eda

October 28, 2021

[31]:
```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from category_encoders import TargetEncoder
```

1 Loading Data

[2]:
```
df = pd.read_csv('dataset.csv', sep=';', dtype={
    'account_status':'category',
    'account_worst_status_0_3m':'category',
    'account_worst_status_12_24m':'category',
    'account_worst_status_3_6m':'category',
    'account_worst_status_6_12m':'category',
    'merchant_category':'category',
    'merchant_group':'category',
    'status_last_archived_0_24m':'category',
    'status_2nd_last_archived_0_24m':'category',
    'status_3rd_last_archived_0_24m':'category',
    'status_max_archived_0_6_months':'category',
    'status_max_archived_0_12_months':'category',
    'status_max_archived_0_24_months':'category',
    'worst_status_active_inv': 'category'
})
```

2 Target Variable

[3]:
```
df['default'].value_counts(normalize=True, dropna=False) * 100
```

[3]:
```
0.0    88.709290
NaN    10.002401
1.0     1.288309
Name: default, dtype: float64
```

The output file with predictions for users with `default = NaN` is the goal of the exercize. Therefore we will filter them out and keep them in a separate dataframe.

[4]:
```
df_final_uotput = df[df['default'].isna()]
```

[5]:
```
df = df[~df['uuid'].isin(df_final_uotput['uuid'])]
```

[6]:
```
df['default'].value_counts(normalize=True, dropna=False) * 100
```

[6]:
```
0.0    98.568507
1.0     1.431493
Name: default, dtype: float64
```

Looks like we have a case of `class imbalance`. But it's not that bad, at least most of the customers pay their bills on time :)

3 Quick Feature Overview

At first glance it seems like some fields will require data imputation.

- account_incoming_debt_vs_paid_0_24m
- account_days_in_ group
- account_status
- account_worst_status_ group
- avg_payment_span_ group
- num_arch_written_off_ group
- worst_status_active_inv group

[7]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 89976 entries, 0 to 89975
Data columns (total 43 columns):
 #   Column                               Non-Null Count  Dtype
---  ------                               --------------  -----
 0   uuid                                 89976 non-null  object
 1   default                              89976 non-null  float64
 2   account_amount_added_12_24m          89976 non-null  int64
 3   account_days_in_dc_12_24m            79293 non-null  float64
 4   account_days_in_rem_12_24m           79293 non-null  float64
 5   account_days_in_term_12_24m          79293 non-null  float64
 6   account_incoming_debt_vs_paid_0_24m  36619 non-null  float64
 7   account_status                       41042 non-null  category
 8   account_worst_status_0_3m            41042 non-null  category
 9   account_worst_status_12_24m          29921 non-null  category
 10  account_worst_status_3_6m            38038 non-null  category
 11  account_worst_status_6_12m           35663 non-null  category
```

```
 12  age                                 89976 non-null  int64
 13  avg_payment_span_0_12m              68508 non-null  float64
 14  avg_payment_span_0_3m               45594 non-null  float64
 15  merchant_category                   89976 non-null  category
 16  merchant_group                      89976 non-null  category
 17  has_paid                            89976 non-null  bool
 18  max_paid_inv_0_12m                  89976 non-null  float64
 19  max_paid_inv_0_24m                  89976 non-null  float64
 20  name_in_email                       89976 non-null  object
 21  num_active_div_by_paid_inv_0_12m    69318 non-null  float64
 22  num_active_inv                      89976 non-null  int64
 23  num_arch_dc_0_12m                   89976 non-null  int64
 24  num_arch_dc_12_24m                  89976 non-null  int64
 25  num_arch_ok_0_12m                   89976 non-null  int64
 26  num_arch_ok_12_24m                  89976 non-null  int64
 27  num_arch_rem_0_12m                  89976 non-null  int64
 28  num_arch_written_off_0_12m          73671 non-null  float64
 29  num_arch_written_off_12_24m         73671 non-null  float64
 30  num_unpaid_bills                    89976 non-null  int64
 31  status_last_archived_0_24m          89976 non-null  category
 32  status_2nd_last_archived_0_24m      89976 non-null  category
 33  status_3rd_last_archived_0_24m      89976 non-null  category
 34  status_max_archived_0_6_months      89976 non-null  category
 35  status_max_archived_0_12_months     89976 non-null  category
 36  status_max_archived_0_24_months     89976 non-null  category
 37  recovery_debt                       89976 non-null  int64
 38  sum_capital_paid_account_0_12m      89976 non-null  int64
 39  sum_capital_paid_account_12_24m     89976 non-null  int64
 40  sum_paid_inv_0_12m                  89976 non-null  int64
 41  time_hours                          89976 non-null  float64
 42  worst_status_active_inv             27436 non-null  category
dtypes: bool(1), category(14), float64(13), int64(13), object(2)
memory usage: 21.2+ MB
```

4 Descriptive Stats default=0 vs default=1

[8]:
```
df[df['default'] == 0].describe().T
```

[8]:
```
                                    count          mean           std  \
default                           88688.0      0.000000      0.000000
account_amount_added_12_24m       88688.0  12251.285055  35522.032684
account_days_in_dc_12_24m         78096.0      0.171648      5.000260
account_days_in_rem_12_24m        78096.0      4.830644     22.422242
account_days_in_term_12_24m       78096.0      0.256402      2.745369
account_incoming_debt_vs_paid_0_24m 35905.0    1.332916     27.187677
age                               88688.0     36.087554     13.005620
```

avg_payment_span_0_12m	67838.0	17.726766	12.167796
avg_payment_span_0_3m	45335.0	14.903550	10.171053
max_paid_inv_0_12m	88688.0	9293.293422	13643.097654
max_paid_inv_0_24m	88688.0	11324.241769	15327.844469
num_active_div_by_paid_inv_0_12m	68603.0	0.110547	0.273332
num_active_inv	88688.0	0.595188	1.543760
num_arch_dc_0_12m	88688.0	0.056930	0.350055
num_arch_dc_12_24m	88688.0	0.055272	0.350175
num_arch_ok_0_12m	88688.0	7.380006	16.168802
num_arch_ok_12_24m	88688.0	6.459995	15.491128
num_arch_rem_0_12m	88688.0	0.467155	1.351612
num_arch_written_off_0_12m	72843.0	0.000082	0.009075
num_arch_written_off_12_24m	72843.0	0.000137	0.012834
num_unpaid_bills	88688.0	2.121482	6.299023
recovery_debt	88688.0	3.140233	98.519889
sum_capital_paid_account_0_12m	88688.0	10827.012335	26566.528209
sum_capital_paid_account_12_24m	88688.0	6571.061598	19230.815955
sum_paid_inv_0_12m	88688.0	39596.846090	89942.815639
time_hours	88688.0	15.342532	5.022549

	min	25%	50% \
default	0.000000	0.000000	0.000000
account_amount_added_12_24m	0.000000	0.000000	0.000000
account_days_in_dc_12_24m	0.000000	0.000000	0.000000
account_days_in_rem_12_24m	0.000000	0.000000	0.000000
account_days_in_term_12_24m	0.000000	0.000000	0.000000
account_incoming_debt_vs_paid_0_24m	0.000000	0.000000	0.147553
age	18.000000	25.000000	34.000000
avg_payment_span_0_12m	0.000000	10.755556	14.833333
avg_payment_span_0_3m	0.000000	8.333333	13.000000
max_paid_inv_0_12m	0.000000	2090.000000	6085.000000
max_paid_inv_0_24m	0.000000	3430.000000	7651.500000
num_active_div_by_paid_inv_0_12m	0.000000	0.000000	0.000000
num_active_inv	0.000000	0.000000	0.000000
num_arch_dc_0_12m	0.000000	0.000000	0.000000
num_arch_dc_12_24m	0.000000	0.000000	0.000000
num_arch_ok_0_12m	0.000000	0.000000	2.000000
num_arch_ok_12_24m	0.000000	0.000000	2.000000
num_arch_rem_0_12m	0.000000	0.000000	0.000000
num_arch_written_off_0_12m	0.000000	0.000000	0.000000
num_arch_written_off_12_24m	0.000000	0.000000	0.000000
num_unpaid_bills	0.000000	0.000000	0.000000
recovery_debt	0.000000	0.000000	0.000000
sum_capital_paid_account_0_12m	0.000000	0.000000	0.000000
sum_capital_paid_account_12_24m	0.000000	0.000000	0.000000
sum_paid_inv_0_12m	0.000000	2780.000000	16285.500000
time_hours	0.000278	11.636389	15.805694

```
                                               75%           max
default                                   0.000000  0.000000e+00
account_amount_added_12_24m            4854.250000  1.128775e+06
account_days_in_dc_12_24m                 0.000000  3.620000e+02
account_days_in_rem_12_24m                0.000000  3.650000e+02
account_days_in_term_12_24m               0.000000  9.700000e+01
account_incoming_debt_vs_paid_0_24m       0.656399  3.914000e+03
age                                      45.000000  1.000000e+02
avg_payment_span_0_12m                   21.000000  2.240000e+02
avg_payment_span_0_3m                    18.000000  8.400000e+01
max_paid_inv_0_12m                    11455.250000  2.790000e+05
max_paid_inv_0_24m                    13895.000000  2.790000e+05
num_active_div_by_paid_inv_0_12m          0.100000  6.000000e+00
num_active_inv                            1.000000  4.700000e+01
num_arch_dc_0_12m                         0.000000  1.600000e+01
num_arch_dc_12_24m                        0.000000  1.300000e+01
num_arch_ok_0_12m                         7.000000  2.610000e+02
num_arch_ok_12_24m                        6.000000  3.130000e+02
num_arch_rem_0_12m                        0.000000  4.200000e+01
num_arch_written_off_0_12m                0.000000  1.000000e+00
num_arch_written_off_12_24m               0.000000  2.000000e+00
num_unpaid_bills                          2.000000  1.820000e+02
recovery_debt                             0.000000  1.119000e+04
sum_capital_paid_account_0_12m         8962.250000  5.714750e+05
sum_capital_paid_account_12_24m          46.250000  3.418590e+05
sum_paid_inv_0_12m                    44395.000000  2.962870e+06
time_hours                               19.549167  2.399972e+01
```

[9]:
```
df[df['default'] == 1].describe().T
```

[9]:
```
                                      count          mean           std  \
default                              1288.0      1.000000      0.000000
account_amount_added_12_24m          1288.0  13988.590839  31138.845393
account_days_in_dc_12_24m            1197.0      3.197995     21.442738
account_days_in_rem_12_24m           1197.0     20.940685     43.112348
account_days_in_term_12_24m          1197.0      2.342523      8.543689
account_incoming_debt_vs_paid_0_24m   714.0      1.210835      3.072370
age                                  1288.0     31.302019     11.659622
avg_payment_span_0_12m                670.0     43.408737     33.490758
avg_payment_span_0_3m                 259.0     24.914134     17.987244
max_paid_inv_0_12m                   1288.0   4458.986025   6110.903212
max_paid_inv_0_24m                   1288.0   5740.916925   7352.611782
num_active_div_by_paid_inv_0_12m      715.0      0.510002      1.018189
num_active_inv                       1288.0      0.840839      1.565551
num_arch_dc_0_12m                    1288.0      0.394410      1.096593
num_arch_dc_12_24m                   1288.0      0.368012      0.965433
```

num_arch_ok_0_12m	1288.0	1.076863	3.199819
num_arch_ok_12_24m	1288.0	0.920807	2.935452
num_arch_rem_0_12m	1288.0	0.474379	1.333670
num_arch_written_off_0_12m	828.0	0.002415	0.049118
num_arch_written_off_12_24m	828.0	0.000000	0.000000
num_unpaid_bills	1288.0	3.572205	5.960716
recovery_debt	1288.0	66.302795	1133.370280
sum_capital_paid_account_0_12m	1288.0	11291.387422	20913.256107
sum_capital_paid_account_12_24m	1288.0	7185.295807	16357.901001
sum_paid_inv_0_12m	1288.0	12816.974379	24167.993185
time_hours	1288.0	14.910725	5.547222

	min	25%	50% \
default	1.000000	1.000000	1.000000
account_amount_added_12_24m	0.000000	0.000000	0.000000
account_days_in_dc_12_24m	0.000000	0.000000	0.000000
account_days_in_rem_12_24m	0.000000	0.000000	0.000000
account_days_in_term_12_24m	0.000000	0.000000	0.000000
account_incoming_debt_vs_paid_0_24m	0.000000	0.037287	0.513352
age	18.000000	21.000000	28.000000
avg_payment_span_0_12m	0.000000	18.541667	37.000000
avg_payment_span_0_3m	0.000000	11.416667	20.500000
max_paid_inv_0_12m	0.000000	0.000000	2750.000000
max_paid_inv_0_24m	0.000000	0.000000	3880.000000
num_active_div_by_paid_inv_0_12m	0.000000	0.000000	0.142857
num_active_inv	0.000000	0.000000	0.000000
num_arch_dc_0_12m	0.000000	0.000000	0.000000
num_arch_dc_12_24m	0.000000	0.000000	0.000000
num_arch_ok_0_12m	0.000000	0.000000	0.000000
num_arch_ok_12_24m	0.000000	0.000000	0.000000
num_arch_rem_0_12m	0.000000	0.000000	0.000000
num_arch_written_off_0_12m	0.000000	0.000000	0.000000
num_arch_written_off_12_24m	0.000000	0.000000	0.000000
num_unpaid_bills	0.000000	0.000000	1.000000
recovery_debt	0.000000	0.000000	0.000000
sum_capital_paid_account_0_12m	0.000000	0.000000	177.000000
sum_capital_paid_account_12_24m	0.000000	0.000000	0.000000
sum_paid_inv_0_12m	0.000000	0.000000	4167.500000
time_hours	0.005556	11.088264	15.365694

	75%	max
default	1.000000	1.000000
account_amount_added_12_24m	13324.500000	446757.000000
account_days_in_dc_12_24m	0.000000	322.000000
account_days_in_rem_12_24m	20.000000	259.000000
account_days_in_term_12_24m	0.000000	67.000000
account_incoming_debt_vs_paid_0_24m	1.065028	41.214429

```
age                                      39.000000      80.000000
avg_payment_span_0_12m                   57.000000     260.000000
avg_payment_span_0_3m                    37.000000      86.000000
max_paid_inv_0_12m                     6954.500000   96200.000000
max_paid_inv_0_24m                     8795.000000   96200.000000
num_active_div_by_paid_inv_0_12m          0.666667       9.000000
num_active_inv                            1.000000      13.000000
num_arch_dc_0_12m                         0.000000      11.000000
num_arch_dc_12_24m                        0.000000       8.000000
num_arch_ok_0_12m                         1.000000      39.000000
num_arch_ok_12_24m                        1.000000      37.000000
num_arch_rem_0_12m                        0.000000      14.000000
num_arch_written_off_0_12m                0.000000       1.000000
num_arch_written_off_12_24m               0.000000       0.000000
num_unpaid_bills                          4.000000      73.000000
recovery_debt                             0.000000   36479.000000
sum_capital_paid_account_0_12m        14680.500000  145930.000000
sum_capital_paid_account_12_24m        6276.000000  148784.000000
sum_paid_inv_0_12m                    14630.500000  195037.000000
time_hours                               19.463542      23.941389
```

Dropping `account_incoming_debt_vs_paid_0_24m` because it has too many missing values and doesn't seam to bring any inforamtion about the target

`Age` seams to have some signal.

Features that have different distributions for default=1 and default=0: * `account_days_in_dc_12_24m` * `account_days_in_rem_12_24m` * `account_days_in_term_12_24m`

5 Categorical Features

[10]:
```
df['worst_status_active_inv'] = df['worst_status_active_inv'].cat.
 ↪add_categories(0)
df['worst_status_active_inv'] = df['worst_status_active_inv'].fillna(0)
df.groupby(['worst_status_active_inv'])['default'].value_counts(normalize=True)
```

[10]:
```
worst_status_active_inv  default
1                        0.0        0.984441
                         1.0        0.015559
2                        0.0        0.959358
                         1.0        0.040642
3                        0.0        0.896774
                         1.0        0.103226
0                        0.0        0.987672
                         1.0        0.012328
Name: default, dtype: float64
```

For `worst_status_active_inv` missing values will be replaced with `1` because the distribution apears to be the same as for `worst_status_active_inv=1`.

It seams like `worst_status_active_inv=3` might be useful

[11]:
```
df.groupby(['name_in_email'])['default'].value_counts(normalize=True)
```

[11]:
```
name_in_email  default
F              0.0        0.987664
               1.0        0.012336
F+L            0.0        0.987513
               1.0        0.012487
F1+L           0.0        0.986293
               1.0        0.013707
Initials       0.0        0.958333
               1.0        0.041667
L              0.0        0.976431
               1.0        0.023569
L1+F           0.0        0.987858
               1.0        0.012142
Nick           0.0        0.980656
               1.0        0.019344
no_match       0.0        0.981052
               1.0        0.018948
Name: default, dtype: float64
```

Looks like `name_in_email=Initials` is the only one with some signal.

[12]:
```
x = df.groupby(['merchant_category'])['default'].value_counts(normalize=True).
 ↪reset_index(name='prob')
x[x['default'] == 1].sort_values('prob', ascending=False)
```

[12]:

	merchant_category	default	prob
89	Tobacco	1.0	0.137931
78	Plants & Flowers	1.0	0.125000
85	Sex toys	1.0	0.111111
25	Dating services	1.0	0.100176
50	Food & Beverage	1.0	0.083650
99	Wheels & Tires	1.0	0.060606
10	Car electronics	1.0	0.048780
97	Video Games & Related accessories	1.0	0.041806
44	Diversified erotic material	1.0	0.039286
21	Cosmetics	1.0	0.036207
17	Collectibles	1.0	0.032609
68	Musical Instruments & Equipment	1.0	0.032258
95	Underwear	1.0	0.026667
1	Adult Shoes & Clothing	1.0	0.025735
40	Diversified electronics	1.0	0.025200

```
102                    Youthful Shoes & Clothing      1.0  0.024990
64                                    Kitchenware      1.0  0.024390
82                               Prints & Photos      1.0  0.022636
58                                Hobby articles      1.0  0.022032
74                                  Pet supplies      1.0  0.021097
46      Electronic equipment & Related accessories     1.0  0.020085
62                             Jewelry & Watches      1.0  0.019632
35              Diversified Home & Garden products      1.0  0.018721
31                              Digital services      1.0  0.018450
6                               Body & Hair Care      1.0  0.018277
93                               Travel services      1.0  0.018182
87                         Sports gear & Outdoor      1.0  0.017878
54                                     Furniture      1.0  0.017647
56                      General Shoes & Clothing      1.0  0.016579
70                                           Non      1.0  0.015625
19                Concept stores & Miscellaneous      1.0  0.015117
72                Personal care & Body improvement     1.0  0.015106
76                        Pharmaceutical products      1.0  0.014970
3                  Automotive Parts & Accessories      1.0  0.014686
23                      Costumes & Party supplies      1.0  0.014599
29                           Dietary supplements      1.0  0.014404
33           Diversified Health & Beauty products      1.0  0.014085
12          Children Clothes & Nurturing products      1.0  0.014001
27                                Decoration & Art      1.0  0.013356
60     Household electronics (whitegoods/appliances)   1.0  0.013333
38                 Diversified children products      1.0  0.013006
91                       Tools & Home improvement      1.0  0.012225
66                                  Music & Movies      1.0  0.008772
80                           Prescription optics      1.0  0.008717
42                      Diversified entertainment      1.0  0.007274
14                                  Children toys      1.0  0.007067
52                                     Fragrances      1.0  0.006944
8                               Books & Magazines      1.0  0.005564
```

I have `merchant_category` in this feature :D This is how it will be encoded.

[13]:
```python
x = df.groupby(['merchant_group'])['default'].value_counts(normalize=True).
↪reset_index(name='prob')
x[x['default'] == 1].sort_values('prob', ascending=False)
```

[13]:

	merchant_group	default	prob
13	Food & Beverage	1.0	0.090909
19	Intangible products	1.0	0.063913
11	Erotic Materials	1.0	0.038806
7	Electronics	1.0	0.023299
5	Clothing & Shoes	1.0	0.022683
1	Automotive Products	1.0	0.020047

```
17           Home & Garden      1.0  0.018507
23  Leisure, Sport & Hobby      1.0  0.018017
21    Jewelry & Accessories     1.0  0.017970
15          Health & Beauty     1.0  0.015784
3         Children Products     1.0  0.012570
9             Entertainment     1.0  0.007419
```

Feature `merchant_group` probably corelates with `merchant_category`. Feature selection will tell which one is more useful.

[14]:
```
# df['worst_status_active_inv']['default'].value_counts()
df.groupby(['worst_status_active_inv'])['default'].value_counts(normalize=True).
↪reset_index(name='prob')
```

[14]:
```
   worst_status_active_inv  default      prob
0                        1      0.0  0.984441
1                        1      1.0  0.015559
2                        2      0.0  0.959358
3                        2      1.0  0.040642
4                        3      0.0  0.896774
5                        3      1.0  0.103226
6                        0      0.0  0.987672
7                        0      1.0  0.012328
```

[15]:
```
df['account_status']  = df['account_status'].cat.add_categories(0)

df['account_status'] = df['account_status'].fillna(0)
df.groupby(['account_status'])['default'].value_counts()
```

[15]:
```
account_status  default
1               0.0        38677
                1.0          668
2               0.0         1524
                1.0          163
3               0.0            5
                1.0            2
4               1.0            3
0               0.0        48482
                1.0          452
Name: default, dtype: int64
```

[16]:
```
df['account_worst_status_0_3m'] = df['account_worst_status_0_3m'].cat.
↪add_categories(0)
df['account_worst_status_0_3m'] = df['account_worst_status_0_3m'].fillna(0)
df.groupby(['account_worst_status_0_3m'])['default'].value_counts()
```

[16]:
```
account_worst_status_0_3m  default
1                          0.0        34118
                           1.0          406
2                          0.0         5672
                           1.0          350
3                          0.0          341
                           1.0           57
4                          0.0           75
                           1.0           23
0                          0.0        48482
                           1.0          452
Name: default, dtype: int64
```

[19]:
```
# df['acount_status_changes_count'] = df['acount_status_changes'].apply(lambda␣
↪x: len(x))
```

[21]:
```
# df.groupby(['acount_status_changes_count'])['default'].value_counts()
```

[22]:
```
df['account_worst_status_3_6m']  = df['account_worst_status_3_6m'].cat.
↪add_categories(0)
df['account_worst_status_3_6m'] = df['account_worst_status_3_6m'].fillna(0)
df.groupby(['account_worst_status_3_6m'])['default'].value_counts(dropna=False)
```

[22]:
```
account_worst_status_3_6m  default
1                          0.0        31353
                           1.0          355
2                          0.0         5463
                           1.0          276
3                          0.0          413
                           1.0           45
4                          0.0           91
                           1.0           42
0                          0.0        51368
                           1.0          570
Name: default, dtype: int64
```

[23]:
```
# df['account_worst_status_0_3m']  = df['account_worst_status_0_3m'].cat.
↪add_categories(0)

df['account_worst_status_0_3m'] = df['account_worst_status_0_3m'].fillna(0)
df.groupby(['account_worst_status_0_3m'])['default'].value_counts(dropna=False)
```

[23]:
```
account_worst_status_0_3m  default
1                          0.0        34118
                           1.0          406
2                          0.0         5672
                           1.0          350
```

```
3                          0.0         341
                           1.0          57
4                          0.0          75
                           1.0          23
0                          0.0       48482
                           1.0         452
Name: default, dtype: int64
```

For `account_worst_status_0_3m` missing values will be replaced with 1 because the distribution (of missing values) apears to be the same as for `account_worst_status_0_3m=1`. Same goes for: * `account_worst_status_3_6m` * `account_worst_status_6_12m` * `account_worst_status_12_24m`

[24]:
```python
df.groupby(['num_arch_written_off_12_24m'])['default'].value_counts()
```

[24]:
```
num_arch_written_off_12_24m  default
0.0                          0.0        72834
                             1.0          828
1.0                          0.0            8
2.0                          0.0            1
Name: default, dtype: int64
```

Replacing missing values with 0 because `num_arch_written_off_12_24m = 1 or 2` result in default=0 most of the time unlike users with NaN values

Same goes for `num_arch_written_off_0_12m`

[25]:
```python
df['age_group'] = pd.cut(df['age'], bins=9)
x = df.groupby(['age_group'])['default'].value_counts(normalize=True).
 ↪reset_index(name='prob')
x[x['default'] == 1].sort_values('prob')
```

[25]:

	age_group	default	prob
11	(63.556, 72.667]	1.0	0.003916
13	(72.667, 81.778]	1.0	0.007220
9	(54.444, 63.556]	1.0	0.007959
7	(45.333, 54.444]	1.0	0.009453
5	(36.222, 45.333]	1.0	0.011895
3	(27.111, 36.222]	1.0	0.012254
1	(17.918, 27.111]	1.0	0.021896

Looks like the younger crew has a bit more chance of default

[26]:
```python
df['time_group'] = pd.cut(df['time_hours'], bins=9)
x = df.groupby(['time_group'])['default'].value_counts(normalize=True).
 ↪reset_index(name='prob')
x[x['default'] == 1].sort_values('prob')
```

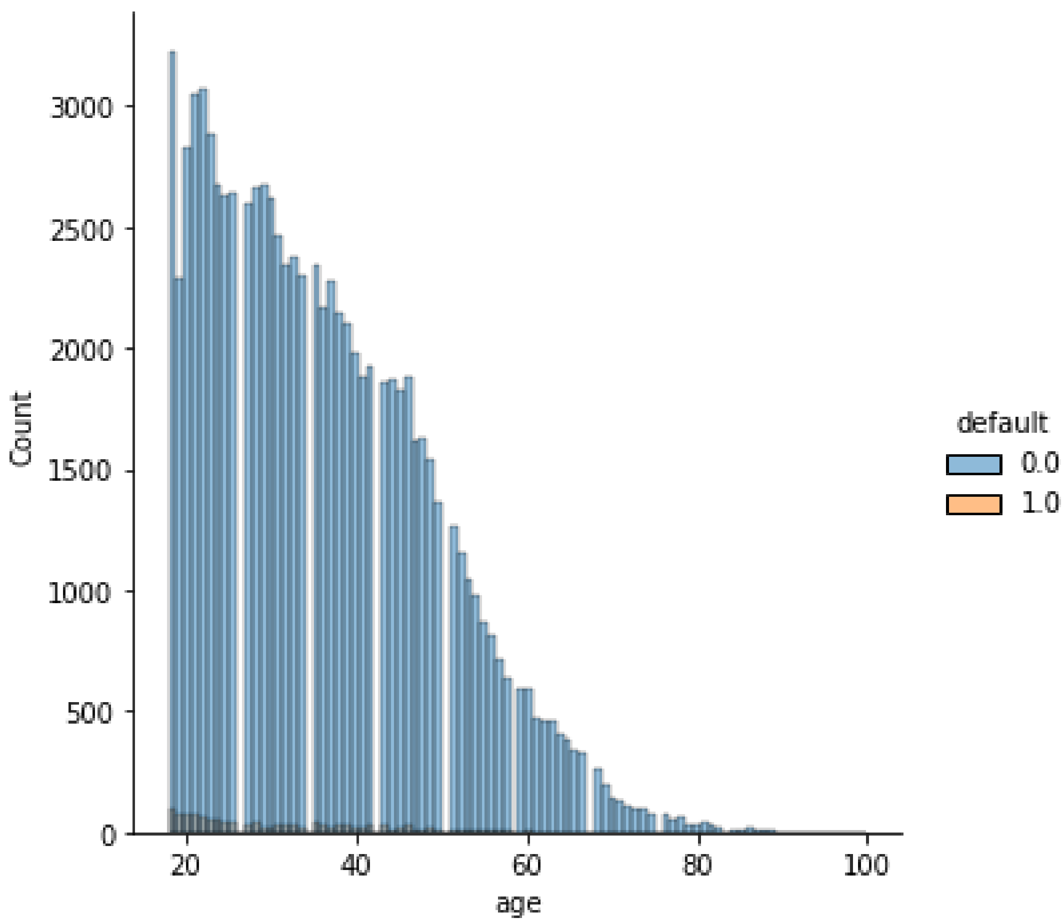
[26]:

	time_group	default	prob
15	(18.667, 21.333]	1.0	0.012481
13	(16.0, 18.667]	1.0	0.013043
7	(8.0, 10.667]	1.0	0.013369
9	(10.667, 13.333]	1.0	0.013963
11	(13.333, 16.0]	1.0	0.014469
5	(5.333, 8.0]	1.0	0.015401
17	(21.333, 24.0]	1.0	0.016523
1	(-0.0237, 2.667]	1.0	0.030371
3	(2.667, 5.333]	1.0	0.030513

6 The rest doesn't seem very useful

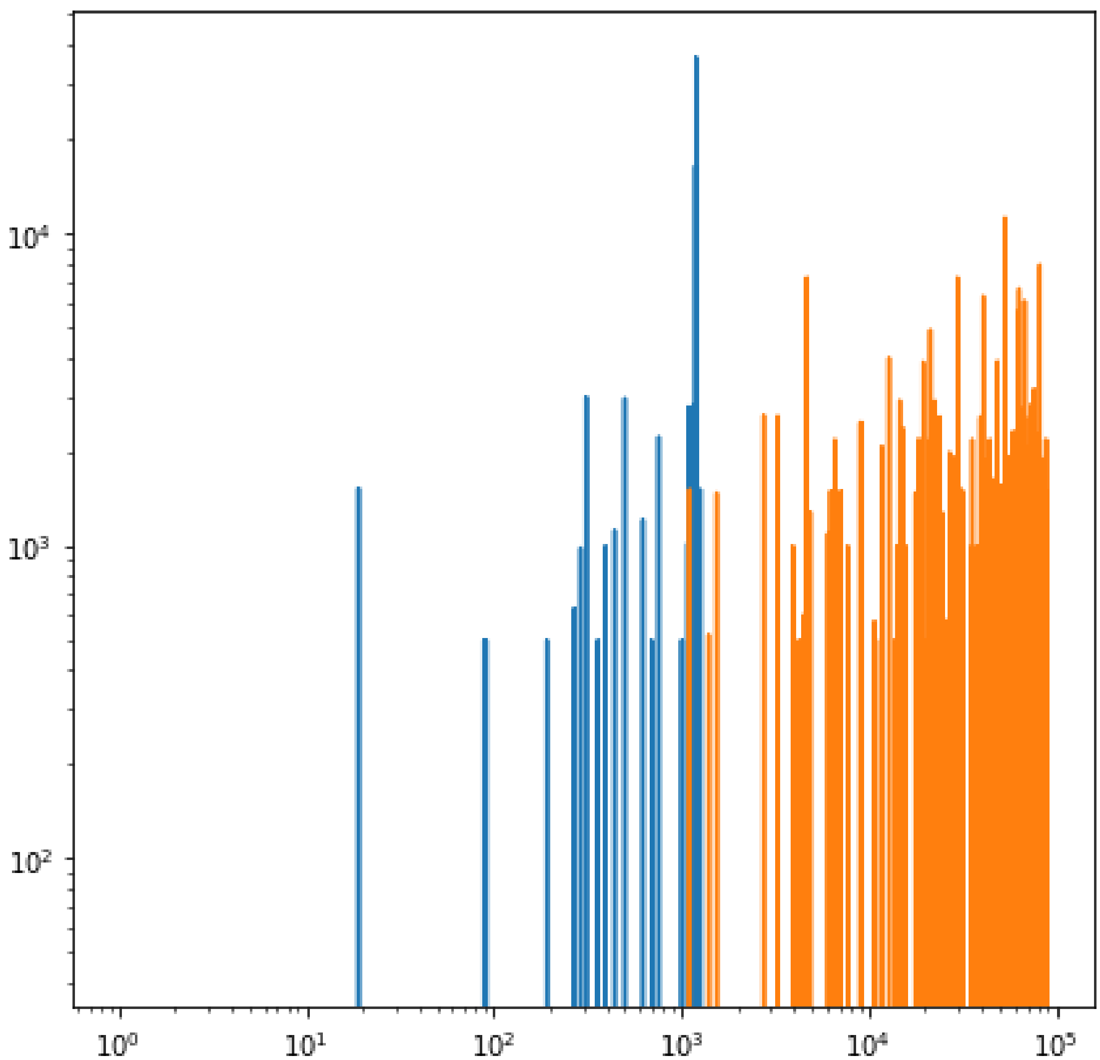
[27]:
```
# sns.displot(df)
sns.displot(df, x="age", hue="default")
```

[27]:
```
<seaborn.axisgrid.FacetGrid at 0x7fd19a68ffd0>
```



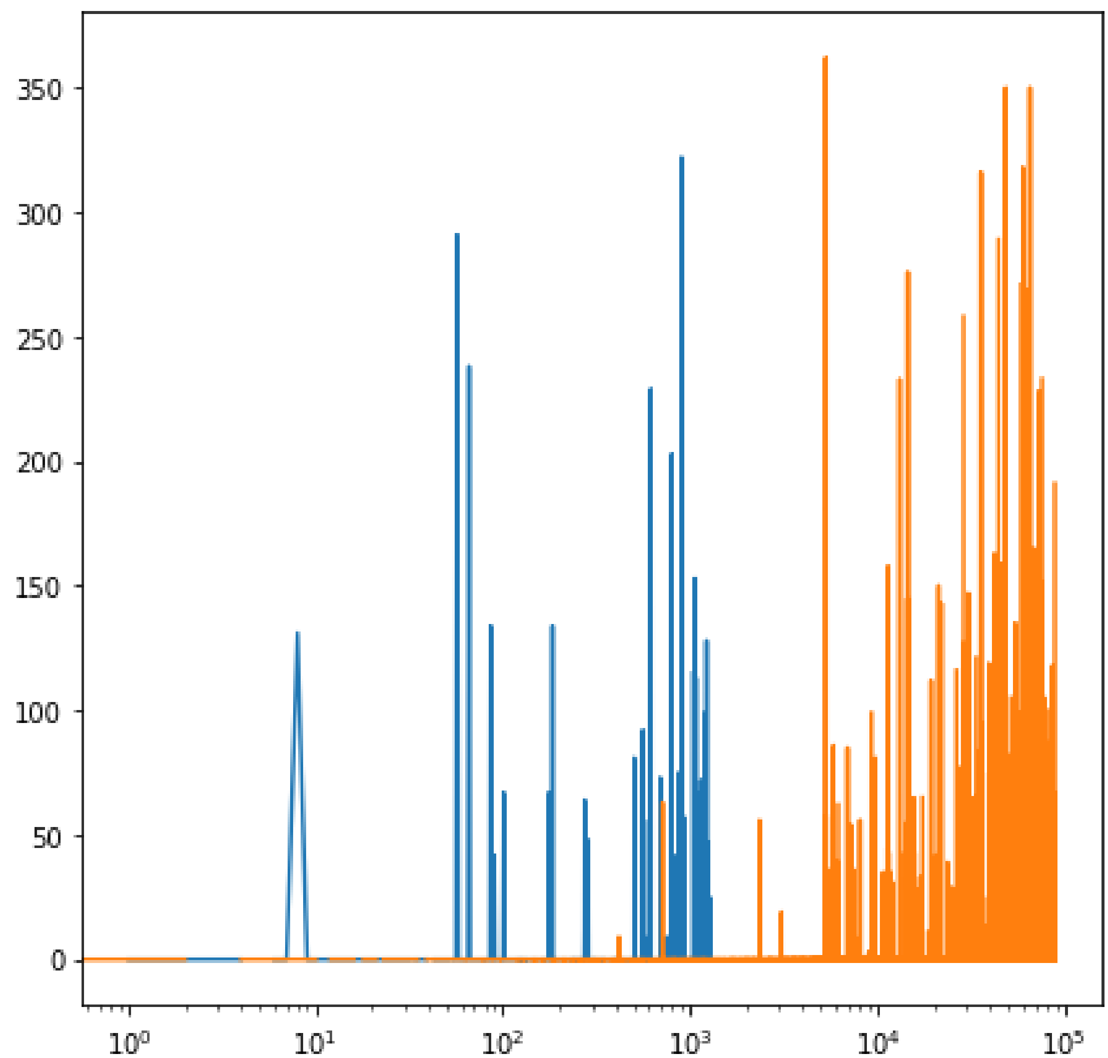
[28]:
```
f, ax = plt.subplots(figsize=(7, 7))
ax.set(xscale="log", yscale="log")
ax.plot(df[df['default'] == 1]['recovery_debt'].values)
ax.plot(df[df['default'] == 0]['recovery_debt'].values)
```

[28]: [<matplotlib.lines.Line2D at 0x7fd1993249d0>]



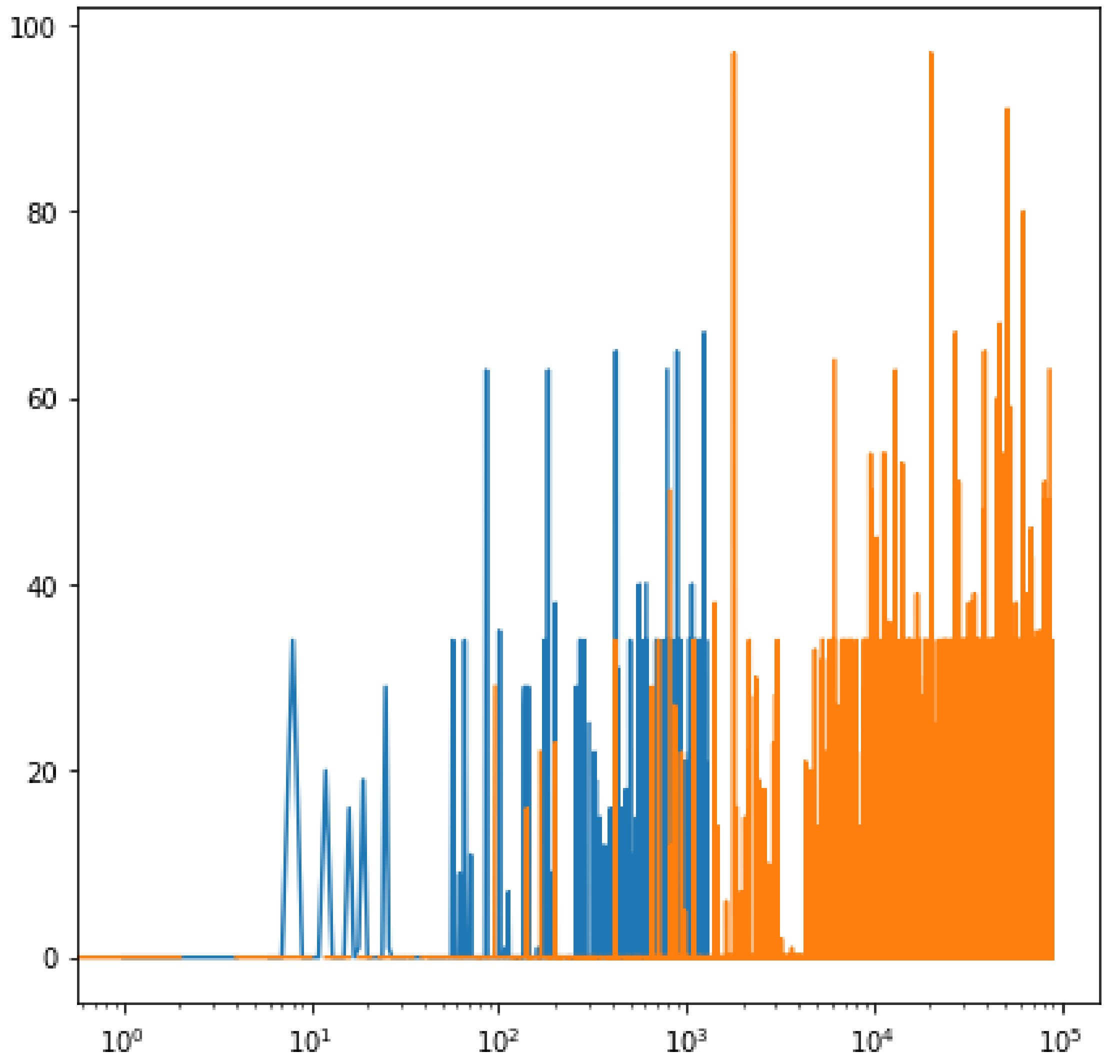
[29]:
```
f, ax = plt.subplots(figsize=(7, 7))
ax.set(xscale="log", )
ax.plot(df[df['default'] == 1]['account_days_in_dc_12_24m'].values)
ax.plot(df[df['default'] == 0]['account_days_in_dc_12_24m'].values)
```

[29]: [<matplotlib.lines.Line2D at 0x7fd18c38bd90>]



[30]:
```
f, ax = plt.subplots(figsize=(7, 7))
ax.set(xscale="log")
ax.plot(df[df['default'] == 1]['account_days_in_term_12_24m'].values)
ax.plot(df[df['default'] == 0]['account_days_in_term_12_24m'].values)
```

[30]: [<matplotlib.lines.Line2D at 0x7fd18c15fbd0>]


100
80
60
40
20
0
10^0
10^1
10^2
10^3
10^4
10^5