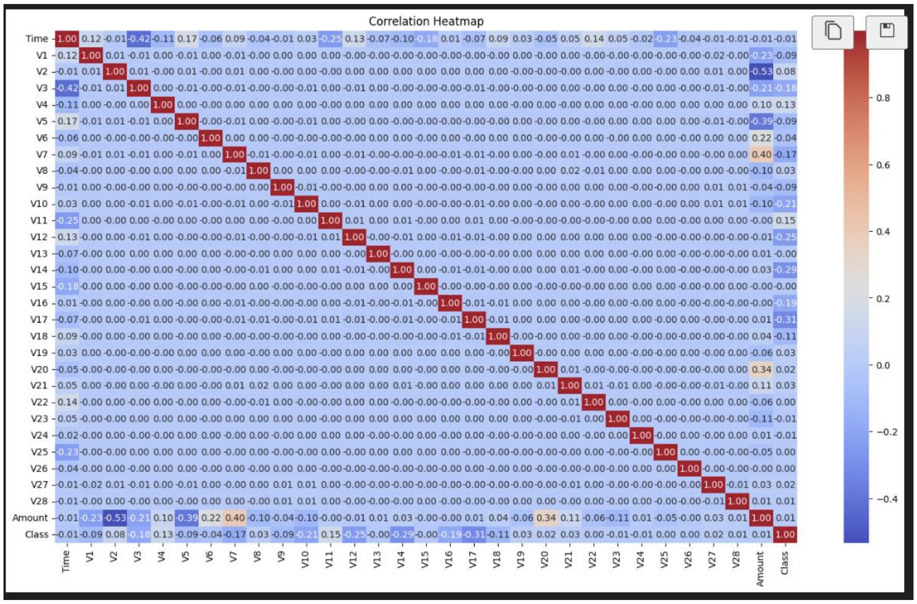
- Transaction time distribution:



- Box plot:

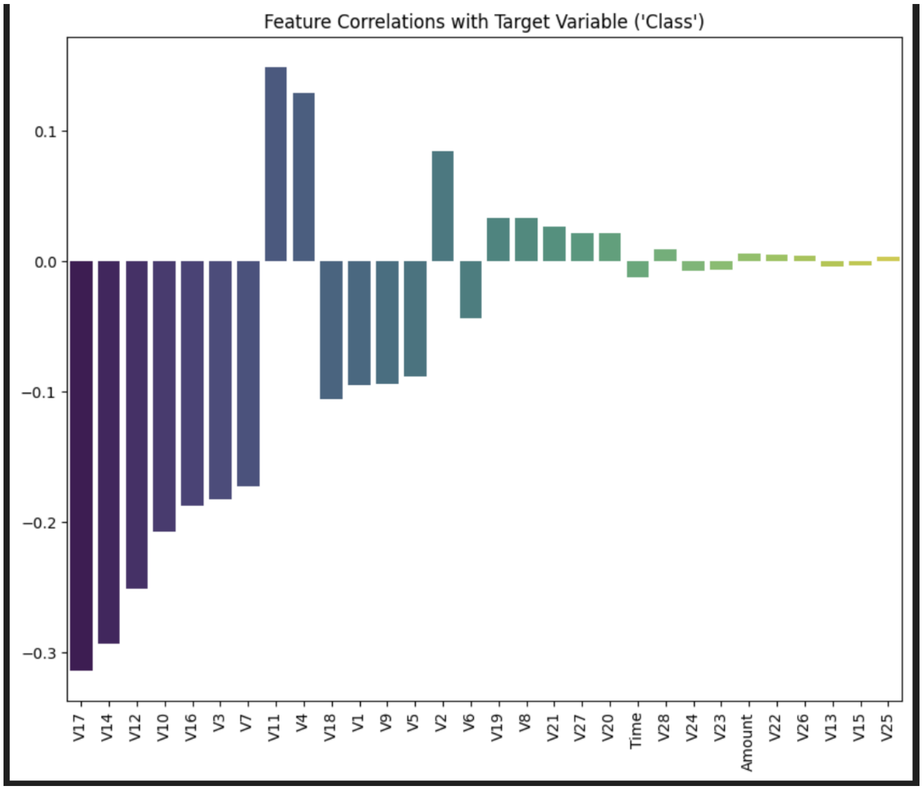


- Heatmap:



	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28	Amount	Class
Time	1.00	0.12	-0.01	-0.42	-0.11	0.17	-0.06	0.09	-0.04	-0.01	0.03	-0.25	0.13	-0.07	-0.10	-0.18	0.01	-0.07	0.09	0.03	-0.05	0.05	0.14	0.05	-0.02	-0.23	-0.04	-0.01	-0.01	-0.01	-0.01
V1	0.12	1.00	0.01	-0.01	0.00	-0.01	0.00	-0.01	-0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.02	-0.00	-0.23	-0.09
V2	-0.01	0.01	1.00	0.01	-0.00	0.01	-0.00	0.01	0.00	-0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00	0.01	0.00	-0.53	0.08
V3	-0.42	-0.01	0.01	1.00	0.00	-0.01	-0.00	-0.01	-0.00	-0.00	-0.01	0.00	-0.01	0.00	-0.00	-0.00	-0.00	-0.01	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.01	-0.00	-0.21	-0.18
V4	-0.11	0.00	-0.00	0.00	1.00	0.00	-0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.10	0.13
V5	0.17	-0.01	0.01	-0.01	0.00	1.00	-0.00	-0.01	0.00	-0.00	-0.01	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	0.00	0.00	-0.01	-0.00	-0.39	-0.09
V6	-0.06	0.00	-0.00	-0.00	-0.00	-0.00	1.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	0.22	-0.04
V7	0.09	-0.01	0.01	-0.01	0.00	-0.01	0.00	1.00	-0.01	-0.00	-0.01	0.00	-0.01	-0.00	-0.00	-0.00	-0.01	-0.01	-0.00	0.00	-0.00	0.01	-0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	0.40	-0.17
V8	-0.04	-0.00	0.00	-0.00	0.00	0.00	0.00	-0.01	1.00	0.00	0.00	0.00	-0.00	-0.00	-0.01	0.00	-0.00	-0.01	-0.00	-0.00	0.00	0.02	-0.01	0.00	0.00	0.00	-0.00	0.00	-0.00	-0.10	0.03
V9	-0.01	0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	1.00	-0.01	-0.00	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	0.01	0.01	-0.04	-0.09
V10	0.03	0.00	0.00	-0.01	0.00	-0.01	-0.00	-0.01	0.00	-0.01	1.00	0.00	-0.01	0.00	0.00	-0.00	-0.00	-0.01	-0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	0.01	0.01	-0.10	-0.21
V11	-0.25	0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	1.00	0.01	0.00	0.01	-0.00	0.00	0.01	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.15
V12	0.13	-0.00	0.00	-0.01	0.00	-0.00	-0.00	-0.01	-0.00	-0.00	-0.01	0.01	1.00	-0.00	-0.01	0.00	-0.01	-0.01	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.25
V13	-0.07	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	1.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.01	-0.00
V14	-0.10	-0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.01	0.00	0.00	0.01	-0.01	-0.00	1.00	0.00	-0.01	-0.01	-0.00	0.00	0.00	0.01	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.03	-0.29
V15	-0.18	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	1.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.00
V16	0.01	-0.00	0.00	-0.00	0.00	-0.00	0.00	-0.01	-0.00	-0.00	-0.00	0.00	-0.01	-0.00	-0.01	-0.00	1.00	-0.01	-0.01	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.19
V17	-0.07	-0.00	0.00	-0.01	0.00	-0.00	-0.00	-0.01	-0.01	-0.00	-0.01	0.01	-0.01	-0.00	-0.01	-0.00	-0.01	1.00	-0.01	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	0.01	-0.31
V18	0.09	-0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.01	1.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.04	-0.11
V19	0.03	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	1.00	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.06	0.03
V20	-0.05	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	-0.00	1.00	0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.34	0.02
V21	0.05	0.00	-0.00	0.00	-0.00	0.00	-0.00	0.01	0.02	0.00	0.00	-0.00	0.00	0.00	0.01	-0.00	0.00	0.00	0.00	0.00	0.01	1.00	0.01	-0.01	0.00	-0.00	-0.00	-0.01	-0.00	0.11	0.03
V22	0.14	-0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.01	0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.01	1.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.06	0.00
V23	0.05	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.01	0.00	1.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.11	-0.01
V24	-0.02	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	1.00	-0.00	0.00	-0.00	0.00	0.01	-0.01
V25	-0.23	-0.00	-0.00	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	1.00	0.00	-0.00	-0.00	-0.05	0.00
V26	-0.04	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	1.00	-0.00	-0.00	-0.00	0.00
V27	-0.01	-0.02	0.01	-0.01	0.00	-0.01	0.00	-0.00	0.00	0.01	0.01	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01	0.00	-0.00	-0.00	-0.00	-0.00	1.00	-0.01	0.03	0.02
V28	-0.01	-0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.01	0.01	0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.01	1.00	0.01	0.01
Amount	-0.01	-0.23	-0.53	-0.21	0.10	-0.39	0.22	0.40	-0.10	-0.04	-0.10	-0.00	-0.01	0.01	0.03	-0.00	-0.00	0.01	0.04	-0.06	0.34	0.11	-0.06	-0.11	0.01	-0.05	-0.00	0.03	0.01	1.00	0.01
Class	-0.01	-0.09	0.08	-0.18	0.13	-0.09	-0.04	-0.17	0.03	-0.09	-0.21	0.15	-0.25	-0.00	-0.29	-0.00	-0.19	-0.31	-0.11	0.03	0.02	0.03	0.00	-0.01	-0.01	0.00	0.00	0.02	0.01	0.01	1.00

- Normalization: Used standard scalar for it.
- Feature selection: Used all features as the data is highly differ for class 0 and 1.



Models:

- ISOLATION FOREST
- ONECLASS SVM
- LOCAL OUTLIER FACTOR

Evaluation metrics:

	Precision	Recall	F1-score	Accuracy	Anomalies
Isolation forest	Class 0: 1.00 Class 1: 0.20	Class 0: 1.00 Class 1: 0.21	1 and 0.21	0.99	94

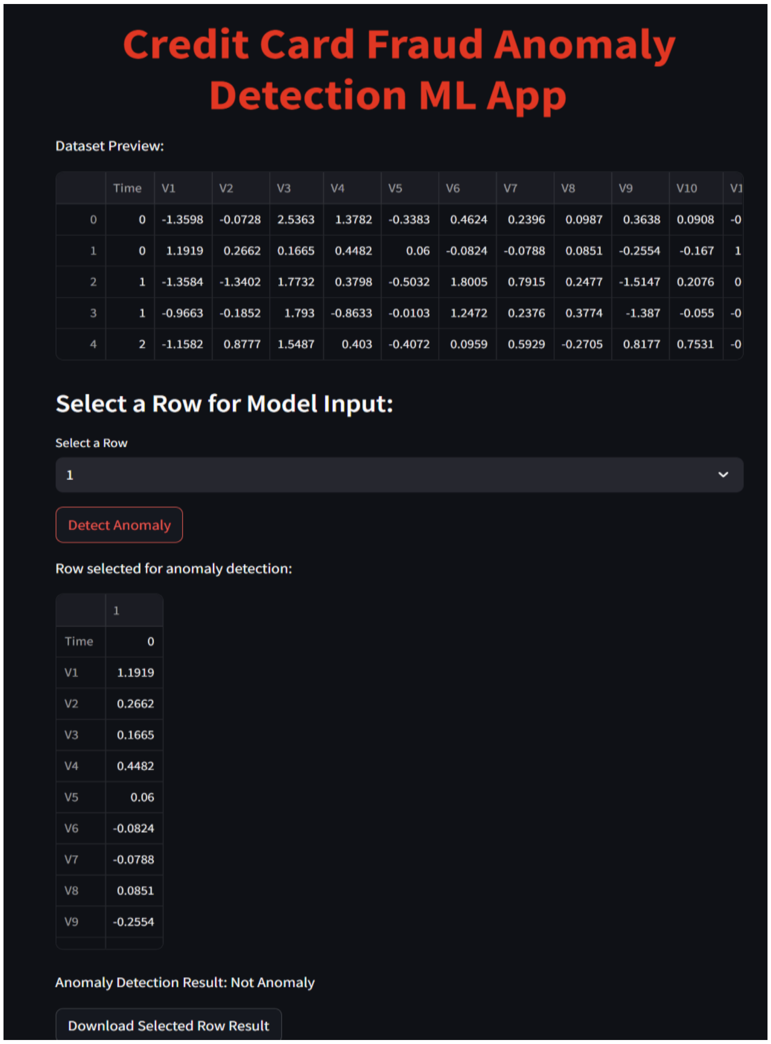
Oneclass SVM	1 and 0.06	0.99 and 0.52	0.99 and 0.11	0.99	736
LOF	1 and 0.01	o.99 and 0.06	0.99 and 0.02	0.99	568

Out of all, the Isolation Forest works well and picked for model evaluation.

Model evaluation:

Used streamlit for app creation.

Link: https://huggingface.co/spaces/saikiranmansa/CreditFraudAnomlyDetection



Credit Card Fraud Anomaly Detection ML App

Dataset Preview:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V1
0	0	-1.3598	-0.0728	2.5363	1.3782	-0.3383	0.4624	0.2396	0.0987	0.3638	0.0908	-0
1	0	1.1919	0.2662	0.1665	0.4482	0.06	-0.0824	-0.0788	0.0851	-0.2554	-0.167	1
2	1	-1.3584	-1.3402	1.7732	0.3798	-0.5032	1.8005	0.7915	0.2477	-1.5147	0.2076	0
3	1	-0.9663	-0.1852	1.793	-0.8633	-0.0103	1.2472	0.2376	0.3774	-1.387	-0.055	-0
4	2	-1.1582	0.8777	1.5487	0.403	-0.4072	0.0959	0.5929	-0.2705	0.8177	0.7531	-0

Select a Row for Model Input:

Select a Row

1

Row selected for anomaly detection:

	1
Time	0
V1	1.1919
V2	0.2662
V3	0.1665
V4	0.4482
V5	0.06
V6	-0.0824
V7	-0.0788
V8	0.0851
V9	-0.2554

Anomaly Detection Result: Not Anomaly