Assignment 12.2 - Term Project

Syed Abidi - 11/20/2020

DSC-530 - Data Exploration and Analysis Assignment

Term Project : Credit Card Fraud

Your dataset

A PowerPoint presentation outlining your statistical question/hypothesis

Using Python, submit your results via your notebook or export your code and submit via the assignment link. You must show your code and work for full credit.

- A minimum of 5 variables in your dataset used during your analysis (for help with selecting, the author made his selection on page 6 of your book). Consider what you think could have an impact on your question - remember this is never perfect, so don't be worried if you miss one (Chapter 1).
- Describe what the 5 variables mean in the dataset (Chapter 1).
- Include a histogram of each of the 5 variables are in your summary and analysis, identify any outliers and explain the reasoning for them being outliers and how you believe they should be handled (Chapter 2).
- Include the other descriptive characteristics about the variables: Mean, Mode, Spread, and Tails (Chapter 2).
- Using pg. 29 of your text as an example, compare two scenarios in your data using a PMF. Reminder, this isnâ€™t comparing two variables against each other - it is the same variable, but a different scenario. Almost like a filter. The example in the book is first babies compared to all other babies, it is still the same variable, but breaking the data out based on criteria we are exploring (Chapter 3).
- Create 1 CDF with one of your variables, using page 41-44 as your guide, what does this tell you about your variable and how does it address the question you are trying to answer (Chapter 4).
- Plot 1 analytical distribution and provide your analysis on how it applies to the dataset you have chosen (Chapter 5).
- Create two scatter plots comparing two variables and provide your analysis on correlation and causation. Remember, covariance, Pearson's correlation, and NonLinear Relationships should also be considered during your analysis (Chapter 7).
- Conduct a test on your hypothesis using one of the methods covered in Chapter 9.
- For this project, conduct a regression analysis on either one dependent and one explanatory variable, or multiple explanatory variables (Chapter 10 & 11).

In [1]:
```
#impriting needed modules
from __future__ import print_function, division
import statsmodels.formula.api as smf
import statsmodels.tsa.stattools as smtsa
import matplotlib.pyplot as plt
from io import StringIO
from tabulate import tabulate
import pandas as pd
import numpy as np
import sys
import nsfg
import first
import thinkstats2
import thinkplot
import math
import brfss
import scipy.stats
import density
import hinc2
import hinc
import random
import hypothesis
import scatter
import brfss
import survival
```

In [2]:
```
# Reading the dataset of Credit card information "creditcardinfo.csv"
df = pd.read_csv('C:\\Users\\abidisy\\Documents\\Bellevue\\DSC 530\\ThinkStats2\\code\\creditcardinfo.c
sv')
```

In [3]:
```
# Defining how I collected the Credit card data

print("Total time spanning: {:.1f} days".format(df['Time'].max() / (3600 * 24.0)))

print("{:.2f} % of all transactions are fraud. ".format(np.sum(df['Class']) / df.shape[0] * 100))
```

```
Total time spanning: 2.0 days
0.17 % of all transactions are fraud.
```

In [4]:
```
# Categorizing the Class variable into Fraud and Non-fraud to get an idea of fraud transactions

df['Class'].value_counts()
```

Out[4]:
```
0    284315
1       492
Name: Class, dtype: int64
```

In [5]:
```
# Running the info to verify if there is any "missing values" or "null values" in any column of give da
ta set
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
```

In [6]:
```
# Get the basis information of the Credit Card data
df.describe()
```

Out[6]:

	Time	V1	V2	V3	V4	V5	V6	V7
count	284807.000000	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05	2.84807
mean	94813.859575	1.165980e-15	3.416908e-16	-1.373150e-15	2.086869e-15	9.604066e-16	1.490107e-15	-5.556467e-16	1.17755
std	47488.145955	1.958696e+00	1.651309e+00	1.516255e+00	1.415869e+00	1.380247e+00	1.332271e+00	1.237094e+00	1.194353
min	0.000000	-5.640751e+01	-7.271573e+01	-4.832559e+01	-5.683171e+00	-1.137433e+02	-2.616051e+01	-4.355724e+01	-7.321672
25%	54201.500000	-9.203734e-01	-5.985499e-01	-8.903648e-01	-8.486401e-01	-6.915971e-01	-7.682956e-01	-5.540759e-01	-2.08629
50%	84692.000000	1.810880e-02	6.548556e-02	1.798463e-01	-1.984653e-02	-5.433583e-02	-2.741871e-01	4.010308e-02	2.23580
75%	139320.500000	1.315642e+00	8.037239e-01	1.027196e+00	7.433413e-01	6.119264e-01	3.985649e-01	5.704361e-01	3.27345
max	172792.000000	2.454930e+00	2.205773e+01	9.382558e+00	1.687534e+01	3.480167e+01	7.330163e+01	1.205895e+02	2.000721

8 rows × 31 columns

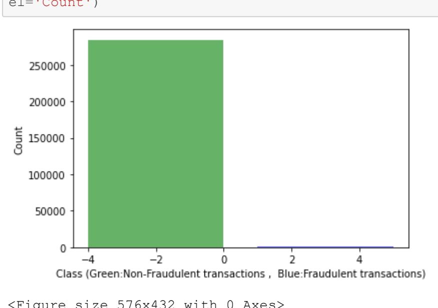
In [7]:
```
# Look the head and tail of the credit card dataset
df
```

Out[7]:

	Time	V1	V2	V3	V4	V5	V6	V7	V8	V9	...	V21	V
0	0.0	-1.359807	-0.072781	2.536347	1.378155	-0.338321	0.462388	0.239599	0.098698	0.363787	...	-0.018307	0.277
1	0.0	1.191857	0.266151	0.166480	0.448154	0.060018	-0.082361	-0.078803	0.085102	-0.255425	...	-0.225775	-0.638
2	1.0	-1.358354	-1.340163	1.773209	0.379780	-0.503198	1.800499	0.791461	0.247676	-1.514654	...	0.247998	0.771
3	1.0	-0.966272	-0.185226	1.792993	-0.863291	-0.010309	1.247203	0.237609	0.377436	-1.387024	...	-0.108300	0.005
4	2.0	-1.158233	0.877737	1.548718	0.403034	-0.407193	0.095921	0.592941	-0.270533	0.817739	...	-0.009431	0.798
...	...	...	...	...	...	...	...	...	...	...	...	...	
284802	172786.0	-11.881118	10.071785	-9.834783	-2.066656	-5.364473	-2.606837	-4.918215	7.305334	1.914428	...	0.213454	0.111
284803	172787.0	-0.732789	-0.055080	2.035030	-0.738589	0.868229	1.058415	0.024330	0.294869	0.584800	...	0.214205	0.924
284804	172788.0	1.919565	-0.301254	-3.249640	-0.557828	2.630515	3.031260	-0.296827	0.708417	0.432454	...	0.232045	0.578
284805	172788.0	-0.240440	0.530483	0.702510	0.689799	-0.377961	0.623708	-0.686180	0.679145	0.392087	...	0.265245	0.800
284806	172792.0	-0.533413	-0.189733	0.703337	-0.506271	-0.012546	-0.649617	1.577006	-0.414650	0.486180	...	0.261057	0.643

284807 rows × 31 columns

In [8]:
```
# Getting the histogram to see transaction types

fraud = df[df.Class==1]
normal = df[df.Class==0]

fraud_hist = thinkstats2.Hist(fraud.Class)
normal_hist = thinkstats2.Hist(normal.Class)

thinkplot.Hist(fraud_hist, align='left', width=4, color='Blue')
thinkplot.Hist(normal_hist, align='right', width=4, color='Green')
thinkplot.Show(xlabel='Class (Green:Non-Fraudulent transactions ,  Blue:Fraudulent transactions)', ylab
el='Count')
```




```
<Figure size 576x432 with 0 Axes>
```

===

Question - 1

- A minimum of 5 variables in your dataset used during your analysis (for help with selecting, the author made his selection on page 6 of your book). Consider what you think could have an impact on your question - remember this is never perfect, so don't be worried if you miss one (Chapter 1).

In [9]:
```
# Answer -1:

# I hvae chosen the following 5 variables
# 1st Variable 'Class'
# 2nd Variable 'Time'
# 3rd Variable 'Amount
# 4th Variable 'V1
# 5th Variable 'V2 to V28'
```

===

Question - 2

- Describe what the 5 variables mean in the dataset (Chapter 1).

In [10]:
```
# Answer -2:
# 1st Variable 'Class' is used to label fraud or normal transaction, 1 means fraud and 0 means normal t
ransactions
# 2nd Variable 'Time' contains the seconds elapsed between each transaction and the first transaction i
n the dataset
# 3rd Variable 'Amount' is used in Euro for the amount of each transaction Amount
# 4th Variable 'V1' is used for the first principal components obtained with payment card assurance for
 the first transactions
# 5th Variable 'V2 to V28' is used for the the principal components obtained with payment card assuranc
e for other transactions
```

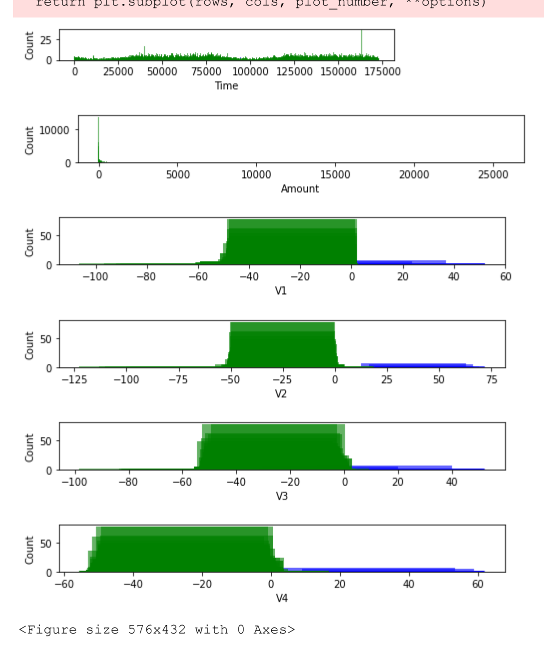
===

Question - 3

- Include a histogram of each of the 5 variables are in your summary and analysis, identify any outliers and explain the reasoning for them being outliers and how you believe they should be handled (Chapter 2).

In [11]:
```
# Answer -3:

# I will use all historgram plots for "Time", "Fraud Amount", "Fraud Variable-1", "Fraud Variable-2",
 "Fraud Variable-3" and
# "Fraud Variable-4"


thinkplot.PrePlot(rows = 6)

thinkplot.SubPlot(1)
fraud_hist1 = thinkstats2.Hist(fraud.Time)
normal_hist1 = thinkstats2.Hist(normal.Time)
thinkplot.Hist(fraud_hist1, align='left', width=50, color='blue')
thinkplot.Hist(normal_hist1, align='right', width=50, color='green')
thinkplot.Show(xlabel='Time', ylabel='Count')

thinkplot.SubPlot(2)
fraud_hist1 = thinkstats2.Hist(fraud.Amount)
normal_hist1 = thinkstats2.Hist(normal.Amount)
thinkplot.Hist(fraud_hist1, align='left', width=50, color='red')
thinkplot.Hist(normal_hist1, align='right', width=50, color='green')
thinkplot.Show(xlabel='Amount', ylabel='Count')

thinkplot.SubPlot(3)
fraud_hist2 = thinkstats2.Hist(fraud.V1)
normal_hist2 = thinkstats2.Hist(normal.V1)
thinkplot.Hist(fraud_hist2, align='left', width=50, color='blue')
thinkplot.Hist(normal_hist2, align='right', width=50, color='green')
thinkplot.Show(xlabel='V1', ylabel='Count')

thinkplot.SubPlot(4)
fraud_hist3 = thinkstats2.Hist(fraud.V2)
normal_hist3 = thinkstats2.Hist(normal.V2)
thinkplot.Hist(fraud_hist3, align='left', width=50, color='blue')
thinkplot.Hist(normal_hist3, align='right', width=50, color='green')
thinkplot.Show(xlabel='V2', ylabel='Count')

thinkplot.SubPlot(5)
fraud_hist4 = thinkstats2.Hist(fraud.V3)
normal_hist4 = thinkstats2.Hist(normal.V3)
thinkplot.Hist(fraud_hist4, align='left', width=50, color='blue')
thinkplot.Hist(normal_hist4, align='right', width=50, color='green')
thinkplot.Show(xlabel='V3', ylabel='Count')

thinkplot.SubPlot(6)
fraud_hist5 = thinkstats2.Hist(fraud.V4)
normal_hist5 = thinkstats2.Hist(normal.V4)
thinkplot.Hist(fraud_hist5, align='left', width=50, color='blue')
thinkplot.Hist(normal_hist5, align='right', width=50, color='green')
thinkplot.Show(xlabel='V4', ylabel='Count')
```

```
C:\Users\abidisy\Documents\Bellevue\DSC 530\ThinkStats2\code\thinkplot.py:182: MatplotlibDeprecationW
arning: Adding an axes using the same arguments as a previous axes currently reuses the earlier insta
nce.  In a future version, a new instance will always be created and returned.  Meanwhile, this warni
ng can be suppressed, and the future behavior ensured, by passing a unique label to each axes instanc
e.
  return plt.subplot(rows, cols, plot_number, **options)
```




```
<Figure size 576x432 with 0 Axes>
```

===

Question - 4

- Include the other descriptive characteristics about the variables: Mean, Mode, Spread, and Tails (Chapter 2).

In [12]:
```
# Answer - 4:
# I will find all descriptive characteristics as sown below:

print("Fraud transaction statistics")
print(fraud['Amount'].describe())
print("\nNormal transaction statistics")
print(normal['Amount'].describe())

df[['Time','Amount','Class','V1','V2','V3','V4']].describe()
```

```
Fraud transaction statistics
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

Normal transaction statistics
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
```

Out[12]:

	Time	Amount	Class	V1	V2	V3	V4
count	284807.000000	284807.000000	284807.000000	2.848070e+05	2.848070e+05	2.848070e+05	2.848070e+05
mean	94813.859575	88.349619	0.001727	1.165980e-15	3.416908e-16	-1.373150e-15	2.086869e-15
std	47488.145955	250.120109	0.041527	1.958696e+00	1.651309e+00	1.516255e+00	1.415869e+00
min	0.000000	0.000000	0.000000	-5.640751e+01	-7.271573e+01	-4.832559e+01	-5.683171e+00
25%	54201.500000	5.600000	0.000000	-9.203734e-01	-5.985499e-01	-8.903648e-01	-8.486401e-01
50%	84692.000000	22.000000	0.000000	1.810880e-02	6.548556e-02	1.798463e-01	-1.984653e-02
75%	139320.500000	77.165000	0.000000	1.315642e+00	8.037239e-01	1.027196e+00	7.433413e-01
max	172792.000000	25691.160000	1.000000	2.454930e+00	2.205773e+01	9.382558e+00	1.687534e+01

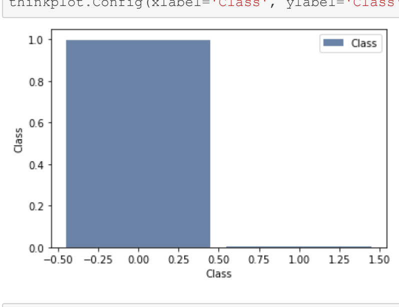
In [13]:
```
# Analysis and oberservations:

# 1) The fraudulent mean of transactions is "122.21" and valid transactions mean is "88.29"

# 2) We found that 50% of the fraudulent transactions were less than 10 and about 50% of the valid tran
sactions were less than 22.

# 3) We found that 75% of the fraudulent transactions are less than 106 and 75% of the valid transactio
ns are less than 77.

# 4) The maximum amount of the fraudulent transaction is 2125.87 and maximum amount of valid transactio
n was 25691.16
```

===

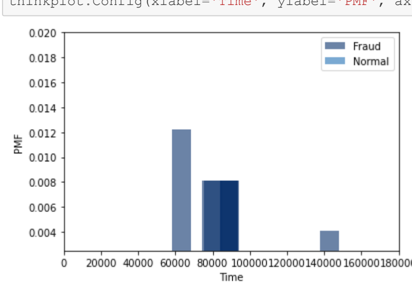
Question - 5

- Using pg. 29 of your text as an example, compare two scenarios in your data using a PMF. Reminder, this isnâ€™t comparing two variables against each other - it is the same variable, but a different scenario. Almost like a filter. The example in the book is first babies compared to all other babies, it is still the same variable, but breaking the data out based on criteria we are exploring (Chapter 3).

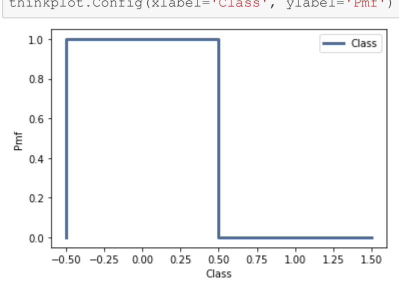
In [17]:
```
# Answer -5 :
# We will compare two classes of Fraud and normal transactions
pmf = thinkstats2.Pmf(df.Class, label = "Class")
thinkplot.Hist(pmf)
thinkplot.Config(xlabel='Class', ylabel='Class')
```



In [14]:
```
fraud_pmf = thinkstats2.Pmf(fraud.Time, label='Fraud')
normal_pmf = thinkstats2.Pmf(normal.Time, label='Normal')

width=10000
axis = [0, 180000, 0.0025, 0.02]
thinkplot.Hist(fraud_pmf, align='right', width=width)
thinkplot.Hist(normal_pmf, align='left', width=width)
thinkplot.Config(xlabel='Time', ylabel='PMF', axis=axis)
```



In [18]:
```
pmf = thinkstats2.Pmf(df.Class, label = "Class")
thinkplot.Pmf(pmf)
thinkplot.Config(xlabel='Class', ylabel='Pmf')
```

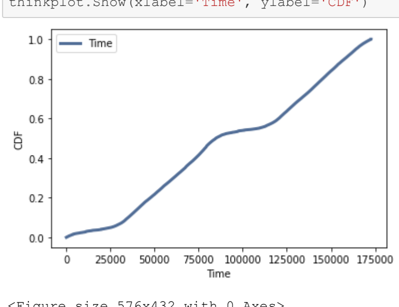


===

Question - 6

- Create 1 CDF with one of your variables, using page 41-44 as your guide, what does this tell you about your variable and how does it address the question you are trying to answer (Chapter 4).

In [19]:
```
# I will create the CDF with one variable of time.

cdf = thinkstats2.Cdf(df.Time, label='Time')
thinkplot.Cdf(cdf)
thinkplot.Show(xlabel='Time', ylabel='CDF')
```




```
<Figure size 576x432 with 0 Axes>
```

===

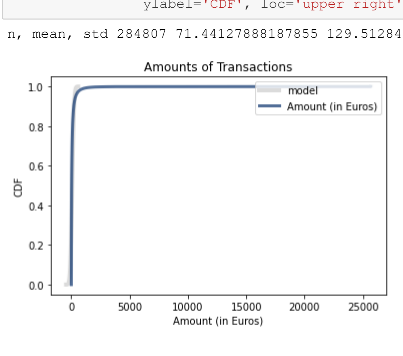
Question - 7

- Plot 1 analytical distribution and provide your analysis on how it applies to the dataset you have chosen (Chapter 5).

In [20]:
```
# Answer - 7:
# I will plot one analytical distribution of "Amount"
amounts = df.Amount.dropna()
```

In [21]:
```
def StandardModel (amounts):

    cdf = thinkstats2.Cdf(amounts, label='Amount (in Euros)')

    mean, var = thinkstats2.TrimmedMeanVar(amounts)

    std = np.sqrt(var)

    print('n, mean, std', len(amounts), mean, std)

    xmin = mean - 4 * std
    xmax = mean + 4 * std

    xs, ps = thinkstats2.RenderNormalCdf(mean, std, xmin, xmax)
    thinkplot.Plot(xs, ps, label='model', linewidth=4, color='0.8')
    thinkplot.Cdf(cdf)


StandardModel(amounts)
thinkplot.Config(title='Amounts of Transactions', xlabel='Amount (in Euros)',
                 ylabel='CDF', loc='upper right')
```

```
n, mean, std 284807 71.44127888187855 129.51284817810276
```

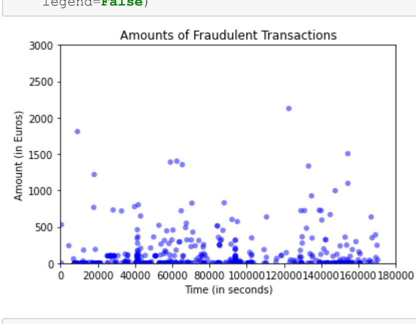


===

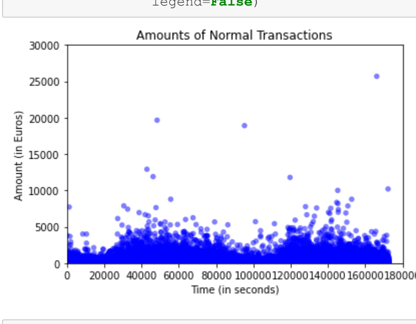
Question - 8

- Create two scatter plots comparing two variables and provide your analysis on correlation and causation. Remember, covariance, Pearson's correlation, and NonLinear Relationships should also be considered during your analysis (Chapter 7).]

In [22]:
```
# Answer - 8

# I will create the two scatter plots of Fraudulent and Non-Fraudulent transactions

thinkplot.Scatter(fraud.Time, fraud.Amount, alpha=0.5)
thinkplot.Config(xlabel='Time (in seconds)',
    ylabel='Amount (in Euros)',
    axis=[0, 180000, 0, 3000],
    title = 'Amounts of Fraudulent Transactions',
    legend=False)
```



In [23]:
```
thinkplot.Scatter(normal.Time, normal.Amount, alpha=0.5)
thinkplot.Config(xlabel='Time (in seconds)',
                 ylabel='Amount (in Euros)',
                 axis=[0, 180000, 0, 30000],
                 title = 'Amounts of Normal Transactions',
                 legend=False)
```



In [24]:
```
def Cov(xs, ys, meanx=None, meany=None):
    xs = np.asarray(xs)
    ys = np.asarray(ys)

    if meanx is None:
        meanx = np.mean(xs)
    if meany is None:
        meany = np.mean(ys)

    cov = np.dot(xs-meanx, ys-meany) / len(xs)
    return cov

def Corr(xs, ys):
    xs = np.asarray(xs)
    ys = np.asarray(ys)

    meanx, varx = thinkstats2.MeanVar(xs)
    meany, vary = thinkstats2.MeanVar(ys)

    corr = Cov(xs, ys, meanx, meany) / np.sqrt(varx * vary)
    return corr

def SpearmanCorr(xs, ys):
    xranks = pd.Series(xs).rank()
    yranks = pd.Series(ys).rank()
    return Corr(xranks, yranks)
```

In [25]:
```
print("Analysis and oberservations:")

print('\nCovariance between Time and Amount for Non-Fraudulent transactions is:{:.4f}'.format(Cov(norma
l.Time, normal.Amount)))
print('\nCovariance between Time and Amount for Fraudulent transactions is:{:.4f}'.format(Cov(fraud.Tim
e, fraud.Amount)))
print('\nPearson Correlation between Time and Amount for Non-Fraudulent transactions is:{:.4f}'.format(
Corr(normal.Time, normal.Amount)))
print('\nPearson Correlation between Time and Amount for Fraudulent transactions is:{:.4f}'.format(Corr
(fraud.Time, fraud.Amount)))
print('\nSpearman Correlation between Time and Amount for Non-Fraudulent transactions is:{:.4f}'.format
(SpearmanCorr(normal.Time, normal.Amount)))
print('\nSpearman Correlation between Time and Amount for Fraudulent transactions is:{:.4f}'.format(Spe
armanCorr(fraud.Time, fraud.Amount)))
```

```
Analysis and oberservations:

Covariance between Time and Amount for Non-Fraudulent transactions is:-126285.9522

Covariance between Time and Amount for Fraudulent transactions is:597140.0657

Pearson Correlation between Time and Amount for Non-Fraudulent transactions is:-0.0106

Pearson Correlation between Time and Amount for Fraudulent transactions is:0.0487

Spearman Correlation between Time and Amount for Non-Fraudulent transactions is:-0.0402

Spearman Correlation between Time and Amount for Fraudulent transactions is:0.0164
```

We found the following two intersting facts:

There is a negative Time correlation of (-0.01) with the Amount for Normal transactions.

There is a weak positive Time correlcation of (0.05) for fraudlent transactions

===

Question - 9

- Conduct a test on your hypothesis using one of the methods covered in Chapter 9.

In [26]:
```
# Answer - 9:

# I am setting up a functions, which will help me to run the samples

class DiffMeans(hypothesis.DiffMeansPermute):


    # We are running a model for null hypothesis
    def RunModel(self):
        g1 = np.random.choice(self.pool, self.n, replace=True)
        g2 = np.random.choice(self.pool, self.m, replace=True)
        return g1, g2

# We are testing diff in mean
def RunSampleTest(fraud, normal):
    data = fraud.Amount.values, normal.Amount.values
    ht = DiffMeans(data)
    pVal = ht.PValue(iters=10000)

    print("\nMeans permute Transaction Amounts (in Euros)")
    print("P Value: {:.3f}".format(pVal))
    print("Actual: {:.3f}".format(ht.actual))
    print("T-test max: {:.3f}".format(ht.MaxTestStat()))


    data = (fraud.Time.dropna().values, normal.Time.dropna().values)
    ht = hypothesis.DiffMeansPermute(data)
    pVal = ht.PValue(iters=10000)
    print("\nMeans permute Transaction Times (in seconds)")
    print("P Value: {:.3f}".format(pVal))
    print("Actual: {:.3f}".format(ht.actual))
    print("T-test max: {:.3f}".format(ht.MaxTestStat()))


# We are running the same test as it was in chapter 9
def RunTests(df, iters=1000):
    n = len(df)
    fraud = df[df.Class==1]
    normal = df[df.Class==0]

    # We are comparing the pregnancy duration
    data = fraud.Amount.values, normal.Amount.values
    ht = hypothesis.DiffMeansPermute(data)
    p1 = ht.PValue(iters=iters)

    data = (fraud.Time.dropna().values, normal.Time.dropna().values)
    ht = hypothesis.DiffMeansPermute(data)
    p2 = ht.PValue(iters=iters)

    # We are testing the correlation
    df2 = df.dropna(subset=['Amount', 'Time'])
    data = df2.Amount.values, df2.Time.values
    ht = hypothesis.CorrelationPermute(data)
    p3 = ht.PValue(iters=iters)

    # We are comparing the pregnancy duration (which is chi-squared)
    data = fraud.Amount.values, normal.Amount.values
    ht = hypothesis.PregLengthTest(data)
    p4 = ht.PValue(iters=iters)

    print("{}\t{:.3f}\t{:.3f}\t{:.3f}\t{:.3f}".format(n, p1, p2, p3, p4))

thinkstats2.RandomSeed(18)
RunSampleTest(fraud,normal)
```

```
Means permute Transaction Amounts (in Euros)
P Value: 0.008
Actual: 33.920
T-test max: 71.557

Means permute Transaction Times (in seconds)
P Value: 0.000
Actual: 14091.395
T-test max: 8186.848
```

In [27]:
```
n = len(df)
print("nval\t Test1\t  Test2\t  Test3\t  Test4\t")
for i in range(7):
    sample = thinkstats2.SampleRows(df, n)
    RunTests(sample)
    n //= 2
```

```
nval     Test1    Test2   Test3   Test4
284807  0.002   0.000   0.000   0.888
142403  0.020   0.000   0.000   0.893
71201   0.035   0.007   0.016   1.000
35600   0.216   0.012   0.000   1.000
17800   0.874   0.049   0.272   0.166
8900    0.572   0.034   0.433   1.000
4450    0.415   0.600   0.119   0.000
```

```
C:\Users\abidisy\Documents\Bellevue\DSC 530\ThinkStats2\code\hypothesis.py:189: RuntimeWarning: inval
id value encountered in true_divide
  stat = sum((observed - expected)**2 / expected)
```

===

Question - 10

- For this project, conduct a regression analysis on either one dependent and one explanatory variable, or multiple explanatory variables (Chapter 10 & 11).

In [28]:

```
# Answer - 10:
# I am conducting the regression analysis on given variables of "Amount" and "Time" as follow:

import statsmodels.formula.api as smf

formula = 'Amount ~ Time'
model = smf.ols(formula, data=df)
results = model.fit()
intercept = results.params["Intercept"]
slope = results.params ["Time"]

slope_pvalue = results.pvalues["Time"]
print(results.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                 Amount   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                  0.000
Method:                 Least Squares   F-statistic:                     31.98
Date:                Sat, 21 Nov 2020   Prob (F-statistic):           1.56e-08
Time:                        21:45:10   Log-Likelihood:            -1.9768e+06
No. Observations:              284807   AIC:                         3.954e+06
Df Residuals:                  284805   BIC:                         3.954e+06
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept     93.6413      1.047     89.480      0.000      91.590      95.692
Time       -5.581e-05   9.87e-06     -5.655      0.000   -7.52e-05   -3.65e-05
==============================================================================
Omnibus:                   588284.473   Durbin-Watson:                   1.983
Prob(Omnibus):                  0.000   Jarque-Bera (JB):       8495666990.381
Skew:                          16.981   Prob(JB):                         0.00
Kurtosis:                     848.432   Cond. No.                     2.37e+05
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 2.37e+05. This might indicate that there are
strong multicollinearity or other numerical problems.
```

In [29]:

```
diff_amounts = normal.Amount.mean() - fraud.Amount.mean()

diff_times = normal.Time.mean() - fraud.Time.mean()

results = smf.ols('Amount ~ Time', data=df).fit()
slope = results.params['Time']
print(f' Slope: {round(slope,7)}')
```

```
 Slope: -5.58e-05
```

In [30]:

```
slopeTimesDff_time = slope * diff_times
print (f'slopeTimesDff_time:  {round(slopeTimesDff_time,4)}')
```

```
slopeTimesDff_time:  -0.7865
```