Credit Card Fraud Detection

Detecting credit card fraud is a critical application of applied data science. To iovate and improve a credit card fraud detection project, you can follow these steps

1. **Data Collection:**
   - Gather comprehensive transaction data, including both legitimate and fraudulent transactions.
   - Obtain historical data that represents different patterns of transactions.

2. Data Preprocessing:
   - Clean and preprocess the data to handle missing values, outliers, and noise.
   - Normalize or standardize features to ensure consistency.

3**. Feature Engineering**:
   - Create relevant features from the data that can help the model differentiate between legitimate and fraudulent transactions.
   - Consider using techniques like PCA (Principal Component Analysis) to reduce dimensionality.

4. Data Split:
   - Divide the data into training, validation, and test sets to evaluate your model's performance accurately.

5. Model Selection and Development:
   - Explore various machine learning algorithms, such as logistic regression, decision trees, random forests, and neural networks.
   - Experiment with ensemble methods and deep learning architectures for improved accuracy.

6. Hyperparameter Tuning:
   - Fine-tune the hyperparameters of your chosen models to optimize their performance.
   - Use techniques like grid search or random search to identify the best hyperparameters.

7. Imbalanced Data Handling:
   - Since fraud cases are typically rare, employ techniques like oversampling, undersampling, or synthetic data generation (SMOTE) to address class imbalance.

8. Evaluation Metrics:
- Use appropriate evaluation metrics like precision, recall, F1-score, and AUC-ROC to assess model performance.
- Consider the business impact of false positives and false negatives when setting thresholds.

9. Cross-Validation:
- Implement cross-validation to assess the model's generalization ability and mitigate overfitting.

10. Real-time Monitoring:
- Deploy the model in a real-time environment where it can continuously monitor and detect fraudulent transactions.

11. Anomaly Detection:
- Combine traditional supervised learning with unsupervised anomaly detection methods, such as isolation forests, to identify novel fraud patterns.

12. Explainability:
- Ensure that your model provides interpretable explanations for its predictions, which can be crucial for regulatory compliance and trust.

13. Continuous Learning:
- Continuously update and retrain your model as new data becomes available to adapt to evolving fraud patterns.

14. Collaboration:
- Work closely with domain experts, risk analysts, and fraud investigators to gain insights and improve model accuracy.

15. Security:
- Implement robust security measures to protect sensitive transaction data and the model itself from potential attacks.

16. Regulatory Compliance:
- Ensure that your project complies with relevant data protection and financial industry regulations, such as GDPR and PCI DSS.

17. Documentation:

- Maintain thorough documentation of the project, including data sources, preprocessing steps, model architecture, and results.

18. Ethical Considerations:

- Address ethical concerns related to data privacy and fairness, and implement safeguards against bias and discrimination.

19. Reporting:

- Generate regular reports and alerts for relevant stakeholders, including financial institutions, about detected fraud incidents and model performance.

20. User Education:

- Educate users and customers about best practices for securing their credit cards and recognizing potential fraud.in credit card fraud detection requires a combination of advanced machine learning techniques, domain expertise, and a commitment to staying up-to-date with evolving fraud tactics and data security practices.

Exploratory Analysis

To begin this exploratory analysis, first use `matplotlib` to import libraries and define functions for plotting the data. Depending on the data, not all plots will be made.

```
from mpl_toolkits.mplot3d import Axes3D
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt # plotting
import numpy as np # linear algebra
import os # accessing directory structure
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
```

There is 1 csv file in the current version of the dataset:

In [2]:

```
print(os.listdir('../input'))
```

```
['creditcard.csv']
```

linkcode

The next hidden code cells define functions for plotting data. Click on the "Code" button in the published kernel to reveal the hidden code.

```
Distribution graphs (histogram/bar graph) of column data
def plotPerColumnDistribution(df, nGraphShown, nGraphPerRow):
    nunique = df.nunique()
    df = df[[col for col in df if nunique[col] > 1 and nunique[col] < 5
0]] # For displaying purposes, pick columns that have between 1 and 50 un
ique values
    nRow, nCol = df.shape
    columnNames = list(df)
    nGraphRow = (nCol + nGraphPerRow - 1) / nGraphPerRow
    plt.figure(num = None, figsize = (6 * nGraphPerRow, 8 * nGraphRow),
dpi = 80, facecolor = 'w', edgecolor = 'k')
    for i in range(min(nCol, nGraphShown)):
        plt.subplot(nGraphRow, nGraphPerRow, i + 1)
        columnDf = df.iloc[:, i]
        if (not np.issubdtype(type(columnDf.iloc[0]), np.number)):
            valueCounts = columnDf.value_counts()
            valueCounts.plot.bar()
        else:
            columnDf.hist()
        plt.ylabel('counts')
        plt.xticks(rotation = 90)
        plt.title(f'{columnNames[i]} (column {i})')
    plt.tight_layout(pad = 1.0, w_pad = 1.0, h_pad = 1.0)
    plt.show()
```

```
Correlation matrix
def plotCorrelationMatrix(df, graphWidth):
    filename = df.dataframeName
    df = df.dropna('columns') # drop columns with NaN
    df = df[[col for col in df if df[col].nunique() > 1]] # keep column
s where there are more than 1 unique values
    if df.shape[1] < 2:
        print(f'No correlation plots shown: The number of non-NaN or co
nstant columns ({df.shape[1]}) is less than 2')
        return
    corr = df.corr()
    plt.figure(num=None, figsize=(graphWidth, graphWidth), dpi=80, face
color='w', edgecolor='k')
    corrMat = plt.matshow(corr, fignum = 1)
    plt.xticks(range(len(corr.columns)), corr.columns, rotation=90)
    plt.yticks(range(len(corr.columns)), corr.columns)
    plt.gca().xaxis.tick_bottom()
    plt.colorbar(corrMat)
    plt.title(f'Correlation Matrix for {filename}', fontsize=15)
    plt.show()
# Scatter and density plots
def plotScatterMatrix(df, plotSize, textSize):
    df = df.select_dtypes(include =[np.number]) # keep only numerical co
lumns
```

```
    # Remove rows and columns that would lead to df being singular
    df = df.dropna('columns')
    df = df[[col for col in df if df[col].nunique() > 1]] # keep column
s where there are more than 1 unique values
    columnNames = list(df)
    if len(columnNames) > 10: # reduce the number of columns for matrix
inversion of kernel density plots
        columnNames = columnNames[:10]
    df = df[columnNames]
    ax = pd.plotting.scatter_matrix(df, alpha=0.75, figsize=[plotSize,
plotSize], diagonal='kde')
    corrs = df.corr().values
    for i, j in zip(*plt.np.triu_indices_from(ax, k = 1)):
        ax[i, j].annotate('Corr. coef = %.3f' % corrs[i, j], (0.8, 0.2)
, xycoords='axes fraction', ha='center', va='center', size=textSize)
    plt.suptitle('Scatter and Density Plot')
    plt.show()
```

Now you're ready to read in the data and use the plotting functions to visualize the data.

Let's check 1st file: ../input/creditcard.csv

In [6]:

```
nRowsRead = 1000 # specify 'None' if want to read whole file
# creditcard.csv has 284807 rows in reality, but we are only loading/preview
ing the first 1000 rows
df1 = pd.read_csv('../input/creditcard.csv', delimiter=',', nrows = nRowsRe
ad)
df1.dataframeName = 'creditcard.csv'
nRow, nCol = df1.shape
print(f'There are {nRow} rows and {nCol} columns')
There are 1000 rows and 31 columns
```

linkcode

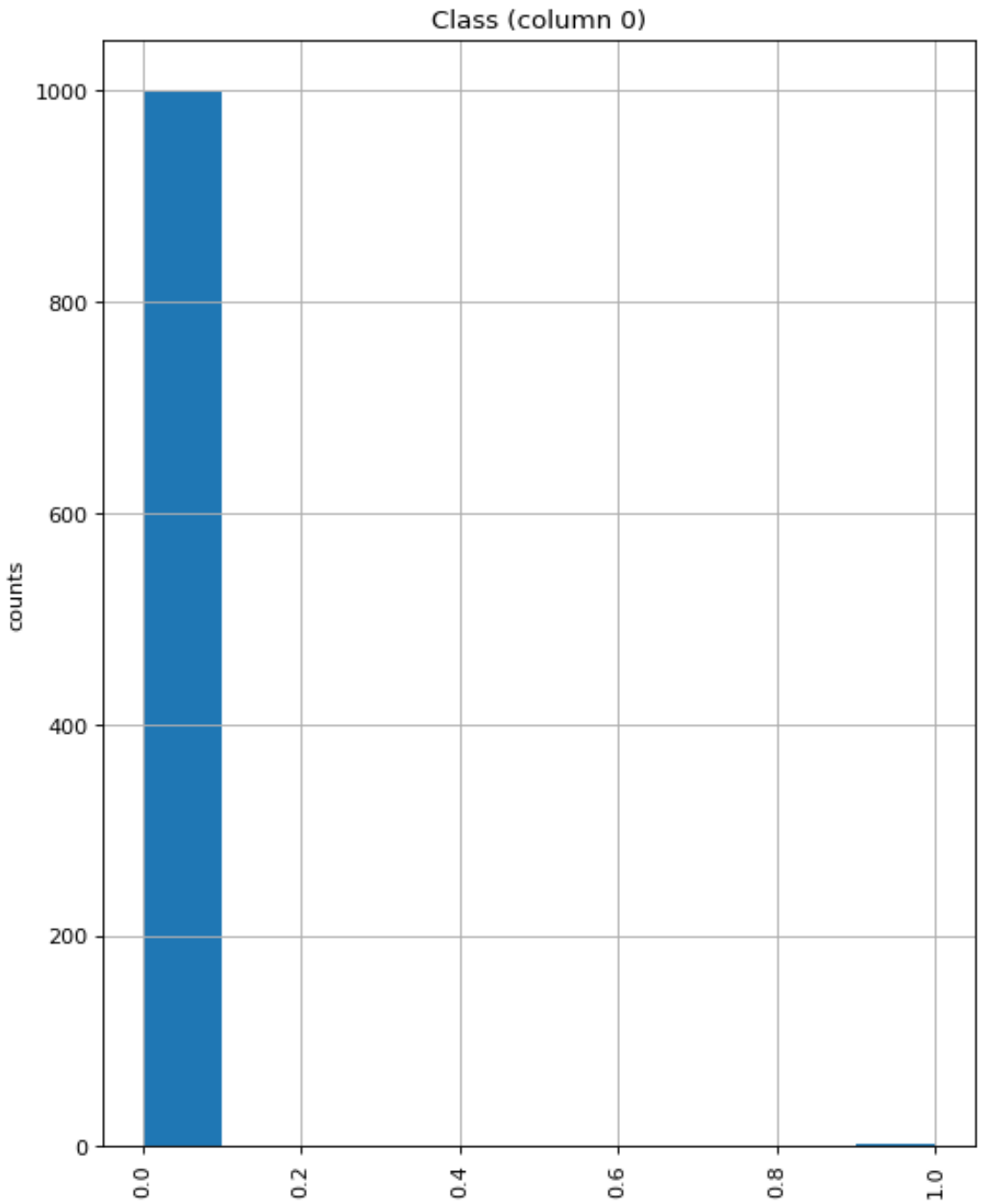
Let's take a quick look at what the data looks like:

```
df1.head(5) df1.head(5)
```

https://www.kaggle.com/code/varnika777/starter-credit-card-fraud-detection-2cb0c438-f?scriptVersionId=11343240&cellId=14

Distribution graphs (histogram/bar graph) of sampled columns:

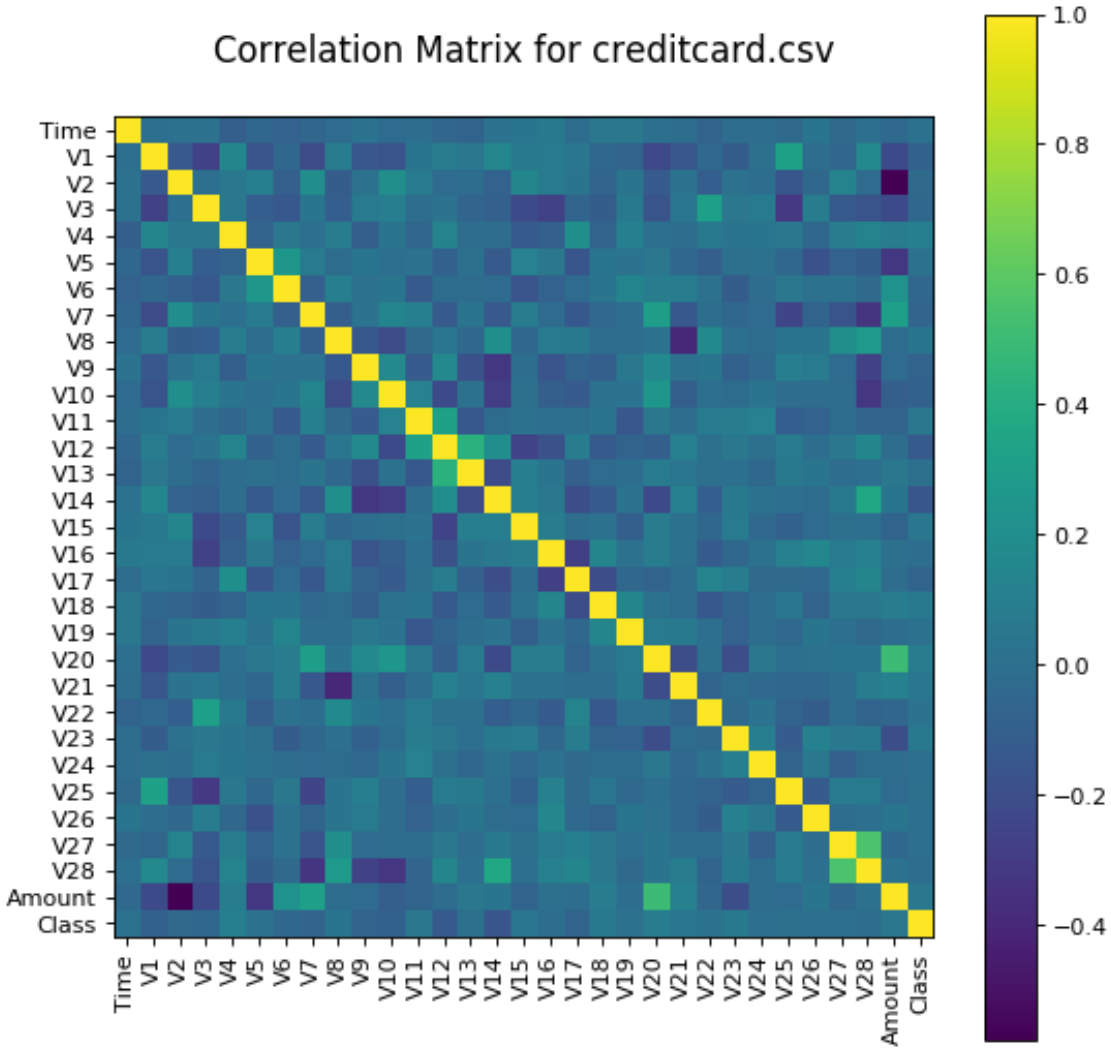
In [8]:



Correlation matrix:

In [9]:

```
linkcode
plotCorrelationMatrix(df1, 8)
```

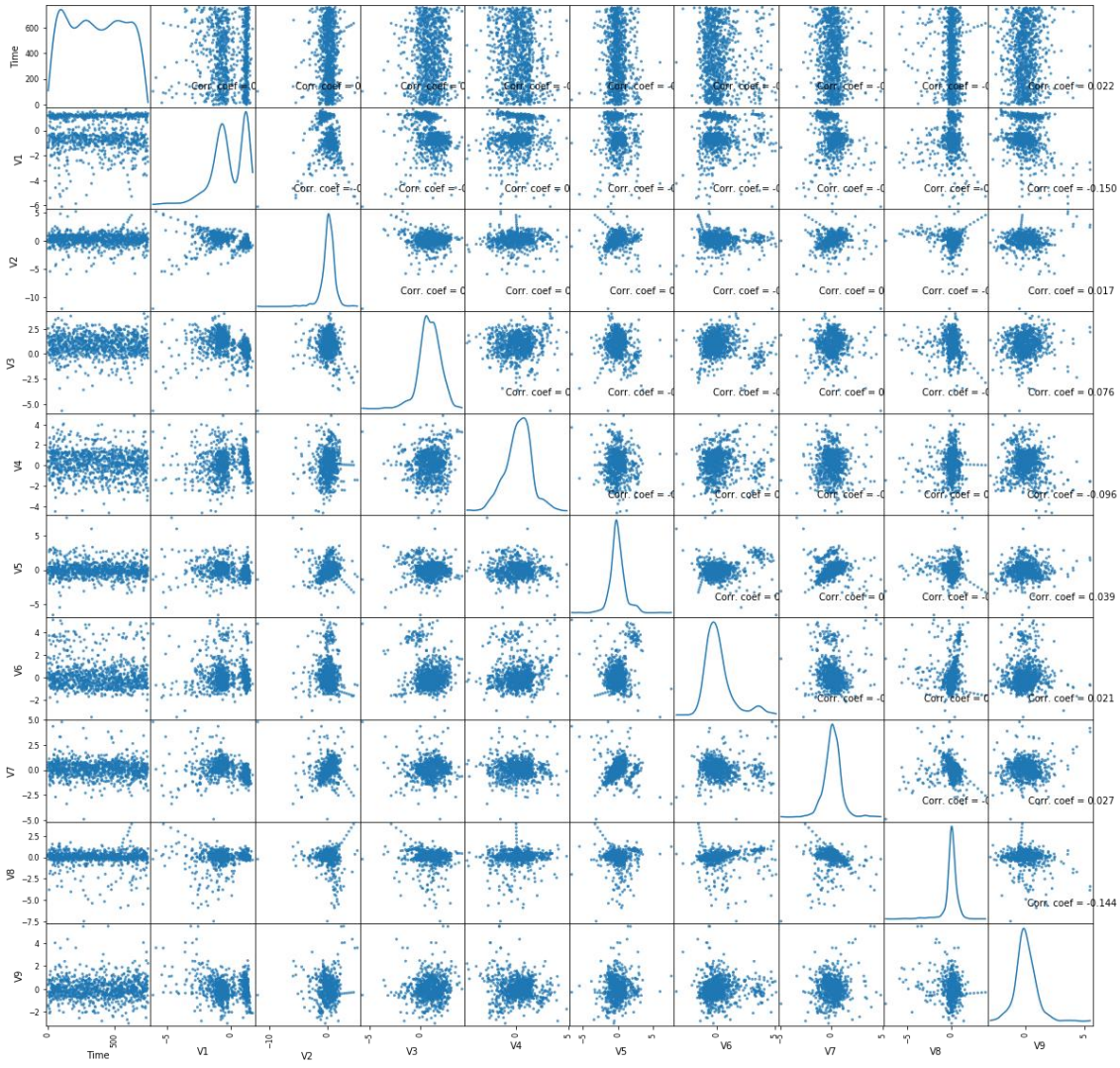


Scatter and density plots:

In [10]:

```
plotScatterMatrix(df1, 20, 10)
```

Scatter and Density Plot



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