code

July 19, 2023

[7]:
```
import google
import re
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from google.cloud import bigquery
```

[2]:
```
# check whether the input wallet address is a valid Bitcoin address
def check_valid(input) -> bool:
    if (34 >= len(input) >= 27) and (re.match(r"^[a-zA-Z0-9]+$", input)):
        return True
    else:
        return False

# create a bigquery client with a specified project
client = bigquery.Client(project="interviewees-bigquery")

# get two wall addresses from user inputs
user_input_first = input("Enter the first wallet address:")
user_input_second = input("Enter the second wallet address:")

# handle invalid addresses from user, and ask users to re-enter inputs when␣
 ↪given invalid ones
while (not check_valid(user_input_first)) or (not␣
 ↪check_valid(user_input_second)):
    user_input_first = input("Please enter the first Bitcoin address of valid␣
 ↪format:")
    user_input_second = input("Please enter the second Bitcoin address of valid␣
 ↪format:")

# the following query retrieve transaction data between two wallet addresses
query = """
   SELECT input_address, output_address,IP.value AS value,
        IP.block_number AS block_number, IP.type AS type,
        IP.block_timestamp AS timestamp, IP.required_signatures AS␣
 ↪required_signatures
        FROM bigquery-public-data.crypto_bitcoin.inputs AS IP,
```

```
        bigquery-public-data.crypto_bitcoin.outputs AS OP,
        UNNEST (IP.addresses) as input_address, UNNEST(OP.addresses) as␣
 ↪output_address
        WHERE IP.spent_transaction_hash = OP.transaction_hash
            AND IP.spent_output_index = OP.index
            AND ((input_address = @user_input_first
            AND output_address = @user_input_second) OR (input_address =␣
 ↪@user_input_second
            AND output_address = @user_input_first));
"""

# add two wall addresses as query paramters before executing the query
job_config = bigquery.QueryJobConfig(
    query_parameters=[
        bigquery.ScalarQueryParameter("user_input_first", "STRING",␣
 ↪user_input_first),
        bigquery.ScalarQueryParameter("user_input_second", "STRING",␣
 ↪user_input_second),
    ]
)

# collect the result returned from query and transform it to a dataframe
result = client.query(query, job_config=job_config).to_dataframe()
```

```
/opt/miniconda3/lib/python3.8/site-packages/google/auth/_default.py:78:
UserWarning: Your application has authenticated using end user credentials from
Google Cloud SDK without a quota project. You might receive a "quota exceeded"
or "API not enabled" error. See the following page for troubleshooting:
https://cloud.google.com/docs/authentication/adc-troubleshooting/user-creds.
  warnings.warn(_CLOUD_SDK_CREDENTIALS_WARNING)

Enter the first wallet address:1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi
Enter the second wallet address:19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6
```

[8]:
```
# show the dataframe scheme and sample data sorted by timestamp
result.sort_values(by=['timestamp'],ascending=True).head(10)
```

[8]:

	input_address	output_address	\
14075	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	
14074	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	
39530	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	
39531	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	
28177	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	
28176	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	
11772	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	
11773	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	
40858	1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi	19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6	

```
40859  19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6  1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi

                value  block_number      type                 timestamp  \
14075  5757.000000000        427466  multisig 2016-08-30 03:44:31+00:00
14074  5757.000000000        427466  multisig 2016-08-30 03:44:31+00:00
39530  5757.000000000        427513  multisig 2016-08-30 11:52:06+00:00
39531  5757.000000000        427513  multisig 2016-08-30 11:52:06+00:00
28177  1000.000000000        516044  multisig 2018-04-01 00:53:15+00:00
28176  1000.000000000        516044  multisig 2018-04-01 00:53:15+00:00
11772  1000.000000000        531486  multisig 2018-07-11 14:18:17+00:00
11773  1000.000000000        531486  multisig 2018-07-11 14:18:17+00:00
40858  1000.000000000        539589  multisig 2018-09-02 03:03:19+00:00
40859  1000.000000000        539589  multisig 2018-09-02 03:03:19+00:00

       required_signatures
14075                    1
14074                    1
39530                    1
39531                    1
28177                    1
28176                    1
11772                    1
11773                    1
40858                    1
40859                    1
```

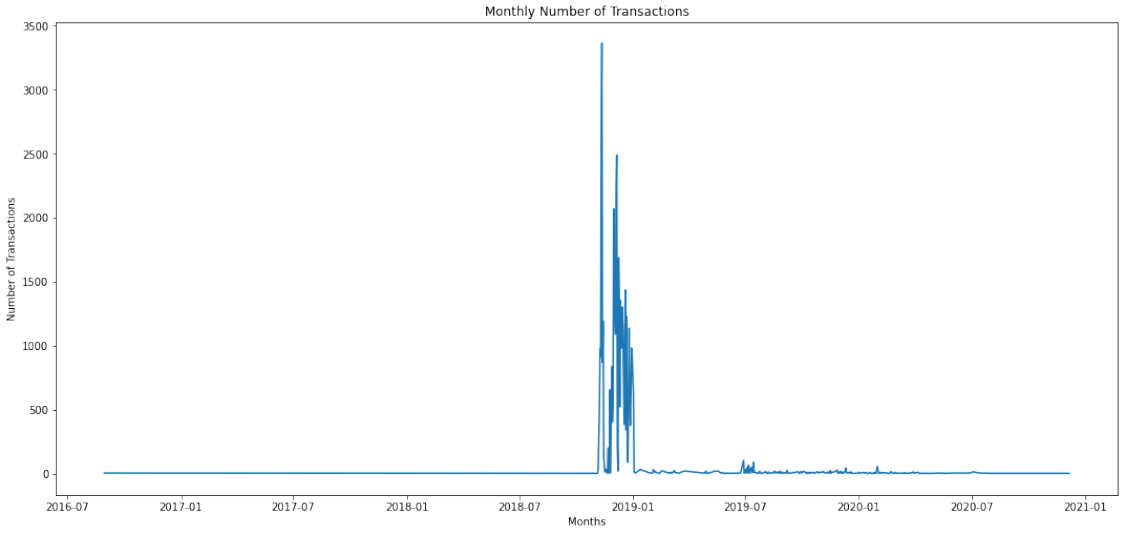
[9]:
```python
# Data Analysis

# find the number of total transactions
count_row = result.shape[0]
print("total number of transactions:",count_row)

# find total value being transfered
sum_of_value = result['value'].sum()
print("total value being transfered:",sum_of_value)

# find average transaction value
average_of_value = result['value'].mean()
print("average value being transfered:", average_of_value)

# find the median transaction value
median_of_value = result['value'].median()
print("median value being transfered:", median_of_value)

# find the max transaction value
max_of_value = result['value'].max()
print("max value being transfered:", max_of_value)
```

```
# find the min transaction value
min_of_value = result['value'].min()
print("min value being transfered:", min_of_value)

# find the start and latest dates of transactions
first_timestamp = result['timestamp'].min()
latest_timestamp = result['timestamp'].max()
print("start date of transaction:", first_timestamp)
print("latest date of transaction:", latest_timestamp)

# sort number transactions of different date decreasingly to observe patterns
date_tran = result[['timestamp']].copy()
date_tran['timestamp'] = date_tran['timestamp'].dt.date
date_tran.rename(columns= {'timestamp': "date"} , inplace=True)
date_tran = date_tran.groupby(['date']).agg(
    number_of_transactions= pd.NamedAgg(column="date", aggfunc="count"))
date_tran = date_tran.sort_values(by=['number_of_transactions'],ascending=␣
 ↪False)

print(date_tran.head(20))
```

```
total number of transactions: 46434
total value being transfered: 46453028.000000000
average value being transfered: 1000.4097859327217
median value being transfered: 1000.0
max value being transfered: 5757.000000000
min value being transfered: 1000.000000000
start date of transaction: 2016-08-30 03:44:31+00:00
latest date of transaction: 2020-12-06 05:45:11+00:00
            number_of_transactions
date
2018-11-12                    3360
2018-11-11                    2648
2018-12-06                    2486
2018-12-05                    2234
2018-12-01                    2068
2018-12-09                    1684
2018-12-20                    1434
2018-12-10                    1376
2018-12-12                    1354
2018-12-15                    1300
2018-12-03                    1280
2018-12-22                    1228
2018-11-14                    1190
2018-12-02                    1150
2018-12-26                    1136
```

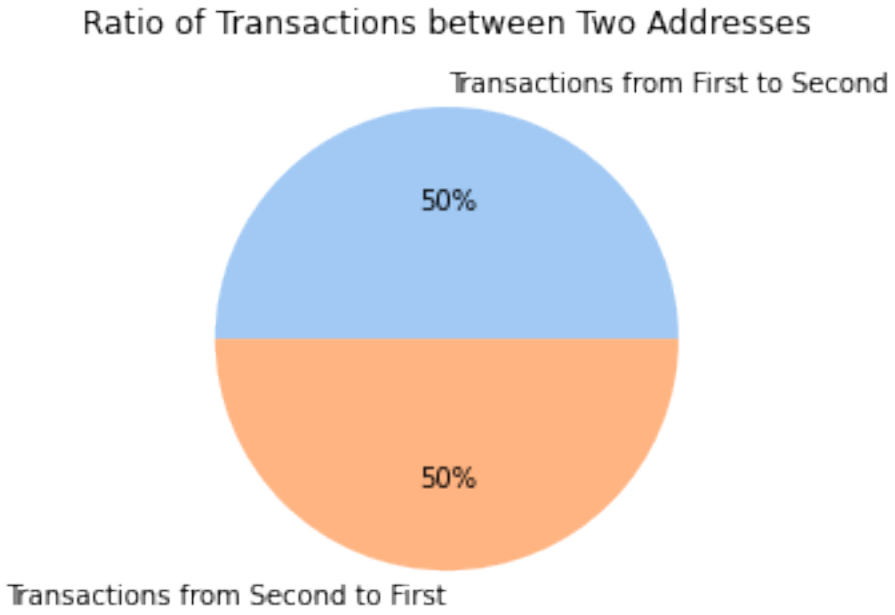
2018-12-19	1106
2018-12-16	1106
2018-12-04	1088
2018-12-14	1012
2018-12-30	980

[10]:
```
# Data Visulization

# create a line plot which describes the relationship between date and number␣
 ↪of transactions happened
fig, ax = plt.subplots(figsize = (15, 7))
sns.lineplot(ax =ax, x='date',y='number_of_transactions', data=date_tran)
plt.tight_layout()
plt.title("Monthly Number of Transactions")
plt.xlabel("Months")
plt.ylabel("Number of Transactions" )
plt.show()
```



[11]:
```
# create a pie chart which illusrates the ratio of transactions from opposite␣
 ↪directions
tran_first_to_second = result['input_address'].
 ↪value_counts()['1PPkPubRnK2ry9PPVW7HJiukqbSnWzXkbi']
tran_second_to_first = result['input_address'].
 ↪value_counts()['19Kz98riwoFdTPnKe6s2Fg2xAEoa39rGg6']
tran_compare_lst = [tran_first_to_second,tran_second_to_first]
labels = ['Transactions from First to Second','Transactions from Second to␣
 ↪First']
colors = sns.color_palette('pastel')[0:2]
plt.pie(tran_compare_lst, labels = labels, colors = colors, autopct='%.0f%%')
```

```
plt.title("Ratio of Transactions between Two Addresses")
plt.show()
```



[12]:
```
# Summary of Analysis and Drived Insights

'''
During the analysis phase, we calculate various metrics (average,mean,median␣
 ↪etc.) about the transactions and realize
the average is close to the min value. After inspection, we realize most␣
 ↪transactions have a fixed value of 1000
except four transcations with a value of 5757. We also notice the duration of␣
 ↪interaction between two addresses ranges from
2016-08-30 to 2020-12-06. In additon, we find out most transactions happened␣
 ↪between the end of 2018 and the
beginning of 2019. In the visulization phase, the line plot proves that most␣
 ↪transactions happened in a short period
of time with significant fluctuations. Finally, the pie chart suggests an␣
 ↪intersting fact that transcations from both
directions exactly equal, which means two wallets may belong to the same␣
 ↪individual or organization.

'''
```

[12]:
```
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```

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