Importing Necessary Packages

```
import pandas as pd
import numpy as np
import matplotlib
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn import metrics
```

Data PreProcessing

```
df=pd.read_csv(r"C:\Users\Arigala.Adarsh\Downloads\creditcard.csv")

df.head()
```

```
   Time         V1         V2         V3         V4         V5         V6
V7  \
0   0.0 -1.359807 -0.072781  2.536347  1.378155 -0.338321  0.462388
0.239599
1   0.0  1.191857  0.266151  0.166480  0.448154  0.060018 -0.082361 -
0.078803
2   1.0 -1.358354 -1.340163  1.773209  0.379780 -0.503198  1.800499
0.791461
3   1.0 -0.966272 -0.185226  1.792993 -0.863291 -0.010309  1.247203
0.237609
4   2.0 -1.158233  0.877737  1.548718  0.403034 -0.407193  0.095921
0.592941

         V8         V9  ...        V21        V22        V23        V24
V25  \
0  0.098698  0.363787  ... -0.018307  0.277838 -0.110474  0.066928
0.128539
1  0.085102 -0.255425  ... -0.225775 -0.638672  0.101288 -0.339846
0.167170
2  0.247676 -1.514654  ...  0.247998  0.771679  0.909412 -0.689281 -
0.327642
3  0.377436 -1.387024  ... -0.108300  0.005274 -0.190321 -1.175575
0.647376
4 -0.270533  0.817739  ... -0.009431  0.798278 -0.137458  0.141267 -
0.206010

         V26        V27        V28  Amount  Class
0 -0.189115  0.133558 -0.021053  149.62      0
1  0.125895 -0.008983  0.014724    2.69      0
```

```
2 -0.139097 -0.055353 -0.059752  378.66      0
3 -0.221929  0.062723  0.061458  123.50      0
4  0.502292  0.219422  0.215153   69.99      0

[5 rows x 31 columns]
```

```
df.shape
```

```
(284807, 31)
```

```
df.columns
```

```
Index(['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'],
      dtype='object')
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284807 entries, 0 to 284806
Data columns (total 31 columns):
 #   Column  Non-Null Count   Dtype
---  ------  --------------   -----
 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
 20  V20     284807 non-null  float64
 21  V21     284807 non-null  float64
 22  V22     284807 non-null  float64
```

```
 23  V23     284807 non-null  float64
 24  V24     284807 non-null  float64
 25  V25     284807 non-null  float64
 26  V26     284807 non-null  float64
 27  V27     284807 non-null  float64
 28  V28     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
```

```
df.isnull().sum()
```

```
Time      0
V1        0
V2        0
V3        0
V4        0
V5        0
V6        0
V7        0
V8        0
V9        0
V10       0
V11       0
V12       0
V13       0
V14       0
V15       0
V16       0
V17       0
V18       0
V19       0
V20       0
V21       0
V22       0
V23       0
V24       0
V25       0
V26       0
V27       0
V28       0
Amount    0
Class     0
dtype: int64
```

```
df.describe()
```

```
                Time             V1             V2             V3
V4  \
```

```
count  284807.000000  2.848070e+05  2.848070e+05  2.848070e+05
2.848070e+05
mean    94813.859575  3.918649e-15  5.682686e-16 -8.761736e-15
2.811118e-15
std     47488.145955  1.958696e+00  1.651309e+00  1.516255e+00
1.415869e+00
min         0.000000 -5.640751e+01 -7.271573e+01 -4.832559e+01 -
5.683171e+00
25%     54201.500000 -9.203734e-01 -5.985499e-01 -8.903648e-01 -
8.486401e-01
50%     84692.000000  1.810880e-02  6.548556e-02  1.798463e-01 -
1.984653e-02
75%    139320.500000  1.315642e+00  8.037239e-01  1.027196e+00
7.433413e-01
max    172792.000000  2.454930e+00  2.205773e+01  9.382558e+00
1.687534e+01

                 V5            V6            V7            V8
V9  \
count  2.848070e+05  2.848070e+05  2.848070e+05  2.848070e+05
2.848070e+05
mean  -1.552103e-15  2.040130e-15 -1.698953e-15 -1.893285e-16 -
3.147640e-15
std    1.380247e+00  1.332271e+00  1.237094e+00  1.194353e+00
1.098632e+00
min   -1.137433e+02 -2.616051e+01 -4.355724e+01 -7.321672e+01 -
1.343407e+01
25%   -6.915971e-01 -7.682956e-01 -5.540759e-01 -2.086297e-01 -
6.430976e-01
50%   -5.433583e-02 -2.741871e-01  4.010308e-02  2.235804e-02 -
5.142873e-02
75%    6.119264e-01  3.985649e-01  5.704361e-01  3.273459e-01
5.971390e-01
max    3.480167e+01  7.330163e+01  1.205895e+02  2.000721e+01
1.559499e+01

       ...           V21           V22           V23           V24  \
count  ...  2.848070e+05  2.848070e+05  2.848070e+05  2.848070e+05
mean   ...  1.473120e-16  8.042109e-16  5.282512e-16  4.456271e-15
std    ...  7.345240e-01  7.257016e-01  6.244603e-01  6.056471e-01
min    ... -3.483038e+01 -1.093314e+01 -4.480774e+01 -2.836627e+00
25%    ... -2.283949e-01 -5.423504e-01 -1.618463e-01 -3.545861e-01
50%    ... -2.945017e-02  6.781943e-03 -1.119293e-02  4.097606e-02
75%    ...  1.863772e-01  5.285536e-01  1.476421e-01  4.395266e-01
max    ...  2.720284e+01  1.050309e+01  2.252841e+01  4.584549e+00

                V25           V26           V27           V28
Amount  \
count  2.848070e+05  2.848070e+05  2.848070e+05  2.848070e+05
284807.000000
```

```
mean   1.426896e-15  1.701640e-15 -3.662252e-16 -1.217809e-16
88.349619
std    5.212781e-01  4.822270e-01  4.036325e-01  3.300833e-01
250.120109
min   -1.029540e+01 -2.604551e+00 -2.256568e+01 -1.543008e+01
0.000000
25%   -3.171451e-01 -3.269839e-01 -7.083953e-02 -5.295979e-02
5.600000
50%    1.659350e-02 -5.213911e-02  1.342146e-03  1.124383e-02
22.000000
75%    3.507156e-01  2.409522e-01  9.104512e-02  7.827995e-02
77.165000
max    7.519589e+00  3.517346e+00  3.161220e+01  3.384781e+01
25691.160000

               Class
count  284807.000000
mean        0.001727
std         0.041527
min         0.000000
25%         0.000000
50%         0.000000
75%         0.000000
max         1.000000

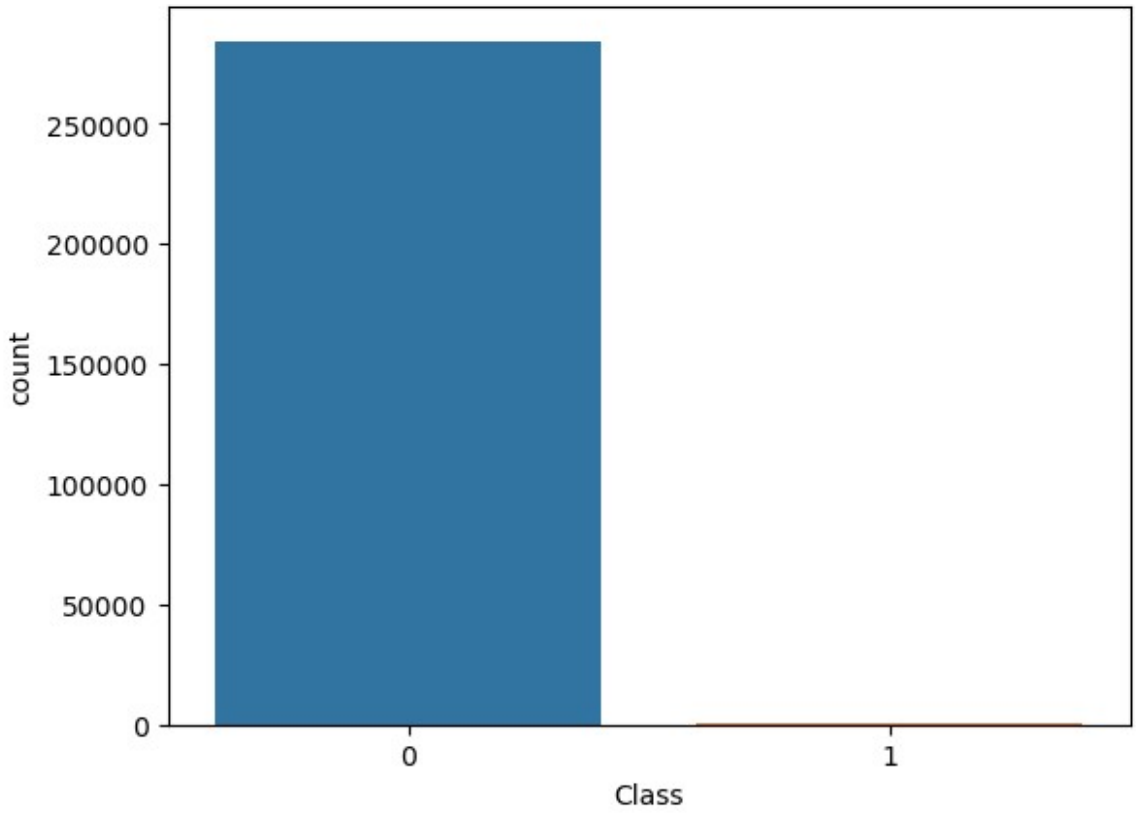
[8 rows x 31 columns]
```

```
df.Class.unique()
```

```
array([0, 1], dtype=int64)
```

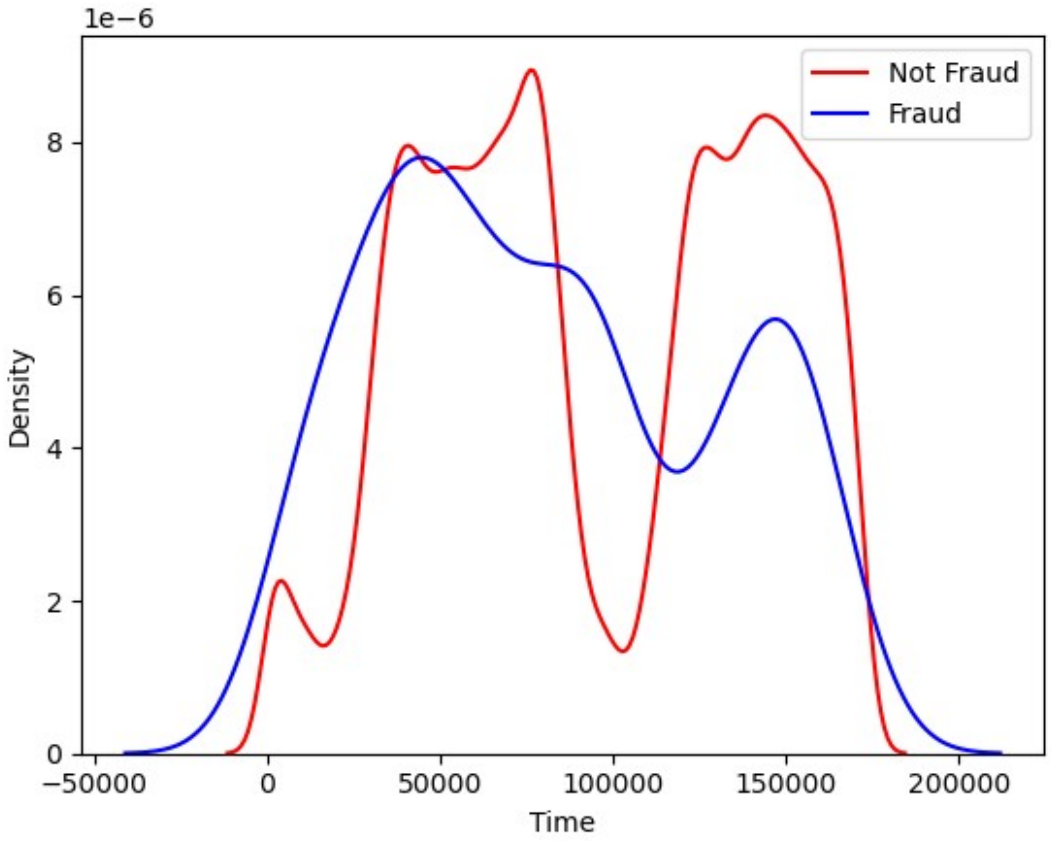
```
sns.countplot(df.Class)
plt.show()
```

```
C:\Users\Arigala.Adarsh\anaconda3\lib\site-packages\seaborn\
_decorators.py:36: FutureWarning: Pass the following variable as a
keyword arg: x. From version 0.12, the only valid positional argument
will be `data`, and passing other arguments without an explicit
keyword will result in an error or misinterpretation.
  warnings.warn(
```




```
class_0 = df.loc[df['Class'] == 0]["Time"]
class_1 = df.loc[df['Class'] == 1]["Time"]
sns.distplot(class_0,hist=False,color="red",label="Not Fraud")
sns.distplot(class_1,hist=False,color="blue",label="Fraud")
plt.legend()
plt.show()
```

```
C:\Users\Arigala.Adarsh\anaconda3\lib\site-packages\seaborn\
distributions.py:2619: FutureWarning: `distplot` is a deprecated
function and will be removed in a future version. Please adapt your
code to use either `displot` (a figure-level function with similar
flexibility) or `kdeplot` (an axes-level function for kernel density
plots).
  warnings.warn(msg, FutureWarning)
C:\Users\Arigala.Adarsh\anaconda3\lib\site-packages\seaborn\
distributions.py:2619: FutureWarning: `distplot` is a deprecated
function and will be removed in a future version. Please adapt your
code to use either `displot` (a figure-level function with similar
flexibility) or `kdeplot` (an axes-level function for kernel density
plots).
  warnings.warn(msg, FutureWarning)
```




```
df.describe().T
```

	count	mean	std	min	25%
Time	284807.0	9.481386e+04	47488.145955	0.000000	54201.500000
V1	284807.0	3.918649e-15	1.958696	-56.407510	-0.920373
V2	284807.0	5.682686e-16	1.651309	-72.715728	-0.598550
V3	284807.0	-8.761736e-15	1.516255	-48.325589	-0.890365
V4	284807.0	2.811118e-15	1.415869	-5.683171	-0.848640
V5	284807.0	-1.552103e-15	1.380247	-113.743307	-0.691597
V6	284807.0	2.040130e-15	1.332271	-26.160506	-0.768296
V7	284807.0	-1.698953e-15	1.237094	-43.557242	-0.554076
V8	284807.0	-1.893285e-16	1.194353	-73.216718	-0.208630
V9	284807.0	-3.147640e-15	1.098632	-13.434066	-0.643098

V10	284807.0	1.772925e-15	1.088850	-24.588262	-0.535426
V11	284807.0	9.289524e-16	1.020713	-4.797473	-0.762494
V12	284807.0	-1.803266e-15	0.999201	-18.683715	-0.405571
V13	284807.0	1.674888e-15	0.995274	-5.791881	-0.648539
V14	284807.0	1.475621e-15	0.958596	-19.214325	-0.425574
V15	284807.0	3.501098e-15	0.915316	-4.498945	-0.582884
V16	284807.0	1.392460e-15	0.876253	-14.129855	-0.468037
V17	284807.0	-7.466538e-16	0.849337	-25.162799	-0.483748
V18	284807.0	4.258754e-16	0.838176	-9.498746	-0.498850
V19	284807.0	9.019919e-16	0.814041	-7.213527	-0.456299
V20	284807.0	5.126845e-16	0.770925	-54.497720	-0.211721
V21	284807.0	1.473120e-16	0.734524	-34.830382	-0.228395
V22	284807.0	8.042109e-16	0.725702	-10.933144	-0.542350
V23	284807.0	5.282512e-16	0.624460	-44.807735	-0.161846
V24	284807.0	4.456271e-15	0.605647	-2.836627	-0.354586
V25	284807.0	1.426896e-15	0.521278	-10.295397	-0.317145
V26	284807.0	1.701640e-15	0.482227	-2.604551	-0.326984
V27	284807.0	-3.662252e-16	0.403632	-22.565679	-0.070840
V28	284807.0	-1.217809e-16	0.330083	-15.430084	-0.052960
Amount	284807.0	8.834962e+01	250.120109	0.000000	5.600000
Class	284807.0	1.727486e-03	0.041527	0.000000	0.000000

	50%	75%	max
Time	84692.000000	139320.500000	172792.000000
V1	0.018109	1.315642	2.454930
V2	0.065486	0.803724	22.057729
V3	0.179846	1.027196	9.382558
V4	-0.019847	0.743341	16.875344
V5	-0.054336	0.611926	34.801666
V6	-0.274187	0.398565	73.301626

```
V7          0.040103       0.570436     120.589494
V8          0.022358       0.327346      20.007208
V9         -0.051429       0.597139      15.594995
V10        -0.092917       0.453923      23.745136
V11        -0.032757       0.739593      12.018913
V12         0.140033       0.618238       7.848392
V13        -0.013568       0.662505       7.126883
V14         0.050601       0.493150      10.526766
V15         0.048072       0.648821       8.877742
V16         0.066413       0.523296      17.315112
V17        -0.065676       0.399675       9.253526
V18        -0.003636       0.500807       5.041069
V19         0.003735       0.458949       5.591971
V20        -0.062481       0.133041      39.420904
V21        -0.029450       0.186377      27.202839
V22         0.006782       0.528554      10.503090
V23        -0.011193       0.147642      22.528412
V24         0.040976       0.439527       4.584549
V25         0.016594       0.350716       7.519589
V26        -0.052139       0.240952       3.517346
V27         0.001342       0.091045      31.612198
V28         0.011244       0.078280      33.847808
Amount     22.000000      77.165000   25691.160000
Class       0.000000       0.000000       1.000000
```

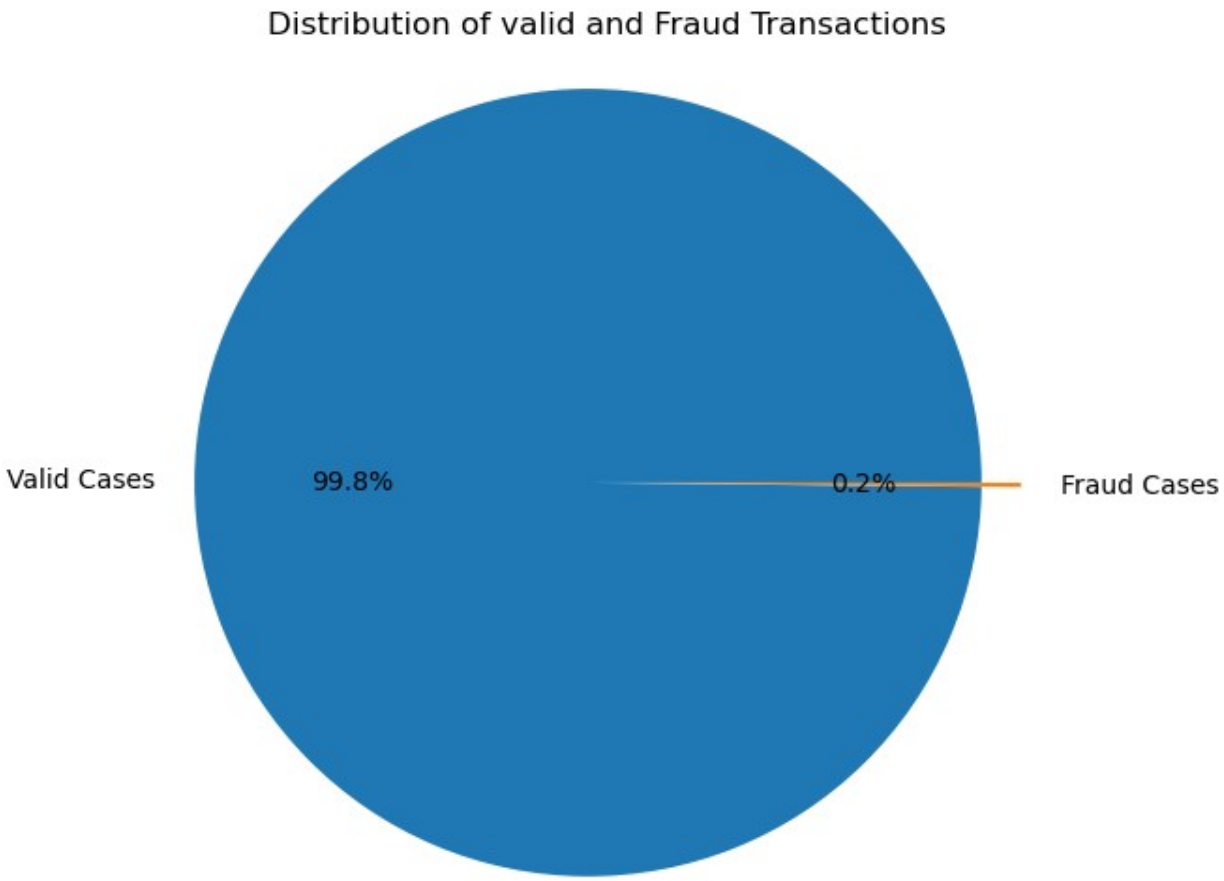
```
Fraud_class=df[df["Class"]==1]
Valid_class=df[df["Class"]==0]
fraction=len(Fraud_class)/len(Valid_class)


percentage=fraction*100
percentage
```

```
0.17304750013189596
```

only 0.17% transactions are fradulent

```
valid_cases=len(Valid_class)
fraud_cases=len(Fraud_class)
labels=['Valid Cases',"Fraud Cases"]
counts=[valid_cases,fraud_cases]
explode=(0,0.1)
plt.figure(figsize=(8,6))
plt.pie(counts,labels=labels,explode=explode,autopct='%1.1f%%')
plt.axis('equal')
plt.title('Distribution of valid and Fraud Transactions')
plt.show()
```



Amount of Transactions

```
#About Fraud-case Amount
Fraud_class.Amount.describe().T
```

```
count     492.000000
mean      122.211321
std       256.683288
min         0.000000
25%         1.000000
50%         9.250000
75%       105.890000
max      2125.870000
Name: Amount, dtype: float64
```

```
#About Valid-case Amount
Valid_class.Amount.describe().T
```

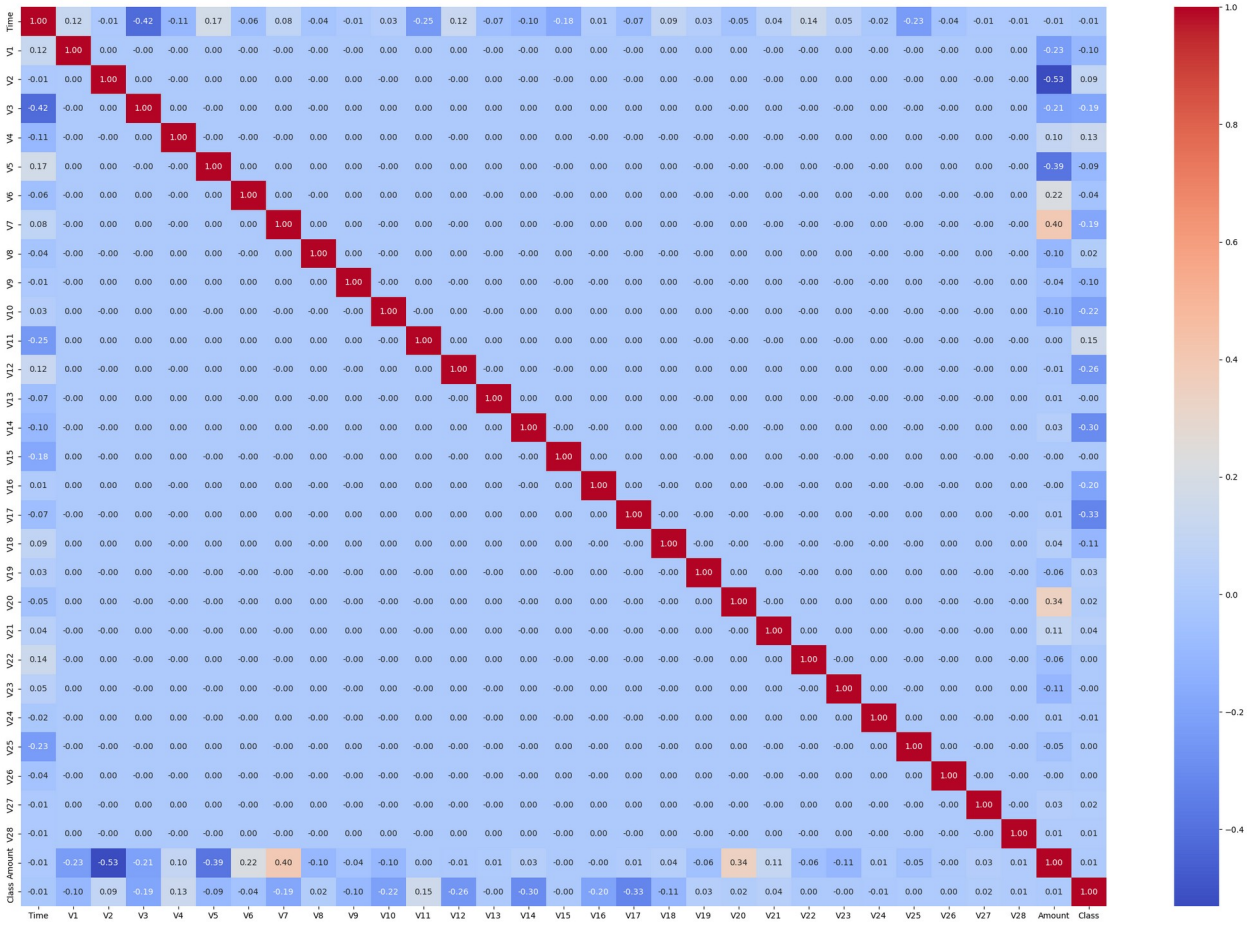
```
count    284315.000000
mean         88.291022
```

```
std          250.105092
min            0.000000
25%            5.650000
50%           22.000000
75%           77.050000
max        25691.160000
Name: Amount, dtype: float64
```

```
df.dtypes
```

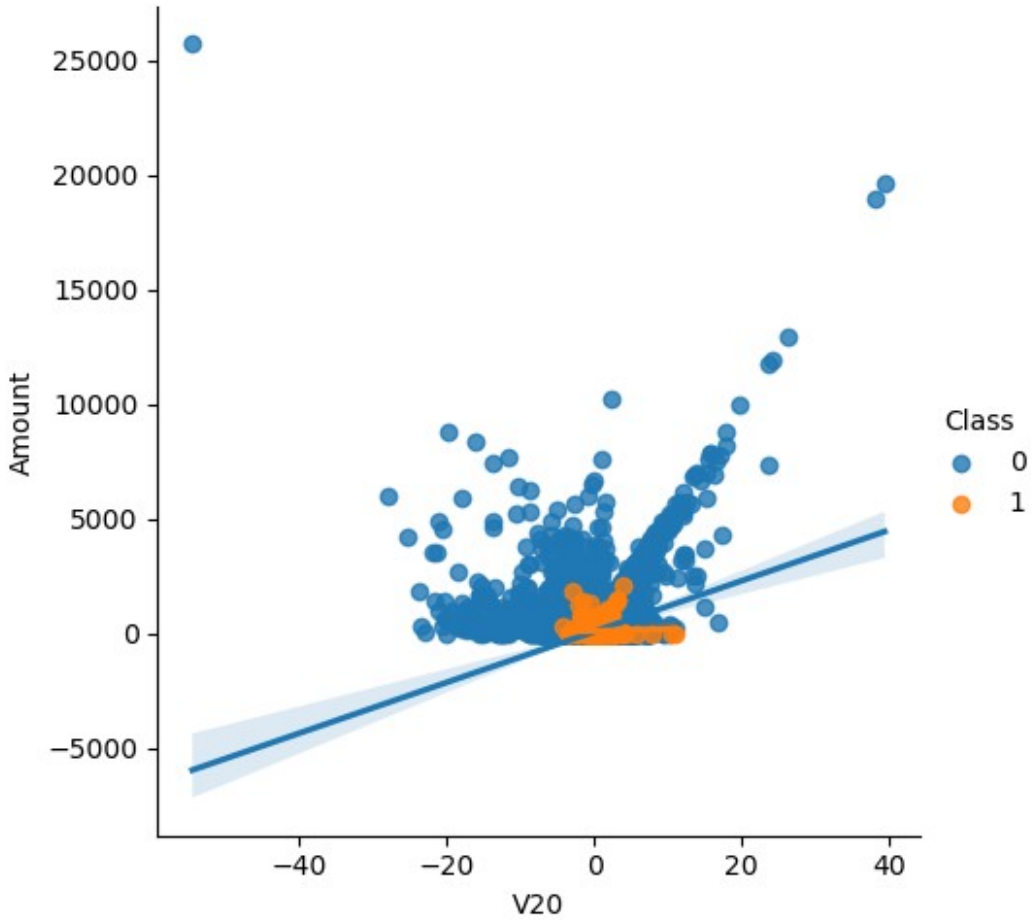
```
Time      float64
V1        float64
V2        float64
V3        float64
V4        float64
V5        float64
V6        float64
V7        float64
V8        float64
V9        float64
V10       float64
V11       float64
V12       float64
V13       float64
V14       float64
V15       float64
V16       float64
V17       float64
V18       float64
V19       float64
V20       float64
V21       float64
V22       float64
V23       float64
V24       float64
V25       float64
V26       float64
V27       float64
V28       float64
Amount    float64
Class       int64
dtype: object
```

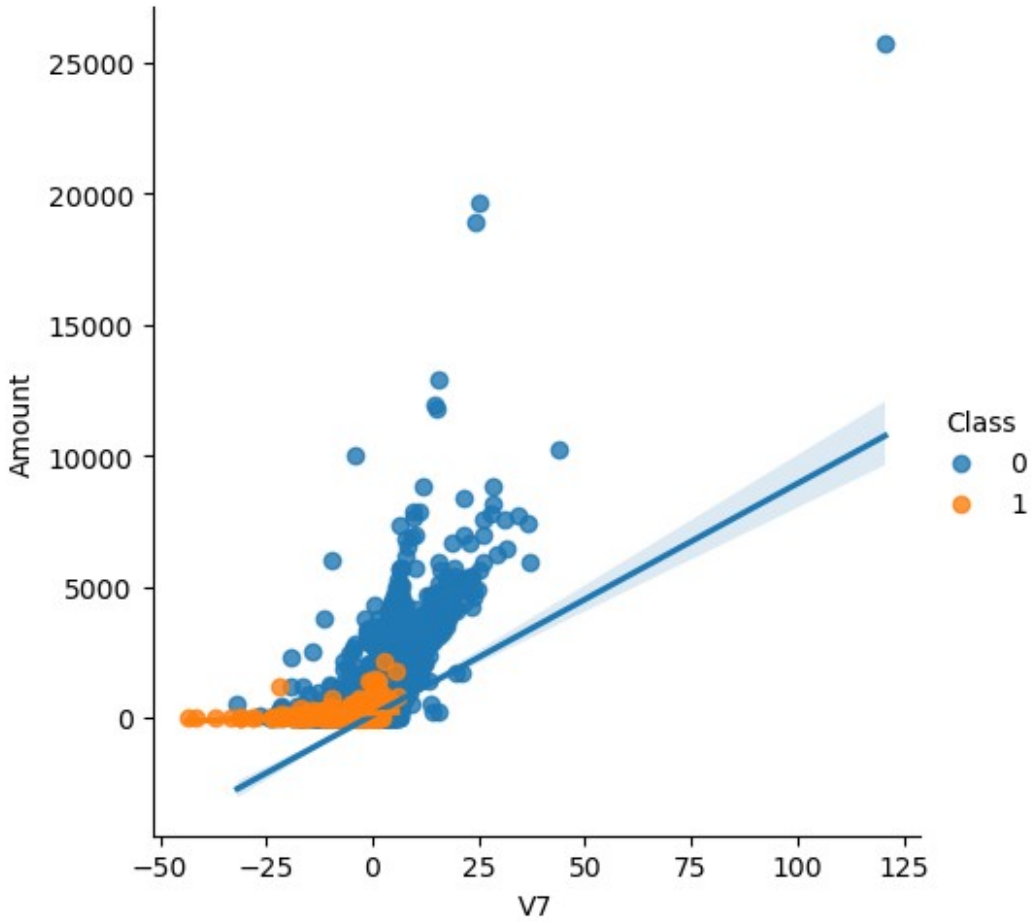
```
plt.figure(figsize=(30,20))
sns.heatmap(df.corr(),annot=True,fmt=".2f",cmap="coolwarm")
plt.show()
```



As expected, there is no notable correlation between features V1-V28. There are certain correlations between some of these features and Time (inverse correlation with V3) and Amount (direct correlation with V7 and V20, inverse correlation with V1 and V5)

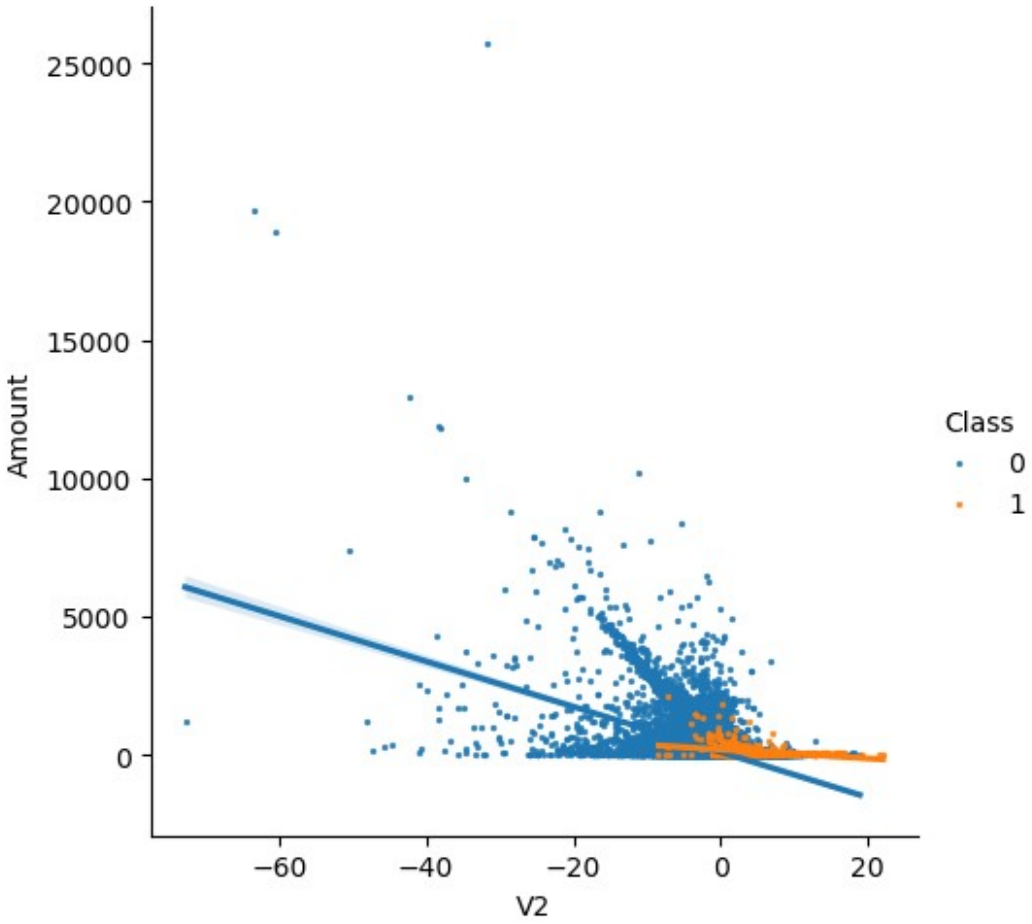
```
s = sns.lmplot(x='V20', y='Amount',data=df, hue='Class',fit_reg=True)
s = sns.lmplot(x='V7', y='Amount',data=df, hue='Class', fit_reg=True)
plt.show()
```

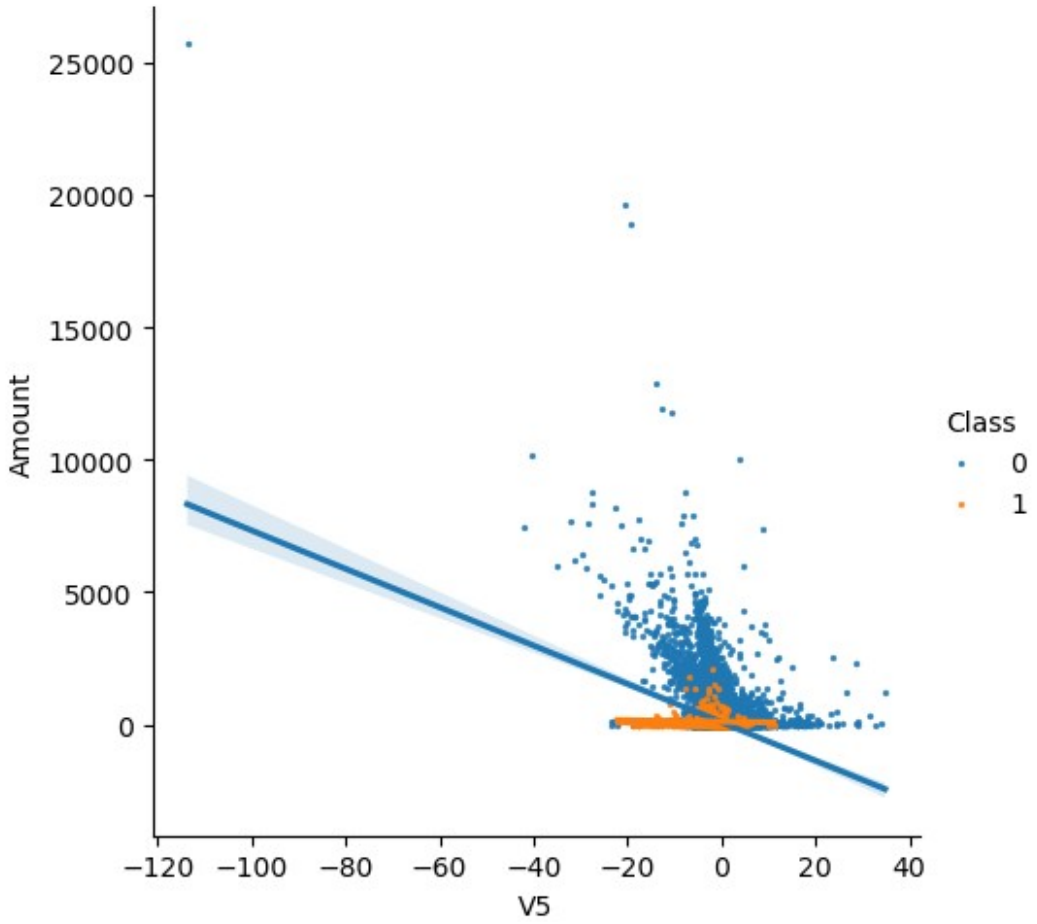

25000
20000
15000
10000
5000
0
−5000
Amount
−40
−20
0
20
40
V20
Class
0
1



We can confirm that the two couples of features are correlated (the regression lines for Class = 0 have a positive slope, whilst the regression line for Class = 1 have a smaller positive slope

```
s = sns.lmplot(x='V2', y='Amount',data=df, hue='Class',
fit_reg=True,scatter_kws={'s':2})
s = sns.lmplot(x='V5', y='Amount',data=df, hue='Class',
fit_reg=True,scatter_kws={'s':2})
plt.show()
```


25000
20000
15000
10000
5000
0
Amount
−60
−40
−20
0
20
V2
Class
0
1



We can confirm that the two couples of features are inverse correlated (the regression lines for Class = 0 have a negative slope while the regression lines for Class = 1 have a very small negative slope).

```
t0 = df.loc[df['Class'] == 0]
t1 = df.loc[df['Class'] == 1]
i = 0

sns.set_style('whitegrid')
plt.figure()
fig, ax = plt.subplots(8,4,figsize=(16,28))

for feature in df.columns:
    i += 1
    plt.subplot(8,4,i)
    sns.kdeplot(t0[feature], bw=0.5,label="Class = 0")
    sns.kdeplot(t1[feature], bw=0.5,label="Class = 1")
    plt.xlabel(feature, fontsize=12)
plt.tight_layout()
plt.show();
```

```
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distributions.py:316: UserWarning: Dataset has 0 variance; skipping
density estimate. Pass `warn_singular=False` to disable this warning.
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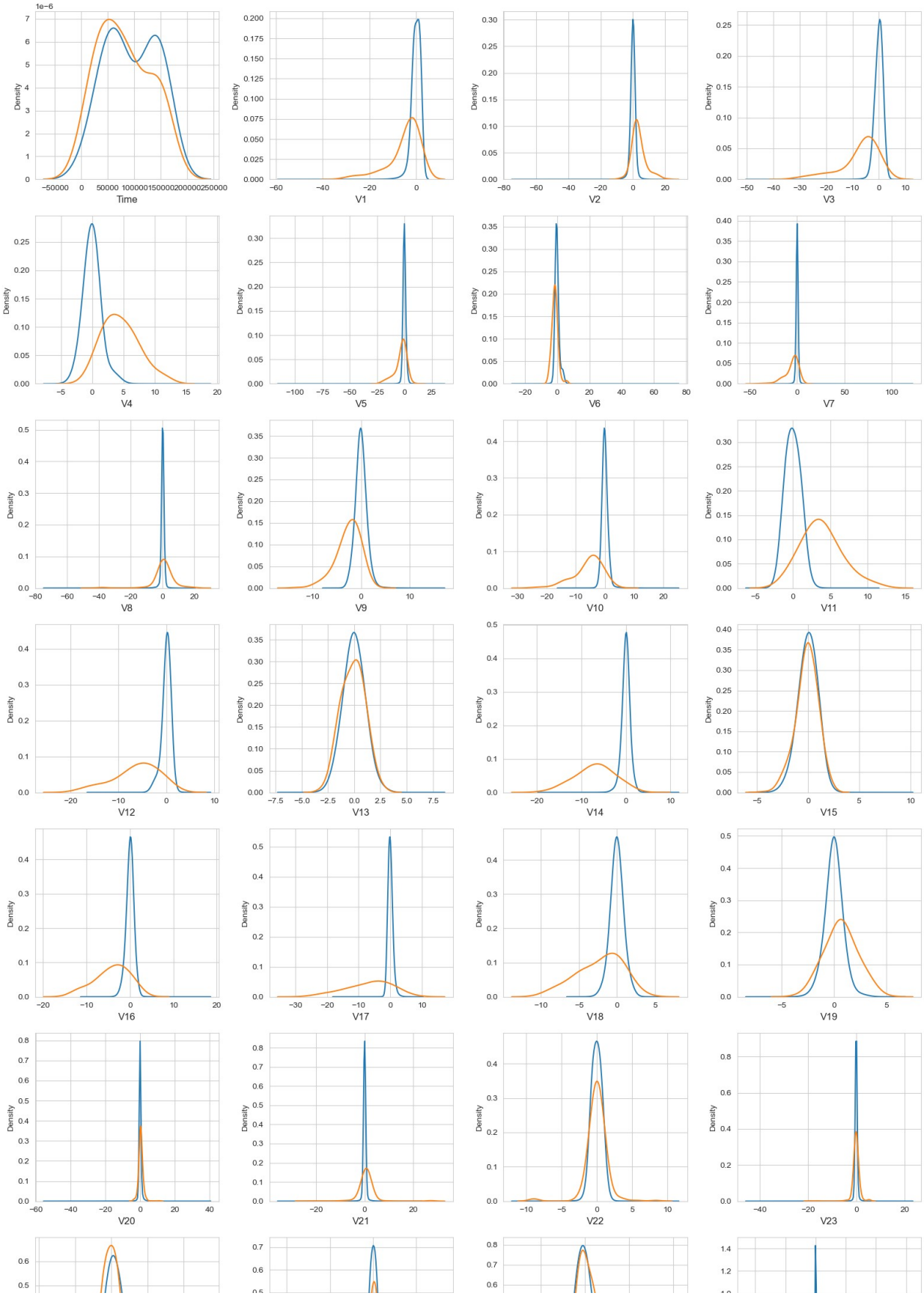
<Figure size 640x480 with 0 Axes>
```


1e−6
Density
Time
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
V16
V17
V18
V19
V20
V21
V22
V23

Segregation of Data(Independent and Dependent)

```
x=df.drop('Class',axis=1)
y=df['Class']
```

Spliting the Dataset into Train dataset and Test Dataset

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.2,rando
m_state=3)
```

Choose the Model

```
random_model=RandomForestClassifier()

 random_model.fit(x_train,y_train)

RandomForestClassifier()

pred=random_model.predict(x_test)

pred

array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

Evolution of the Model

```
print(metrics.accuracy_score(y_test,pred))

0.9994382219725431

print(metrics.f1_score(y_test,pred))

0.8222222222222222

print(metrics.recall_score(y_test,pred))

0.74

print(metrics.classification_report(y_test,pred))

              precision    recall  f1-score   support

           0       1.00      1.00      1.00     56862
```

```
           1       0.93      0.74      0.82       100

    accuracy                           1.00     56962
   macro avg       0.96      0.87      0.91     56962
weighted avg       1.00      1.00      1.00     56962
```

```
sns.distplot(y_test,hist=False,color='red')
sns.distplot(pred,hist=False,color="blue")
plt.show()
```

```
C:\Users\Arigala.Adarsh\anaconda3\lib\site-packages\seaborn\
distributions.py:2619: FutureWarning: `distplot` is a deprecated
function and will be removed in a future version. Please adapt your
code to use either `displot` (a figure-level function with similar
flexibility) or `kdeplot` (an axes-level function for kernel density
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