Lab-3-Data_Preprocessing

July 15, 2020

Data Preprocessing The sklearn.preprocessing package provides several common utility functions and transformer classes to change raw feature vectors into a representation that is more suitable for the downstream estimators.

1. Data Cleaning

1.1. Handling missing data
1.1.1.Dropping rows that contain missing value
We can drop the rows that contain null or missing data by using dropna(). If we set inplace to True then the original dataset gets modified

```
In [1]: import numpy as np
        import pandas as pd
        df = pd.read_csv('lending_club_loans.csv', low_memory=False)
        df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 42538 entries, 0 to 42537
Columns: 115 entries, id to total_il_high_credit_limit
dtypes: float64(86), object(29)
memory usage: 37.3+ MB
```

```
In [2]: #dropna will not work on NAN and NAT
        df1 = pd.DataFrame({'A':[1,2,3,4,5],'B':[1,2,'NaN',4,5],'C':[1,2,3,'NaT',5]})
        df1.isnull()
```

```
Out[2]:        A      B      C
        0  False  False  False
        1  False  False  False
        2  False  False  False
        3  False  False  False
        4  False  False  False
```

```
In [3]: #therefore replace with ap.nanm
        df1.replace(["NaN", 'NaT'], np.nan, inplace = True)
        df1.isnull()
```

Out[3]:
```
       A      B      C
0  False  False  False
1  False  False  False
2  False   True  False
3  False  False   True
4  False  False  False
```

In [4]:
```
df2= df1.dropna()
df2
```

Out[4]:
```
   A    B    C
0  1  1.0  1.0
1  2  2.0  2.0
4  5  5.0  5.0
```

In [5]:
```
df.isnull()
```

Out[5]:
```
          id  member_id  loan_amnt  funded_amnt  funded_amnt_inv   term  \
0      False      False      False        False            False  False
1      False      False      False        False            False  False
2      False      False      False        False            False  False
3      False      False      False        False            False  False
4      False      False      False        False            False  False
5      False      False      False        False            False  False
6      False      False      False        False            False  False
7      False      False      False        False            False  False
8      False      False      False        False            False  False
9      False      False      False        False            False  False
10     False      False      False        False            False  False
11     False      False      False        False            False  False
12     False      False      False        False            False  False
13     False      False      False        False            False  False
14     False      False      False        False            False  False
15     False      False      False        False            False  False
16     False      False      False        False            False  False
17     False      False      False        False            False  False
18     False      False      False        False            False  False
19     False      False      False        False            False  False
20     False      False      False        False            False  False
21     False      False      False        False            False  False
22     False      False      False        False            False  False
23     False      False      False        False            False  False
24     False      False      False        False            False  False
25     False      False      False        False            False  False
26     False      False      False        False            False  False
27     False      False      False        False            False  False
28     False      False      False        False            False  False
29     False      False      False        False            False  False
...      ...        ...        ...          ...              ...    ...
```

```
42508  False      False      False        False            False  False
42509  False      False      False        False            False  False
42510  False      False      False        False            False  False
42511  False      False      False        False            False  False
42512  False      False      False        False            False  False
42513  False      False      False        False            False  False
42514  False      False      False        False            False  False
42515  False      False      False        False            False  False
42516  False      False      False        False            False  False
42517  False      False      False        False            False  False
42518  False      False      False        False            False  False
42519  False      False      False        False            False  False
42520  False      False      False        False            False  False
42521  False      False      False        False            False  False
42522  False      False      False        False            False  False
42523  False      False      False        False            False  False
42524  False      False      False        False            False  False
42525  False      False      False        False            False  False
42526  False      False      False        False            False  False
42527  False      False      False        False            False  False
42528  False      False      False        False            False  False
42529  False      False      False        False            False  False
42530  False      False      False        False            False  False
42531  False      False      False        False            False  False
42532  False      False      False        False            False  False
42533  False      False      False        False            False  False
42534  False      False      False        False            False  False
42535  False      False      False        False            False  False
42536  False       True       True         True             True   True
42537  False       True       True         True             True   True

       int_rate  installment  grade  sub_grade            ...              \
0         False        False  False      False            ...
1         False        False  False      False            ...
2         False        False  False      False            ...
3         False        False  False      False            ...
4         False        False  False      False            ...
5         False        False  False      False            ...
6         False        False  False      False            ...
7         False        False  False      False            ...
8         False        False  False      False            ...
9         False        False  False      False            ...
10        False        False  False      False            ...
11        False        False  False      False            ...
12        False        False  False      False            ...
13        False        False  False      False            ...
14        False        False  False      False            ...
15        False        False  False      False            ...
```

```
16        False        False  False      False             ...
17        False        False  False      False             ...
18        False        False  False      False             ...
19        False        False  False      False             ...
20        False        False  False      False             ...
21        False        False  False      False             ...
22        False        False  False      False             ...
23        False        False  False      False             ...
24        False        False  False      False             ...
25        False        False  False      False             ...
26        False        False  False      False             ...
27        False        False  False      False             ...
28        False        False  False      False             ...
29        False        False  False      False             ...
...         ...          ...    ...        ...             ...
42508     False        False  False      False             ...
42509     False        False  False      False             ...
42510     False        False  False      False             ...
42511     False        False  False      False             ...
42512     False        False  False      False             ...
42513     False        False  False      False             ...
42514     False        False  False      False             ...
42515     False        False  False      False             ...
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42517     False        False  False      False             ...
42518     False        False  False      False             ...
42519     False        False  False      False             ...
42520     False        False  False      False             ...
42521     False        False  False      False             ...
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42531     False        False  False      False             ...
42532     False        False  False      False             ...
42533     False        False  False      False             ...
42534     False        False  False      False             ...
42535     False        False  False      False             ...
42536      True         True   True       True             ...
42537      True         True   True       True             ...

       num_tl_90g_dpd_24m  num_tl_op_past_12m  pct_tl_nvr_dlq  \
0                    True                True            True
```

1	True	True	True
2	True	True	True
3	True	True	True
4	True	True	True
5	True	True	True
6	True	True	True
7	True	True	True
8	True	True	True
9	True	True	True
10	True	True	True
11	True	True	True
12	True	True	True
13	True	True	True
14	True	True	True
15	True	True	True
16	True	True	True
17	True	True	True
18	True	True	True
19	True	True	True
20	True	True	True
21	True	True	True
22	True	True	True
23	True	True	True
24	True	True	True
25	True	True	True
26	True	True	True
27	True	True	True
28	True	True	True
29	True	True	True
...	...	...	...
42508	True	True	True
42509	True	True	True
42510	True	True	True
42511	True	True	True
42512	True	True	True
42513	True	True	True
42514	True	True	True
42515	True	True	True
42516	True	True	True
42517	True	True	True
42518	True	True	True
42519	True	True	True
42520	True	True	True
42521	True	True	True
42522	True	True	True
42523	True	True	True
42524	True	True	True
42525	True	True	True

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42526                True                True           True
42527                True                True           True
42528                True                True           True
42529                True                True           True
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42531                True                True           True
42532                True                True           True
42533                True                True           True
42534                True                True           True
42535                True                True           True
42536                True                True           True
42537                True                True           True

       percent_bc_gt_75  pub_rec_bankruptcies  tax_liens  tot_hi_cred_lim  \
0                  True                 False      False             True
1                  True                 False      False             True
2                  True                 False      False             True
3                  True                 False      False             True
4                  True                 False      False             True
5                  True                 False      False             True
6                  True                 False      False             True
7                  True                 False      False             True
8                  True                 False      False             True
9                  True                 False      False             True
10                 True                 False      False             True
11                 True                 False      False             True
12                 True                 False      False             True
13                 True                 False      False             True
14                 True                 False      False             True
15                 True                 False      False             True
16                 True                 False      False             True
17                 True                 False      False             True
18                 True                 False      False             True
19                 True                 False      False             True
20                 True                 False      False             True
21                 True                 False      False             True
22                 True                 False      False             True
23                 True                 False      False             True
24                 True                 False      False             True
25                 True                 False      False             True
26                 True                 False      False             True
27                 True                 False      False             True
28                 True                 False      False             True
29                 True                 False      False             True
...                 ...                   ...        ...              ...
42508              True                  True       True             True
42509              True                  True       True             True
42510              True                  True       True             True
```

42511	True	True	True	True
42512	True	True	True	True
42513	True	True	True	True
42514	True	True	True	True
42515	True	True	True	True
42516	True	True	True	True
42517	True	True	True	True
42518	True	True	True	True
42519	True	True	True	True
42520	True	True	True	True
42521	True	True	True	True
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42523	True	True	True	True
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42525	True	True	True	True
42526	True	True	True	True
42527	True	True	True	True
42528	True	True	True	True
42529	True	True	True	True
42530	True	True	True	True
42531	True	True	True	True
42532	True	True	True	True
42533	True	True	True	True
42534	True	True	True	True
42535	True	True	True	True
42536	True	True	True	True
42537	True	True	True	True

	total_bal_ex_mort	total_bc_limit	total_il_high_credit_limit
0	True	True	True
1	True	True	True
2	True	True	True
3	True	True	True
4	True	True	True
5	True	True	True
6	True	True	True
7	True	True	True
8	True	True	True
9	True	True	True
10	True	True	True
11	True	True	True
12	True	True	True
13	True	True	True
14	True	True	True
15	True	True	True
16	True	True	True
17	True	True	True
18	True	True	True

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19                True            True                True
20                True            True                True
21                True            True                True
22                True            True                True
23                True            True                True
24                True            True                True
25                True            True                True
26                True            True                True
27                True            True                True
28                True            True                True
29                True            True                True
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42508             True            True                True
42509             True            True                True
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42531             True            True                True
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42533             True            True                True
42534             True            True                True
42535             True            True                True
42536             True            True                True
42537             True            True                True

[42538 rows x 115 columns]
```

In [6]:
```
# making new data frame with dropped NA values
df.replace(["NaN", 'NaT'], np.nan, inplace = True)
df.isnull()
```

Out[6]:

	id	member_id	loan_amnt	funded_amnt	funded_amnt_inv	term	\
0	False	False	False	False	False	False	
1	False	False	False	False	False	False	
2	False	False	False	False	False	False	
3	False	False	False	False	False	False	
4	False	False	False	False	False	False	
5	False	False	False	False	False	False	
6	False	False	False	False	False	False	
7	False	False	False	False	False	False	
8	False	False	False	False	False	False	
9	False	False	False	False	False	False	
10	False	False	False	False	False	False	
11	False	False	False	False	False	False	
12	False	False	False	False	False	False	
13	False	False	False	False	False	False	
14	False	False	False	False	False	False	
15	False	False	False	False	False	False	
16	False	False	False	False	False	False	
17	False	False	False	False	False	False	
18	False	False	False	False	False	False	
19	False	False	False	False	False	False	
20	False	False	False	False	False	False	
21	False	False	False	False	False	False	
22	False	False	False	False	False	False	
23	False	False	False	False	False	False	
24	False	False	False	False	False	False	
25	False	False	False	False	False	False	
26	False	False	False	False	False	False	
27	False	False	False	False	False	False	
28	False	False	False	False	False	False	
29	False	False	False	False	False	False	
...	...	...	...	...	...	...	
42508	False	False	False	False	False	False	
42509	False	False	False	False	False	False	
42510	False	False	False	False	False	False	
42511	False	False	False	False	False	False	
42512	False	False	False	False	False	False	
42513	False	False	False	False	False	False	
42514	False	False	False	False	False	False	
42515	False	False	False	False	False	False	
42516	False	False	False	False	False	False	
42517	False	False	False	False	False	False	
42518	False	False	False	False	False	False	
42519	False	False	False	False	False	False	
42520	False	False	False	False	False	False	
42521	False	False	False	False	False	False	
42522	False	False	False	False	False	False	
42523	False	False	False	False	False	False	

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42524  False      False      False        False            False  False
42525  False      False      False        False            False  False
42526  False      False      False        False            False  False
42527  False      False      False        False            False  False
42528  False      False      False        False            False  False
42529  False      False      False        False            False  False
42530  False      False      False        False            False  False
42531  False      False      False        False            False  False
42532  False      False      False        False            False  False
42533  False      False      False        False            False  False
42534  False      False      False        False            False  False
42535  False      False      False        False            False  False
42536  False       True       True         True             True   True
42537  False       True       True         True             True   True

       int_rate  installment  grade  sub_grade            ...             \
0         False        False  False      False            ...
1         False        False  False      False            ...
2         False        False  False      False            ...
3         False        False  False      False            ...
4         False        False  False      False            ...
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23        False        False  False      False            ...
24        False        False  False      False            ...
25        False        False  False      False            ...
26        False        False  False      False            ...
27        False        False  False      False            ...
28        False        False  False      False            ...
29        False        False  False      False            ...
...         ...          ...    ...        ...            ...
42508     False        False  False      False            ...
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42509     False        False  False      False            ...
42510     False        False  False      False            ...
42511     False        False  False      False            ...
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42519     False        False  False      False            ...
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42522     False        False  False      False            ...
42523     False        False  False      False            ...
42524     False        False  False      False            ...
42525     False        False  False      False            ...
42526     False        False  False      False            ...
42527     False        False  False      False            ...
42528     False        False  False      False            ...
42529     False        False  False      False            ...
42530     False        False  False      False            ...
42531     False        False  False      False            ...
42532     False        False  False      False            ...
42533     False        False  False      False            ...
42534     False        False  False      False            ...
42535     False        False  False      False            ...
42536      True         True   True       True            ...
42537      True         True   True       True            ...

       num_tl_90g_dpd_24m  num_tl_op_past_12m  pct_tl_nvr_dlq  \
0                    True                True            True
1                    True                True            True
2                    True                True            True
3                    True                True            True
4                    True                True            True
5                    True                True            True
6                    True                True            True
7                    True                True            True
8                    True                True            True
9                    True                True            True
10                   True                True            True
11                   True                True            True
12                   True                True            True
13                   True                True            True
14                   True                True            True
15                   True                True            True
16                   True                True            True
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17                 True                True           True
18                 True                True           True
19                 True                True           True
20                 True                True           True
21                 True                True           True
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23                 True                True           True
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25                 True                True           True
26                 True                True           True
27                 True                True           True
28                 True                True           True
29                 True                True           True
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42508              True                True           True
42509              True                True           True
42510              True                True           True
42511              True                True           True
42512              True                True           True
42513              True                True           True
42514              True                True           True
42515              True                True           True
42516              True                True           True
42517              True                True           True
42518              True                True           True
42519              True                True           True
42520              True                True           True
42521              True                True           True
42522              True                True           True
42523              True                True           True
42524              True                True           True
42525              True                True           True
42526              True                True           True
42527              True                True           True
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42529              True                True           True
42530              True                True           True
42531              True                True           True
42532              True                True           True
42533              True                True           True
42534              True                True           True
42535              True                True           True
42536              True                True           True
42537              True                True           True

       percent_bc_gt_75  pub_rec_bankruptcies  tax_liens  tot_hi_cred_lim  \
0                  True                 False      False             True
1                  True                 False      False             True
```

2	True	False	False	True
3	True	False	False	True
4	True	False	False	True
5	True	False	False	True
6	True	False	False	True
7	True	False	False	True
8	True	False	False	True
9	True	False	False	True
10	True	False	False	True
11	True	False	False	True
12	True	False	False	True
13	True	False	False	True
14	True	False	False	True
15	True	False	False	True
16	True	False	False	True
17	True	False	False	True
18	True	False	False	True
19	True	False	False	True
20	True	False	False	True
21	True	False	False	True
22	True	False	False	True
23	True	False	False	True
24	True	False	False	True
25	True	False	False	True
26	True	False	False	True
27	True	False	False	True
28	True	False	False	True
29	True	False	False	True
...	...	...	...	...
42508	True	True	True	True
42509	True	True	True	True
42510	True	True	True	True
42511	True	True	True	True
42512	True	True	True	True
42513	True	True	True	True
42514	True	True	True	True
42515	True	True	True	True
42516	True	True	True	True
42517	True	True	True	True
42518	True	True	True	True
42519	True	True	True	True
42520	True	True	True	True
42521	True	True	True	True
42522	True	True	True	True
42523	True	True	True	True
42524	True	True	True	True
42525	True	True	True	True
42526	True	True	True	True

42527	True	True	True	True
42528	True	True	True	True
42529	True	True	True	True
42530	True	True	True	True
42531	True	True	True	True
42532	True	True	True	True
42533	True	True	True	True
42534	True	True	True	True
42535	True	True	True	True
42536	True	True	True	True
42537	True	True	True	True

	total_bal_ex_mort	total_bc_limit	total_il_high_credit_limit
0	True	True	True
1	True	True	True
2	True	True	True
3	True	True	True
4	True	True	True
5	True	True	True
6	True	True	True
7	True	True	True
8	True	True	True
9	True	True	True
10	True	True	True
11	True	True	True
12	True	True	True
13	True	True	True
14	True	True	True
15	True	True	True
16	True	True	True
17	True	True	True
18	True	True	True
19	True	True	True
20	True	True	True
21	True	True	True
22	True	True	True
23	True	True	True
24	True	True	True
25	True	True	True
26	True	True	True
27	True	True	True
28	True	True	True
29	True	True	True
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42508	True	True	True
42509	True	True	True
42510	True	True	True
42511	True	True	True

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42512                True                True                True
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42517                True                True                True
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42519                True                True                True
42520                True                True                True
42521                True                True                True
42522                True                True                True
42523                True                True                True
42524                True                True                True
42525                True                True                True
42526                True                True                True
42527                True                True                True
42528                True                True                True
42529                True                True                True
42530                True                True                True
42531                True                True                True
42532                True                True                True
42533                True                True                True
42534                True                True                True
42535                True                True                True
42536                True                True                True
42537                True                True                True

[42538 rows x 115 columns]
```

```
In [7]: new_df = df.dropna(axis=0,how='any')

        # comparing sizes of data frames
        print("Old data frame length:", len(df), "\nNew data frame length:",
              len(new_df), "\nNumber of rows with at least 1 NA value: ",
              (len(df)-len(new_df)))
```

```
Old data frame length: 42538
New data frame length: 0
Number of rows with at least 1 NA value:  42538
```

Always dropping rows that contain any null values may not be a good strategy as we may miss the randomness is the dataset So, what is the next best option to handle missing value?

1.1.2. Setting threshold for null values in a row

we can set a threshold count and if a rows exceeds the threshold count for null values then we can drop the row. We will drop a row from data_1 only if a row contains 50% of the data as null values

In [8]:
```
half_count = len(df) / 2
df.dropna(thresh=half_count, axis=1,inplace=True) # Drop any column with more than 50%
df
```

Out[8]:

	id	member_id	loan_amnt	\
0	1077501	1296599.0	5000.0	
1	1077430	1314167.0	2500.0	
2	1077175	1313524.0	2400.0	
3	1076863	1277178.0	10000.0	
4	1075358	1311748.0	3000.0	
5	1075269	1311441.0	5000.0	
6	1069639	1304742.0	7000.0	
7	1072053	1288686.0	3000.0	
8	1071795	1306957.0	5600.0	
9	1071570	1306721.0	5375.0	
10	1070078	1305201.0	6500.0	
11	1069908	1305008.0	12000.0	
12	1064687	1298717.0	9000.0	
13	1069866	1304956.0	3000.0	
14	1069057	1303503.0	10000.0	
15	1069759	1304871.0	1000.0	
16	1065775	1299699.0	10000.0	
17	1069971	1304884.0	3600.0	
18	1062474	1294539.0	6000.0	
19	1069742	1304855.0	9200.0	
20	1069740	1284848.0	20250.0	
21	1039153	1269083.0	21000.0	
22	1069710	1304821.0	10000.0	
23	1069700	1304810.0	10000.0	
24	1069559	1304634.0	6000.0	
25	1069697	1273773.0	15000.0	
26	1069800	1304679.0	15000.0	
27	1069657	1304764.0	5000.0	
28	1069799	1304678.0	4000.0	
29	1047704	1278806.0	8500.0	
...	...	...	...	
42508	91175	91170.0	6000.0	
42509	91126	91067.0	5350.0	
42510	91023	70879.0	1900.0	
42511	90106	90090.0	10000.0	
42512	89258	80039.0	2000.0	
42513	88637	88629.0	6000.0	
42514	88046	88023.0	4400.0	
42515	85961	85923.0	1200.0	
42516	85818	85802.0	5000.0	
42517	85781	85727.0	1400.0	
42518	85675	85667.0	1000.0	
42519	84670	79576.0	5000.0	

```
42520                                                 84098    84091.0     2500.0
42521                                                 83979    83974.0     3000.0
42522                                                 83489    83471.0     2600.0
42523                                                 83185    83132.0     1000.0
42524                                                 76629    76623.0     1275.0
42525                                                 74014    73890.0     6450.0
42526                                                 81085    80973.0    10500.0
42527                                                 77792    77764.0     3000.0
42528                                                 77757    70626.0     3000.0
42529                                                 74505    74469.0     2000.0
42530                                                 74323    74301.0     6500.0
42531                                                 73582    73096.0     3500.0
42532                                                 72998    72992.0     1000.0
42533                                                 72176    70868.0     2525.0
42534                                                 71623    70735.0     6500.0
42535                                                 70686    70681.0     5000.0
42536  Total amount funded in policy code 1: 460296150        NaN        NaN
42537         Total amount funded in policy code 2: 0        NaN        NaN

       funded_amnt  funded_amnt_inv        term int_rate  installment grade  \
0           5000.0      4975.000000   36 months   10.65%       162.87     B
1           2500.0      2500.000000   60 months   15.27%        59.83     C
2           2400.0      2400.000000   36 months   15.96%        84.33     C
3          10000.0     10000.000000   36 months   13.49%       339.31     C
4           3000.0      3000.000000   60 months   12.69%        67.79     B
5           5000.0      5000.000000   36 months    7.90%       156.46     A
6           7000.0      7000.000000   60 months   15.96%       170.08     C
7           3000.0      3000.000000   36 months   18.64%       109.43     E
8           5600.0      5600.000000   60 months   21.28%       152.39     F
9           5375.0      5350.000000   60 months   12.69%       121.45     B
10          6500.0      6500.000000   60 months   14.65%       153.45     C
11         12000.0     12000.000000   36 months   12.69%       402.54     B
12          9000.0      9000.000000   36 months   13.49%       305.38     C
13          3000.0      3000.000000   36 months    9.91%        96.68     B
14         10000.0     10000.000000   36 months   10.65%       325.74     B
15          1000.0      1000.000000   36 months   16.29%        35.31     D
16         10000.0     10000.000000   36 months   15.27%       347.98     C
17          3600.0      3600.000000   36 months    6.03%       109.57     A
18          6000.0      6000.000000   36 months   11.71%       198.46     B
19          9200.0      9200.000000   36 months    6.03%       280.01     A
20         20250.0     19142.161077   60 months   15.27%       484.63     C
21         21000.0     21000.000000   36 months   12.42%       701.73     B
22         10000.0     10000.000000   36 months   11.71%       330.76     B
23         10000.0     10000.000000   36 months   11.71%       330.76     B
24          6000.0      6000.000000   36 months   11.71%       198.46     B
25         15000.0     15000.000000   36 months    9.91%       483.38     B
26         15000.0      8725.000000   36 months   14.27%       514.64     C
27          5000.0      5000.000000   60 months   16.77%       123.65     D
```

```
28          4000.0      4000.000000   36 months   11.71%       132.31     B
29          8500.0      8500.000000   36 months   11.71%       281.15     B
...            ...              ...         ...      ...          ...   ...
42508       6000.0      1200.000000   36 months   13.12%       202.51     D
42509       5350.0       625.000000   36 months   13.12%       180.57     D
42510       1900.0       900.000000   36 months    9.64%        61.00     B
42511      10000.0       350.000000   36 months   14.70%       345.18     E
42512       2000.0      1275.000000   36 months    7.12%        61.87     A
42513       6000.0       650.000000   36 months   10.59%       195.28     C
42514       4400.0      1400.000000   36 months    9.64%       141.25     B
42515       1200.0       500.000000   36 months    9.01%        38.17     B
42516       5000.0       375.000000   36 months   11.22%       164.23     C
42517       1400.0       475.000000   36 months   10.91%        45.78     C
42518       1000.0       625.000000   36 months   14.07%        34.21     E
42519       5000.0       300.000000   36 months    7.75%       156.11     A
42520       2500.0       225.000000   36 months    7.43%        77.69     A
42521       3000.0       250.000000   36 months    7.43%        93.23     A
42522       2600.0       575.000000   36 months    8.38%        81.94     A
42523       1000.0       625.000000   36 months    7.12%        30.94     A
42524       1275.0         0.000000   36 months   12.49%        42.65     D
42525       6450.0         0.000000   36 months   11.22%       211.85     C
42526      10500.0       275.000000   36 months   11.22%       344.87     C
42527       3000.0       125.000000   36 months    9.01%        95.42     B
42528       3000.0         0.000000   36 months    9.33%        95.86     B
42529       2000.0       225.000000   36 months    9.96%        64.50     B
42530       6500.0         0.000000   36 months    9.64%       208.66     B
42531       3500.0       225.000000   36 months   10.28%       113.39     C
42532       1000.0         0.000000   36 months    9.64%        32.11     B
42533       2525.0       225.000000   36 months    9.33%        80.69     B
42534       6500.0         0.000000   36 months    8.38%       204.84     A
42535       5000.0         0.000000   36 months    7.75%       156.11     A
42536          NaN              NaN         NaN      NaN          NaN   NaN
42537          NaN              NaN         NaN      NaN          NaN   NaN

      sub_grade    ...    last_fico_range_high last_fico_range_low  \
0            B2    ...                   744.0               740.0
1            C4    ...                   499.0                 0.0
2            C5    ...                   719.0               715.0
3            C1    ...                   604.0               600.0
4            B5    ...                   694.0               690.0
5            A4    ...                   679.0               675.0
6            C5    ...                   654.0               650.0
7            E1    ...                   689.0               685.0
8            F2    ...                   499.0                 0.0
9            B5    ...                   519.0               515.0
10           C3    ...                   734.0               730.0
11           B5    ...                   669.0               665.0
12           C1    ...                   619.0               615.0
```

13	B1	...	734.0	730.0
14	B2	...	654.0	650.0
15	D1	...	769.0	765.0
16	C4	...	639.0	635.0
17	A1	...	794.0	790.0
18	B3	...	559.0	555.0
19	A1	...	644.0	640.0
20	C4	...	684.0	680.0
21	B4	...	534.0	530.0
22	B3	...	779.0	775.0
23	B3	...	684.0	680.0
24	B3	...	499.0	0.0
25	B1	...	734.0	730.0
26	C2	...	509.0	505.0
27	D2	...	579.0	575.0
28	B3	...	689.0	685.0
29	B3	...	599.0	595.0
...	...	...	...	...
42508	D5	...	664.0	660.0
42509	D5	...	704.0	700.0
42510	B4	...	709.0	705.0
42511	E5	...	499.0	0.0
42512	A1	...	809.0	805.0
42513	C2	...	769.0	765.0
42514	B4	...	584.0	580.0
42515	B2	...	694.0	690.0
42516	C4	...	679.0	675.0
42517	C3	...	679.0	675.0
42518	E3	...	499.0	0.0
42519	A3	...	759.0	755.0
42520	A2	...	789.0	785.0
42521	A2	...	799.0	795.0
42522	A5	...	614.0	610.0
42523	A1	...	599.0	595.0
42524	D3	...	624.0	620.0
42525	C4	...	574.0	570.0
42526	C4	...	744.0	740.0
42527	B2	...	594.0	590.0
42528	B3	...	714.0	710.0
42529	B5	...	594.0	590.0
42530	B4	...	684.0	680.0
42531	C1	...	819.0	815.0
42532	B4	...	784.0	780.0
42533	B3	...	714.0	710.0
42534	A5	...	724.0	720.0
42535	A3	...	794.0	790.0
42536	NaN	...	NaN	NaN
42537	NaN	...	NaN	NaN

	collections_12_mths_ex_med	policy_code	application_type	acc_now_delinq	\
0	False	True	INDIVIDUAL	False	
1	False	True	INDIVIDUAL	False	
2	False	True	INDIVIDUAL	False	
3	False	True	INDIVIDUAL	False	
4	False	True	INDIVIDUAL	False	
5	False	True	INDIVIDUAL	False	
6	False	True	INDIVIDUAL	False	
7	False	True	INDIVIDUAL	False	
8	False	True	INDIVIDUAL	False	
9	False	True	INDIVIDUAL	False	
10	False	True	INDIVIDUAL	False	
11	False	True	INDIVIDUAL	False	
12	False	True	INDIVIDUAL	False	
13	False	True	INDIVIDUAL	False	
14	False	True	INDIVIDUAL	False	
15	False	True	INDIVIDUAL	False	
16	False	True	INDIVIDUAL	False	
17	False	True	INDIVIDUAL	False	
18	False	True	INDIVIDUAL	False	
19	False	True	INDIVIDUAL	False	
20	False	True	INDIVIDUAL	False	
21	False	True	INDIVIDUAL	False	
22	False	True	INDIVIDUAL	False	
23	False	True	INDIVIDUAL	False	
24	False	True	INDIVIDUAL	False	
25	False	True	INDIVIDUAL	False	
26	False	True	INDIVIDUAL	False	
27	False	True	INDIVIDUAL	False	
28	False	True	INDIVIDUAL	False	
29	False	True	INDIVIDUAL	False	
...	...	...	...	...	
42508	NaN	True	INDIVIDUAL	False	
42509	NaN	True	INDIVIDUAL	False	
42510	NaN	True	INDIVIDUAL	NaN	
42511	NaN	True	INDIVIDUAL	False	
42512	NaN	True	INDIVIDUAL	False	
42513	NaN	True	INDIVIDUAL	False	
42514	NaN	True	INDIVIDUAL	False	
42515	NaN	True	INDIVIDUAL	NaN	
42516	NaN	True	INDIVIDUAL	NaN	
42517	NaN	True	INDIVIDUAL	NaN	
42518	NaN	True	INDIVIDUAL	NaN	
42519	NaN	True	INDIVIDUAL	NaN	
42520	NaN	True	INDIVIDUAL	NaN	
42521	NaN	True	INDIVIDUAL	NaN	
42522	NaN	True	INDIVIDUAL	NaN	

42523	NaN	True	INDIVIDUAL	NaN
42524	NaN	True	INDIVIDUAL	NaN
42525	NaN	True	INDIVIDUAL	NaN
42526	NaN	True	INDIVIDUAL	NaN
42527	NaN	True	INDIVIDUAL	NaN
42528	NaN	True	INDIVIDUAL	NaN
42529	NaN	True	INDIVIDUAL	NaN
42530	NaN	True	INDIVIDUAL	NaN
42531	NaN	True	INDIVIDUAL	NaN
42532	NaN	True	INDIVIDUAL	NaN
42533	NaN	True	INDIVIDUAL	NaN
42534	NaN	True	INDIVIDUAL	NaN
42535	NaN	True	INDIVIDUAL	NaN
42536	NaN	NaN	NaN	NaN
42537	NaN	NaN	NaN	NaN

	chargeoff_within_12_mths	delinq_amnt	pub_rec_bankruptcies	tax_liens
0	False	0.0	0.0	False
1	False	0.0	0.0	False
2	False	0.0	0.0	False
3	False	0.0	0.0	False
4	False	0.0	0.0	False
5	False	0.0	0.0	False
6	False	0.0	0.0	False
7	False	0.0	0.0	False
8	False	0.0	0.0	False
9	False	0.0	0.0	False
10	False	0.0	0.0	False
11	False	0.0	0.0	False
12	False	0.0	0.0	False
13	False	0.0	0.0	False
14	False	0.0	0.0	False
15	False	0.0	0.0	False
16	False	0.0	0.0	False
17	False	0.0	0.0	False
18	False	0.0	0.0	False
19	False	0.0	0.0	False
20	False	0.0	0.0	False
21	False	0.0	0.0	False
22	False	0.0	0.0	False
23	False	0.0	0.0	False
24	False	0.0	0.0	False
25	False	0.0	0.0	False
26	False	0.0	0.0	False
27	False	0.0	0.0	False
28	False	0.0	0.0	False
29	False	0.0	0.0	False
...	...	...	...	...

```
42508                    NaN         0.0                  NaN       NaN
42509                    NaN         0.0                  NaN       NaN
42510                    NaN         NaN                  NaN       NaN
42511                    NaN         0.0                  NaN       NaN
42512                    NaN         0.0                  NaN       NaN
42513                    NaN         0.0                  NaN       NaN
42514                    NaN         0.0                  NaN       NaN
42515                    NaN         NaN                  NaN       NaN
42516                    NaN         NaN                  NaN       NaN
42517                    NaN         NaN                  NaN       NaN
42518                    NaN         NaN                  NaN       NaN
42519                    NaN         NaN                  NaN       NaN
42520                    NaN         NaN                  NaN       NaN
42521                    NaN         NaN                  NaN       NaN
42522                    NaN         NaN                  NaN       NaN
42523                    NaN         NaN                  NaN       NaN
42524                    NaN         NaN                  NaN       NaN
42525                    NaN         NaN                  NaN       NaN
42526                    NaN         NaN                  NaN       NaN
42527                    NaN         NaN                  NaN       NaN
42528                    NaN         NaN                  NaN       NaN
42529                    NaN         NaN                  NaN       NaN
42530                    NaN         NaN                  NaN       NaN
42531                    NaN         NaN                  NaN       NaN
42532                    NaN         NaN                  NaN       NaN
42533                    NaN         NaN                  NaN       NaN
42534                    NaN         NaN                  NaN       NaN
42535                    NaN         NaN                  NaN       NaN
42536                    NaN         NaN                  NaN       NaN
42537                    NaN         NaN                  NaN       NaN

[42538 rows x 58 columns]
```

What if I do not want to drop any rows with missing data instead fill it with more meaning value?

1.1.3 Filling Missing data with Value There are different ways we can fill the missing data with some meaningful values like mean or median or most frequently value available in the column. One of the method is to use fillna() by specifying how we want to fill the null or missing values.

```
In [9]: #fill with mean
        df['loan_amnt'].fillna(df['loan_amnt'].mean(), inplace = True)
        df

Out[9]:                                                    id  member_id  \
        0                                             1077501  1296599.0
        1                                             1077430  1314167.0
        2                                             1077175  1313524.0
        3                                             1076863  1277178.0
```

4	1075358	1311748.0
5	1075269	1311441.0
6	1069639	1304742.0
7	1072053	1288686.0
8	1071795	1306957.0
9	1071570	1306721.0
10	1070078	1305201.0
11	1069908	1305008.0
12	1064687	1298717.0
13	1069866	1304956.0
14	1069057	1303503.0
15	1069759	1304871.0
16	1065775	1299699.0
17	1069971	1304884.0
18	1062474	1294539.0
19	1069742	1304855.0
20	1069740	1284848.0
21	1039153	1269083.0
22	1069710	1304821.0
23	1069700	1304810.0
24	1069559	1304634.0
25	1069697	1273773.0
26	1069800	1304679.0
27	1069657	1304764.0
28	1069799	1304678.0
29	1047704	1278806.0
...	...	...
42508	91175	91170.0
42509	91126	91067.0
42510	91023	70879.0
42511	90106	90090.0
42512	89258	80039.0
42513	88637	88629.0
42514	88046	88023.0
42515	85961	85923.0
42516	85818	85802.0
42517	85781	85727.0
42518	85675	85667.0
42519	84670	79576.0
42520	84098	84091.0
42521	83979	83974.0
42522	83489	83471.0
42523	83185	83132.0
42524	76629	76623.0
42525	74014	73890.0
42526	81085	80973.0
42527	77792	77764.0
42528	77757	70626.0

```
42529                                                 74505    74469.0
42530                                                 74323    74301.0
42531                                                 73582    73096.0
42532                                                 72998    72992.0
42533                                                 72176    70868.0
42534                                                 71623    70735.0
42535                                                 70686    70681.0
42536  Total amount funded in policy code 1: 460296150        NaN
42537          Total amount funded in policy code 2: 0        NaN

          loan_amnt  funded_amnt  funded_amnt_inv        term int_rate  \
0       5000.000000       5000.0      4975.000000   36 months   10.65%
1       2500.000000       2500.0      2500.000000   60 months   15.27%
2       2400.000000       2400.0      2400.000000   36 months   15.96%
3      10000.000000      10000.0     10000.000000   36 months   13.49%
4       3000.000000       3000.0      3000.000000   60 months   12.69%
5       5000.000000       5000.0      5000.000000   36 months    7.90%
6       7000.000000       7000.0      7000.000000   60 months   15.96%
7       3000.000000       3000.0      3000.000000   36 months   18.64%
8       5600.000000       5600.0      5600.000000   60 months   21.28%
9       5375.000000       5375.0      5350.000000   60 months   12.69%
10      6500.000000       6500.0      6500.000000   60 months   14.65%
11     12000.000000      12000.0     12000.000000   36 months   12.69%
12      9000.000000       9000.0      9000.000000   36 months   13.49%
13      3000.000000       3000.0      3000.000000   36 months    9.91%
14     10000.000000      10000.0     10000.000000   36 months   10.65%
15      1000.000000       1000.0      1000.000000   36 months   16.29%
16     10000.000000      10000.0     10000.000000   36 months   15.27%
17      3600.000000       3600.0      3600.000000   36 months    6.03%
18      6000.000000       6000.0      6000.000000   36 months   11.71%
19      9200.000000       9200.0      9200.000000   36 months    6.03%
20     20250.000000      20250.0     19142.161077   60 months   15.27%
21     21000.000000      21000.0     21000.000000   36 months   12.42%
22     10000.000000      10000.0     10000.000000   36 months   11.71%
23     10000.000000      10000.0     10000.000000   36 months   11.71%
24      6000.000000       6000.0      6000.000000   36 months   11.71%
25     15000.000000      15000.0     15000.000000   36 months    9.91%
26     15000.000000      15000.0      8725.000000   36 months   14.27%
27      5000.000000       5000.0      5000.000000   60 months   16.77%
28      4000.000000       4000.0      4000.000000   36 months   11.71%
29      8500.000000       8500.0      8500.000000   36 months   11.71%
...             ...          ...              ...         ...      ...
42508   6000.000000       6000.0      1200.000000   36 months   13.12%
42509   5350.000000       5350.0       625.000000   36 months   13.12%
42510   1900.000000       1900.0       900.000000   36 months    9.64%
42511  10000.000000      10000.0       350.000000   36 months   14.70%
42512   2000.000000       2000.0      1275.000000   36 months    7.12%
42513   6000.000000       6000.0       650.000000   36 months   10.59%
```

```
42514   4400.000000       4400.0      1400.000000   36 months    9.64%
42515   1200.000000       1200.0       500.000000   36 months    9.01%
42516   5000.000000       5000.0       375.000000   36 months   11.22%
42517   1400.000000       1400.0       475.000000   36 months   10.91%
42518   1000.000000       1000.0       625.000000   36 months   14.07%
42519   5000.000000       5000.0       300.000000   36 months    7.75%
42520   2500.000000       2500.0       225.000000   36 months    7.43%
42521   3000.000000       3000.0       250.000000   36 months    7.43%
42522   2600.000000       2600.0       575.000000   36 months    8.38%
42523   1000.000000       1000.0       625.000000   36 months    7.12%
42524   1275.000000       1275.0         0.000000   36 months   12.49%
42525   6450.000000       6450.0         0.000000   36 months   11.22%
42526  10500.000000      10500.0       275.000000   36 months   11.22%
42527   3000.000000       3000.0       125.000000   36 months    9.01%
42528   3000.000000       3000.0         0.000000   36 months    9.33%
42529   2000.000000       2000.0       225.000000   36 months    9.96%
42530   6500.000000       6500.0         0.000000   36 months    9.64%
42531   3500.000000       3500.0       225.000000   36 months   10.28%
42532   1000.000000       1000.0         0.000000   36 months    9.64%
42533   2525.000000       2525.0       225.000000   36 months    9.33%
42534   6500.000000       6500.0         0.000000   36 months    8.38%
42535   5000.000000       5000.0         0.000000   36 months    7.75%
42536  11089.722581          NaN              NaN         NaN      NaN
42537  11089.722581          NaN              NaN         NaN      NaN

       installment grade sub_grade    ...    last_fico_range_high  \
0           162.87     B        B2    ...                   744.0
1            59.83     C        C4    ...                   499.0
2            84.33     C        C5    ...                   719.0
3           339.31     C        C1    ...                   604.0
4            67.79     B        B5    ...                   694.0
5           156.46     A        A4    ...                   679.0
6           170.08     C        C5    ...                   654.0
7           109.43     E        E1    ...                   689.0
8           152.39     F        F2    ...                   499.0
9           121.45     B        B5    ...                   519.0
10          153.45     C        C3    ...                   734.0
11          402.54     B        B5    ...                   669.0
12          305.38     C        C1    ...                   619.0
13           96.68     B        B1    ...                   734.0
14          325.74     B        B2    ...                   654.0
15           35.31     D        D1    ...                   769.0
16          347.98     C        C4    ...                   639.0
17          109.57     A        A1    ...                   794.0
18          198.46     B        B3    ...                   559.0
19          280.01     A        A1    ...                   644.0
20          484.63     C        C4    ...                   684.0
21          701.73     B        B4    ...                   534.0
```

```
22          330.76     B        B3    ...                   779.0
23          330.76     B        B3    ...                   684.0
24          198.46     B        B3    ...                   499.0
25          483.38     B        B1    ...                   734.0
26          514.64     C        C2    ...                   509.0
27          123.65     D        D2    ...                   579.0
28          132.31     B        B3    ...                   689.0
29          281.15     B        B3    ...                   599.0
...            ...   ...       ...   ...                     ...
42508       202.51     D        D5    ...                   664.0
42509       180.57     D        D5    ...                   704.0
42510        61.00     B        B4    ...                   709.0
42511       345.18     E        E5    ...                   499.0
42512        61.87     A        A1    ...                   809.0
42513       195.28     C        C2    ...                   769.0
42514       141.25     B        B4    ...                   584.0
42515        38.17     B        B2    ...                   694.0
42516       164.23     C        C4    ...                   679.0
42517        45.78     C        C3    ...                   679.0
42518        34.21     E        E3    ...                   499.0
42519       156.11     A        A3    ...                   759.0
42520        77.69     A        A2    ...                   789.0
42521        93.23     A        A2    ...                   799.0
42522        81.94     A        A5    ...                   614.0
42523        30.94     A        A1    ...                   599.0
42524        42.65     D        D3    ...                   624.0
42525       211.85     C        C4    ...                   574.0
42526       344.87     C        C4    ...                   744.0
42527        95.42     B        B2    ...                   594.0
42528        95.86     B        B3    ...                   714.0
42529        64.50     B        B5    ...                   594.0
42530       208.66     B        B4    ...                   684.0
42531       113.39     C        C1    ...                   819.0
42532        32.11     B        B4    ...                   784.0
42533        80.69     B        B3    ...                   714.0
42534       204.84     A        A5    ...                   724.0
42535       156.11     A        A3    ...                   794.0
42536          NaN   NaN       NaN    ...                     NaN
42537          NaN   NaN       NaN    ...                     NaN

      last_fico_range_low collections_12_mths_ex_med  policy_code  \
0                   740.0                      False         True
1                     0.0                      False         True
2                   715.0                      False         True
3                   600.0                      False         True
4                   690.0                      False         True
5                   675.0                      False         True
6                   650.0                      False         True
```

7	685.0	False	True
8	0.0	False	True
9	515.0	False	True
10	730.0	False	True
11	665.0	False	True
12	615.0	False	True
13	730.0	False	True
14	650.0	False	True
15	765.0	False	True
16	635.0	False	True
17	790.0	False	True
18	555.0	False	True
19	640.0	False	True
20	680.0	False	True
21	530.0	False	True
22	775.0	False	True
23	680.0	False	True
24	0.0	False	True
25	730.0	False	True
26	505.0	False	True
27	575.0	False	True
28	685.0	False	True
29	595.0	False	True
...	...	...	...
42508	660.0	NaN	True
42509	700.0	NaN	True
42510	705.0	NaN	True
42511	0.0	NaN	True
42512	805.0	NaN	True
42513	765.0	NaN	True
42514	580.0	NaN	True
42515	690.0	NaN	True
42516	675.0	NaN	True
42517	675.0	NaN	True
42518	0.0	NaN	True
42519	755.0	NaN	True
42520	785.0	NaN	True
42521	795.0	NaN	True
42522	610.0	NaN	True
42523	595.0	NaN	True
42524	620.0	NaN	True
42525	570.0	NaN	True
42526	740.0	NaN	True
42527	590.0	NaN	True
42528	710.0	NaN	True
42529	590.0	NaN	True
42530	680.0	NaN	True
42531	815.0	NaN	True

```
42532              780.0                      NaN         True
42533              710.0                      NaN         True
42534              720.0                      NaN         True
42535              790.0                      NaN         True
42536                NaN                      NaN          NaN
42537                NaN                      NaN          NaN

      application_type acc_now_delinq chargeoff_within_12_mths delinq_amnt  \
0           INDIVIDUAL          False                    False         0.0
1           INDIVIDUAL          False                    False         0.0
2           INDIVIDUAL          False                    False         0.0
3           INDIVIDUAL          False                    False         0.0
4           INDIVIDUAL          False                    False         0.0
5           INDIVIDUAL          False                    False         0.0
6           INDIVIDUAL          False                    False         0.0
7           INDIVIDUAL          False                    False         0.0
8           INDIVIDUAL          False                    False         0.0
9           INDIVIDUAL          False                    False         0.0
10          INDIVIDUAL          False                    False         0.0
11          INDIVIDUAL          False                    False         0.0
12          INDIVIDUAL          False                    False         0.0
13          INDIVIDUAL          False                    False         0.0
14          INDIVIDUAL          False                    False         0.0
15          INDIVIDUAL          False                    False         0.0
16          INDIVIDUAL          False                    False         0.0
17          INDIVIDUAL          False                    False         0.0
18          INDIVIDUAL          False                    False         0.0
19          INDIVIDUAL          False                    False         0.0
20          INDIVIDUAL          False                    False         0.0
21          INDIVIDUAL          False                    False         0.0
22          INDIVIDUAL          False                    False         0.0
23          INDIVIDUAL          False                    False         0.0
24          INDIVIDUAL          False                    False         0.0
25          INDIVIDUAL          False                    False         0.0
26          INDIVIDUAL          False                    False         0.0
27          INDIVIDUAL          False                    False         0.0
28          INDIVIDUAL          False                    False         0.0
29          INDIVIDUAL          False                    False         0.0
...                ...            ...                      ...         ...
42508       INDIVIDUAL          False                      NaN         0.0
42509       INDIVIDUAL          False                      NaN         0.0
42510       INDIVIDUAL            NaN                      NaN         NaN
42511       INDIVIDUAL          False                      NaN         0.0
42512       INDIVIDUAL          False                      NaN         0.0
42513       INDIVIDUAL          False                      NaN         0.0
42514       INDIVIDUAL          False                      NaN         0.0
42515       INDIVIDUAL            NaN                      NaN         NaN
42516       INDIVIDUAL            NaN                      NaN         NaN
```

```
42517       INDIVIDUAL            NaN                    NaN         NaN
42518       INDIVIDUAL            NaN                    NaN         NaN
42519       INDIVIDUAL            NaN                    NaN         NaN
42520       INDIVIDUAL            NaN                    NaN         NaN
42521       INDIVIDUAL            NaN                    NaN         NaN
42522       INDIVIDUAL            NaN                    NaN         NaN
42523       INDIVIDUAL            NaN                    NaN         NaN
42524       INDIVIDUAL            NaN                    NaN         NaN
42525       INDIVIDUAL            NaN                    NaN         NaN
42526       INDIVIDUAL            NaN                    NaN         NaN
42527       INDIVIDUAL            NaN                    NaN         NaN
42528       INDIVIDUAL            NaN                    NaN         NaN
42529       INDIVIDUAL            NaN                    NaN         NaN
42530       INDIVIDUAL            NaN                    NaN         NaN
42531       INDIVIDUAL            NaN                    NaN         NaN
42532       INDIVIDUAL            NaN                    NaN         NaN
42533       INDIVIDUAL            NaN                    NaN         NaN
42534       INDIVIDUAL            NaN                    NaN         NaN
42535       INDIVIDUAL            NaN                    NaN         NaN
42536              NaN            NaN                    NaN         NaN
42537              NaN            NaN                    NaN         NaN

      pub_rec_bankruptcies tax_liens
0                      0.0     False
1                      0.0     False
2                      0.0     False
3                      0.0     False
4                      0.0     False
5                      0.0     False
6                      0.0     False
7                      0.0     False
8                      0.0     False
9                      0.0     False
10                     0.0     False
11                     0.0     False
12                     0.0     False
13                     0.0     False
14                     0.0     False
15                     0.0     False
16                     0.0     False
17                     0.0     False
18                     0.0     False
19                     0.0     False
20                     0.0     False
21                     0.0     False
22                     0.0     False
23                     0.0     False
24                     0.0     False
```

```
25                    0.0     False
26                    0.0     False
27                    0.0     False
28                    0.0     False
29                    0.0     False
...                   ...       ...
42508                 NaN       NaN
42509                 NaN       NaN
42510                 NaN       NaN
42511                 NaN       NaN
42512                 NaN       NaN
42513                 NaN       NaN
42514                 NaN       NaN
42515                 NaN       NaN
42516                 NaN       NaN
42517                 NaN       NaN
42518                 NaN       NaN
42519                 NaN       NaN
42520                 NaN       NaN
42521                 NaN       NaN
42522                 NaN       NaN
42523                 NaN       NaN
42524                 NaN       NaN
42525                 NaN       NaN
42526                 NaN       NaN
42527                 NaN       NaN
42528                 NaN       NaN
42529                 NaN       NaN
42530                 NaN       NaN
42531                 NaN       NaN
42532                 NaN       NaN
42533                 NaN       NaN
42534                 NaN       NaN
42535                 NaN       NaN
42536                 NaN       NaN
42537                 NaN       NaN

[42538 rows x 58 columns]
```

```
In [10]: #fill with median
         df['funded_amnt'].fillna(df['funded_amnt'].median(), inplace = True)
         df
```

```
Out[10]:                                                    id  member_id  \
         0                                             1077501  1296599.0
         1                                             1077430  1314167.0
         2                                             1077175  1313524.0
         3                                             1076863  1277178.0
```

4	1075358	1311748.0
5	1075269	1311441.0
6	1069639	1304742.0
7	1072053	1288686.0
8	1071795	1306957.0
9	1071570	1306721.0
10	1070078	1305201.0
11	1069908	1305008.0
12	1064687	1298717.0
13	1069866	1304956.0
14	1069057	1303503.0
15	1069759	1304871.0
16	1065775	1299699.0
17	1069971	1304884.0
18	1062474	1294539.0
19	1069742	1304855.0
20	1069740	1284848.0
21	1039153	1269083.0
22	1069710	1304821.0
23	1069700	1304810.0
24	1069559	1304634.0
25	1069697	1273773.0
26	1069800	1304679.0
27	1069657	1304764.0
28	1069799	1304678.0
29	1047704	1278806.0
...	...	...
42508	91175	91170.0
42509	91126	91067.0
42510	91023	70879.0
42511	90106	90090.0
42512	89258	80039.0
42513	88637	88629.0
42514	88046	88023.0
42515	85961	85923.0
42516	85818	85802.0
42517	85781	85727.0
42518	85675	85667.0
42519	84670	79576.0
42520	84098	84091.0
42521	83979	83974.0
42522	83489	83471.0
42523	83185	83132.0
42524	76629	76623.0
42525	74014	73890.0
42526	81085	80973.0
42527	77792	77764.0
42528	77757	70626.0

```
42529                                                 74505    74469.0
42530                                                 74323    74301.0
42531                                                 73582    73096.0
42532                                                 72998    72992.0
42533                                                 72176    70868.0
42534                                                 71623    70735.0
42535                                                 70686    70681.0
42536  Total amount funded in policy code 1: 460296150        NaN
42537          Total amount funded in policy code 2: 0        NaN

          loan_amnt  funded_amnt  funded_amnt_inv        term int_rate  \
0       5000.000000       5000.0      4975.000000   36 months   10.65%
1       2500.000000       2500.0      2500.000000   60 months   15.27%
2       2400.000000       2400.0      2400.000000   36 months   15.96%
3      10000.000000      10000.0     10000.000000   36 months   13.49%
4       3000.000000       3000.0      3000.000000   60 months   12.69%
5       5000.000000       5000.0      5000.000000   36 months    7.90%
6       7000.000000       7000.0      7000.000000   60 months   15.96%
7       3000.000000       3000.0      3000.000000   36 months   18.64%
8       5600.000000       5600.0      5600.000000   60 months   21.28%
9       5375.000000       5375.0      5350.000000   60 months   12.69%
10      6500.000000       6500.0      6500.000000   60 months   14.65%
11     12000.000000      12000.0     12000.000000   36 months   12.69%
12      9000.000000       9000.0      9000.000000   36 months   13.49%
13      3000.000000       3000.0      3000.000000   36 months    9.91%
14     10000.000000      10000.0     10000.000000   36 months   10.65%
15      1000.000000       1000.0      1000.000000   36 months   16.29%
16     10000.000000      10000.0     10000.000000   36 months   15.27%
17      3600.000000       3600.0      3600.000000   36 months    6.03%
18      6000.000000       6000.0      6000.000000   36 months   11.71%
19      9200.000000       9200.0      9200.000000   36 months    6.03%
20     20250.000000      20250.0     19142.161077   60 months   15.27%
21     21000.000000      21000.0     21000.000000   36 months   12.42%
22     10000.000000      10000.0     10000.000000   36 months   11.71%
23     10000.000000      10000.0     10000.000000   36 months   11.71%
24      6000.000000       6000.0      6000.000000   36 months   11.71%
25     15000.000000      15000.0     15000.000000   36 months    9.91%
26     15000.000000      15000.0      8725.000000   36 months   14.27%
27      5000.000000       5000.0      5000.000000   60 months   16.77%
28      4000.000000       4000.0      4000.000000   36 months   11.71%
29      8500.000000       8500.0      8500.000000   36 months   11.71%
...             ...          ...              ...         ...      ...
42508   6000.000000       6000.0      1200.000000   36 months   13.12%
42509   5350.000000       5350.0       625.000000   36 months   13.12%
42510   1900.000000       1900.0       900.000000   36 months    9.64%
42511  10000.000000      10000.0       350.000000   36 months   14.70%
42512   2000.000000       2000.0      1275.000000   36 months    7.12%
42513   6000.000000       6000.0       650.000000   36 months   10.59%
```

```
42514   4400.000000       4400.0      1400.000000   36 months    9.64%
42515   1200.000000       1200.0       500.000000   36 months    9.01%
42516   5000.000000       5000.0       375.000000   36 months   11.22%
42517   1400.000000       1400.0       475.000000   36 months   10.91%
42518   1000.000000       1000.0       625.000000   36 months   14.07%
42519   5000.000000       5000.0       300.000000   36 months    7.75%
42520   2500.000000       2500.0       225.000000   36 months    7.43%
42521   3000.000000       3000.0       250.000000   36 months    7.43%
42522   2600.000000       2600.0       575.000000   36 months    8.38%
42523   1000.000000       1000.0       625.000000   36 months    7.12%
42524   1275.000000       1275.0         0.000000   36 months   12.49%
42525   6450.000000       6450.0         0.000000   36 months   11.22%
42526  10500.000000      10500.0       275.000000   36 months   11.22%
42527   3000.000000       3000.0       125.000000   36 months    9.01%
42528   3000.000000       3000.0         0.000000   36 months    9.33%
42529   2000.000000       2000.0       225.000000   36 months    9.96%
42530   6500.000000       6500.0         0.000000   36 months    9.64%
42531   3500.000000       3500.0       225.000000   36 months   10.28%
42532   1000.000000       1000.0         0.000000   36 months    9.64%
42533   2525.000000       2525.0       225.000000   36 months    9.33%
42534   6500.000000       6500.0         0.000000   36 months    8.38%
42535   5000.000000       5000.0         0.000000   36 months    7.75%
42536  11089.722581       9600.0              NaN         NaN      NaN
42537  11089.722581       9600.0              NaN         NaN      NaN

       installment grade sub_grade    ...    last_fico_range_high  \
0           162.87     B        B2    ...                   744.0
1            59.83     C        C4    ...                   499.0
2            84.33     C        C5    ...                   719.0
3           339.31     C        C1    ...                   604.0
4            67.79     B        B5    ...                   694.0
5           156.46     A        A4    ...                   679.0
6           170.08     C        C5    ...                   654.0
7           109.43     E        E1    ...                   689.0
8           152.39     F        F2    ...                   499.0
9           121.45     B        B5    ...                   519.0
10          153.45     C        C3    ...                   734.0
11          402.54     B        B5    ...                   669.0
12          305.38     C        C1    ...                   619.0
13           96.68     B        B1    ...                   734.0
14          325.74     B        B2    ...                   654.0
15           35.31     D        D1    ...                   769.0
16          347.98     C        C4    ...                   639.0
17          109.57     A        A1    ...                   794.0
18          198.46     B        B3    ...                   559.0
19          280.01     A        A1    ...                   644.0
20          484.63     C        C4    ...                   684.0
21          701.73     B        B4    ...                   534.0
```

```
22          330.76     B        B3    ...                 779.0
23          330.76     B        B3    ...                 684.0
24          198.46     B        B3    ...                 499.0
25          483.38     B        B1    ...                 734.0
26          514.64     C        C2    ...                 509.0
27          123.65     D        D2    ...                 579.0
28          132.31     B        B3    ...                 689.0
29          281.15     B        B3    ...                 599.0
...            ...   ...       ...    ...                   ...
42508       202.51     D        D5    ...                 664.0
42509       180.57     D        D5    ...                 704.0
42510        61.00     B        B4    ...                 709.0
42511       345.18     E        E5    ...                 499.0
42512        61.87     A        A1    ...                 809.0
42513       195.28     C        C2    ...                 769.0
42514       141.25     B        B4    ...                 584.0
42515        38.17     B        B2    ...                 694.0
42516       164.23     C        C4    ...                 679.0
42517        45.78     C        C3    ...                 679.0
42518        34.21     E        E3    ...                 499.0
42519       156.11     A        A3    ...                 759.0
42520        77.69     A        A2    ...                 789.0
42521        93.23     A        A2    ...                 799.0
42522        81.94     A        A5    ...                 614.0
42523        30.94     A        A1    ...                 599.0
42524        42.65     D        D3    ...                 624.0
42525       211.85     C        C4    ...                 574.0
42526       344.87     C        C4    ...                 744.0
42527        95.42     B        B2    ...                 594.0
42528        95.86     B        B3    ...                 714.0
42529        64.50     B        B5    ...                 594.0
42530       208.66     B        B4    ...                 684.0
42531       113.39     C        C1    ...                 819.0
42532        32.11     B        B4    ...                 784.0
42533        80.69     B        B3    ...                 714.0
42534       204.84     A        A5    ...                 724.0
42535       156.11     A        A3    ...                 794.0
42536          NaN   NaN       NaN    ...                   NaN
42537          NaN   NaN       NaN    ...                   NaN

      last_fico_range_low collections_12_mths_ex_med  policy_code  \
0                   740.0                      False         True
1                     0.0                      False         True
2                   715.0                      False         True
3                   600.0                      False         True
4                   690.0                      False         True
5                   675.0                      False         True
6                   650.0                      False         True
```

7	685.0	False	True
8	0.0	False	True
9	515.0	False	True
10	730.0	False	True
11	665.0	False	True
12	615.0	False	True
13	730.0	False	True
14	650.0	False	True
15	765.0	False	True
16	635.0	False	True
17	790.0	False	True
18	555.0	False	True
19	640.0	False	True
20	680.0	False	True
21	530.0	False	True
22	775.0	False	True
23	680.0	False	True
24	0.0	False	True
25	730.0	False	True
26	505.0	False	True
27	575.0	False	True
28	685.0	False	True
29	595.0	False	True
...	...	...	...
42508	660.0	NaN	True
42509	700.0	NaN	True
42510	705.0	NaN	True
42511	0.0	NaN	True
42512	805.0	NaN	True
42513	765.0	NaN	True
42514	580.0	NaN	True
42515	690.0	NaN	True
42516	675.0	NaN	True
42517	675.0	NaN	True
42518	0.0	NaN	True
42519	755.0	NaN	True
42520	785.0	NaN	True
42521	795.0	NaN	True
42522	610.0	NaN	True
42523	595.0	NaN	True
42524	620.0	NaN	True
42525	570.0	NaN	True
42526	740.0	NaN	True
42527	590.0	NaN	True
42528	710.0	NaN	True
42529	590.0	NaN	True
42530	680.0	NaN	True
42531	815.0	NaN	True

```
42532              780.0                      NaN         True
42533              710.0                      NaN         True
42534              720.0                      NaN         True
42535              790.0                      NaN         True
42536                NaN                      NaN          NaN
42537                NaN                      NaN          NaN

      application_type acc_now_delinq chargeoff_within_12_mths delinq_amnt  \
0           INDIVIDUAL          False                    False         0.0
1           INDIVIDUAL          False                    False         0.0
2           INDIVIDUAL          False                    False         0.0
3           INDIVIDUAL          False                    False         0.0
4           INDIVIDUAL          False                    False         0.0
5           INDIVIDUAL          False                    False         0.0
6           INDIVIDUAL          False                    False         0.0
7           INDIVIDUAL          False                    False         0.0
8           INDIVIDUAL          False                    False         0.0
9           INDIVIDUAL          False                    False         0.0
10          INDIVIDUAL          False                    False         0.0
11          INDIVIDUAL          False                    False         0.0
12          INDIVIDUAL          False                    False         0.0
13          INDIVIDUAL          False                    False         0.0
14          INDIVIDUAL          False                    False         0.0
15          INDIVIDUAL          False                    False         0.0
16          INDIVIDUAL          False                    False         0.0
17          INDIVIDUAL          False                    False         0.0
18          INDIVIDUAL          False                    False         0.0
19          INDIVIDUAL          False                    False         0.0
20          INDIVIDUAL          False                    False         0.0
21          INDIVIDUAL          False                    False         0.0
22          INDIVIDUAL          False                    False         0.0
23          INDIVIDUAL          False                    False         0.0
24          INDIVIDUAL          False                    False         0.0
25          INDIVIDUAL          False                    False         0.0
26          INDIVIDUAL          False                    False         0.0
27          INDIVIDUAL          False                    False         0.0
28          INDIVIDUAL          False                    False         0.0
29          INDIVIDUAL          False                    False         0.0
...                ...            ...                      ...         ...
42508       INDIVIDUAL          False                      NaN         0.0
42509       INDIVIDUAL          False                      NaN         0.0
42510       INDIVIDUAL            NaN                      NaN         NaN
42511       INDIVIDUAL          False                      NaN         0.0
42512       INDIVIDUAL          False                      NaN         0.0
42513       INDIVIDUAL          False                      NaN         0.0
42514       INDIVIDUAL          False                      NaN         0.0
42515       INDIVIDUAL            NaN                      NaN         NaN
42516       INDIVIDUAL            NaN                      NaN         NaN
```

42517	INDIVIDUAL	NaN	NaN	NaN
42518	INDIVIDUAL	NaN	NaN	NaN
42519	INDIVIDUAL	NaN	NaN	NaN
42520	INDIVIDUAL	NaN	NaN	NaN
42521	INDIVIDUAL	NaN	NaN	NaN
42522	INDIVIDUAL	NaN	NaN	NaN
42523	INDIVIDUAL	NaN	NaN	NaN
42524	INDIVIDUAL	NaN	NaN	NaN
42525	INDIVIDUAL	NaN	NaN	NaN
42526	INDIVIDUAL	NaN	NaN	NaN
42527	INDIVIDUAL	NaN	NaN	NaN
42528	INDIVIDUAL	NaN	NaN	NaN
42529	INDIVIDUAL	NaN	NaN	NaN
42530	INDIVIDUAL	NaN	NaN	NaN
42531	INDIVIDUAL	NaN	NaN	NaN
42532	INDIVIDUAL	NaN	NaN	NaN
42533	INDIVIDUAL	NaN	NaN	NaN
42534	INDIVIDUAL	NaN	NaN	NaN
42535	INDIVIDUAL	NaN	NaN	NaN
42536	NaN	NaN	NaN	NaN
42537	NaN	NaN	NaN	NaN

	pub_rec_bankruptcies	tax_liens
0	0.0	False
1	0.0	False
2	0.0	False
3	0.0	False
4	0.0	False
5	0.0	False
6	0.0	False
7	0.0	False
8	0.0	False
9	0.0	False
10	0.0	False
11	0.0	False
12	0.0	False
13	0.0	False
14	0.0	False
15	0.0	False
16	0.0	False
17	0.0	False
18	0.0	False
19	0.0	False
20	0.0	False
21	0.0	False
22	0.0	False
23	0.0	False
24	0.0	False

```
25                    0.0     False
26                    0.0     False
27                    0.0     False
28                    0.0     False
29                    0.0     False
...                   ...       ...
42508                 NaN       NaN
42509                 NaN       NaN
42510                 NaN       NaN
42511                 NaN       NaN
42512                 NaN       NaN
42513                 NaN       NaN
42514                 NaN       NaN
42515                 NaN       NaN
42516                 NaN       NaN
42517                 NaN       NaN
42518                 NaN       NaN
42519                 NaN       NaN
42520                 NaN       NaN
42521                 NaN       NaN
42522                 NaN       NaN
42523                 NaN       NaN
42524                 NaN       NaN
42525                 NaN       NaN
42526                 NaN       NaN
42527                 NaN       NaN
42528                 NaN       NaN
42529                 NaN       NaN
42530                 NaN       NaN
42531                 NaN       NaN
42532                 NaN       NaN
42533                 NaN       NaN
42534                 NaN       NaN
42535                 NaN       NaN
42536                 NaN       NaN
42537                 NaN       NaN

[42538 rows x 58 columns]
```

1.1.4 Imputing missing data with mean,median or most frequently used value for the column

we will create the Imputer object and set a strategy for handling the missing values. Different strategy available are mean, median and most_frequent we then fit the imputter objects on the column where we want to handle the missing values After fitting the data we transform the data from the dataframe

```
In [11]: from sklearn.preprocessing import Imputer
         countryData = pd.DataFrame({"Country":["France","Spain", "Germany", "USA"], "Age":[np
         countryData
```

```
Out[11]:     Age  Country   Salary
          0   NaN   France      NaN
          1  45.0    Spain  90000.0
          2   NaN  Germany      NaN
          3  32.0      USA  75000.0

In [12]: imp = Imputer(missing_values='NaN', strategy='mean', axis=0)
         imp.fit(countryData.iloc[:,[0,2]])
         countryData.iloc[:,[0,2]]=imp.transform(countryData.iloc[:,[0,2]])
         countryData

Out[12]:     Age  Country   Salary
          0  38.5   France  82500.0
          1  45.0    Spain  90000.0
          2  38.5  Germany  82500.0
          3  32.0      USA  75000.0
```

1.1.5 Using replace method

```
In [13]: countryData = pd.DataFrame({"Country":["France","Spain", "Germany", "USA"], "Age":[np
         countryData

Out[13]:     Age  Country   Salary
          0   NaN   France      NaN
          1  45.0    Spain  90000.0
          2   NaN  Germany      NaN
          3  32.0      USA  75000.0

In [14]: countryData.replace({'Age':np.NAN},40 )

Out[14]:     Age  Country   Salary
          0  40.0   France      NaN
          1  45.0    Spain  90000.0
          2  40.0  Germany      NaN
          3  32.0      USA  75000.0
```

1.2 Removing duplicate entries from the dataset

```
In [15]: df.drop_duplicates(keep='first')

Out[15]:                                                      id  member_id  \
          0                                                1077501  1296599.0
          1                                                1077430  1314167.0
          2                                                1077175  1313524.0
          3                                                1076863  1277178.0
          4                                                1075358  1311748.0
          5                                                1075269  1311441.0
          6                                                1069639  1304742.0
          7                                                1072053  1288686.0
```

8	1071795	1306957.0
9	1071570	1306721.0
10	1070078	1305201.0
11	1069908	1305008.0
12	1064687	1298717.0
13	1069866	1304956.0
14	1069057	1303503.0
15	1069759	1304871.0
16	1065775	1299699.0
17	1069971	1304884.0
18	1062474	1294539.0
19	1069742	1304855.0
20	1069740	1284848.0
21	1039153	1269083.0
22	1069710	1304821.0
23	1069700	1304810.0
24	1069559	1304634.0
25	1069697	1273773.0
26	1069800	1304679.0
27	1069657	1304764.0
28	1069799	1304678.0
29	1047704	1278806.0
...	...	...
42508	91175	91170.0
42509	91126	91067.0
42510	91023	70879.0
42511	90106	90090.0
42512	89258	80039.0
42513	88637	88629.0
42514	88046	88023.0
42515	85961	85923.0
42516	85818	85802.0
42517	85781	85727.0
42518	85675	85667.0
42519	84670	79576.0
42520	84098	84091.0
42521	83979	83974.0
42522	83489	83471.0
42523	83185	83132.0
42524	76629	76623.0
42525	74014	73890.0
42526	81085	80973.0
42527	77792	77764.0
42528	77757	70626.0
42529	74505	74469.0
42530	74323	74301.0
42531	73582	73096.0
42532	72998	72992.0

```
42533                                                 72176    70868.0
42534                                                 71623    70735.0
42535                                                 70686    70681.0
42536  Total amount funded in policy code 1: 460296150        NaN
42537          Total amount funded in policy code 2: 0        NaN

         loan_amnt  funded_amnt  funded_amnt_inv        term int_rate  \
0       5000.000000       5000.0      4975.000000   36 months   10.65%
1       2500.000000       2500.0      2500.000000   60 months   15.27%
2       2400.000000       2400.0      2400.000000   36 months   15.96%
3      10000.000000      10000.0     10000.000000   36 months   13.49%
4       3000.000000       3000.0      3000.000000   60 months   12.69%
5       5000.000000       5000.0      5000.000000   36 months    7.90%
6       7000.000000       7000.0      7000.000000   60 months   15.96%
7       3000.000000       3000.0      3000.000000   36 months   18.64%
8       5600.000000       5600.0      5600.000000   60 months   21.28%
9       5375.000000       5375.0      5350.000000   60 months   12.69%
10      6500.000000       6500.0      6500.000000   60 months   14.65%
11     12000.000000      12000.0     12000.000000   36 months   12.69%
12      9000.000000       9000.0      9000.000000   36 months   13.49%
13      3000.000000       3000.0      3000.000000   36 months    9.91%
14     10000.000000      10000.0     10000.000000   36 months   10.65%
15      1000.000000       1000.0      1000.000000   36 months   16.29%
16     10000.000000      10000.0     10000.000000   36 months   15.27%
17      3600.000000       3600.0      3600.000000   36 months    6.03%
18      6000.000000       6000.0      6000.000000   36 months   11.71%
19      9200.000000       9200.0      9200.000000   36 months    6.03%
20     20250.000000      20250.0     19142.161077   60 months   15.27%
21     21000.000000      21000.0     21000.000000   36 months   12.42%
22     10000.000000      10000.0     10000.000000   36 months   11.71%
23     10000.000000      10000.0     10000.000000   36 months   11.71%
24      6000.000000       6000.0      6000.000000   36 months   11.71%
25     15000.000000      15000.0     15000.000000   36 months    9.91%
26     15000.000000      15000.0      8725.000000   36 months   14.27%
27      5000.000000       5000.0      5000.000000   60 months   16.77%
28      4000.000000       4000.0      4000.000000   36 months   11.71%
29      8500.000000       8500.0      8500.000000   36 months   11.71%
...             ...          ...              ...         ...      ...
42508   6000.000000       6000.0      1200.000000   36 months   13.12%
42509   5350.000000       5350.0       625.000000   36 months   13.12%
42510   1900.000000       1900.0       900.000000   36 months    9.64%
42511  10000.000000      10000.0       350.000000   36 months   14.70%
42512   2000.000000       2000.0      1275.000000   36 months    7.12%
42513   6000.000000       6000.0       650.000000   36 months   10.59%
42514   4400.000000       4400.0      1400.000000   36 months    9.64%
42515   1200.000000       1200.0       500.000000   36 months    9.01%
42516   5000.000000       5000.0       375.000000   36 months   11.22%
42517   1400.000000       1400.0       475.000000   36 months   10.91%
```

```
42518   1000.000000       1000.0       625.000000   36 months   14.07%
42519   5000.000000       5000.0       300.000000   36 months    7.75%
42520   2500.000000       2500.0       225.000000   36 months    7.43%
42521   3000.000000       3000.0       250.000000   36 months    7.43%
42522   2600.000000       2600.0       575.000000   36 months    8.38%
42523   1000.000000       1000.0       625.000000   36 months    7.12%
42524   1275.000000       1275.0         0.000000   36 months   12.49%
42525   6450.000000       6450.0         0.000000   36 months   11.22%
42526  10500.000000      10500.0       275.000000   36 months   11.22%
42527   3000.000000       3000.0       125.000000   36 months    9.01%
42528   3000.000000       3000.0         0.000000   36 months    9.33%
42529   2000.000000       2000.0       225.000000   36 months    9.96%
42530   6500.000000       6500.0         0.000000   36 months    9.64%
42531   3500.000000       3500.0       225.000000   36 months   10.28%
42532   1000.000000       1000.0         0.000000   36 months    9.64%
42533   2525.000000       2525.0       225.000000   36 months    9.33%
42534   6500.000000       6500.0         0.000000   36 months    8.38%
42535   5000.000000       5000.0         0.000000   36 months    7.75%
42536  11089.722581       9600.0              NaN         NaN      NaN
42537  11089.722581       9600.0              NaN         NaN      NaN

       installment grade sub_grade    ...    last_fico_range_high  \
0           162.87     B        B2    ...                   744.0
1            59.83     C        C4    ...                   499.0
2            84.33     C        C5    ...                   719.0
3           339.31     C        C1    ...                   604.0
4            67.79     B        B5    ...                   694.0
5           156.46     A        A4    ...                   679.0
6           170.08     C        C5    ...                   654.0
7           109.43     E        E1    ...                   689.0
8           152.39     F        F2    ...                   499.0
9           121.45     B        B5    ...                   519.0
10          153.45     C        C3    ...                   734.0
11          402.54     B        B5    ...                   669.0
12          305.38     C        C1    ...                   619.0
13           96.68     B        B1    ...                   734.0
14          325.74     B        B2    ...                   654.0
15           35.31     D        D1    ...                   769.0
16          347.98     C        C4    ...                   639.0
17          109.57     A        A1    ...                   794.0
18          198.46     B        B3    ...                   559.0
19          280.01     A        A1    ...                   644.0
20          484.63     C        C4    ...                   684.0
21          701.73     B        B4    ...                   534.0
22          330.76     B        B3    ...                   779.0
23          330.76     B        B3    ...                   684.0
24          198.46     B        B3    ...                   499.0
25          483.38     B        B1    ...                   734.0
```

```
26          514.64     C        C2    ...                   509.0
27          123.65     D        D2    ...                   579.0
28          132.31     B        B3    ...                   689.0
29          281.15     B        B3    ...                   599.0
...            ...   ...       ...    ...                     ...
42508       202.51     D        D5    ...                   664.0
42509       180.57     D        D5    ...                   704.0
42510        61.00     B        B4    ...                   709.0
42511       345.18     E        E5    ...                   499.0
42512        61.87     A        A1    ...                   809.0
42513       195.28     C        C2    ...                   769.0
42514       141.25     B        B4    ...                   584.0
42515        38.17     B        B2    ...                   694.0
42516       164.23     C        C4    ...                   679.0
42517        45.78     C        C3    ...                   679.0
42518        34.21     E        E3    ...                   499.0
42519       156.11     A        A3    ...                   759.0
42520        77.69     A        A2    ...                   789.0
42521        93.23     A        A2    ...                   799.0
42522        81.94     A        A5    ...                   614.0
42523        30.94     A        A1    ...                   599.0
42524        42.65     D        D3    ...                   624.0
42525       211.85     C        C4    ...                   574.0
42526       344.87     C        C4    ...                   744.0
42527        95.42     B        B2    ...                   594.0
42528        95.86     B        B3    ...                   714.0
42529        64.50     B        B5    ...                   594.0
42530       208.66     B        B4    ...                   684.0
42531       113.39     C        C1    ...                   819.0
42532        32.11     B        B4    ...                   784.0
42533        80.69     B        B3    ...                   714.0
42534       204.84     A        A5    ...                   724.0
42535       156.11     A        A3    ...                   794.0
42536          NaN   NaN       NaN    ...                     NaN
42537          NaN   NaN       NaN    ...                     NaN

      last_fico_range_low collections_12_mths_ex_med  policy_code  \
0                   740.0                      False         True
1                     0.0                      False         True
2                   715.0                      False         True
3                   600.0                      False         True
4                   690.0                      False         True
5                   675.0                      False         True
6                   650.0                      False         True
7                   685.0                      False         True
8                     0.0                      False         True
9                   515.0                      False         True
10                  730.0                      False         True
```

11	665.0	False	True
12	615.0	False	True
13	730.0	False	True
14	650.0	False	True
15	765.0	False	True
16	635.0	False	True
17	790.0	False	True
18	555.0	False	True
19	640.0	False	True
20	680.0	False	True
21	530.0	False	True
22	775.0	False	True
23	680.0	False	True
24	0.0	False	True
25	730.0	False	True
26	505.0	False	True
27	575.0	False	True
28	685.0	False	True
29	595.0	False	True
...	...	...	...
42508	660.0	NaN	True
42509	700.0	NaN	True
42510	705.0	NaN	True
42511	0.0	NaN	True
42512	805.0	NaN	True
42513	765.0	NaN	True
42514	580.0	NaN	True
42515	690.0	NaN	True
42516	675.0	NaN	True
42517	675.0	NaN	True
42518	0.0	NaN	True
42519	755.0	NaN	True
42520	785.0	NaN	True
42521	795.0	NaN	True
42522	610.0	NaN	True
42523	595.0	NaN	True
42524	620.0	NaN	True
42525	570.0	NaN	True
42526	740.0	NaN	True
42527	590.0	NaN	True
42528	710.0	NaN	True
42529	590.0	NaN	True
42530	680.0	NaN	True
42531	815.0	NaN	True
42532	780.0	NaN	True
42533	710.0	NaN	True
42534	720.0	NaN	True
42535	790.0	NaN	True

```
42536                NaN                        NaN          NaN
42537                NaN                        NaN          NaN

      application_type acc_now_delinq chargeoff_within_12_mths delinq_amnt  \
0           INDIVIDUAL          False                    False         0.0
1           INDIVIDUAL          False                    False         0.0
2           INDIVIDUAL          False                    False         0.0
3           INDIVIDUAL          False                    False         0.0
4           INDIVIDUAL          False                    False         0.0
5           INDIVIDUAL          False                    False         0.0
6           INDIVIDUAL          False                    False         0.0
7           INDIVIDUAL          False                    False         0.0
8           INDIVIDUAL          False                    False         0.0
9           INDIVIDUAL          False                    False         0.0
10          INDIVIDUAL          False                    False         0.0
11          INDIVIDUAL          False                    False         0.0
12          INDIVIDUAL          False                    False         0.0
13          INDIVIDUAL          False                    False         0.0
14          INDIVIDUAL          False                    False         0.0
15          INDIVIDUAL          False                    False         0.0
16          INDIVIDUAL          False                    False         0.0
17          INDIVIDUAL          False                    False         0.0
18          INDIVIDUAL          False                    False         0.0
19          INDIVIDUAL          False                    False         0.0
20          INDIVIDUAL          False                    False         0.0
21          INDIVIDUAL          False                    False         0.0
22          INDIVIDUAL          False                    False         0.0
23          INDIVIDUAL          False                    False         0.0
24          INDIVIDUAL          False                    False         0.0
25          INDIVIDUAL          False                    False         0.0
26          INDIVIDUAL          False                    False         0.0
27          INDIVIDUAL          False                    False         0.0
28          INDIVIDUAL          False                    False         0.0
29          INDIVIDUAL          False                    False         0.0
...                ...            ...                      ...         ...
42508       INDIVIDUAL          False                      NaN         0.0
42509       INDIVIDUAL          False                      NaN         0.0
42510       INDIVIDUAL            NaN                      NaN         NaN
42511       INDIVIDUAL          False                      NaN         0.0
42512       INDIVIDUAL          False                      NaN         0.0
42513       INDIVIDUAL          False                      NaN         0.0
42514       INDIVIDUAL          False                      NaN         0.0
42515       INDIVIDUAL            NaN                      NaN         NaN
42516       INDIVIDUAL            NaN                      NaN         NaN
42517       INDIVIDUAL            NaN                      NaN         NaN
42518       INDIVIDUAL            NaN                      NaN         NaN
42519       INDIVIDUAL            NaN                      NaN         NaN
42520       INDIVIDUAL            NaN                      NaN         NaN
```

42521	INDIVIDUAL	NaN	NaN	NaN
42522	INDIVIDUAL	NaN	NaN	NaN
42523	INDIVIDUAL	NaN	NaN	NaN
42524	INDIVIDUAL	NaN	NaN	NaN
42525	INDIVIDUAL	NaN	NaN	NaN
42526	INDIVIDUAL	NaN	NaN	NaN
42527	INDIVIDUAL	NaN	NaN	NaN
42528	INDIVIDUAL	NaN	NaN	NaN
42529	INDIVIDUAL	NaN	NaN	NaN
42530	INDIVIDUAL	NaN	NaN	NaN
42531	INDIVIDUAL	NaN	NaN	NaN
42532	INDIVIDUAL	NaN	NaN	NaN
42533	INDIVIDUAL	NaN	NaN	NaN
42534	INDIVIDUAL	NaN	NaN	NaN
42535	INDIVIDUAL	NaN	NaN	NaN
42536	NaN	NaN	NaN	NaN
42537	NaN	NaN	NaN	NaN

	pub_rec_bankruptcies	tax_liens
0	0.0	False
1	0.0	False
2	0.0	False
3	0.0	False
4	0.0	False
5	0.0	False
6	0.0	False
7	0.0	False
8	0.0	False
9	0.0	False
10	0.0	False
11	0.0	False
12	0.0	False
13	0.0	False
14	0.0	False
15	0.0	False
16	0.0	False
17	0.0	False
18	0.0	False
19	0.0	False
20	0.0	False
21	0.0	False
22	0.0	False
23	0.0	False
24	0.0	False
25	0.0	False
26	0.0	False
27	0.0	False
28	0.0	False

```
29                    0.0     False
...                   ...       ...
42508                 NaN       NaN
42509                 NaN       NaN
42510                 NaN       NaN
42511                 NaN       NaN
42512                 NaN       NaN
42513                 NaN       NaN
42514                 NaN       NaN
42515                 NaN       NaN
42516                 NaN       NaN
42517                 NaN       NaN
42518                 NaN       NaN
42519                 NaN       NaN
42520                 NaN       NaN
42521                 NaN       NaN
42522                 NaN       NaN
42523                 NaN       NaN
42524                 NaN       NaN
42525                 NaN       NaN
42526                 NaN       NaN
42527                 NaN       NaN
42528                 NaN       NaN
42529                 NaN       NaN
42530                 NaN       NaN
42531                 NaN       NaN
42532                 NaN       NaN
42533                 NaN       NaN
42534                 NaN       NaN
42535                 NaN       NaN
42536                 NaN       NaN
42537                 NaN       NaN

[42538 rows x 58 columns]
```

1.3. Removing irrelevenat observations

```
In [16]: df.drop([42536,42537], inplace=True, axis=0)
         df
```

```
Out[16]:            id  member_id  loan_amnt  funded_amnt  funded_amnt_inv  \
         0      1077501  1296599.0     5000.0       5000.0      4975.000000
         1      1077430  1314167.0     2500.0       2500.0      2500.000000
         2      1077175  1313524.0     2400.0       2400.0      2400.000000
         3      1076863  1277178.0    10000.0      10000.0     10000.000000
         4      1075358  1311748.0     3000.0       3000.0      3000.000000
         5      1075269  1311441.0     5000.0       5000.0      5000.000000
         6      1069639  1304742.0     7000.0       7000.0      7000.000000
```

7	1072053	1288686.0	3000.0	3000.0	3000.000000
8	1071795	1306957.0	5600.0	5600.0	5600.000000
9	1071570	1306721.0	5375.0	5375.0	5350.000000
10	1070078	1305201.0	6500.0	6500.0	6500.000000
11	1069908	1305008.0	12000.0	12000.0	12000.000000
12	1064687	1298717.0	9000.0	9000.0	9000.000000
13	1069866	1304956.0	3000.0	3000.0	3000.000000
14	1069057	1303503.0	10000.0	10000.0	10000.000000
15	1069759	1304871.0	1000.0	1000.0	1000.000000
16	1065775	1299699.0	10000.0	10000.0	10000.000000
17	1069971	1304884.0	3600.0	3600.0	3600.000000
18	1062474	1294539.0	6000.0	6000.0	6000.000000
19	1069742	1304855.0	9200.0	9200.0	9200.000000
20	1069740	1284848.0	20250.0	20250.0	19142.161077
21	1039153	1269083.0	21000.0	21000.0	21000.000000
22	1069710	1304821.0	10000.0	10000.0	10000.000000
23	1069700	1304810.0	10000.0	10000.0	10000.000000
24	1069559	1304634.0	6000.0	6000.0	6000.000000
25	1069697	1273773.0	15000.0	15000.0	15000.000000
26	1069800	1304679.0	15000.0	15000.0	8725.000000
27	1069657	1304764.0	5000.0	5000.0	5000.000000
28	1069799	1304678.0	4000.0	4000.0	4000.000000
29	1047704	1278806.0	8500.0	8500.0	8500.000000
...	...	...	...	...	...
42506	94406	94385.0	6725.0	6725.0	825.000000
42507	93055	92947.0	2000.0	2000.0	1025.000000
42508	91175	91170.0	6000.0	6000.0	1200.000000
42509	91126	91067.0	5350.0	5350.0	625.000000
42510	91023	70879.0	1900.0	1900.0	900.000000
42511	90106	90090.0	10000.0	10000.0	350.000000
42512	89258	80039.0	2000.0	2000.0	1275.000000
42513	88637	88629.0	6000.0	6000.0	650.000000
42514	88046	88023.0	4400.0	4400.0	1400.000000
42515	85961	85923.0	1200.0	1200.0	500.000000
42516	85818	85802.0	5000.0	5000.0	375.000000
42517	85781	85727.0	1400.0	1400.0	475.000000
42518	85675	85667.0	1000.0	1000.0	625.000000
42519	84670	79576.0	5000.0	5000.0	300.000000
42520	84098	84091.0	2500.0	2500.0	225.000000
42521	83979	83974.0	3000.0	3000.0	250.000000
42522	83489	83471.0	2600.0	2600.0	575.000000
42523	83185	83132.0	1000.0	1000.0	625.000000
42524	76629	76623.0	1275.0	1275.0	0.000000
42525	74014	73890.0	6450.0	6450.0	0.000000
42526	81085	80973.0	10500.0	10500.0	275.000000
42527	77792	77764.0	3000.0	3000.0	125.000000
42528	77757	70626.0	3000.0	3000.0	0.000000
42529	74505	74469.0	2000.0	2000.0	225.000000

```
42530    74323    74301.0     6500.0       6500.0         0.000000
42531    73582    73096.0     3500.0       3500.0       225.000000
42532    72998    72992.0     1000.0       1000.0         0.000000
42533    72176    70868.0     2525.0       2525.0       225.000000
42534    71623    70735.0     6500.0       6500.0         0.000000
42535    70686    70681.0     5000.0       5000.0         0.000000

              term int_rate  installment grade sub_grade    ...     \
0        36 months   10.65%       162.87     B        B2    ...
1        60 months   15.27%        59.83     C        C4    ...
2        36 months   15.96%        84.33     C        C5    ...
3        36 months   13.49%       339.31     C        C1    ...
4        60 months   12.69%        67.79     B        B5    ...
5        36 months    7.90%       156.46     A        A4    ...
6        60 months   15.96%       170.08     C        C5    ...
7        36 months   18.64%       109.43     E        E1    ...
8        60 months   21.28%       152.39     F        F2    ...
9        60 months   12.69%       121.45     B        B5    ...
10       60 months   14.65%       153.45     C        C3    ...
11       36 months   12.69%       402.54     B        B5    ...
12       36 months   13.49%       305.38     C        C1    ...
13       36 months    9.91%        96.68     B        B1    ...
14       36 months   10.65%       325.74     B        B2    ...
15       36 months   16.29%        35.31     D        D1    ...
16       36 months   15.27%       347.98     C        C4    ...
17       36 months    6.03%       109.57     A        A1    ...
18       36 months   11.71%       198.46     B        B3    ...
19       36 months    6.03%       280.01     A        A1    ...
20       60 months   15.27%       484.63     C        C4    ...
21       36 months   12.42%       701.73     B        B4    ...
22       36 months   11.71%       330.76     B        B3    ...
23       36 months   11.71%       330.76     B        B3    ...
24       36 months   11.71%       198.46     B        B3    ...
25       36 months    9.91%       483.38     B        B1    ...
26       36 months   14.27%       514.64     C        C2    ...
27       60 months   16.77%       123.65     D        D2    ...
28       36 months   11.71%       132.31     B        B3    ...
29       36 months   11.71%       281.15     B        B3    ...
...            ...      ...          ...   ...       ...    ...
42506    36 months   13.12%       226.98     D        D5    ...
42507    36 months   12.80%        67.20     D        D4    ...
42508    36 months   13.12%       202.51     D        D5    ...
42509    36 months   13.12%       180.57     D        D5    ...
42510    36 months    9.64%        61.00     B        B4    ...
42511    36 months   14.70%       345.18     E        E5    ...
42512    36 months    7.12%        61.87     A        A1    ...
42513    36 months   10.59%       195.28     C        C2    ...
42514    36 months    9.64%       141.25     B        B4    ...
```

```
42515   36 months    9.01%       38.17     B        B2    ...
42516   36 months   11.22%      164.23     C        C4    ...
42517   36 months   10.91%       45.78     C        C3    ...
42518   36 months   14.07%       34.21     E        E3    ...
42519   36 months    7.75%      156.11     A        A3    ...
42520   36 months    7.43%       77.69     A        A2    ...
42521   36 months    7.43%       93.23     A        A2    ...
42522   36 months    8.38%       81.94     A        A5    ...
42523   36 months    7.12%       30.94     A        A1    ...
42524   36 months   12.49%       42.65     D        D3    ...
42525   36 months   11.22%      211.85     C        C4    ...
42526   36 months   11.22%      344.87     C        C4    ...
42527   36 months    9.01%       95.42     B        B2    ...
42528   36 months    9.33%       95.86     B        B3    ...
42529   36 months    9.96%       64.50     B        B5    ...
42530   36 months    9.64%      208.66     B        B4    ...
42531   36 months   10.28%      113.39     C        C1    ...
42532   36 months    9.64%       32.11     B        B4    ...
42533   36 months    9.33%       80.69     B        B3    ...
42534   36 months    8.38%      204.84     A        A5    ...
42535   36 months    7.75%      156.11     A        A3    ...

      last_fico_range_high last_fico_range_low collections_12_mths_ex_med  \
0                    744.0              740.0                       False
1                    499.0                0.0                       False
2                    719.0              715.0                       False
3                    604.0              600.0                       False
4                    694.0              690.0                       False
5                    679.0              675.0                       False
6                    654.0              650.0                       False
7                    689.0              685.0                       False
8                    499.0                0.0                       False
9                    519.0              515.0                       False
10                   734.0              730.0                       False
11                   669.0              665.0                       False
12                   619.0              615.0                       False
13                   734.0              730.0                       False
14                   654.0              650.0                       False
15                   769.0              765.0                       False
16                   639.0              635.0                       False
17                   794.0              790.0                       False
18                   559.0              555.0                       False
19                   644.0              640.0                       False
20                   684.0              680.0                       False
21                   534.0              530.0                       False
22                   779.0              775.0                       False
23                   684.0              680.0                       False
24                   499.0                0.0                       False
```

```
25                  734.0               730.0                      False
26                  509.0               505.0                      False
27                  579.0               575.0                      False
28                  689.0               685.0                      False
29                  599.0               595.0                      False
...                   ...                 ...                        ...
42506               634.0               630.0                        NaN
42507               514.0               510.0                        NaN
42508               664.0               660.0                        NaN
42509               704.0               700.0                        NaN
42510               709.0               705.0                        NaN
42511               499.0                 0.0                        NaN
42512               809.0               805.0                        NaN
42513               769.0               765.0                        NaN
42514               584.0               580.0                        NaN
42515               694.0               690.0                        NaN
42516               679.0               675.0                        NaN
42517               679.0               675.0                        NaN
42518               499.0                 0.0                        NaN
42519               759.0               755.0                        NaN
42520               789.0               785.0                        NaN
42521               799.0               795.0                        NaN
42522               614.0               610.0                        NaN
42523               599.0               595.0                        NaN
42524               624.0               620.0                        NaN
42525               574.0               570.0                        NaN
42526               744.0               740.0                        NaN
42527               594.0               590.0                        NaN
42528               714.0               710.0                        NaN
42529               594.0               590.0                        NaN
42530               684.0               680.0                        NaN
42531               819.0               815.0                        NaN
42532               784.0               780.0                        NaN
42533               714.0               710.0                        NaN
42534               724.0               720.0                        NaN
42535               794.0               790.0                        NaN

       policy_code application_type acc_now_delinq chargeoff_within_12_mths  \
0             True       INDIVIDUAL          False                      False
1             True       INDIVIDUAL          False                      False
2             True       INDIVIDUAL          False                      False
3             True       INDIVIDUAL          False                      False
4             True       INDIVIDUAL          False                      False
5             True       INDIVIDUAL          False                      False
6             True       INDIVIDUAL          False                      False
7             True       INDIVIDUAL          False                      False
8             True       INDIVIDUAL          False                      False
9             True       INDIVIDUAL          False                      False
```

10	True	INDIVIDUAL	False	False
11	True	INDIVIDUAL	False	False
12	True	INDIVIDUAL	False	False
13	True	INDIVIDUAL	False	False
14	True	INDIVIDUAL	False	False
15	True	INDIVIDUAL	False	False
16	True	INDIVIDUAL	False	False
17	True	INDIVIDUAL	False	False
18	True	INDIVIDUAL	False	False
19	True	INDIVIDUAL	False	False
20	True	INDIVIDUAL	False	False
21	True	INDIVIDUAL	False	False
22	True	INDIVIDUAL	False	False
23	True	INDIVIDUAL	False	False
24	True	INDIVIDUAL	False	False
25	True	INDIVIDUAL	False	False
26	True	INDIVIDUAL	False	False
27	True	INDIVIDUAL	False	False
28	True	INDIVIDUAL	False	False
29	True	INDIVIDUAL	False	False
...	...	...	...	...
42506	True	INDIVIDUAL	False	NaN
42507	True	INDIVIDUAL	False	NaN
42508	True	INDIVIDUAL	False	NaN
42509	True	INDIVIDUAL	False	NaN
42510	True	INDIVIDUAL	NaN	NaN
42511	True	INDIVIDUAL	False	NaN
42512	True	INDIVIDUAL	False	NaN
42513	True	INDIVIDUAL	False	NaN
42514	True	INDIVIDUAL	False	NaN
42515	True	INDIVIDUAL	NaN	NaN
42516	True	INDIVIDUAL	NaN	NaN
42517	True	INDIVIDUAL	NaN	NaN
42518	True	INDIVIDUAL	NaN	NaN
42519	True	INDIVIDUAL	NaN	NaN
42520	True	INDIVIDUAL	NaN	NaN
42521	True	INDIVIDUAL	NaN	NaN
42522	True	INDIVIDUAL	NaN	NaN
42523	True	INDIVIDUAL	NaN	NaN
42524	True	INDIVIDUAL	NaN	NaN
42525	True	INDIVIDUAL	NaN	NaN
42526	True	INDIVIDUAL	NaN	NaN
42527	True	INDIVIDUAL	NaN	NaN
42528	True	INDIVIDUAL	NaN	NaN
42529	True	INDIVIDUAL	NaN	NaN
42530	True	INDIVIDUAL	NaN	NaN
42531	True	INDIVIDUAL	NaN	NaN
42532	True	INDIVIDUAL	NaN	NaN

```
42533         True       INDIVIDUAL            NaN                      NaN
42534         True       INDIVIDUAL            NaN                      NaN
42535         True       INDIVIDUAL            NaN                      NaN

      delinq_amnt pub_rec_bankruptcies tax_liens
0             0.0                  0.0     False
1             0.0                  0.0     False
2             0.0                  0.0     False
3             0.0                  0.0     False
4             0.0                  0.0     False
5             0.0                  0.0     False
6             0.0                  0.0     False
7             0.0                  0.0     False
8             0.0                  0.0     False
9             0.0                  0.0     False
10            0.0                  0.0     False
11            0.0                  0.0     False
12            0.0                  0.0     False
13            0.0                  0.0     False
14            0.0                  0.0     False
15            0.0                  0.0     False
16            0.0                  0.0     False
17            0.0                  0.0     False
18            0.0                  0.0     False
19            0.0                  0.0     False
20            0.0                  0.0     False
21            0.0                  0.0     False
22            0.0                  0.0     False
23            0.0                  0.0     False
24            0.0                  0.0     False
25            0.0                  0.0     False
26            0.0                  0.0     False
27            0.0                  0.0     False
28            0.0                  0.0     False
29            0.0                  0.0     False
...           ...                  ...       ...
42506         0.0                  NaN       NaN
42507         0.0                  NaN       NaN
42508         0.0                  NaN       NaN
42509         0.0                  NaN       NaN
42510         NaN                  NaN       NaN
42511         0.0                  NaN       NaN
42512         0.0                  NaN       NaN
42513         0.0                  NaN       NaN
42514         0.0                  NaN       NaN
42515         NaN                  NaN       NaN
42516         NaN                  NaN       NaN
42517         NaN                  NaN       NaN
```

```
42518         NaN                  NaN       NaN
42519         NaN                  NaN       NaN
42520         NaN                  NaN       NaN
42521         NaN                  NaN       NaN
42522         NaN                  NaN       NaN
42523         NaN                  NaN       NaN
42524         NaN                  NaN       NaN
42525         NaN                  NaN       NaN
42526         NaN                  NaN       NaN
42527         NaN                  NaN       NaN
42528         NaN                  NaN       NaN
42529         NaN                  NaN       NaN
42530         NaN                  NaN       NaN
42531         NaN                  NaN       NaN
42532         NaN                  NaN       NaN
42533         NaN                  NaN       NaN
42534         NaN                  NaN       NaN
42535         NaN                  NaN       NaN

[42536 rows x 58 columns]
```

2. Data Transformation Feature scaling is the method to limit the range of variables so that they can be compared on common grounds. It is performed on continuous variables. Lets plot the distribution of all the continuous variables in the data set.

2.1 Min-Max Normalization or Rescaling
xnorm = (X-Xmin)/ (Xmax-Xmin)

```
In [17]: import matplotlib.pyplot as plt
         %matplotlib inline
         # Create data samples x1, x2, x3
         df = pd.DataFrame({
             # positive skew
             'x1': np.random.chisquare(8, 1000),
             # negative skew
             'x2': np.random.beta(8, 2, 1000) * 40,
             # no skew
             'x3': np.random.normal(50, 3, 1000)
         })
         df
```

```
Out[17]:          x1         x2         x3
         0     4.176608  36.578501  53.278469
         1    11.762533  30.574695  53.018049
         2     6.502315  36.777874  48.015045
         3     4.373445  35.828148  50.063159
         4     4.232660  29.378933  50.233194
         5     2.130249  35.112108  53.277256
         6     1.767400  33.833223  49.938346
```

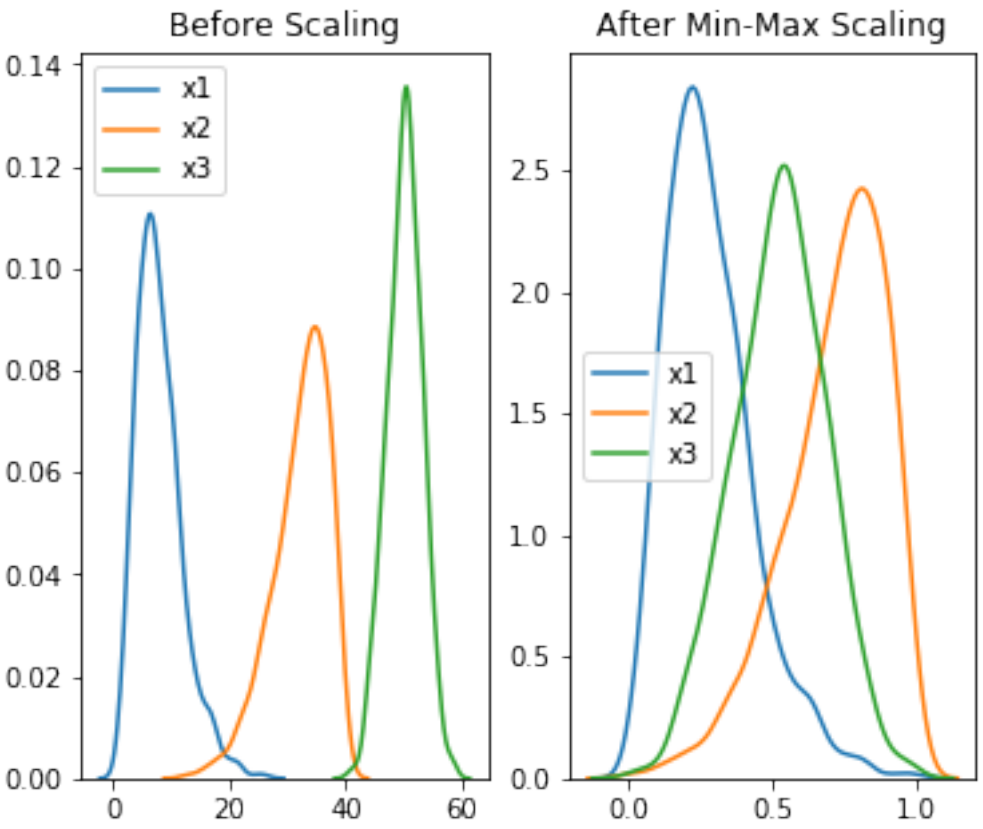
7	6.356473	39.116542	53.343309
8	10.524769	33.924826	51.555350
9	7.423300	34.847636	53.520430
10	5.700439	37.542186	51.893499
11	9.870685	31.214974	50.897999
12	6.140859	30.056021	45.247602
13	3.396192	25.785211	54.832185
14	3.349601	37.372898	51.721646
15	10.962452	28.185094	46.317004
16	10.728609	37.629154	49.989800
17	7.254143	34.248109	53.432171
18	10.079955	32.692325	55.423879
19	7.045191	32.750820	50.372525
20	6.398252	28.728606	47.396270
21	9.553095	28.322186	46.954989
22	5.250622	25.688546	49.292995
23	5.567015	24.767568	50.293283
24	4.798372	34.037735	45.470087
25	2.619429	29.994384	51.155127
26	8.811075	29.652466	50.123312
27	5.274134	29.566529	54.941685
28	5.422298	29.937114	52.504430
29	12.474314	29.378271	52.811595
..	...	...	...
970	20.306841	33.390367	49.175230
971	3.156177	35.735982	46.325561
972	16.536062	29.070146	52.057782
973	7.091280	32.257698	53.663401
974	1.421279	29.969979	49.569683
975	10.389134	28.556535	47.611947
976	15.453047	35.135510	49.778348
977	2.423340	32.950679	49.373322
978	3.701311	34.233299	51.975502
979	10.293042	26.695088	50.696987
980	6.464377	33.822910	46.826542
981	3.656951	27.433069	51.979545
982	4.213380	31.769439	51.703752
983	8.758165	28.098044	47.025437
984	7.005155	39.730607	48.436875
985	7.746603	38.559149	52.544724
986	7.197039	29.312129	44.713459
987	15.169891	35.443128	44.165024
988	4.259811	37.305274	49.496617
989	6.753583	35.842331	50.951803
990	17.070655	32.385656	53.691918
991	10.276571	30.897110	55.165659
992	6.964506	30.248598	49.785705
993	6.377272	21.451023	51.444754

```
994    4.237889  33.841525  54.888862
995    9.352061  24.807878  46.197119
996    8.104146  37.909359  46.066406
997    9.820446  32.563369  53.232693
998    6.022620  32.667803  52.162870
999   12.266281  27.496064  46.881607

[1000 rows x 3 columns]
```

We infer that each one of them are in different range For data with attributes of varying scales, we can rescale attributes to possess the same scale. We rescale attributes into the range 0 to 1 and call it normalization. We use the MinMaxScaler class from scikit-learn.

```
In [18]: from sklearn.preprocessing import MinMaxScaler
         import seaborn as sns
         # Use MinMaxScaler
         scaler = MinMaxScaler()
         scaled_df = scaler.fit_transform(df)
         scaled_df = pd.DataFrame(scaled_df, columns=['x1', 'x2', 'x3'])
         # Plot and visualize
         fig, (ax1, ax2) = plt.subplots(ncols=2, figsize=(6, 5))
         ax1.set_title('Before Scaling')
         sns.kdeplot(df['x1'], ax=ax1)
         sns.kdeplot(df['x2'], ax=ax1)
         sns.kdeplot(df['x3'], ax=ax1)
         ax2.set_title('After Min-Max Scaling')
         sns.kdeplot(scaled_df['x1'], ax=ax2)
         sns.kdeplot(scaled_df['x2'], ax=ax2)
         sns.kdeplot(scaled_df['x3'], ax=ax2)
         plt.show()
```



2.2 Z-score Normalization or standardizing or Mean Removal Standardize features by removing the mean and scaling to unit variance

The standard score of a sample x is calculated as:

z = (x - u) / s where u is the mean of the training samples or zero if with_mean=False, and s is the standard deviation of the 4 training samples or one if with_std=False.

Centering and scaling happen independently on each feature by computing the relevant statistics on the samples in the training set. Mean and standard deviation are then stored to be used on later data using the transform method.

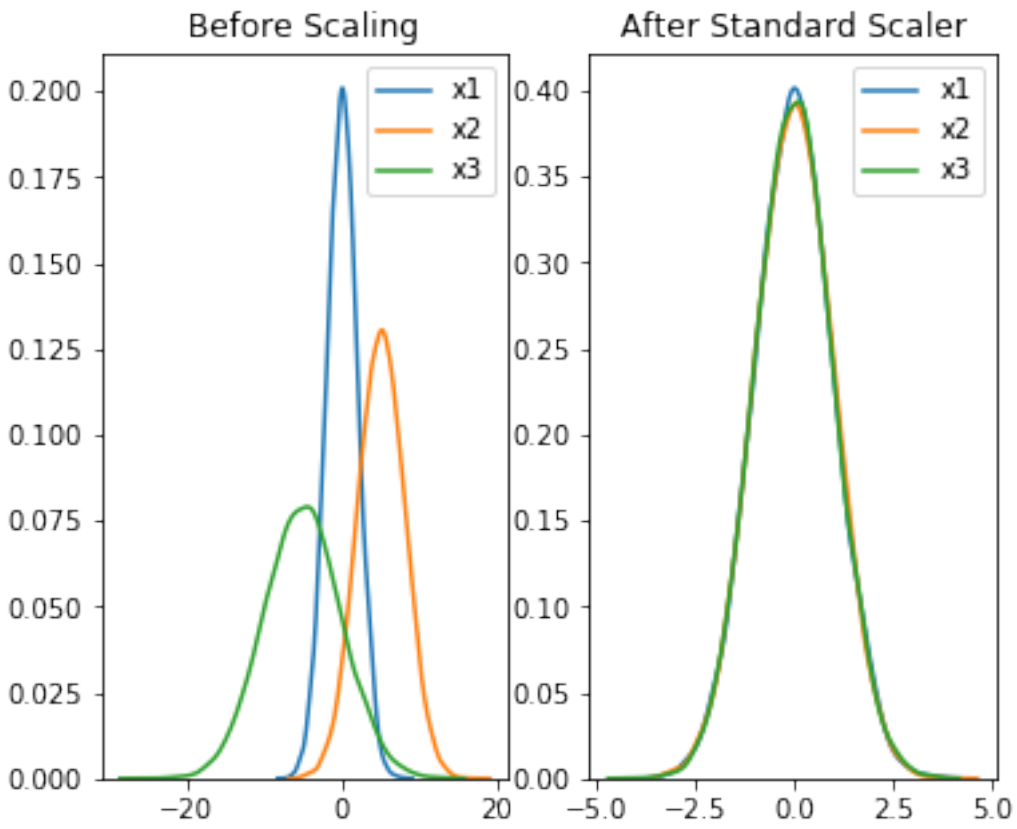
```
In [19]: from sklearn.preprocessing import StandardScaler
         # Create data samples x1, x2, x3
         np.random.seed(1)
         df = pd.DataFrame({
             'x1': np.random.normal(0, 2, 10000),
             'x2': np.random.normal(5, 3, 10000),
             'x3': np.random.normal(-5, 5, 10000)
         })
         # Use StandardScaler
         scaler = StandardScaler()
         scaled_df = scaler.fit_transform(df)
         scaled_df = pd.DataFrame(scaled_df, columns=['x1', 'x2', 'x3'])
```

```
# Plot and visualize
fig, (ax1, ax2) = plt.subplots(ncols=2, figsize=(6, 5))

ax1.set_title('Before Scaling')
sns.kdeplot(df['x1'], ax=ax1)
sns.kdeplot(df['x2'], ax=ax1)
sns.kdeplot(df['x3'], ax=ax1)

ax2.set_title('After Standard Scaler')
sns.kdeplot(scaled_df['x1'], ax=ax2)
sns.kdeplot(scaled_df['x2'], ax=ax2)
sns.kdeplot(scaled_df['x3'], ax=ax2)

plt.show()
```



2.3 Robust Scaler Scale features using statistics that are robust to outliers.

This Scaler removes the median and scales the data according to the quantile range (defaults to IQR: Interquartile Range). The IQR is the range between the 1st quartile (25th quantile) and the 3rd quartile (75th quantile).

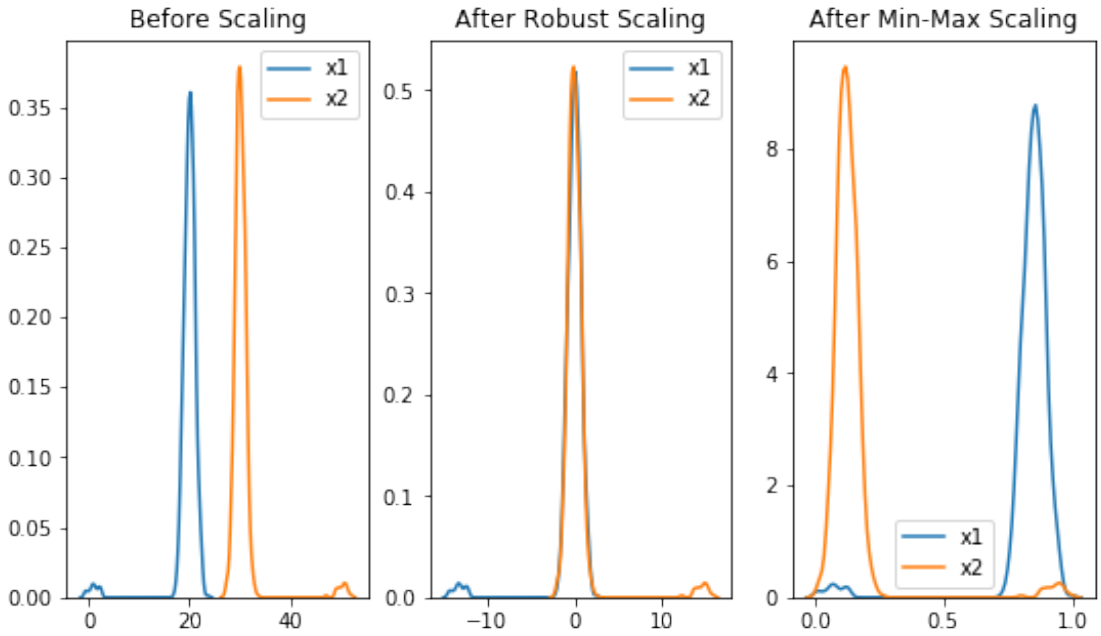
The RobustScaler uses a similar method to the Min-Max scaler. However, it uses the interquartile range instead of the min-max, which makes it robust to outliers. It follows the following formula for each feature:

(Xi-Q1)/(Q3-Q1)

```
In [20]: from sklearn.preprocessing import RobustScaler
         # Create data samples x1, x2
         x = pd.DataFrame({
             # Distribution with lower outliers
             'x1': np.concatenate([np.random.normal(20, 1, 1000), np.random.normal(1, 1, 25)])
             # Distribution with higher outliers
             'x2': np.concatenate([np.random.normal(30, 1, 1000), np.random.normal(50, 1, 25)])
         })
         # Use RobustScaler
         scaler = RobustScaler()
         robust_scaled_df = scaler.fit_transform(x)
         robust_scaled_df = pd.DataFrame(robust_scaled_df, columns=['x1', 'x2'])

         # Use MinMaxScaler
         scaler = MinMaxScaler()
         minmax_scaled_df = scaler.fit_transform(x)
         minmax_scaled_df = pd.DataFrame(minmax_scaled_df, columns=['x1', 'x2'])

         # Plot and visualize
         fig, (ax1, ax2, ax3) = plt.subplots(ncols=3, figsize=(9, 5))
         ax1.set_title('Before Scaling')
         sns.kdeplot(x['x1'], ax=ax1)
         sns.kdeplot(x['x2'], ax=ax1)
         ax2.set_title('After Robust Scaling')
         sns.kdeplot(robust_scaled_df['x1'], ax=ax2)
         sns.kdeplot(robust_scaled_df['x2'], ax=ax2)
         ax3.set_title('After Min-Max Scaling')
         sns.kdeplot(minmax_scaled_df['x1'], ax=ax3)
         sns.kdeplot(minmax_scaled_df['x2'], ax=ax3)
         plt.show()
```



3. Converting Numeric features to Binary feataures

```
In [26]: from sklearn.preprocessing import Binarizer
         # Create data samples x1, x2
         x = pd.DataFrame({
             # Distribution with lower outliers
             'x1': np.concatenate([np.random.normal(20, 1, 1000), np.random.normal(1, 1, 25)]),
             # Distribution with higher outliers
             'x2': np.concatenate([np.random.normal(30, 1, 1000), np.random.normal(50, 1, 25)])
         })
         # Use Binarizer
         scaler = Binarizer(threshold=5)
         binarized_df = scaler.transform(x)
         binarized_df = pd.DataFrame(binarized_df, columns=['x1', 'x2'])
         binarized_df
```

```
Out[26]:      x1   x2
         0   1.0  1.0
         1   1.0  1.0
         2   1.0  1.0
         3   1.0  1.0
         4   1.0  1.0
         5   1.0  1.0
         6   1.0  1.0
         7   1.0  1.0
         8   1.0  1.0
```

```
9      1.0  1.0
10     1.0  1.0
11     1.0  1.0
12     1.0  1.0
13     1.0  1.0
14     1.0  1.0
15     1.0  1.0
16     1.0  1.0
17     1.0  1.0
18     1.0  1.0
19     1.0  1.0
20     1.0  1.0
21     1.0  1.0
22     1.0  1.0
23     1.0  1.0
24     1.0  1.0
25     1.0  1.0
26     1.0  1.0
27     1.0  1.0
28     1.0  1.0
29     1.0  1.0
...    ...  ...
995    1.0  1.0
996    1.0  1.0
997    1.0  1.0
998    1.0  1.0
999    1.0  1.0
1000   0.0  1.0
1001   0.0  1.0
1002   0.0  1.0
1003   0.0  1.0
1004   0.0  1.0
1005   0.0  1.0
1006   0.0  1.0
1007   0.0  1.0
1008   0.0  1.0
1009   0.0  1.0
1010   0.0  1.0
1011   0.0  1.0
1012   0.0  1.0
1013   0.0  1.0
1014   0.0  1.0
1015   0.0  1.0
1016   0.0  1.0
1017   0.0  1.0
1018   0.0  1.0
1019   0.0  1.0
1020   0.0  1.0
```

```
1021  0.0  1.0
1022  0.0  1.0
1023  0.0  1.0
1024  0.0  1.0

[1025 rows x 2 columns]
```

4. Handling Ordinal Categorical Variables

```
In [60]: df_cat = pd.DataFrame(data =
                              [['green','M',10.1,'class1'],
                               ['blue','L',20.1,'class2'],
                               ['white','M',30.1,'class1']])
         df_cat.columns = ['color','size','price','classlabel']
         df_cat

Out[60]:    color size  price classlabel
         0  green    M   10.1     class1
         1   blue    L   20.1     class2
         2  white    M   30.1     class1

In [62]: #Using Label Encoder
         from sklearn.preprocessing import LabelEncoder
         label_encode = LabelEncoder()
         label_encode.fit_transform(['S','L','M'])
         df_cat['size'] =label_encode.transform(df_cat['size'].values)
         df_cat

Out[62]:    color  size  price classlabel
         0  green     1   10.1     class1
         1   blue     0   20.1     class2
         2  white     1   30.1     class1

In [63]: #Using Label Encoder
         from sklearn.preprocessing import LabelEncoder
         label_encode = LabelEncoder()
         df_cat['classlabel'] =label_encode.fit_transform(df_cat['classlabel'].values)
         df_cat

Out[63]:    color  size  price  classlabel
         0  green     1   10.1           0
         1   blue     0   20.1           1
         2  white     1   30.1           0
```

5. Handling Nomial Categorical Variables

```
In [74]: #Using OneHotEncoder
         from sklearn.preprocessing import OneHotEncoder
         enc = LabelEncoder()
```

```
        new_cat_features = enc.fit_transform(df_cat['color'].values)
        print( new_cat_features) # [1 0 2]
        new_cat_features = new_cat_features.reshape(-1, 1) # Needs to be the correct shape
        ohe = OneHotEncoder(sparse=False) #Easier to read
        print(ohe.fit_transform(new_cat_features))
```

```
[1 0 2]
[[0. 1. 0.]
 [1. 0. 0.]
 [0. 0. 1.]]
```

```
In [76]: # Using get dummies
         df_cat1 = pd.get_dummies(df_cat[['color','size','price','classlabel']])
         df_cat1
```

Out[76]:

	size	price	classlabel	color_blue	color_green	color_white
0	1	10.1	0	0	1	0
1	0	20.1	1	1	0	0
2	1	30.1	0	0	0	1