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33085625

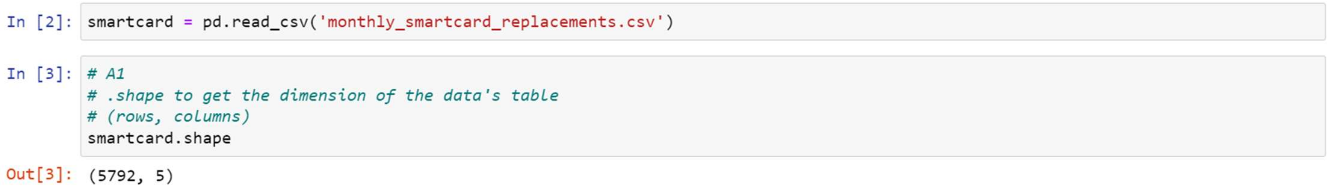
A1

ANSWER:

Data Instances = 5792 (5792 rows, not including the first row which is the column headers)

Data Variables = 5 (5 columns)

CODE:



```
In [2]: smartcard = pd.read_csv('monthly_smartcard_replacements.csv')

In [3]: # A1
        # .shape to get the dimension of the data's table
        # (rows, columns)
        smartcard.shape

Out[3]: (5792, 5)
```

A1

.shape to get the dimension of the data's table

(rows, columns)

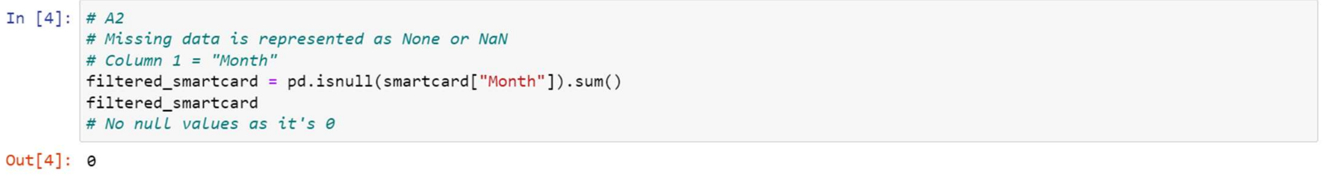
smartcard.shape

A2

ANSWER:

There are no null values in the data set of each column

CODE:



```
In [4]: # A2
        # Missing data is represented as None or NaN
        # Column 1 = "Month"
        filtered_smartcard = pd.isnull(smartcard["Month"]).sum()
        filtered_smartcard
        # No null values as it's 0

Out[4]: 0
```

A2

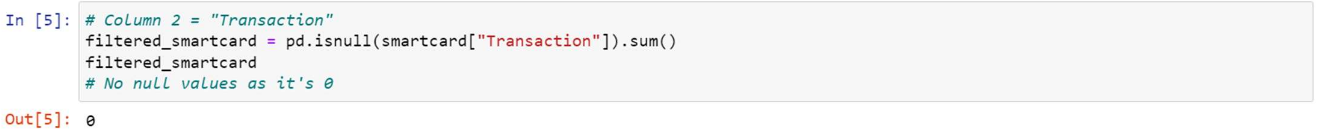
Missing data is represented as None or NaN

Column 1 = "Month"

filtered_smartcard = pd.isnull(smartcard["Month"]).sum()

filtered_smartcard

No null values as it's 0



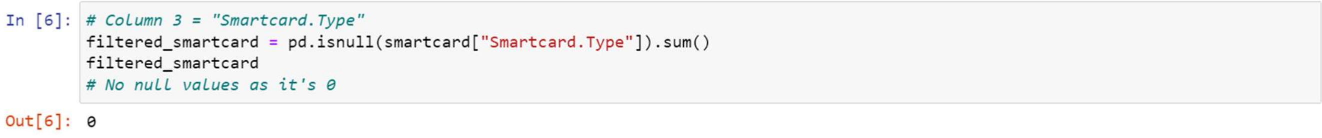
```
In [5]: # Column 2 = "Transaction"
        filtered_smartcard = pd.isnull(smartcard["Transaction"]).sum()
        filtered_smartcard
        # No null values as it's 0

Out[5]: 0
```

Column 2 = "Transaction"

filtered_smartcard = pd.isnull(smartcard["Transaction"]).sum()

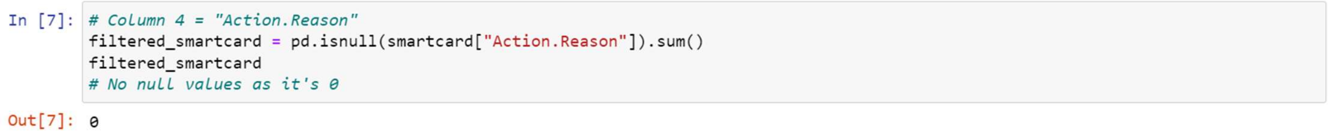
filtered_smartcard

No null values as it's 0



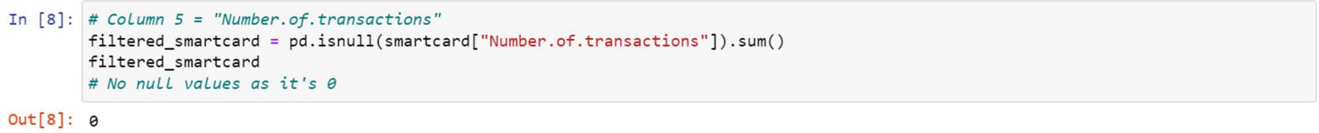
```
In [6]: # Column 3 = "Smartcard.Type"
        filtered_smartcard = pd.isnull(smartcard["Smartcard.Type"]).sum()
        filtered_smartcard
        # No null values as it's 0

Out[6]: 0
```

```
# Column 3 = "Smartcard.Type"

filtered_smartcard = pd.isnull(smartcard["Smartcard.Type"]).sum()

filtered_smartcard

# No null values as it's 0
```



```
In [7]: # Column 4 = "Action.Reason"
        filtered_smartcard = pd.isnull(smartcard["Action.Reason"]).sum()
        filtered_smartcard
        # No null values as it's 0

Out[7]: 0
```

```
# Column 4 = "Action.Reason"

filtered_smartcard = pd.isnull(smartcard["Action.Reason"]).sum()

filtered_smartcard

# No null values as it's 0
```



```
In [8]: # Column 5 = "Number.of.transactions"
        filtered_smartcard = pd.isnull(smartcard["Number.of.transactions"]).sum()
        filtered_smartcard
        # No null values as it's 0

Out[8]: 0
```

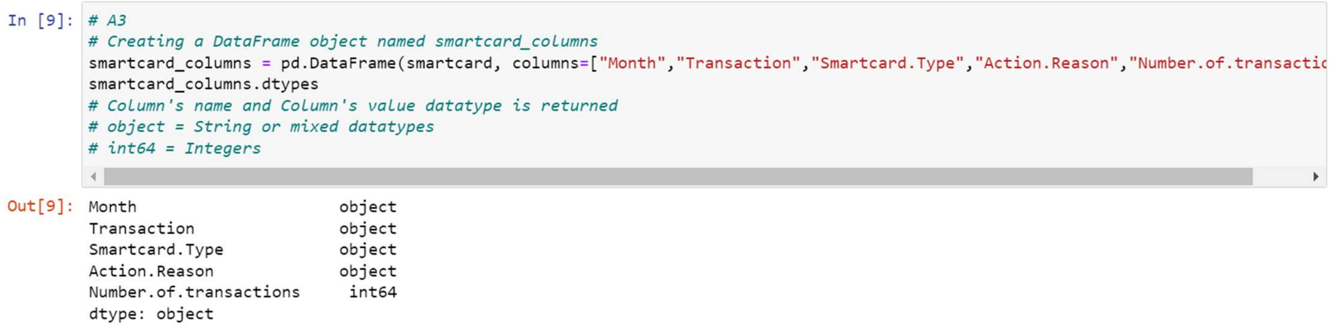
```
# Column 5 = "Number.of.transactions"

filtered_smartcard = pd.isnull(smartcard["Number.of.transactions"]).sum()

filtered_smartcard

# No null values as it's 0
```

A3

ANSWER:

The columns Month, Transaction, Smartcard.Type and Action.Reason is of object datatype whereas Number.of.transaction is of int64 datatype

CODE:



```
In [9]: # A3
        # Creating a DataFrame object named smartcard_columns
        smartcard_columns = pd.DataFrame(smartcard, columns=["Month","Transaction","Smartcard.Type","Action.Reason","Number.of.transactic
        smartcard_columns.dtypes
        # Column's name and Column's value datatype is returned
        # object = String or mixed datatypes
        # int64 = Integers

Out[9]: Month                     object
        Transaction               object
        Smartcard.Type            object
        Action.Reason             object
        Number.of.transactions     int64
        dtype: object
```

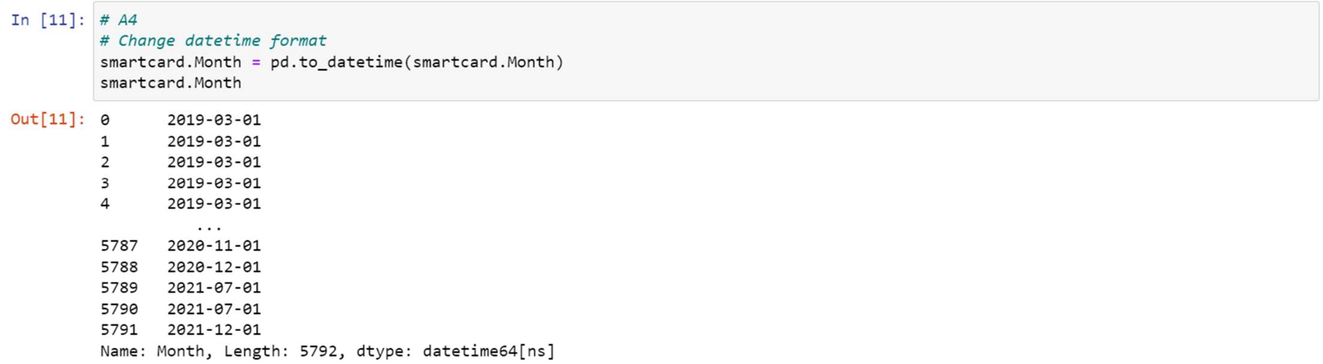
```
# A3

# Creating a DataFrame object named smartcard_columns

smartcard_columns = pd.DataFrame(smartcard,
columns=["Month","Transaction","Smartcard.Type","Action.Reason","Number.of.transactions"])

smartcard_columns.dtypes

# Column's name and Column's value datatype is returned

# object = String or mixed datatypes

# int64 = Integers
```

A4

ANSWER:

The original column of Month display like ‘2019-03’ as shown in the csv file but now the format is changed to include the date like ‘2019-03-01’

CODE:



```
In [11]: # A4
         # Change datetime format
         smartcard.Month = pd.to_datetime(smartcard.Month)
         smartcard.Month
```

```
Out[11]: 0       2019-03-01
         1       2019-03-01
         2       2019-03-01
         3       2019-03-01
         4       2019-03-01
                    ...
         5787    2020-11-01
         5788    2020-12-01
         5789    2021-07-01
         5790    2021-07-01
         5791    2021-12-01
         Name: Month, Length: 5792, dtype: datetime64[ns]
```

A4

Change datetime format

smartcard.Month = pd.to_datetime(smartcard.Month)

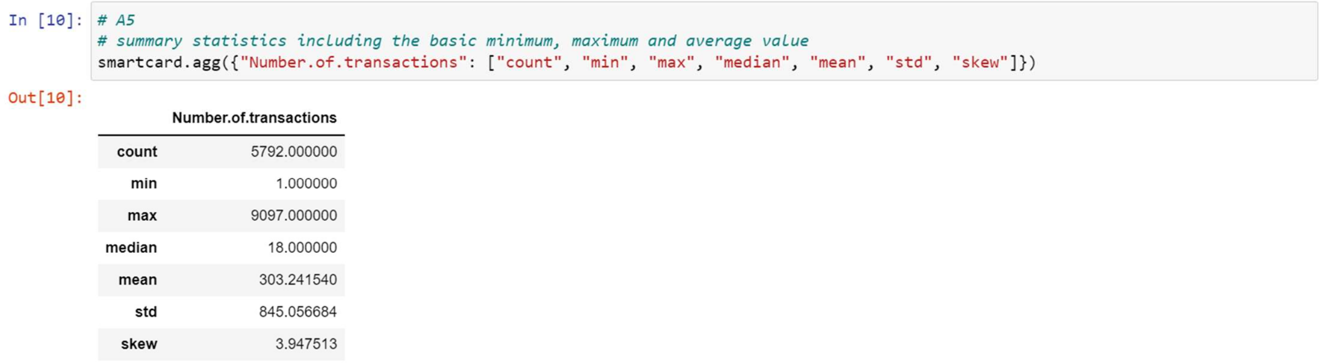
smartcard.Month

A5

ANSWER:

- Amongst the 5792 rows under the column Number.of.transactions, there is an average of 303 transactions happening with the minimum transaction happening being 1 and the maximum transaction happening recorded being 9097 due to different smartcard type and reasons of action occurring in different months
- From the summary statistics of minimum transaction happening, it is known that there will always be 1 transaction happening for different smartcard type and reasons of action occurring in different months
- From the summary statistics of count and median transaction happening, there is an even number of observations included in the dataset. Hence, after arranging the data in ascending order, 18 is the value with the same number of data point above and below it, which means 18 is the 50th percentile
- From the summary statistics of skewness, 3.947513 is larger than 1 and is positive. Larger than 1 mean the data collected in this csv file is highly skewed and is not symmetrical. Positive means the data are rightly skewed and most of the outliers if present in the data collected are distributed to the right side of the distribution
- Standard deviation of the data under the column Number.of.transactions is 845 which means each data recorded is spread out into a wider range of values and is further from the mean value in the data

CODE:



```
In [10]: # A5
         # summary statistics including the basic minimum, maximum and average value
         smartcard.agg({"Number.of.transactions": ["count", "min", "max", "median", "mean", "std", "skew"]})
```

Out[10]:

	Number.of.transactions
count	5792.000000
min	1.000000
max	9097.000000
median	18.000000
mean	303.241540
std	845.056684
skew	3.947513

A5

summary statistics including the basic minimum, maximum and average value

smartcard.agg({"Number.of.transactions": ["count", "min", "max", "median", "mean", "std", "skew"]})

A6

ANSWER:

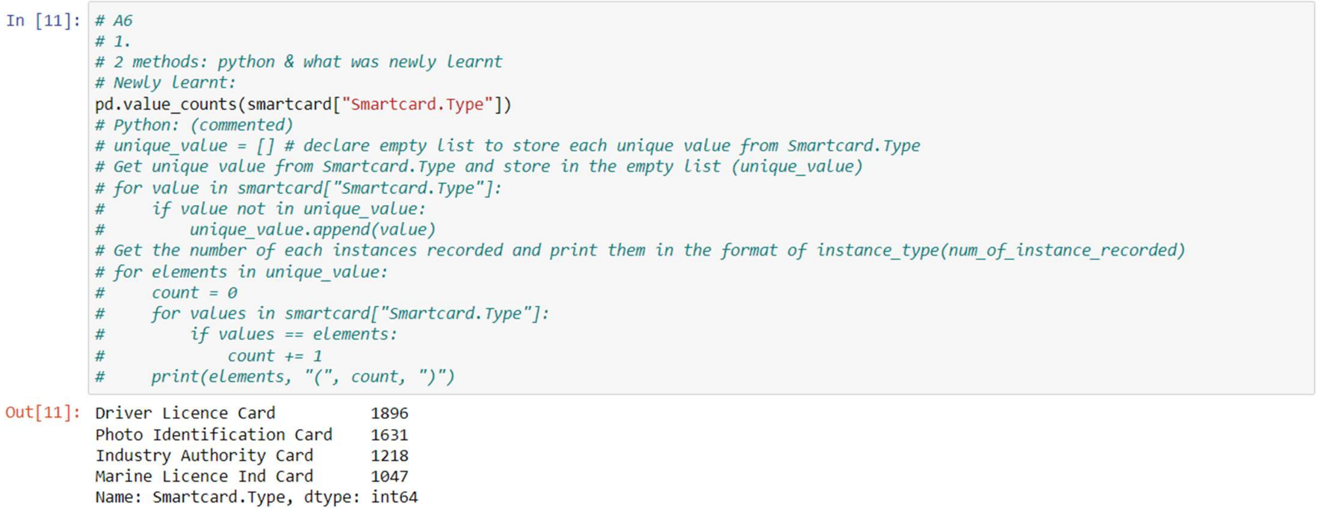
1. 4 different smartcard types recorded:

```
Photo Identification Card (1631)
Driver Licence Card (1896)
Industry Authority Card (1218)
Marine Licence Ind Card (1047)
```

2. 32.7% (in 3 significant figures)

CODE:

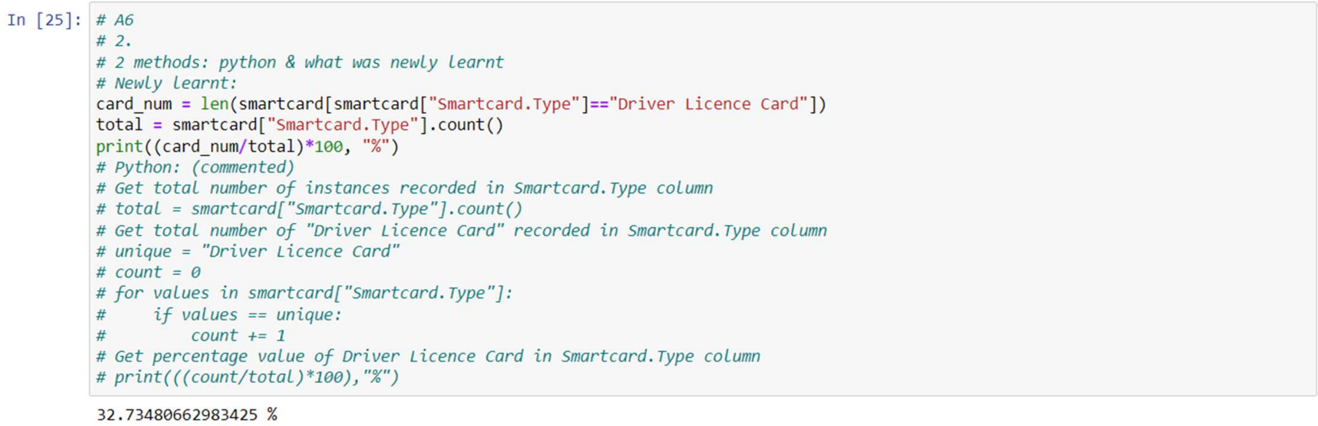
1.



```
In [11]: # A6
         # 1.
         # 2 methods: python & what was newly learnt
         # Newly learnt:
         pd.value_counts(smartcard["Smartcard.Type"])
         # Python: (commented)
         # unique_value = [] # declare empty list to store each unique value from Smartcard.Type
         # Get unique value from Smartcard.Type and store in the empty list (unique_value)
         # for value in smartcard["Smartcard.Type"]:
         #     if value not in unique_value:
         #         unique_value.append(value)
         # Get the number of each instances recorded and print them in the format of instance_type(num_of_instance_recorded)
         # for elements in unique_value:
         #     count = 0
         #     for values in smartcard["Smartcard.Type"]:
         #         if values == elements:
         #             count += 1
         #     print(elements, "(", count, ")")

Out[11]: Driver Licence Card          1896
         Photo Identification Card    1631
         Industry Authority Card      1218
         Marine Licence Ind Card      1047
         Name: Smartcard.Type, dtype: int64
```

```
# A6
# 1.
pd.value_counts(smartcard["Smartcard.Type"])
```

2.



```
In [25]: # A6
         # 2.
         # 2 methods: python & what was newly learnt
         # Newly learnt:
         card_num = len(smartcard[smartcard["Smartcard.Type"]=="Driver Licence Card"])
         total = smartcard["Smartcard.Type"].count()
         print((card_num/total)*100, "%")
         # Python: (commented)
         # Get total number of instances recorded in Smartcard.Type column
         # total = smartcard["Smartcard.Type"].count()
         # Get total number of "Driver Licence Card" recorded in Smartcard.Type column
         # unique = "Driver Licence Card"
         # count = 0
         # for values in smartcard["Smartcard.Type"]:
         #     if values == unique:
         #         count += 1
         # Get percentage value of Driver Licence Card in Smartcard.Type column
         # print(((count/total)*100),"%")

         32.73480662983425 %
```

```
# A6
# 2.
card_num = len(smartcard[smartcard["Smartcard.Type"]=="Driver Licence Card"])
total = smartcard["Smartcard.Type"].count()
# print percentage
print((card_num/total)*100, "%")
```

A7

ANSWER:

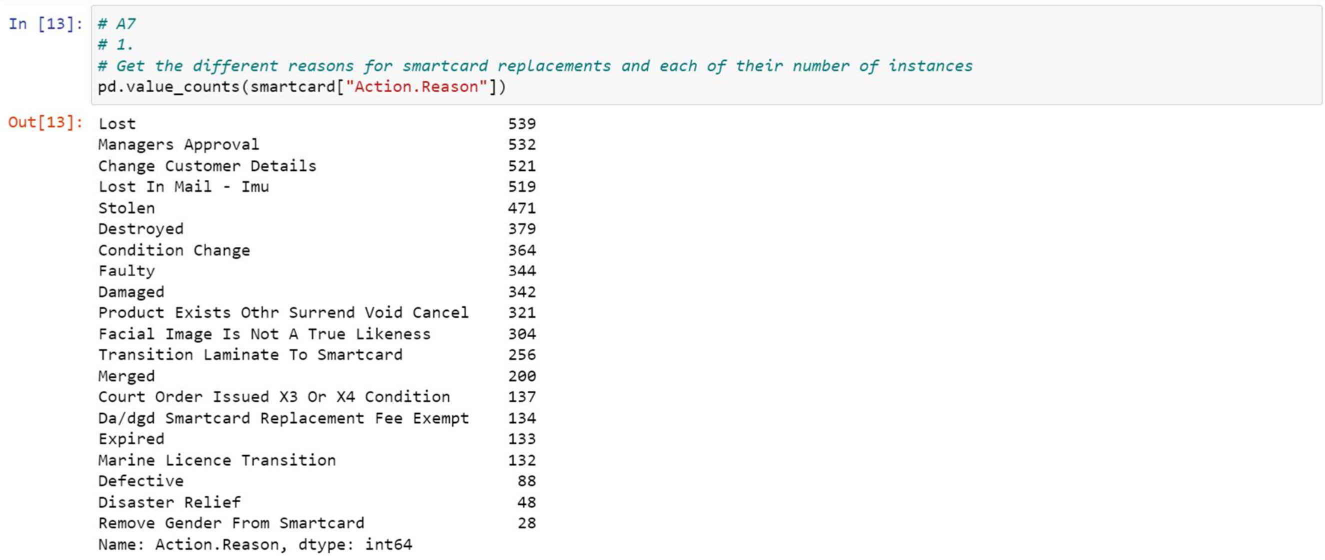
1. 20 different reasons for smartcard replacements

```
2. Lost                                         539
3. Managers Approval                            532
4. Change Customer Details                      521
5. Lost In Mail - Imu                           519
6. Stolen                                       471
7. Destroyed                                    379
8. Condition Change                             364
9. Faulty                                       344
10.     Damaged                                     342
11.     Product Exists Othr Surrend Void Cancel     321
12.     Facial Image Is Not A True Likeness         304
13.     Transition Laminate To Smartcard            256
14.     Merged                                      200
15.     Court Order Issued X3 Or X4 Condition       137
16.     Da/dgd Smartcard Replacement Fee Exempt     134
17.     Expired                                     133
18.     Marine Licence Transition                   132
19.     Defective                                    88
20.     Disaster Relief                              48
21.     Remove Gender From Smartcard                 28
```

2. 264 months as 264 rows were recorded

CODE:

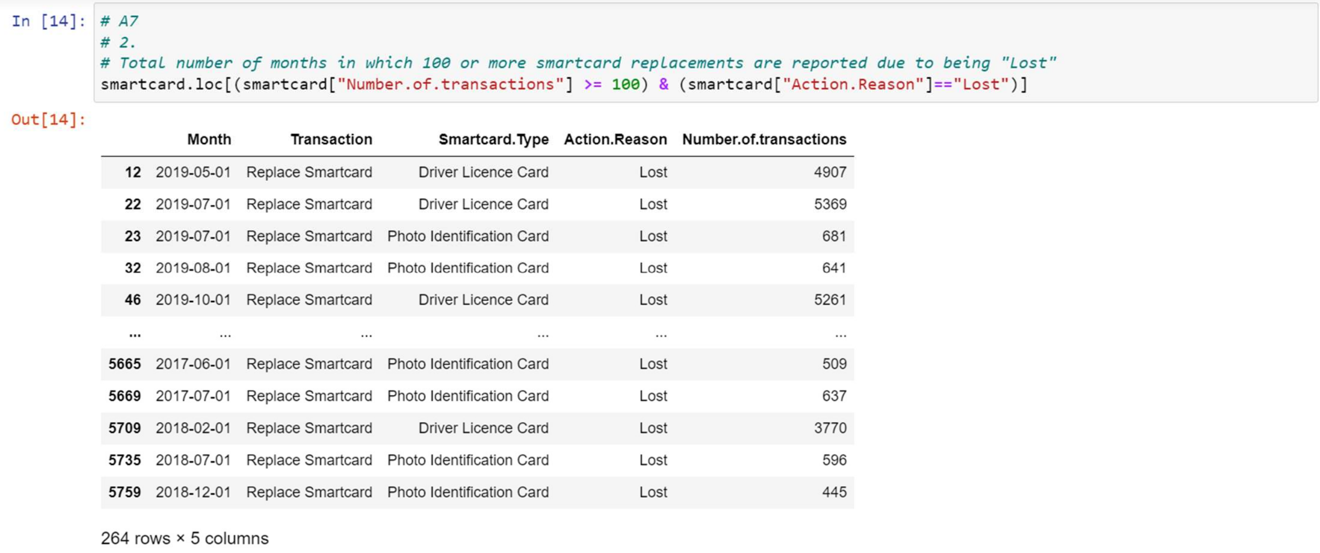
1.



```
In [13]: # A7
         # 1.
         # Get the different reasons for smartcard replacements and each of their number of instances
         pd.value_counts(smartcard["Action.Reason"])

Out[13]: Lost                                       539
         Managers Approval                          532
         Change Customer Details                    521
         Lost In Mail - Imu                         519
         Stolen                                     471
         Destroyed                                  379
         Condition Change                           364
         Faulty                                     344
         Damaged                                    342
         Product Exists Othr Surrend Void Cancel    321
         Facial Image Is Not A True Likeness        304
         Transition Laminate To Smartcard           256
         Merged                                     200
         Court Order Issued X3 Or X4 Condition      137
         Da/dgd Smartcard Replacement Fee Exempt    134
         Expired                                    133
         Marine Licence Transition                  132
         Defective                                   88
         Disaster Relief                             48
         Remove Gender From Smartcard                28
         Name: Action.Reason, dtype: int64
```

```
# A7

# 1.

# Get the different reasons for smartcard replacements and each of their number of instances

pd.value_counts(smartcard["Action.Reason"])
```

2.



In [14]:
```
# A7
# 2.
# Total number of months in which 100 or more smartcard replacements are reported due to being "Lost"
smartcard.loc[(smartcard["Number.of.transactions"] >= 100) & (smartcard["Action.Reason"]=="Lost")]
```

Out[14]:

	Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions
12	2019-05-01	Replace Smartcard	Driver Licence Card	Lost	4907
22	2019-07-01	Replace Smartcard	Driver Licence Card	Lost	5369
23	2019-07-01	Replace Smartcard	Photo Identification Card	Lost	681
32	2019-08-01	Replace Smartcard	Photo Identification Card	Lost	641
46	2019-10-01	Replace Smartcard	Driver Licence Card	Lost	5261
...	...	...	...	...	...
5665	2017-06-01	Replace Smartcard	Photo Identification Card	Lost	509
5669	2017-07-01	Replace Smartcard	Photo Identification Card	Lost	637
5709	2018-02-01	Replace Smartcard	Driver Licence Card	Lost	3770
5735	2018-07-01	Replace Smartcard	Photo Identification Card	Lost	596
5759	2018-12-01	Replace Smartcard	Photo Identification Card	Lost	445

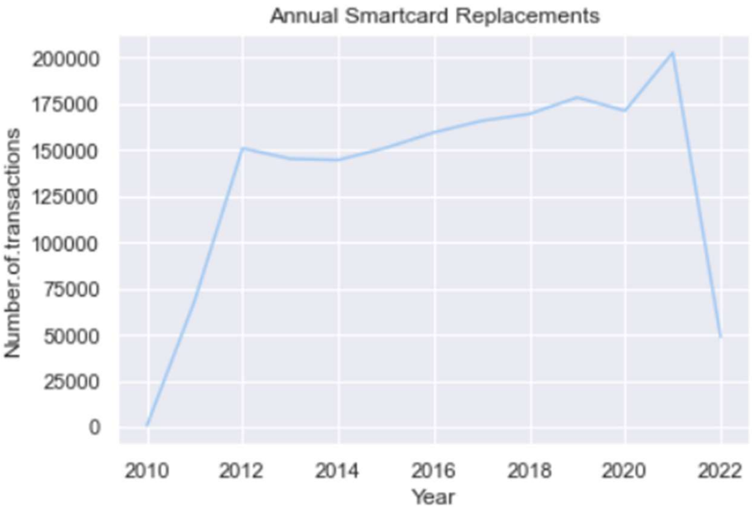
264 rows × 5 columns

```
# A7
# 2.
# Total number of months in which 100 or more smartcard replacements are reported due to being "Lost"
smartcard.loc[(smartcard["Number.of.transactions"] >= 100) & (smartcard["Action.Reason"]=="Lost")]
```

B1

ANSWER:

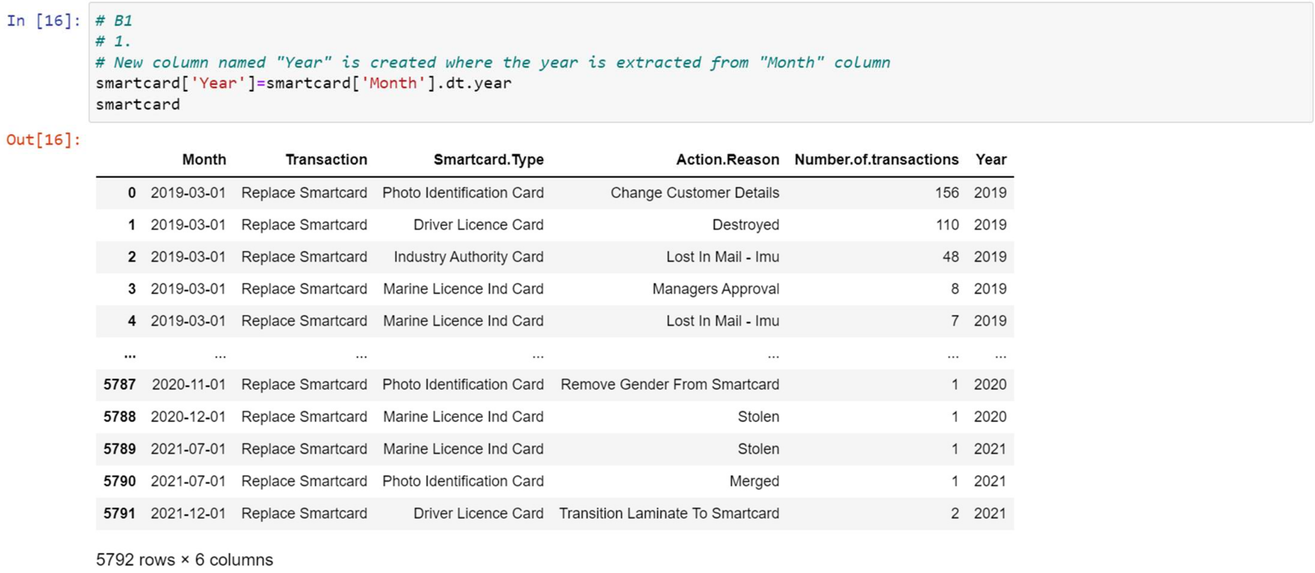
1. New column named "Year" is created where the year is extracted from "Month" column

2. 

3. Overall, the line displayed in the line graph increased where the line started going up from year 2010 to 2012 but declined for a year and remained constant until 2014 where the line then started to gradually increase by going up to year 2019. The line then decreased from 2019 to 2020 and climbed up to peak during 2021 and starts declining since 2021. From this line graph, the highest number of transactions recorded was during year 2021 and the least number of transactions recorded was during year 2010 which is the start of the line graph. From what was observed, people were introduced to smartcards around year 2010 and was unaccustomed to use it. But it took 2 years for people to be used to the presence of these smartcards and hence during the next 8 years after year 2012, smartcards were more often used in the daily lives of people as see from the above graph where the climb during these 8 years were constant. The incrementation from year 2010 to 2012 was larger and steeper compared to the incrementation from year 2020 to 2021 which means the rate of transaction happening was increasing and people are slowly adapting to the use of smartcards.

CODE:

1.



```
In [16]: # B1
         # 1.
         # New column named "Year" is created where the year is extracted from "Month" column
         smartcard['Year']=smartcard['Month'].dt.year
         smartcard
```

Out[16]:

	Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions	Year
0	2019-03-01	Replace Smartcard	Photo Identification Card	Change Customer Details	156	2019
1	2019-03-01	Replace Smartcard	Driver Licence Card	Destroyed	110	2019
2	2019-03-01	Replace Smartcard	Industry Authority Card	Lost In Mail - Imu	48	2019
3	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Managers Approval	8	2019
4	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Lost In Mail - Imu	7	2019
...	...	...	...	...	...	...
5787	2020-11-01	Replace Smartcard	Photo Identification Card	Remove Gender From Smartcard	1	2020
5788	2020-12-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1	2020
5789	2021-07-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1	2021
5790	2021-07-01	Replace Smartcard	Photo Identification Card	Merged	1	2021
5791	2021-12-01	Replace Smartcard	Driver Licence Card	Transition Laminate To Smartcard	2	2021

5792 rows × 6 columns

B1

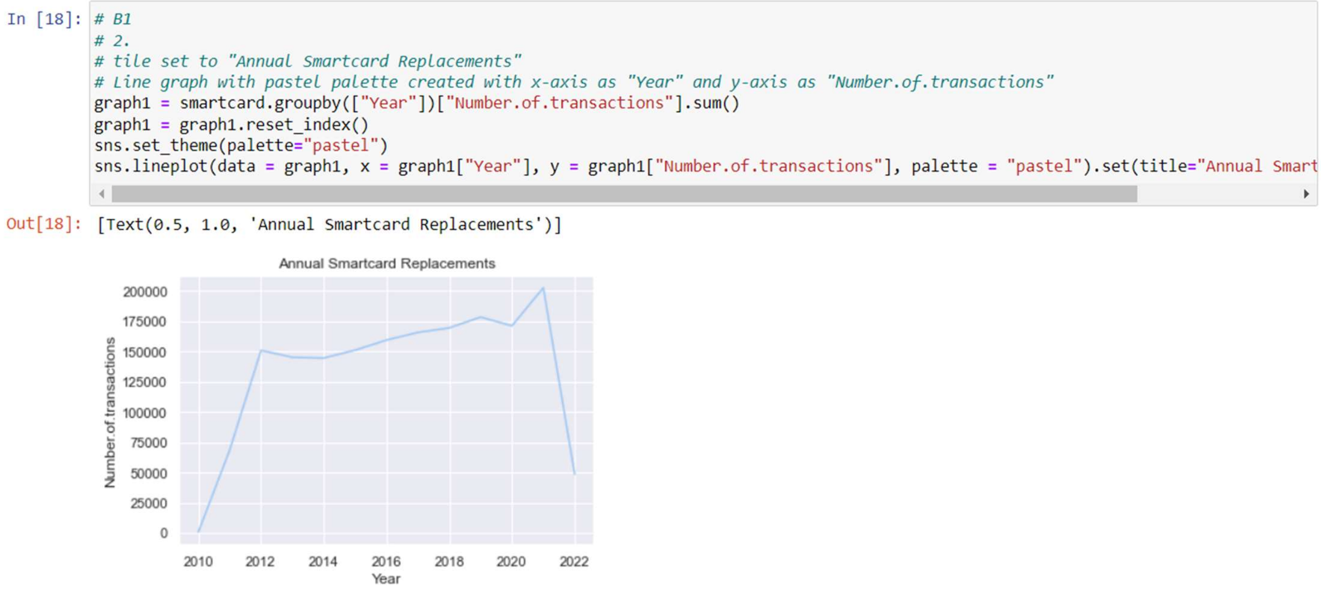
1.

New column named "Year" I created where the year is extracted from "Month" column

smartcard['Year']=smartcard['Month'].dt.year

smartcard

2.



```
In [18]: # B1
         # 2.
         # tile set to "Annual Smartcard Replacements"
         # Line graph with pastel palette created with x-axis as "Year" and y-axis as "Number.of.transactions"
         graph1 = smartcard.groupby(["Year"])["Number.of.transactions"].sum()
         graph1 = graph1.reset_index()
         sns.set_theme(palette="pastel")
         sns.lineplot(data = graph1, x = graph1["Year"], y = graph1["Number.of.transactions"], palette = "pastel").set(title="Annual Smart
```

```
Out[18]: [Text(0.5, 1.0, 'Annual Smartcard Replacements')]
```

B1

2.

tile set to "Annual Smartcard Replacements"

Line graph with pastel palette created with x-axis as "Year" and y-axis as "Number.of.transactions"

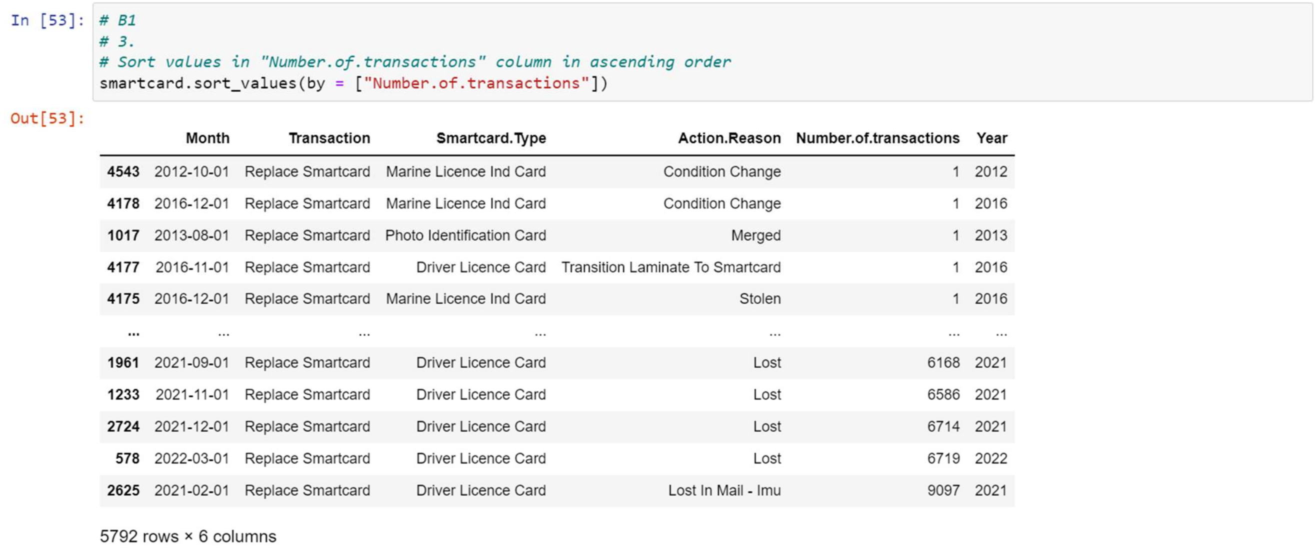
graph1 = smartcard.groupby(["Year"])["Number.of.transactions"].sum()

graph1 = graph1.reset_index()

sns.set_theme(palette="pastel")

sns.lineplot(data = graph1, x = graph1["Year"], y = graph1["Number.of.transactions"], palette = "pastel").set(title="Annual Smartcard Replacements")

3.



```
In [53]: # B1
         # 3.
         # Sort values in "Number.of.transactions" column in ascending order
         smartcard.sort_values(by = ["Number.of.transactions"])
```

Out[53]:

	Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions	Year
4543	2012-10-01	Replace Smartcard	Marine Licence Ind Card	Condition Change	1	2012
4178	2016-12-01	Replace Smartcard	Marine Licence Ind Card	Condition Change	1	2016
1017	2013-08-01	Replace Smartcard	Photo Identification Card	Merged	1	2013
4177	2016-11-01	Replace Smartcard	Driver Licence Card	Transition Laminate To Smartcard	1	2016
4175	2016-12-01	Replace Smartcard	Marine Licence Ind Card	Stolen	1	2016
...	...	...	...	...	...	...
1961	2021-09-01	Replace Smartcard	Driver Licence Card	Lost	6168	2021
1233	2021-11-01	Replace Smartcard	Driver Licence Card	Lost	6586	2021
2724	2021-12-01	Replace Smartcard	Driver Licence Card	Lost	6714	2021
578	2022-03-01	Replace Smartcard	Driver Licence Card	Lost	6719	2022
2625	2021-02-01	Replace Smartcard	Driver Licence Card	Lost In Mail - Imu	9097	2021

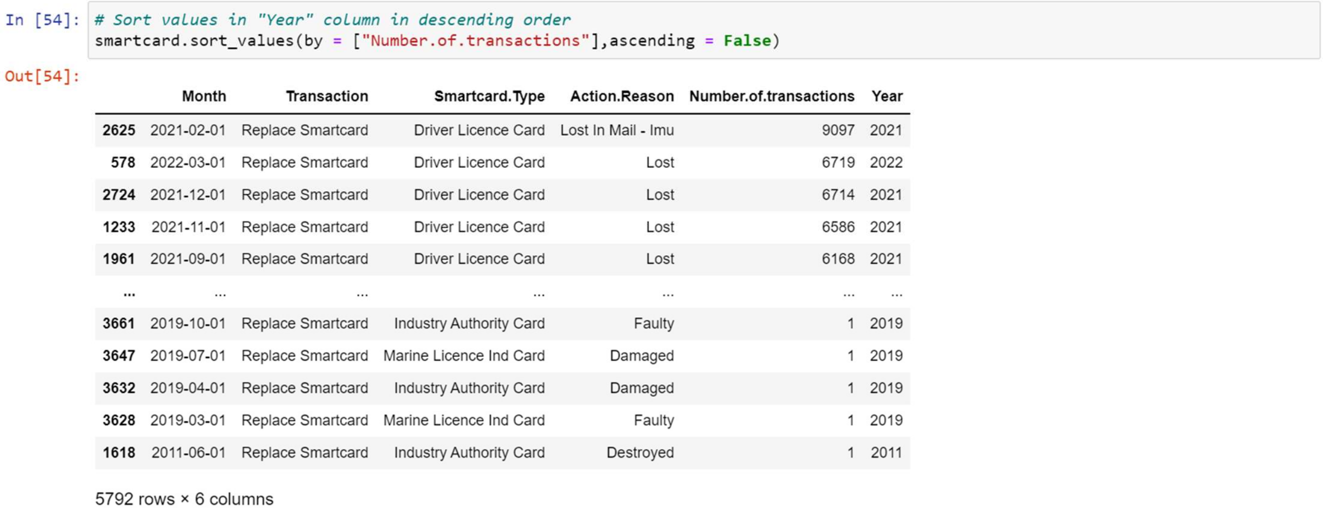
5792 rows × 6 columns

B1

3.

Sort values in "Number.of.transactions" column in ascending order

smartcard.sort_values(by = ["Number.of.transactions"])



```
In [54]: # Sort values in "Year" column in descending order
         smartcard.sort_values(by = ["Number.of.transactions"],ascending = False)
```

Out[54]:

	Month	Transaction	Smartcard.Type	Action.Reason	Number.of.transactions	Year
2625	2021-02-01	Replace Smartcard	Driver Licence Card	Lost In Mail - Imu	9097	2021
578	2022-03-01	Replace Smartcard	Driver Licence Card	Lost	6719	2022
2724	2021-12-01	Replace Smartcard	Driver Licence Card	Lost	6714	2021
1233	2021-11-01	Replace Smartcard	Driver Licence Card	Lost	6586	2021
1961	2021-09-01	Replace Smartcard	Driver Licence Card	Lost	6168	2021
...	...	...	...	...	...	...
3661	2019-10-01	Replace Smartcard	Industry Authority Card	Faulty	1	2019
3647	2019-07-01	Replace Smartcard	Marine Licence Ind Card	Damaged	1	2019
3632	2019-04-01	Replace Smartcard	Industry Authority Card	Damaged	1	2019
3628	2019-03-01	Replace Smartcard	Marine Licence Ind Card	Faulty	1	2019
1618	2011-06-01	Replace Smartcard	Industry Authority Card	Destroyed	1	2011

5792 rows × 6 columns

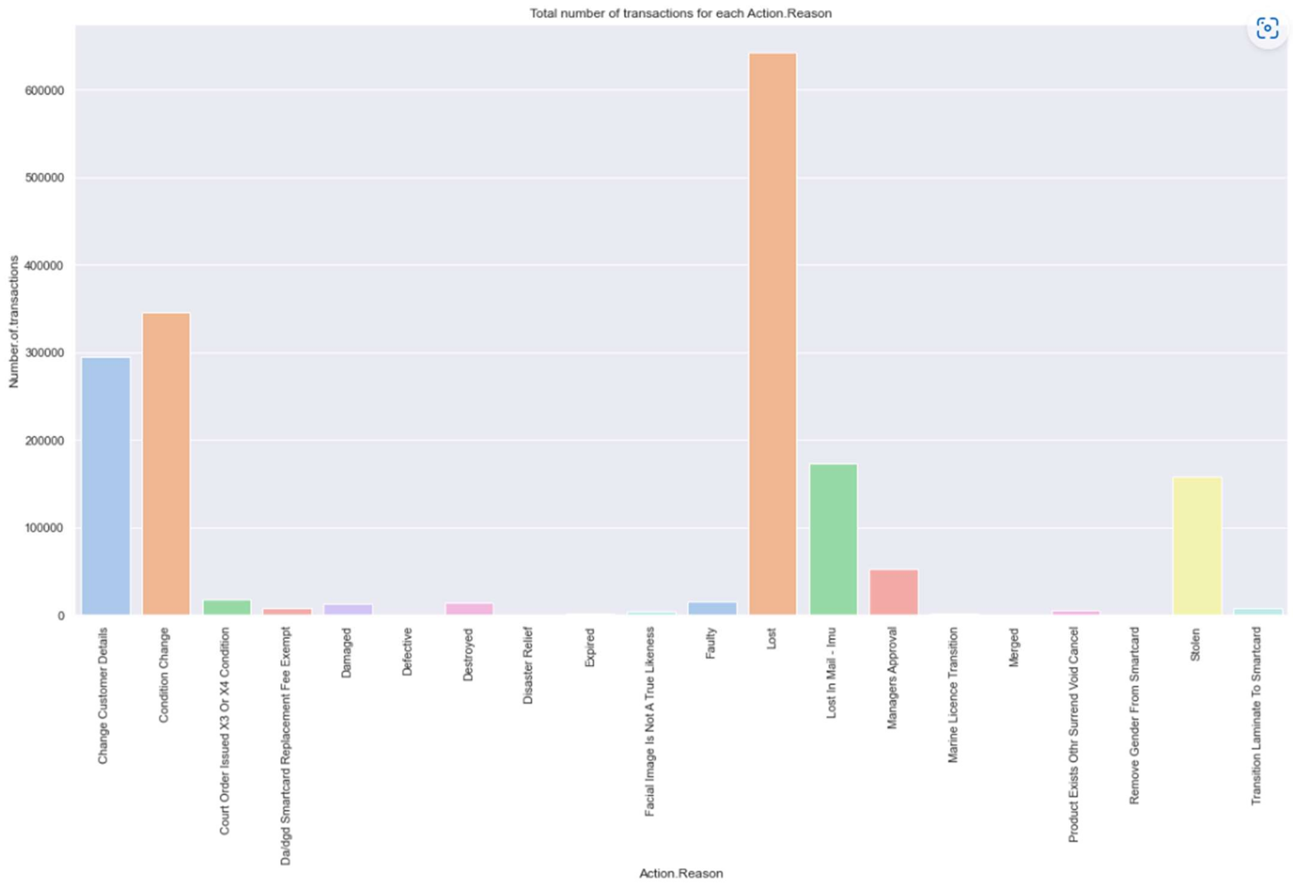
Sort values in "Year" column in descending order

smartcard.sort_values(by = ["Number.of.transactions"],ascending = False)

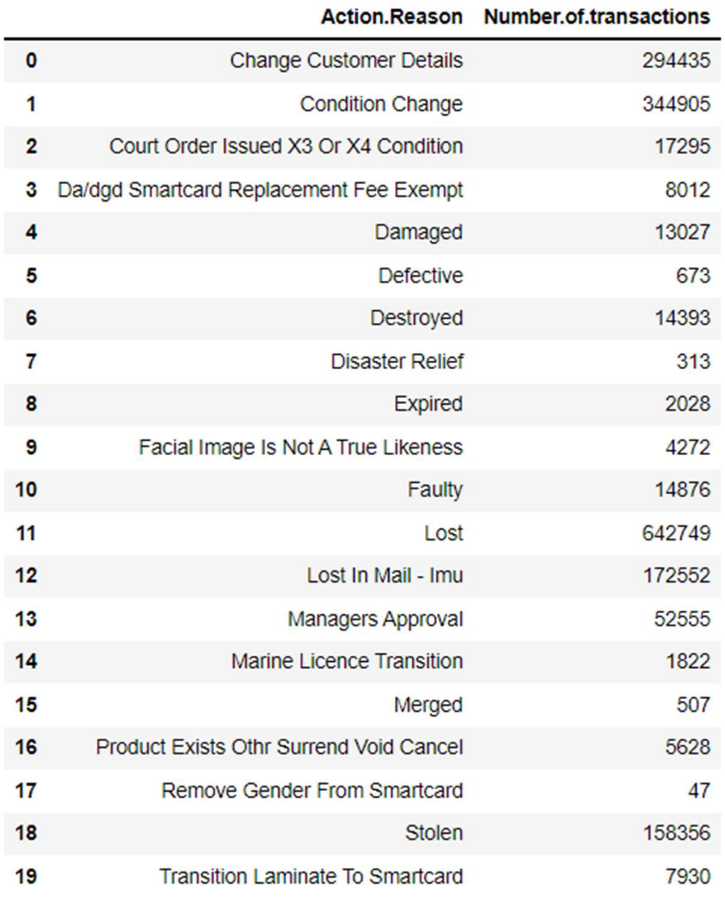
B2

ANSWER:

1.



2. According to the graph above, it's 'Lost', 'Condition Change' and 'Change Customer Details'

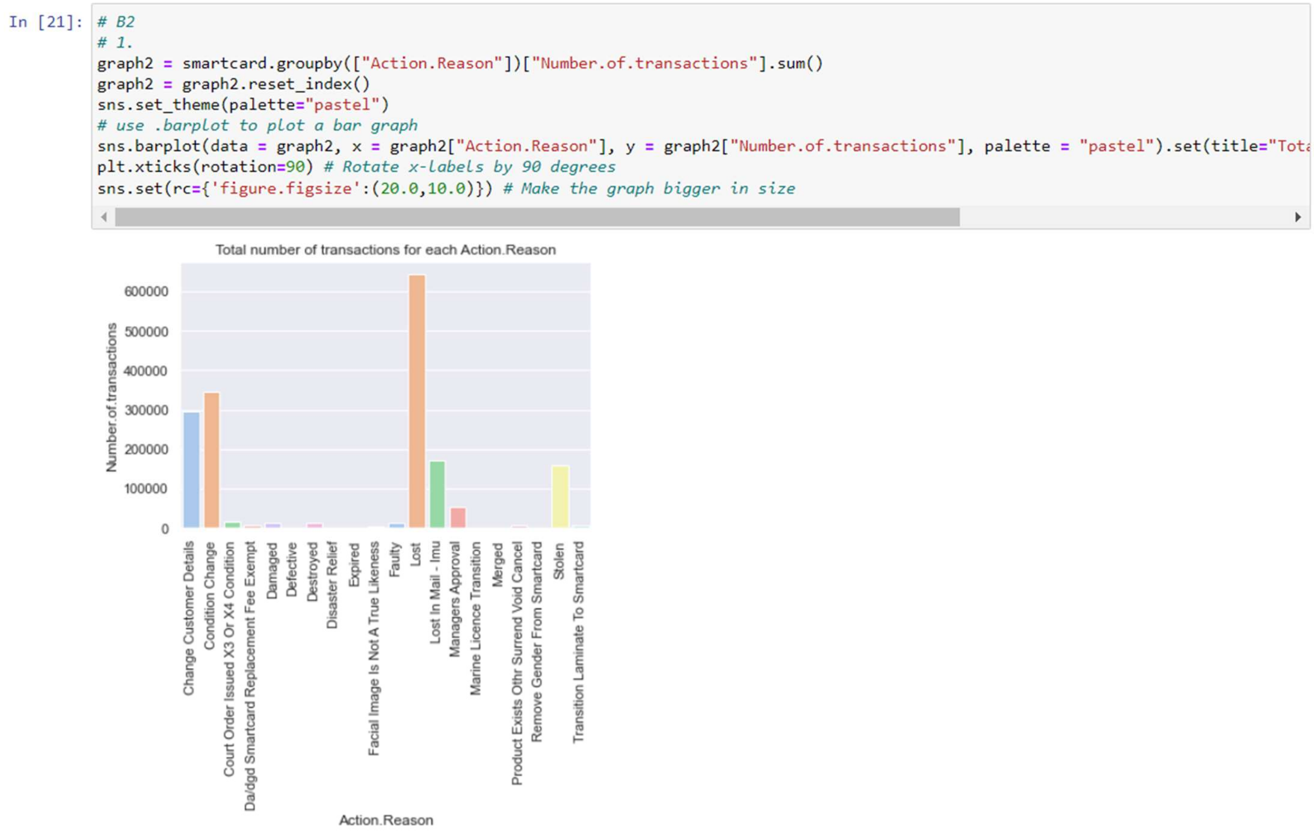


	Action.Reason	Number.of.transactions
0	Change Customer Details	294435
1	Condition Change	344905
2	Court Order Issued X3 Or X4 Condition	17295
3	Da/dgd Smartcard Replacement Fee Exempt	8012
4	Damaged	13027
5	Defective	673
6	Destroyed	14393
7	Disaster Relief	313
8	Expired	2028
9	Facial Image Is Not A True Likeness	4272
10	Faulty	14876
11	Lost	642749
12	Lost In Mail - Imu	172552
13	Managers Approval	52555
14	Marine Licence Transition	1822
15	Merged	507
16	Product Exists Othr Surrend Void Cancel	5628
17	Remove Gender From Smartcard	47
18	Stolen	158356
19	Transition Laminate To Smartcard	7930

3.

14 is the only one between 1000 and 2000. 14 is Marine Licence Transition

CODE:



```
In [21]: # B2
         # 1.
         graph2 = smartcard.groupby(["Action.Reason"])["Number.of.transactions"].sum()
         graph2 = graph2.reset_index()
         sns.set_theme(palette="pastel")
         # use .barplot to plot a bar graph
         sns.barplot(data = graph2, x = graph2["Action.Reason"], y = graph2["Number.of.transactions"], palette = "pastel").set(title="Tota
         plt.xticks(rotation=90) # Rotate x-labels by 90 degrees
         sns.set(rc={'figure.figsize':(20.0,10.0)}) # Make the graph bigger in size
```

Total number of transactions for each Action.Reason
Number.of.transactions
600000
500000
400000
300000
200000
100000
0
Change Customer Details
Condition Change
Court Order Issued X3 Or X4 Condition
Da/dgd Smartcard Replacement Fee Exempt
Damaged
Defective
Destroyed
Disaster Relief
Expired
Facial Image Is Not A True Likeness
Faulty
Lost
Lost In Mail - Imu
Managers Approval
Marine Licence Transition
Merged
Product Exists Othr Surrend Void Cancel
Remove Gender From Smartcard
Stolen
Transition Laminate To Smartcard
Action.Reason

B2

1.

graph2 = smartcard.groupby(["Action.Reason"])["Number.of.transactions"].sum()

graph2 = graph2.reset_index()

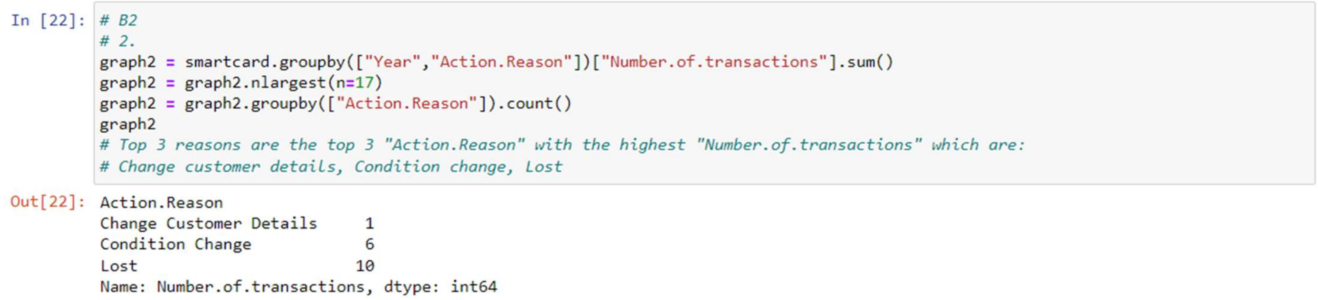
sns.set_theme(palette="pastel")

use .barplot to plot a bar graph

sns.barplot(data = graph2, x = graph2["Action.Reason"], y = graph2["Number.of.transactions"], palette = "pastel").set(title="Total number of transactions for each Action.Reason")

plt.xticks(rotation=90) # Rotate x-labels by 90 degrees

sns.set(rc={'figure.figsize':(20.0,10.0)}) # Make the graph bigger in size



```
In [22]: # B2
         # 2.
         graph2 = smartcard.groupby(["Year","Action.Reason"])["Number.of.transactions"].sum()
         graph2 = graph2.nlargest(n=17)
         graph2 = graph2.groupby(["Action.Reason"]).count()
         graph2
         # Top 3 reasons are the top 3 "Action.Reason" with the highest "Number.of.transactions" which are:
         # Change customer details, Condition change, Lost

Out[22]: Action.Reason
         Change Customer Details     1
         Condition Change            6
         Lost                       10
         Name: Number.of.transactions, dtype: int64
```

B2

2.

graph2 = smartcard.groupby(["Year","Action.Reason"])["Number.of.transactions"].sum()

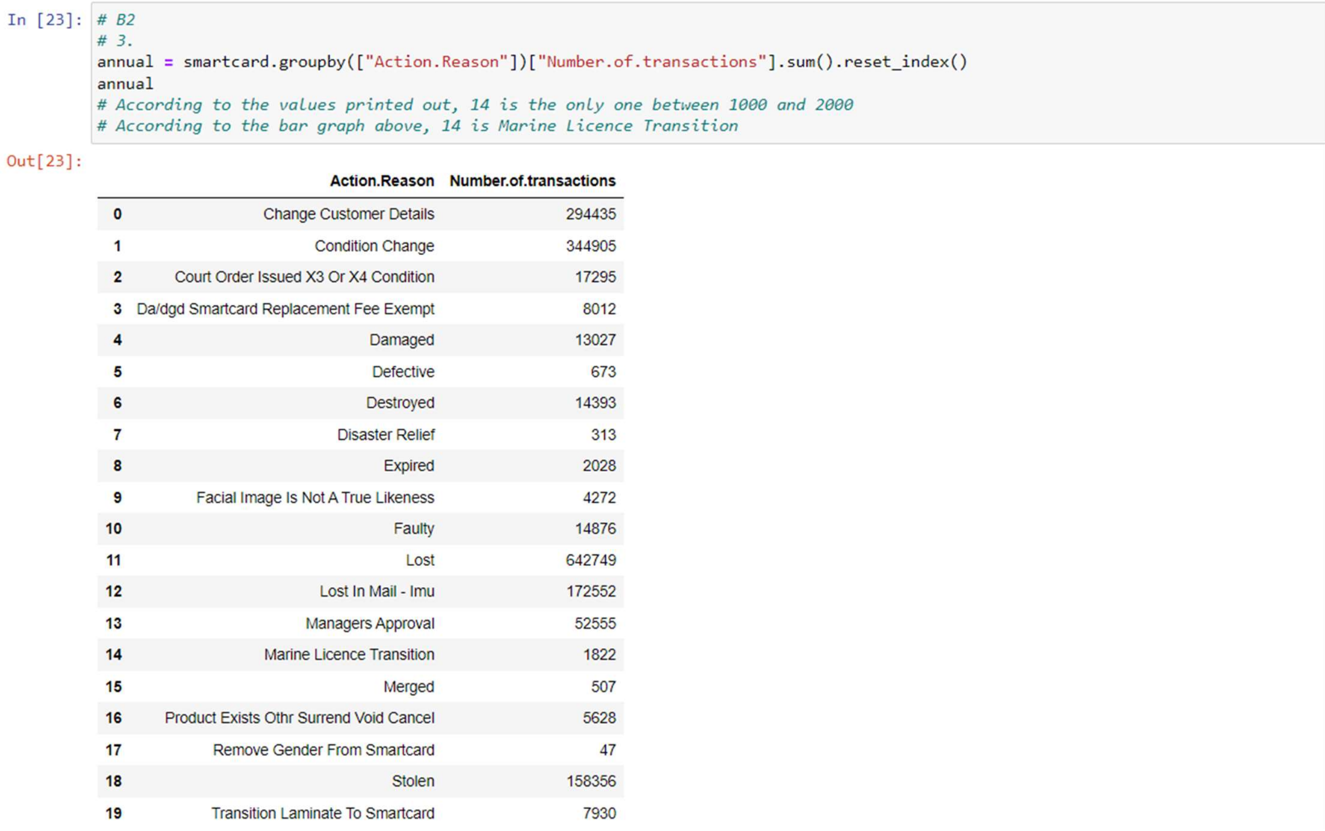
graph2 = graph2.nlargest(n=17)

graph2 = graph2.groupby(["Action.Reason"]).count()

graph2

# Top 3 reasons are the top 3 "Action.Reason" with the highest "Number.of.transactions" which are:

# Change customer details, Condition change, Lost



In [23]:
```
# B2
# 3.
annual = smartcard.groupby(["Action.Reason"])["Number.of.transactions"].sum().reset_index()
annual
# According to the values printed out, 14 is the only one between 1000 and 2000
# According to the bar graph above, 14 is Marine Licence Transition
```

Out[23]:

	Action.Reason	Number.of.transactions
0	Change Customer Details	294435
1	Condition Change	344905
2	Court Order Issued X3 Or X4 Condition	17295
3	Da/dgd Smartcard Replacement Fee Exempt	8012
4	Damaged	13027
5	Defective	673
6	Destroyed	14393
7	Disaster Relief	313
8	Expired	2028
9	Facial Image Is Not A True Likeness	4272
10	Faulty	14876
11	Lost	642749
12	Lost In Mail - Imu	172552
13	Managers Approval	52555
14	Marine Licence Transition	1822
15	Merged	507
16	Product Exists Othr Surrend Void Cancel	5628
17	Remove Gender From Smartcard	47
18	Stolen	158356
19	Transition Laminate To Smartcard	7930

B2

3.

annual = smartcard.groupby(["Action.Reason"])["Number.of.transactions"].sum().reset_index()

annual

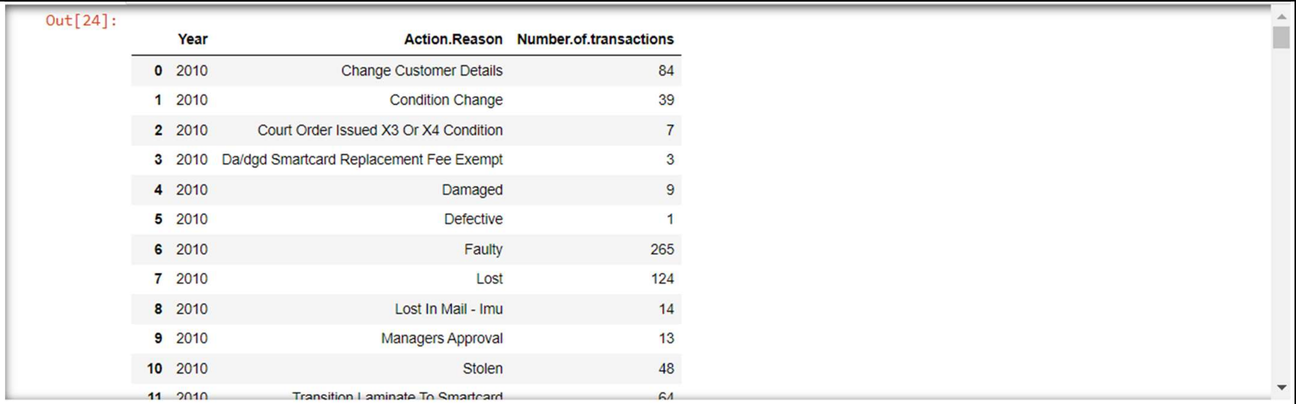
According to the values printed out, 14 is the only one between 1000 and 2000

According to the bar graph above, 14 is Marine Licence Transition

B3

ANSWER:

1.



Out[24]:

	Year	Action.Reason	Number.of.transactions
0	2010	Change Customer Details	84
1	2010	Condition Change	39
2	2010	Court Order Issued X3 Or X4 Condition	7
3	2010	Da/dgd Smartcard Replacement Fee Exempt	3
4	2010	Damaged	9
5	2010	Defective	1
6	2010	Faulty	265
7	2010	Lost	124
8	2010	Lost In Mail - Imu	14
9	2010	Managers Approval	13
10	2010	Stolen	48
11	2010	Transition Laminate To Smartcard	64

Scrollable in the .ipynb file

2.

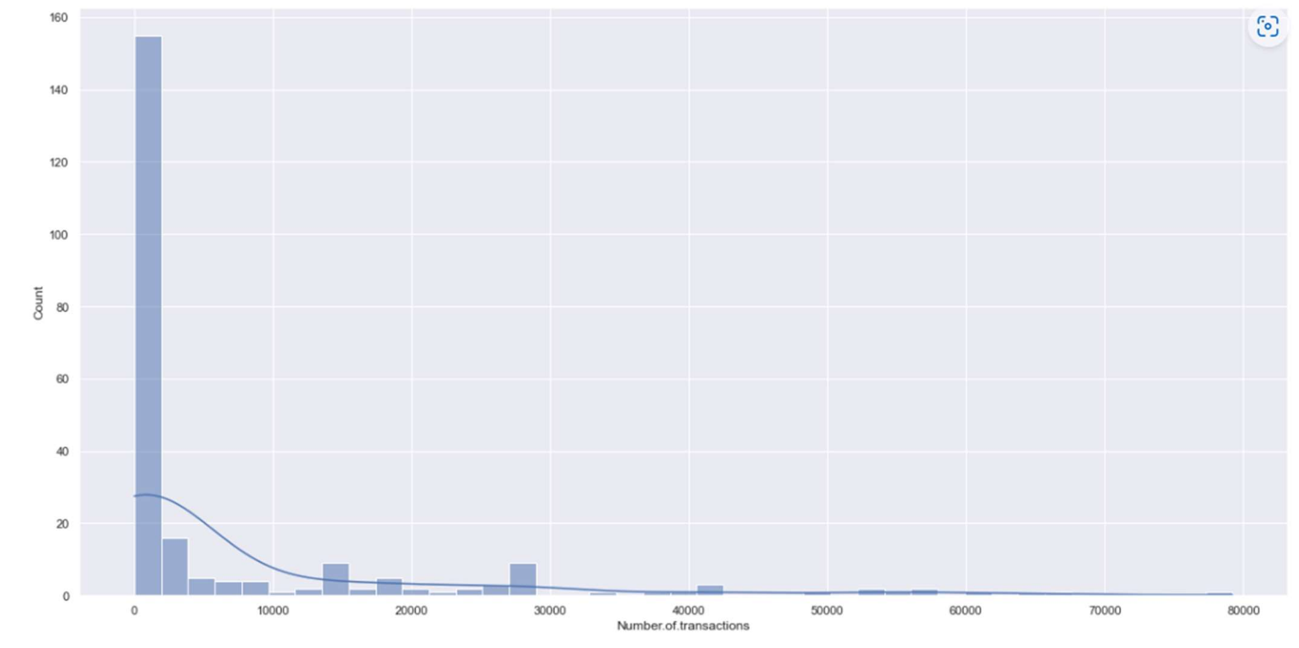
```
Lost                             12
Change Customer Details          11
```

```
Condition Change            11
Stolen                      10
Lost In Mail - Imu           8
```

3.

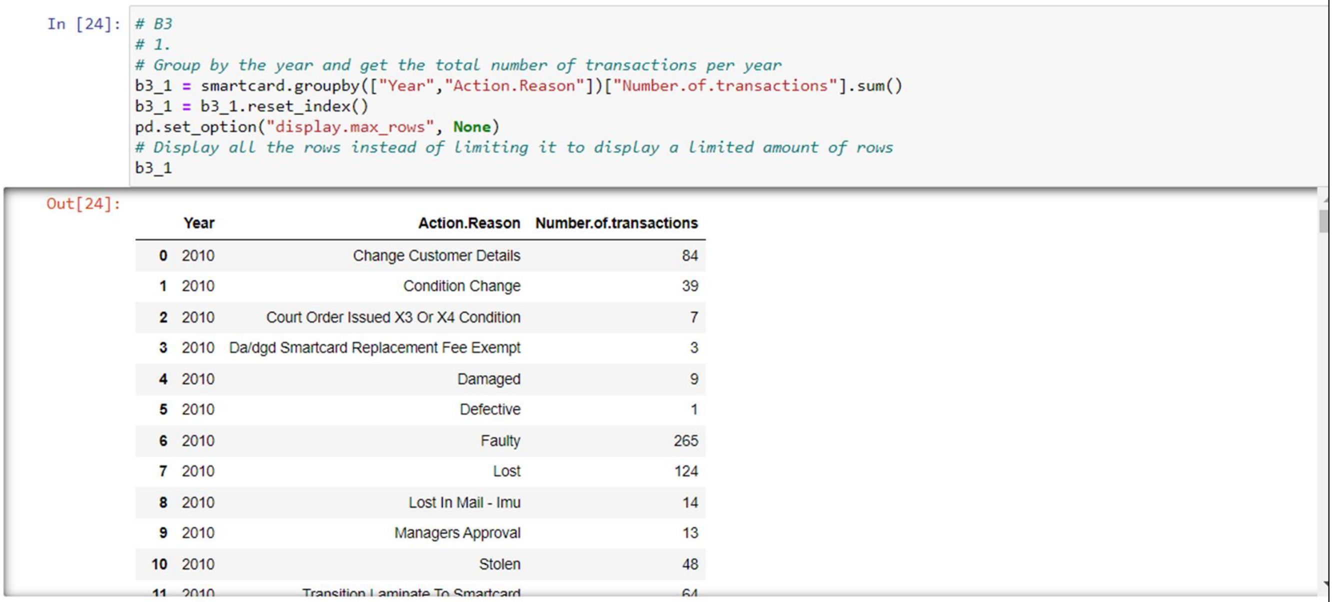
```
['Change Customer Details' 'Condition Change' 'Lost' 'Lost In Mail - Imu' 'Stole
n']
```

4.



5. According to the histogram above, the data is distributed whereby there is a higher density of number of transactions less than 10,000 recorded in the data given when compared to the number of transactions recorded in the data given that is more than 10,000. The histogram above does not show a bell curve in any ways which means that the frequency of the total number of transactions is unequally distributed and hence not a normal distribution. The histogram above has bars that are alternately tall and short with a peak at the start and also a high percentage of the data distribution lied on the right-hand side of the peak as the peak is at 0 to 2000 of number of transactions which is essentially the start of the histogram. This shows that majority of the population only do around 1 to 2000 transaction annually.

CODE:



In [24]:

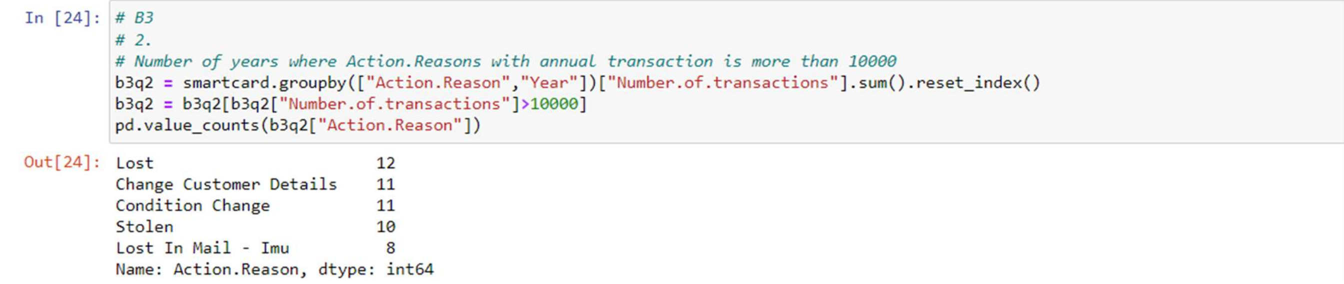
```
# B3
# 1.
# Group by the year and get the total number of transactions per year
b3_1 = smartcard.groupby(["Year","Action.Reason"])["Number.of.transactions"].sum()
b3_1 = b3_1.reset_index()
pd.set_option("display.max_rows", None)
# Display all the rows instead of limiting it to display a limited amount of rows
b3_1
```

Out[24]:

	Year	Action.Reason	Number.of.transactions
0	2010	Change Customer Details	84
1	2010	Condition Change	39
2	2010	Court Order Issued X3 Or X4 Condition	7
3	2010	Da/dgd Smartcard Replacement Fee Exempt	3
4	2010	Damaged	9
5	2010	Defective	1
6	2010	Faulty	265
7	2010	Lost	124
8	2010	Lost In Mail - Imu	14
9	2010	Managers Approval	13
10	2010	Stolen	48
11	2010	Transition Laminate To Smartcard	64

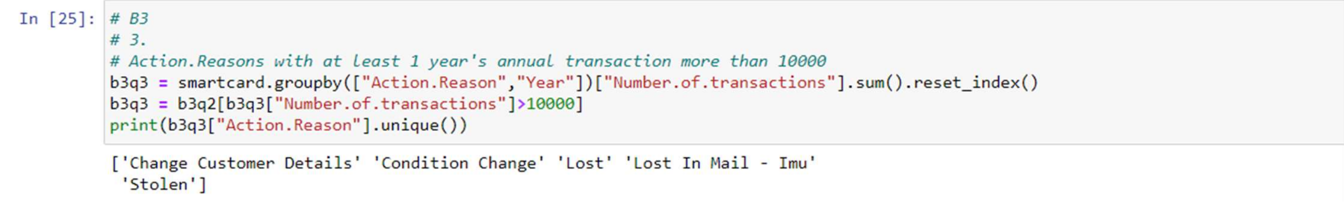
B3

```
# 1.
# Group by the year and get the total number of transactions per year
b3_1 = smartcard.groupby(["Year","Action.Reason"])["Number.of.transactions"].sum()
b3_1 = b3_1.reset_index()
pd.set_option("display.max_rows", None)
# Display all the rows instead of limiting it to display a limited amount of rows
b3_1
```



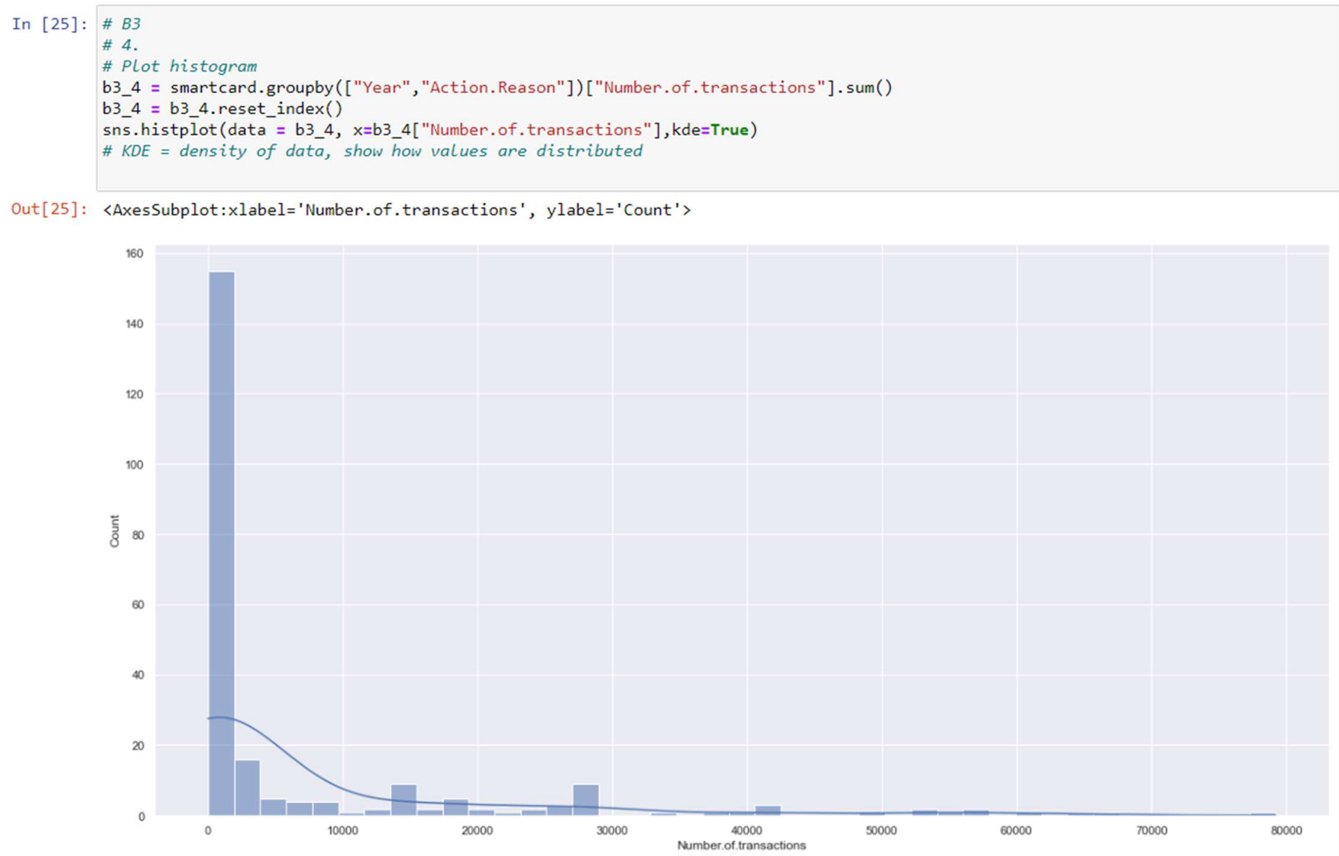
```
In [24]: # B3
         # 2.
         # Number of years where Action.Reasons with annual transaction is more than 10000
         b3q2 = smartcard.groupby(["Action.Reason","Year"])["Number.of.transactions"].sum().reset_index()
         b3q2 = b3q2[b3q2["Number.of.transactions"]>10000]
         pd.value_counts(b3q2["Action.Reason"])

Out[24]: Lost                       12
         Change Customer Details    11
         Condition Change           11
         Stolen                     10
         Lost In Mail - Imu          8
         Name: Action.Reason, dtype: int64
```

```
# B3
# 2.
# Number of years where Action.Reasons with annual transaction is more than 10000
b3q2 = smartcard.groupby(["Action.Reason","Year"])["Number.of.transactions"].sum().reset_index()
b3q2 = b3q2[b3q2["Number.of.transactions"]>10000]
pd.value_counts(b3q2["Action.Reason"])
```



```
In [25]: # B3
         # 3.
         # Action.Reasons with at least 1 year's annual transaction more than 10000
         b3q3 = smartcard.groupby(["Action.Reason","Year"])["Number.of.transactions"].sum().reset_index()
         b3q3 = b3q2[b3q3["Number.of.transactions"]>10000]
         print(b3q3["Action.Reason"].unique())

         ['Change Customer Details' 'Condition Change' 'Lost' 'Lost In Mail - Imu'
          'Stolen']
```

```
# B3
# 3.
# Action.Reasons with at least 1 year's annual transaction more than 10000
b3q3 = smartcard.groupby(["Action.Reason","Year"])["Number.of.transactions"].sum().reset_index()
b3q3 = b3q2[b3q3["Number.of.transactions"]>10000]
print(b3q3["Action.Reason"].unique())
```



```
In [25]: # B3
         # 4.
         # Plot histogram
         b3_4 = smartcard.groupby(["Year","Action.Reason"])["Number.of.transactions"].sum()
         b3_4 = b3_4.reset_index()
         sns.histplot(data = b3_4, x=b3_4["Number.of.transactions"],kde=True)
         # KDE = density of data, show how values are distributed

Out[25]: <AxesSubplot:xlabel='Number.of.transactions', ylabel='Count'>
```

```
# B3
# 4.
# Plot histogram
b3_4 = smartcard.groupby(["Year","Action.Reason"])["Number.of.transactions"].sum()
b3_4 = b3_4.reset_index()
sns.histplot(data = b3_4, x=b3_4["Number.of.transactions"],kde=True)
# KDE = density of data, show how values are distributed
```

--- NO CODE WAS TYPED FOR B3 Q5 ---