bank-loan-default-risk-analysis

July 19, 2024

[1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
%matplotlib inline
import itertools
import matplotlib.style as style
```

[2]:

```
pd.set_option('display.max_row',500)
pd.set_option('display.max_columns',500)
pd.set_option('display.width',1000)
pd.set_option('display.expand_frame_repr',False)
```

[3]:

```
applicationDF=pd.read_csv(r'C:\2 NIT\Resume project\application_data.csv')
previousDF   = pd.read_csv(r'C:\2 NIT\Resume project\previous_application.csv')
```

[4]:

```
applicationDF.head()
```

[4]:

```
   SK_ID_CURR  TARGET NAME_CONTRACT_TYPE CODE_GENDER FLAG_OWN_CAR
FLAG_OWN_REALTY  CNT_CHILDREN  AMT_INCOME_TOTAL  AMT_CREDIT  AMT_ANNUITY
AMT_GOODS_PRICE NAME_TYPE_SUITE NAME_INCOME_TYPE            NAME_EDUCATION_TYPE
NAME_FAMILY_STATUS  NAME_HOUSING_TYPE  REGION_POPULATION_RELATIVE  DAYS_BIRTH
DAYS_EMPLOYED  DAYS_REGISTRATION  DAYS_ID_PUBLISH  OWN_CAR_AGE  FLAG_MOBIL
FLAG_EMP_PHONE  FLAG_WORK_PHONE  FLAG_CONT_MOBILE  FLAG_PHONE  FLAG_EMAIL
OCCUPATION_TYPE  CNT_FAM_MEMBERS  REGION_RATING_CLIENT
REGION_RATING_CLIENT_W_CITY WEEKDAY_APPR_PROCESS_START  HOUR_APPR_PROCESS_START
REG_REGION_NOT_LIVE_REGION  REG_REGION_NOT_WORK_REGION
LIVE_REGION_NOT_WORK_REGION  REG_CITY_NOT_LIVE_CITY  REG_CITY_NOT_WORK_CITY
LIVE_CITY_NOT_WORK_CITY       ORGANIZATION_TYPE  EXT_SOURCE_1  EXT_SOURCE_2
EXT_SOURCE_3  APARTMENTS_AVG  BASEMENTAREA_AVG  YEARS_BEGINEXPLUATATION_AVG
YEARS_BUILD_AVG  COMMONAREA_AVG  ELEVATORS_AVG  ENTRANCES_AVG  FLOORSMAX_AVG
FLOORSMIN_AVG  LANDAREA_AVG  LIVINGAPARTMENTS_AVG  LIVINGAREA_AVG
NONLIVINGAPARTMENTS_AVG  NONLIVINGAREA_AVG  APARTMENTS_MODE  BASEMENTAREA_MODE
YEARS_BEGINEXPLUATATION_MODE  YEARS_BUILD_MODE  COMMONAREA_MODE  ELEVATORS_MODE
ENTRANCES_MODE  FLOORSMAX_MODE  FLOORSMIN_MODE  LANDAREA_MODE
```

```
LIVINGAPARTMENTS_MODE  LIVINGAREA_MODE  NONLIVINGAPARTMENTS_MODE
NONLIVINGAREA_MODE  APARTMENTS_MEDI  BASEMENTAREA_MEDI
YEARS_BEGINEXPLUATATION_MEDI  YEARS_BUILD_MEDI  COMMONAREA_MEDI  ELEVATORS_MEDI
ENTRANCES_MEDI  FLOORSMAX_MEDI  FLOORSMIN_MEDI  LANDAREA_MEDI
LIVINGAPARTMENTS_MEDI  LIVINGAREA_MEDI  NONLIVINGAPARTMENTS_MEDI
NONLIVINGAREA_MEDI FONDKAPREMONT_MODE  HOUSETYPE_MODE  TOTALAREA_MODE
WALLSMATERIAL_MODE EMERGENCYSTATE_MODE  OBS_30_CNT_SOCIAL_CIRCLE
DEF_30_CNT_SOCIAL_CIRCLE  OBS_60_CNT_SOCIAL_CIRCLE  DEF_60_CNT_SOCIAL_CIRCLE
DAYS_LAST_PHONE_CHANGE  FLAG_DOCUMENT_2  FLAG_DOCUMENT_3  FLAG_DOCUMENT_4
FLAG_DOCUMENT_5  FLAG_DOCUMENT_6  FLAG_DOCUMENT_7  FLAG_DOCUMENT_8
FLAG_DOCUMENT_9  FLAG_DOCUMENT_10  FLAG_DOCUMENT_11  FLAG_DOCUMENT_12
FLAG_DOCUMENT_13  FLAG_DOCUMENT_14  FLAG_DOCUMENT_15  FLAG_DOCUMENT_16
FLAG_DOCUMENT_17  FLAG_DOCUMENT_18  FLAG_DOCUMENT_19  FLAG_DOCUMENT_20
FLAG_DOCUMENT_21  AMT_REQ_CREDIT_BUREAU_HOUR  AMT_REQ_CREDIT_BUREAU_DAY
AMT_REQ_CREDIT_BUREAU_WEEK  AMT_REQ_CREDIT_BUREAU_MON  AMT_REQ_CREDIT_BUREAU_QRT
AMT_REQ_CREDIT_BUREAU_YEAR
0      100002       1         Cash loans           M            N
Y             0          202500.0    406597.5      24700.5         351000.0
Unaccompanied          Working  Secondary / secondary special  Single / not
married  House / apartment                   0.018801       -9461
-637           -3648.0            -2120           NaN           1
1                0                 1           1           0        Laborers
1.0                     2                             2
WEDNESDAY                       10                            0
0                            0                       0                       0
0  Business Entity Type 3      0.083037      0.262949      0.139376
0.0247            0.0369                            0.9722           0.6192
0.0143           0.00         0.0690         0.0833          0.1250        0.0369
0.0202          0.0190                   0.0000            0.0000
0.0252             0.0383                          0.9722            0.6341
0.0144          0.0000          0.0690          0.0833          0.1250
0.0377                  0.022           0.0198                      0.0
0.0           0.0250            0.0369                          0.9722
0.6243           0.0144            0.00          0.0690          0.0833
0.1250         0.0375                 0.0205            0.0193
0.0000                0.00   reg oper account  block of flats          0.0149
Stone, brick                  No                        2.0
2.0                       2.0                       2.0                 -1134.0
0                1                0                 0                0
0                0                0                  0                 0
0                 0                 0                 0                 0
0                 0                 0                 0                 0
0.0                        0.0                           0.0
0.0                        0.0                           1.0
1      100003       0         Cash loans           F            N
N             0          270000.0   1293502.5      35698.5        1129500.0
Family    State servant               Higher education               Married
```

```
House / apartment                    0.003541      -16765          -1188
-1186.0             -291          NaN           1               1
0                 1           1           0      Core staff              2.0
1                            1                     MONDAY
11                           0                           0
0                       0                       0                        0
School      0.311267      0.622246           NaN          0.0959
0.0529                       0.9851           0.7960          0.0605
0.08         0.0345         0.2917         0.3333        0.0130
0.0773          0.0549                   0.0039             0.0098
0.0924             0.0538                        0.9851            0.8040
0.0497          0.0806          0.0345          0.2917          0.3333
0.0128                  0.079           0.0554                       0.0
0.0           0.0968             0.0529                        0.9851
0.7987           0.0608            0.08          0.0345          0.2917
0.3333         0.0132                 0.0787           0.0558
0.0039                0.01   reg oper account  block of flats          0.0714
Block                  No                       1.0                       0.0
1.0                       0.0                  -828.0                0
1                0                0                0                0
0                0                 0                 0                 0
0                 0                 0                 0                 0
0                 0                 0                 0
0.0                        0.0                           0.0
0.0                        0.0                           0.0
2      100004       0    Revolving loans           M            Y
Y             0           67500.0    135000.0       6750.0         135000.0
Unaccompanied          Working  Secondary / secondary special  Single / not
married  House / apartment                    0.010032      -19046
-225            -4260.0            -2531         26.0           1
1                1                 1           1           0        Laborers
1.0                     2                            2
MONDAY                        9                           0
0                            0                       0                       0
0              Government           NaN      0.555912      0.729567
NaN               NaN                          NaN              NaN
NaN            NaN            NaN            NaN            NaN           NaN
NaN             NaN                      NaN                NaN              NaN
NaN                           NaN               NaN              NaN
NaN             NaN             NaN             NaN            NaN
NaN              NaN                       NaN                 NaN
NaN                NaN                          NaN               NaN
NaN             NaN             NaN             NaN             NaN
NaN                    NaN              NaN                       NaN
NaN                NaN             NaN             NaN                NaN
NaN                       0.0                       0.0
0.0                       0.0                  -815.0                0
```

```
0                0                0                0                0
0                0                 0                 0                 0
0                 0                 0                 0                 0
0                 0                 0                 0
0.0                        0.0                         0.0
0.0                        0.0                         0.0
3      100006       0         Cash loans           F            N
Y             0          135000.0    312682.5      29686.5         297000.0
Unaccompanied          Working  Secondary / secondary special        Civil
marriage  House / apartment                    0.008019      -19005
-3039            -9833.0            -2437          NaN           1
1                0                 1           0           0        Laborers
2.0                     2                            2
WEDNESDAY                       17                           0
0                            0                       0                       0
0  Business Entity Type 3           NaN      0.650442           NaN
NaN               NaN                          NaN              NaN
NaN            NaN            NaN            NaN            NaN           NaN
NaN             NaN                      NaN                NaN              NaN
NaN                           NaN               NaN              NaN
NaN             NaN             NaN             NaN            NaN
NaN              NaN                       NaN                 NaN
NaN                NaN                           NaN               NaN
NaN             NaN             NaN             NaN             NaN
NaN                    NaN              NaN                       NaN
NaN                NaN             NaN             NaN                NaN
NaN                       2.0                       0.0
2.0                       0.0                  -617.0                0
1                0                0                0                0
0                0                 0                 0                 0
0                 0                 0                 0                 0
0                 0                 0                 0
NaN                        NaN                         NaN
NaN                        NaN                         NaN
4      100007       0         Cash loans           M            N
Y             0          121500.0    513000.0      21865.5         513000.0
Unaccompanied          Working  Secondary / secondary special  Single / not
married  House / apartment                    0.028663      -19932
-3038            -4311.0            -3458          NaN           1
1                0                 1           0           0      Core staff
1.0                     2                            2
THURSDAY                       11                           0
0                            0                       0                       1
1                Religion           NaN      0.322738           NaN
NaN               NaN                          NaN              NaN
NaN            NaN            NaN            NaN            NaN           NaN
NaN             NaN                      NaN                NaN              NaN
NaN                           NaN               NaN              NaN
NaN             NaN             NaN             NaN            NaN
NaN              NaN                       NaN                 NaN
NaN                NaN                           NaN              NaN
NaN             NaN             NaN             NaN             NaN
NaN                    NaN              NaN                          NaN
NaN                NaN             NaN             NaN                  NaN
NaN                       0.0                       0.0
0.0                       0.0                   -1106.0                0
0                0                0                0                0
1                0                 0                 0                 0
0                 0                 0                 0                 0
0                 0                 0                 0
0.0                        0.0                            0.0
0.0                        0.0                            0.0
```

[5]:
```
previousDF.head()
```

[5]:
```
   SK_ID_PREV  SK_ID_CURR NAME_CONTRACT_TYPE  AMT_ANNUITY  AMT_APPLICATION
AMT_CREDIT  AMT_DOWN_PAYMENT  AMT_GOODS_PRICE WEEKDAY_APPR_PROCESS_START
HOUR_APPR_PROCESS_START FLAG_LAST_APPL_PER_CONTRACT  NFLAG_LAST_APPL_IN_DAY
RATE_DOWN_PAYMENT  RATE_INTEREST_PRIMARY  RATE_INTEREST_PRIVILEGED
NAME_CASH_LOAN_PURPOSE NAME_CONTRACT_STATUS  DAYS_DECISION
NAME_PAYMENT_TYPE CODE_REJECT_REASON  NAME_TYPE_SUITE NAME_CLIENT_TYPE
NAME_GOODS_CATEGORY NAME_PORTFOLIO NAME_PRODUCT_TYPE             CHANNEL_TYPE
SELLERPLACE_AREA NAME_SELLER_INDUSTRY  CNT_PAYMENT NAME_YIELD_GROUP
PRODUCT_COMBINATION  DAYS_FIRST_DRAWING  DAYS_FIRST_DUE
DAYS_LAST_DUE_1ST_VERSION  DAYS_LAST_DUE  DAYS_TERMINATION
NFLAG_INSURED_ON_APPROVAL
0     2030495      271877     Consumer loans     1730.430          17145.0
17145.0               0.0          17145.0                   SATURDAY
15                          Y                       1                0.0
0.182832                 0.867336                    XAP             Approved
-73  Cash through the bank                XAP             NaN          Repeater
Mobile             POS                 XNA             Country-wide
35          Connectivity         12.0           middle  POS mobile with interest
365243.0          -42.0                       300.0          -42.0
-37.0                        0.0
1     2802425      108129         Cash loans    25188.615         607500.0
679671.0              NaN          607500.0                   THURSDAY
11                          Y                       1                NaN
NaN                       NaN                    XNA             Approved
-164                  XNA                 XAP    Unaccompanied         Repeater
XNA           Cash             x-sell          Contact center               -1
XNA         36.0       low_action          Cash X-Sell: low           365243.0
-134.0                      916.0      365243.0         365243.0
1.0
```

```
2     2523466      122040         Cash loans    15060.735         112500.0
136444.5               NaN         112500.0                    TUESDAY
11                           Y                       1                NaN
NaN                       NaN                    XNA             Approved
-301  Cash through the bank                XAP  Spouse, partner         Repeater
XNA           Cash            x-sell  Credit and cash offices                -1
XNA         12.0             high         Cash X-Sell: high            365243.0
-271.0                       59.0       365243.0          365243.0
1.0
3     2819243      176158         Cash loans    47041.335         450000.0
470790.0               NaN         450000.0                     MONDAY
7                           Y                       1                NaN
NaN                       NaN                    XNA             Approved
-512  Cash through the bank                XAP              NaN         Repeater
XNA           Cash            x-sell  Credit and cash offices                -1
XNA         12.0           middle       Cash X-Sell: middle            365243.0
-482.0                     -152.0         -182.0            -177.0
1.0
4     1784265      202054         Cash loans    31924.395         337500.0
404055.0               NaN         337500.0                   THURSDAY
9                           Y                       1                NaN
NaN                       NaN                Repairs              Refused
-781  Cash through the bank                 HC              NaN         Repeater
XNA           Cash           walk-in  Credit and cash offices                -1
XNA         24.0             high         Cash Street: high                 NaN
NaN                        NaN            NaN               NaN
NaN
```

[6]:
```
applicationDF.shape
```

[6]:
```
(307511, 122)
```

[7]:
```
previousDF.shape
```

[7]:
```
(1670214, 37)
```

[8]:
```
applicationDF.info(verbose=True)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 307511 entries, 0 to 307510
Data columns (total 122 columns):
 #    Column                        Dtype
---   ------                        -----
 0    SK_ID_CURR                    int64
 1    TARGET                        int64
 2    NAME_CONTRACT_TYPE            object
 3    CODE_GENDER                   object
```

```
4    FLAG_OWN_CAR                  object
5    FLAG_OWN_REALTY               object
6    CNT_CHILDREN                  int64
7    AMT_INCOME_TOTAL              float64
8    AMT_CREDIT                    float64
9    AMT_ANNUITY                   float64
10   AMT_GOODS_PRICE               float64
11   NAME_TYPE_SUITE               object
12   NAME_INCOME_TYPE              object
13   NAME_EDUCATION_TYPE           object
14   NAME_FAMILY_STATUS            object
15   NAME_HOUSING_TYPE             object
16   REGION_POPULATION_RELATIVE    float64
17   DAYS_BIRTH                    int64
18   DAYS_EMPLOYED                 int64
19   DAYS_REGISTRATION             float64
20   DAYS_ID_PUBLISH               int64
21   OWN_CAR_AGE                   float64
22   FLAG_MOBIL                    int64
23   FLAG_EMP_PHONE                int64
24   FLAG_WORK_PHONE               int64
25   FLAG_CONT_MOBILE              int64
26   FLAG_PHONE                    int64
27   FLAG_EMAIL                    int64
28   OCCUPATION_TYPE               object
29   CNT_FAM_MEMBERS               float64
30   REGION_RATING_CLIENT          int64
31   REGION_RATING_CLIENT_W_CITY   int64
32   WEEKDAY_APPR_PROCESS_START    object
33   HOUR_APPR_PROCESS_START       int64
34   REG_REGION_NOT_LIVE_REGION    int64
35   REG_REGION_NOT_WORK_REGION    int64
36   LIVE_REGION_NOT_WORK_REGION   int64
37   REG_CITY_NOT_LIVE_CITY        int64
38   REG_CITY_NOT_WORK_CITY        int64
39   LIVE_CITY_NOT_WORK_CITY       int64
40   ORGANIZATION_TYPE             object
41   EXT_SOURCE_1                  float64
42   EXT_SOURCE_2                  float64
43   EXT_SOURCE_3                  float64
44   APARTMENTS_AVG                float64
45   BASEMENTAREA_AVG              float64
46   YEARS_BEGINEXPLUATATION_AVG   float64
47   YEARS_BUILD_AVG               float64
48   COMMONAREA_AVG                float64
49   ELEVATORS_AVG                 float64
50   ENTRANCES_AVG                 float64
51   FLOORSMAX_AVG                 float64
```

```
52  FLOORSMIN_AVG                 float64
53  LANDAREA_AVG                  float64
54  LIVINGAPARTMENTS_AVG          float64
55  LIVINGAREA_AVG                float64
56  NONLIVINGAPARTMENTS_AVG       float64
57  NONLIVINGAREA_AVG             float64
58  APARTMENTS_MODE               float64
59  BASEMENTAREA_MODE             float64
60  YEARS_BEGINEXPLUATATION_MODE  float64
61  YEARS_BUILD_MODE              float64
62  COMMONAREA_MODE               float64
63  ELEVATORS_MODE                float64
64  ENTRANCES_MODE                float64
65  FLOORSMAX_MODE                float64
66  FLOORSMIN_MODE                float64
67  LANDAREA_MODE                 float64
68  LIVINGAPARTMENTS_MODE         float64
69  LIVINGAREA_MODE               float64
70  NONLIVINGAPARTMENTS_MODE      float64
71  NONLIVINGAREA_MODE            float64
72  APARTMENTS_MEDI               float64
73  BASEMENTAREA_MEDI             float64
74  YEARS_BEGINEXPLUATATION_MEDI  float64
75  YEARS_BUILD_MEDI              float64
76  COMMONAREA_MEDI               float64
77  ELEVATORS_MEDI                float64
78  ENTRANCES_MEDI                float64
79  FLOORSMAX_MEDI                float64
80  FLOORSMIN_MEDI                float64
81  LANDAREA_MEDI                 float64
82  LIVINGAPARTMENTS_MEDI         float64
83  LIVINGAREA_MEDI               float64
84  NONLIVINGAPARTMENTS_MEDI      float64
85  NONLIVINGAREA_MEDI            float64
86  FONDKAPREMONT_MODE            object
87  HOUSETYPE_MODE                object
88  TOTALAREA_MODE                float64
89  WALLSMATERIAL_MODE            object
90  EMERGENCYSTATE_MODE           object
91  OBS_30_CNT_SOCIAL_CIRCLE      float64
92  DEF_30_CNT_SOCIAL_CIRCLE      float64
93  OBS_60_CNT_SOCIAL_CIRCLE      float64
94  DEF_60_CNT_SOCIAL_CIRCLE      float64
95  DAYS_LAST_PHONE_CHANGE        float64
96  FLAG_DOCUMENT_2               int64
97  FLAG_DOCUMENT_3               int64
98  FLAG_DOCUMENT_4               int64
99  FLAG_DOCUMENT_5               int64
```

```
 100  FLAG_DOCUMENT_6               int64
 101  FLAG_DOCUMENT_7               int64
 102  FLAG_DOCUMENT_8               int64
 103  FLAG_DOCUMENT_9               int64
 104  FLAG_DOCUMENT_10              int64
 105  FLAG_DOCUMENT_11              int64
 106  FLAG_DOCUMENT_12              int64
 107  FLAG_DOCUMENT_13              int64
 108  FLAG_DOCUMENT_14              int64
 109  FLAG_DOCUMENT_15              int64
 110  FLAG_DOCUMENT_16              int64
 111  FLAG_DOCUMENT_17              int64
 112  FLAG_DOCUMENT_18              int64
 113  FLAG_DOCUMENT_19              int64
 114  FLAG_DOCUMENT_20              int64
 115  FLAG_DOCUMENT_21              int64
 116  AMT_REQ_CREDIT_BUREAU_HOUR    float64
 117  AMT_REQ_CREDIT_BUREAU_DAY     float64
 118  AMT_REQ_CREDIT_BUREAU_WEEK    float64
 119  AMT_REQ_CREDIT_BUREAU_MON     float64
 120  AMT_REQ_CREDIT_BUREAU_QRT     float64
 121  AMT_REQ_CREDIT_BUREAU_YEAR    float64
dtypes: float64(65), int64(41), object(16)
memory usage: 286.2+ MB
```

[9]:

```
previousDF.info(verbose=True)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1670214 entries, 0 to 1670213
Data columns (total 37 columns):
 #   Column                       Non-Null Count    Dtype
---  ------                       --------------    -----
 0   SK_ID_PREV                   1670214 non-null  int64
 1   SK_ID_CURR                   1670214 non-null  int64
 2   NAME_CONTRACT_TYPE           1670214 non-null  object
 3   AMT_ANNUITY                  1297979 non-null  float64
 4   AMT_APPLICATION              1670214 non-null  float64
 5   AMT_CREDIT                   1670213 non-null  float64
 6   AMT_DOWN_PAYMENT             774370 non-null   float64
 7   AMT_GOODS_PRICE              1284699 non-null  float64
 8   WEEKDAY_APPR_PROCESS_START   1670214 non-null  object
 9   HOUR_APPR_PROCESS_START      1670214 non-null  int64
 10  FLAG_LAST_APPL_PER_CONTRACT  1670214 non-null  object
 11  NFLAG_LAST_APPL_IN_DAY       1670214 non-null  int64
 12  RATE_DOWN_PAYMENT            774370 non-null   float64
 13  RATE_INTEREST_PRIMARY        5951 non-null     float64
 14  RATE_INTEREST_PRIVILEGED     5951 non-null     float64
 15  NAME_CASH_LOAN_PURPOSE       1670214 non-null  object
 16  NAME_CONTRACT_STATUS         1670214 non-null  object
 17  DAYS_DECISION                1670214 non-null  int64
 18  NAME_PAYMENT_TYPE            1670214 non-null  object
 19  CODE_REJECT_REASON           1670214 non-null  object
 20  NAME_TYPE_SUITE              849809 non-null   object
 21  NAME_CLIENT_TYPE             1670214 non-null  object
 22  NAME_GOODS_CATEGORY          1670214 non-null  object
 23  NAME_PORTFOLIO               1670214 non-null  object
 24  NAME_PRODUCT_TYPE            1670214 non-null  object
 25  CHANNEL_TYPE                 1670214 non-null  object
 26  SELLERPLACE_AREA             1670214 non-null  int64
 27  NAME_SELLER_INDUSTRY         1670214 non-null  object
 28  CNT_PAYMENT                  1297984 non-null  float64
 29  NAME_YIELD_GROUP             1670214 non-null  object
 30  PRODUCT_COMBINATION          1669868 non-null  object
 31  DAYS_FIRST_DRAWING           997149 non-null   float64
 32  DAYS_FIRST_DUE               997149 non-null   float64
 33  DAYS_LAST_DUE_1ST_VERSION    997149 non-null   float64
 34  DAYS_LAST_DUE                997149 non-null   float64
 35  DAYS_TERMINATION             997149 non-null   float64
 36  NFLAG_INSURED_ON_APPROVAL    997149 non-null   float64
dtypes: float64(15), int64(6), object(16)
memory usage: 471.5+ MB
```

[10]:

```
previousDF.describe()
```

[10]:

```
         SK_ID_PREV    SK_ID_CURR   AMT_ANNUITY  AMT_APPLICATION    AMT_CREDIT  \
AMT_DOWN_PAYMENT  AMT_GOODS_PRICE  HOUR_APPR_PROCESS_START
NFLAG_LAST_APPL_IN_DAY  RATE_DOWN_PAYMENT  RATE_INTEREST_PRIMARY
RATE_INTEREST_PRIVILEGED  DAYS_DECISION  SELLERPLACE_AREA   CNT_PAYMENT
DAYS_FIRST_DRAWING  DAYS_FIRST_DUE  DAYS_LAST_DUE_1ST_VERSION  DAYS_LAST_DUE
DAYS_TERMINATION  NFLAG_INSURED_ON_APPROVAL
count  1.670214e+06  1.670214e+06  1.297979e+06     1.670214e+06  1.670213e+06
7.743700e+05     1.284699e+06             1.670214e+06            1.670214e+06
774370.000000            5951.000000               5951.000000   1.670214e+06
1.670214e+06  1.297984e+06       997149.000000   997149.000000
997149.000000  997149.000000     997149.000000              997149.000000
mean   1.923089e+06  2.783572e+05  1.595512e+04     1.752339e+05  1.961140e+05
6.697402e+03     2.278473e+05             1.248418e+01            9.964675e-01
0.079637               0.188357                  0.773503  -8.806797e+02
3.139511e+02  1.605408e+01       342209.855039    13826.269337
33767.774054   76582.403064      81992.343838                   0.332570
std    5.325980e+05  1.028148e+05  1.478214e+04     2.927798e+05  3.185746e+05
2.092150e+04     3.153966e+05             3.334028e+00            5.932963e-02
0.107823               0.087671                  0.100879   7.790997e+02
7.127443e+03  1.456729e+01        88916.115834     72444.869708
106857.034789  149647.415123     153303.516729                   0.471134
```

```
min    1.000001e+06  1.000010e+05  0.000000e+00     0.000000e+00  0.000000e+00
-9.000000e-01     0.000000e+00             0.000000e+00            0.000000e+00
-0.000015               0.034781                  0.373150  -2.922000e+03
-1.000000e+00  0.000000e+00        -2922.000000    -2892.000000
-2801.000000   -2889.000000      -2874.000000                   0.000000
25%    1.461857e+06  1.893290e+05  6.321780e+03     1.872000e+04  2.416050e+04
0.000000e+00     5.084100e+04             1.000000e+01            1.000000e+00
0.000000               0.160716                  0.715645  -1.300000e+03
-1.000000e+00  6.000000e+00       365243.000000    -1628.000000
-1242.000000   -1314.000000      -1270.000000                   0.000000
50%    1.923110e+06  2.787145e+05  1.125000e+04     7.104600e+04  8.054100e+04
1.638000e+03     1.123200e+05             1.200000e+01            1.000000e+00
0.051605               0.189122                  0.835095  -5.810000e+02
3.000000e+00  1.200000e+01       365243.000000     -831.000000
-361.000000    -537.000000       -499.000000                   0.000000
75%    2.384280e+06  3.675140e+05  2.065842e+04     1.803600e+05  2.164185e+05
7.740000e+03     2.340000e+05             1.500000e+01            1.000000e+00
0.108909               0.193330                  0.852537  -2.800000e+02
8.200000e+01  2.400000e+01       365243.000000     -411.000000
129.000000     -74.000000        -44.000000                   1.000000
max    2.845382e+06  4.562550e+05  4.180581e+05     6.905160e+06  6.905160e+06
3.060045e+06     6.905160e+06             2.300000e+01            1.000000e+00
1.000000               1.000000                  1.000000  -1.000000e+00
4.000000e+06  8.400000e+01       365243.000000   365243.000000
365243.000000  365243.000000     365243.000000                   1.000000
```

[11]:
```
applicationDF.isnull().sum()
```

[11]:
```
SK_ID_CURR                           0
TARGET                               0
NAME_CONTRACT_TYPE                   0
CODE_GENDER                          0
FLAG_OWN_CAR                         0
FLAG_OWN_REALTY                      0
CNT_CHILDREN                         0
AMT_INCOME_TOTAL                     0
AMT_CREDIT                           0
AMT_ANNUITY                         12
AMT_GOODS_PRICE                    278
NAME_TYPE_SUITE                   1292
NAME_INCOME_TYPE                     0
NAME_EDUCATION_TYPE                  0
NAME_FAMILY_STATUS                   0
NAME_HOUSING_TYPE                    0
REGION_POPULATION_RELATIVE           0
DAYS_BIRTH                           0
DAYS_EMPLOYED                        0
```

```
DAYS_REGISTRATION                    0
DAYS_ID_PUBLISH                      0
OWN_CAR_AGE                     202929
FLAG_MOBIL                           0
FLAG_EMP_PHONE                       0
FLAG_WORK_PHONE                      0
FLAG_CONT_MOBILE                     0
FLAG_PHONE                           0
FLAG_EMAIL                           0
OCCUPATION_TYPE                  96391
CNT_FAM_MEMBERS                      2
REGION_RATING_CLIENT                 0
REGION_RATING_CLIENT_W_CITY          0
WEEKDAY_APPR_PROCESS_START           0
HOUR_APPR_PROCESS_START              0
REG_REGION_NOT_LIVE_REGION           0
REG_REGION_NOT_WORK_REGION           0
LIVE_REGION_NOT_WORK_REGION          0
REG_CITY_NOT_LIVE_CITY               0
REG_CITY_NOT_WORK_CITY               0
LIVE_CITY_NOT_WORK_CITY              0
ORGANIZATION_TYPE                    0
EXT_SOURCE_1                    173378
EXT_SOURCE_2                       660
EXT_SOURCE_3                     60965
APARTMENTS_AVG                  156061
BASEMENTAREA_AVG                179943
YEARS_BEGINEXPLUATATION_AVG     150007
YEARS_BUILD_AVG                 204488
COMMONAREA_AVG                  214865
ELEVATORS_AVG                   163891
ENTRANCES_AVG                   154828
FLOORSMAX_AVG                   153020
FLOORSMIN_AVG                   208642
LANDAREA_AVG                    182590
LIVINGAPARTMENTS_AVG            210199
LIVINGAREA_AVG                  154350
NONLIVINGAPARTMENTS_AVG         213514
NONLIVINGAREA_AVG               169682
APARTMENTS_MODE                 156061
BASEMENTAREA_MODE               179943
YEARS_BEGINEXPLUATATION_MODE    150007
YEARS_BUILD_MODE                204488
COMMONAREA_MODE                 214865
ELEVATORS_MODE                  163891
ENTRANCES_MODE                  154828
FLOORSMAX_MODE                  153020
```

```
FLOORSMIN_MODE                  208642
LANDAREA_MODE                   182590
LIVINGAPARTMENTS_MODE           210199
LIVINGAREA_MODE                 154350
NONLIVINGAPARTMENTS_MODE        213514
NONLIVINGAREA_MODE              169682
APARTMENTS_MEDI                 156061
BASEMENTAREA_MEDI               179943
YEARS_BEGINEXPLUATATION_MEDI    150007
YEARS_BUILD_MEDI                204488
COMMONAREA_MEDI                 214865
ELEVATORS_MEDI                  163891
ENTRANCES_MEDI                  154828
FLOORSMAX_MEDI                  153020
FLOORSMIN_MEDI                  208642
LANDAREA_MEDI                   182590
LIVINGAPARTMENTS_MEDI           210199
LIVINGAREA_MEDI                 154350
NONLIVINGAPARTMENTS_MEDI        213514
NONLIVINGAREA_MEDI              169682
FONDKAPREMONT_MODE              210295
HOUSETYPE_MODE                  154297
TOTALAREA_MODE                  148431
WALLSMATERIAL_MODE              156341
EMERGENCYSTATE_MODE             145755
OBS_30_CNT_SOCIAL_CIRCLE          1021
DEF_30_CNT_SOCIAL_CIRCLE          1021
OBS_60_CNT_SOCIAL_CIRCLE          1021
DEF_60_CNT_SOCIAL_CIRCLE          1021
DAYS_LAST_PHONE_CHANGE               1
FLAG_DOCUMENT_2                      0
FLAG_DOCUMENT_3                      0
FLAG_DOCUMENT_4                      0
FLAG_DOCUMENT_5                      0
FLAG_DOCUMENT_6                      0
FLAG_DOCUMENT_7                      0
FLAG_DOCUMENT_8                      0
FLAG_DOCUMENT_9                      0
FLAG_DOCUMENT_10                     0
FLAG_DOCUMENT_11                     0
FLAG_DOCUMENT_12                     0
FLAG_DOCUMENT_13                     0
FLAG_DOCUMENT_14                     0
FLAG_DOCUMENT_15                     0
FLAG_DOCUMENT_16                     0
FLAG_DOCUMENT_17                     0
FLAG_DOCUMENT_18                     0
```

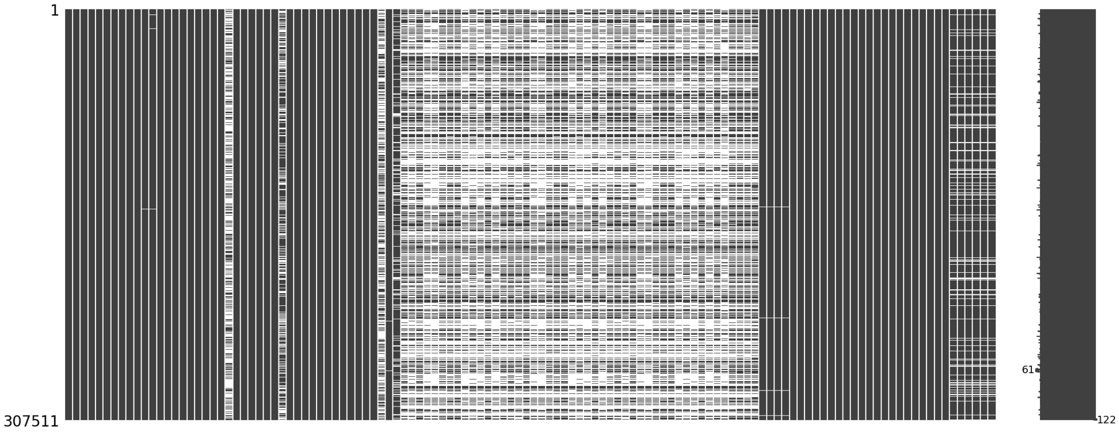
```
FLAG_DOCUMENT_19                   0
FLAG_DOCUMENT_20                   0
FLAG_DOCUMENT_21                   0
AMT_REQ_CREDIT_BUREAU_HOUR     41519
AMT_REQ_CREDIT_BUREAU_DAY      41519
AMT_REQ_CREDIT_BUREAU_WEEK     41519
AMT_REQ_CREDIT_BUREAU_MON      41519
AMT_REQ_CREDIT_BUREAU_QRT      41519
AMT_REQ_CREDIT_BUREAU_YEAR     41519
dtype: int64
```

[12]:

```
import missingno as mn
mn.matrix(applicationDF)
```

[12]:

```
<Axes: >
```



[13]:

```
round(applicationDF.isnull().sum()/applicationDF.shape[0]*100.00,2)
```

[13]:

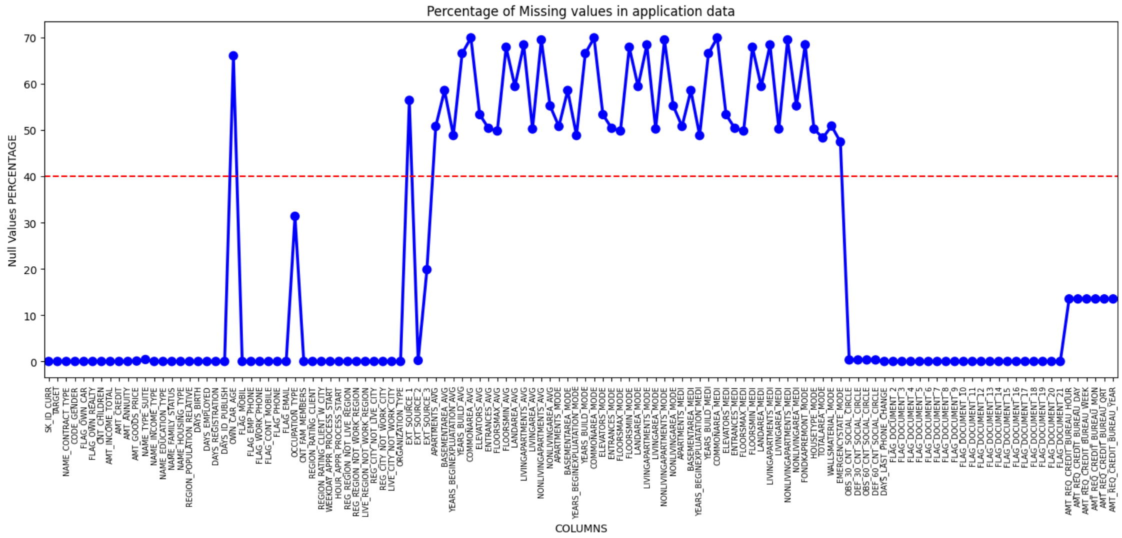
```
SK_ID_CURR                      0.00
TARGET                          0.00
NAME_CONTRACT_TYPE              0.00
CODE_GENDER                     0.00
FLAG_OWN_CAR                    0.00
FLAG_OWN_REALTY                 0.00
CNT_CHILDREN                    0.00
AMT_INCOME_TOTAL                0.00
AMT_CREDIT                      0.00
AMT_ANNUITY                     0.00
AMT_GOODS_PRICE                 0.09
NAME_TYPE_SUITE                 0.42
NAME_INCOME_TYPE                0.00
NAME_EDUCATION_TYPE             0.00
```

```
NAME_FAMILY_STATUS               0.00
NAME_HOUSING_TYPE                0.00
REGION_POPULATION_RELATIVE       0.00
DAYS_BIRTH                       0.00
DAYS_EMPLOYED                    0.00
DAYS_REGISTRATION                0.00
DAYS_ID_PUBLISH                  0.00
OWN_CAR_AGE                     65.99
FLAG_MOBIL                       0.00
FLAG_EMP_PHONE                   0.00
FLAG_WORK_PHONE                  0.00
FLAG_CONT_MOBILE                 0.00
FLAG_PHONE                       0.00
FLAG_EMAIL                       0.00
OCCUPATION_TYPE                 31.35
CNT_FAM_MEMBERS                  0.00
REGION_RATING_CLIENT             0.00
REGION_RATING_CLIENT_W_CITY      0.00
WEEKDAY_APPR_PROCESS_START       0.00
HOUR_APPR_PROCESS_START          0.00
REG_REGION_NOT_LIVE_REGION       0.00
REG_REGION_NOT_WORK_REGION       0.00
LIVE_REGION_NOT_WORK_REGION      0.00
REG_CITY_NOT_LIVE_CITY           0.00
REG_CITY_NOT_WORK_CITY           0.00
LIVE_CITY_NOT_WORK_CITY          0.00
ORGANIZATION_TYPE                0.00
EXT_SOURCE_1                    56.38
EXT_SOURCE_2                     0.21
EXT_SOURCE_3                    19.83
APARTMENTS_AVG                  50.75
BASEMENTAREA_AVG                58.52
YEARS_BEGINEXPLUATATION_AVG     48.78
YEARS_BUILD_AVG                 66.50
COMMONAREA_AVG                  69.87
ELEVATORS_AVG                   53.30
ENTRANCES_AVG                   50.35
FLOORSMAX_AVG                   49.76
FLOORSMIN_AVG                   67.85
LANDAREA_AVG                    59.38
LIVINGAPARTMENTS_AVG            68.35
LIVINGAREA_AVG                  50.19
NONLIVINGAPARTMENTS_AVG         69.43
NONLIVINGAREA_AVG               55.18
APARTMENTS_MODE                 50.75
BASEMENTAREA_MODE               58.52
YEARS_BEGINEXPLUATATION_MODE    48.78
```

```
YEARS_BUILD_MODE                66.50
COMMONAREA_MODE                 69.87
ELEVATORS_MODE                  53.30
ENTRANCES_MODE                  50.35
FLOORSMAX_MODE                  49.76
FLOORSMIN_MODE                  67.85
LANDAREA_MODE                   59.38
LIVINGAPARTMENTS_MODE           68.35
LIVINGAREA_MODE                 50.19
NONLIVINGAPARTMENTS_MODE        69.43
NONLIVINGAREA_MODE              55.18
APARTMENTS_MEDI                 50.75
BASEMENTAREA_MEDI               58.52
YEARS_BEGINEXPLUATATION_MEDI    48.78
YEARS_BUILD_MEDI                66.50
COMMONAREA_MEDI                 69.87
ELEVATORS_MEDI                  53.30
ENTRANCES_MEDI                  50.35
FLOORSMAX_MEDI                  49.76
FLOORSMIN_MEDI                  67.85
LANDAREA_MEDI                   59.38
LIVINGAPARTMENTS_MEDI           68.35
LIVINGAREA_MEDI                 50.19
NONLIVINGAPARTMENTS_MEDI        69.43
NONLIVINGAREA_MEDI              55.18
FONDKAPREMONT_MODE              68.39
HOUSETYPE_MODE                  50.18
TOTALAREA_MODE                  48.27
WALLSMATERIAL_MODE              50.84
EMERGENCYSTATE_MODE             47.40
OBS_30_CNT_SOCIAL_CIRCLE         0.33
DEF_30_CNT_SOCIAL_CIRCLE         0.33
OBS_60_CNT_SOCIAL_CIRCLE         0.33
DEF_60_CNT_SOCIAL_CIRCLE         0.33
DAYS_LAST_PHONE_CHANGE           0.00
FLAG_DOCUMENT_2                  0.00
FLAG_DOCUMENT_3                  0.00
FLAG_DOCUMENT_4                  0.00
FLAG_DOCUMENT_5                  0.00
FLAG_DOCUMENT_6                  0.00
FLAG_DOCUMENT_7                  0.00
FLAG_DOCUMENT_8                  0.00
FLAG_DOCUMENT_9                  0.00
FLAG_DOCUMENT_10                 0.00
FLAG_DOCUMENT_11                 0.00
FLAG_DOCUMENT_12                 0.00
FLAG_DOCUMENT_13                 0.00
```

```
FLAG_DOCUMENT_14               0.00
FLAG_DOCUMENT_15               0.00
FLAG_DOCUMENT_16               0.00
FLAG_DOCUMENT_17               0.00
FLAG_DOCUMENT_18               0.00
FLAG_DOCUMENT_19               0.00
FLAG_DOCUMENT_20               0.00
FLAG_DOCUMENT_21               0.00
AMT_REQ_CREDIT_BUREAU_HOUR    13.50
AMT_REQ_CREDIT_BUREAU_DAY     13.50
AMT_REQ_CREDIT_BUREAU_WEEK    13.50
AMT_REQ_CREDIT_BUREAU_MON     13.50
AMT_REQ_CREDIT_BUREAU_QRT     13.50
AMT_REQ_CREDIT_BUREAU_YEAR    13.50
dtype: float64
```

[14]:
```
null_applicationDF = pd.DataFrame((applicationDF.isnull().sum())*100/
  ↪applicationDF.shape[0]).reset_index()
null_applicationDF.columns = ['Column Name', 'Null Values Percentage']
fig = plt.figure(figsize=(18,6))
ax = sns.pointplot(x="Column Name",y="Null Values␣
  ↪Percentage",data=null_applicationDF,color='blue')
plt.xticks(rotation =90,fontsize =7)
ax.axhline(40, ls='--',color='red')
plt.title("Percentage of Missing values in application data")
plt.ylabel("Null Values PERCENTAGE")
plt.xlabel("COLUMNS")
plt.show()
```



[15]:
```
nullcol_40_application = null_applicationDF[null_applicationDF["Null Values␣
↪Percentage"]>=40]
```

[16]:
```
nullcol_40_application
```

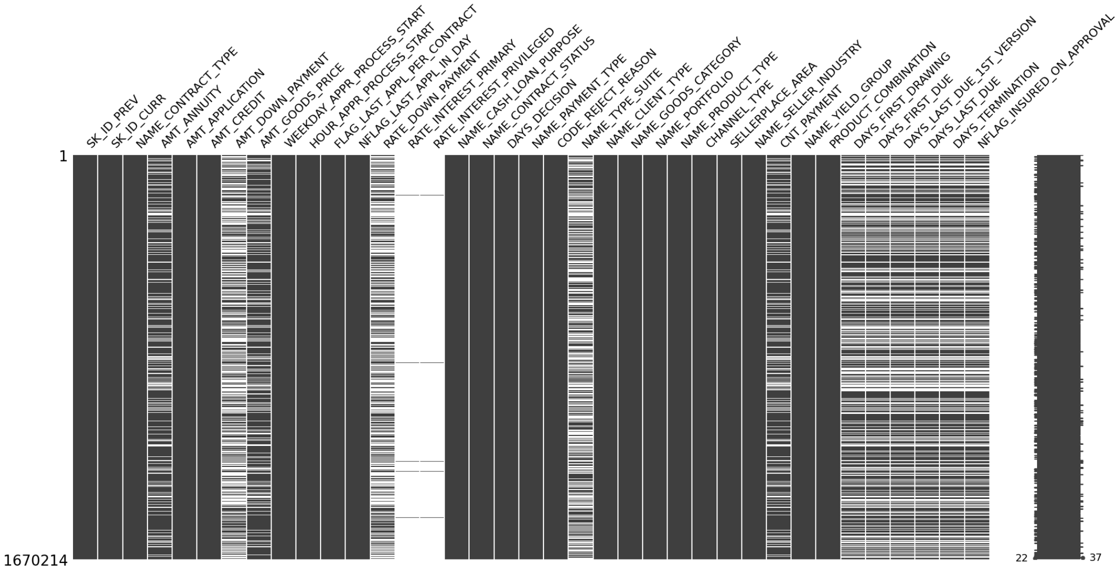
[16]:
```
                     Column Name  Null Values Percentage
21                   OWN_CAR_AGE               65.990810
41                  EXT_SOURCE_1               56.381073
44                APARTMENTS_AVG               50.749729
45              BASEMENTAREA_AVG               58.515956
46   YEARS_BEGINEXPLUATATION_AVG               48.781019
47               YEARS_BUILD_AVG               66.497784
48                COMMONAREA_AVG               69.872297
49                 ELEVATORS_AVG               53.295980
50                 ENTRANCES_AVG               50.348768
51                 FLOORSMAX_AVG               49.760822
52                 FLOORSMIN_AVG               67.848630
53                  LANDAREA_AVG               59.376738
54          LIVINGAPARTMENTS_AVG               68.354953
55                LIVINGAREA_AVG               50.193326
56       NONLIVINGAPARTMENTS_AVG               69.432963
57             NONLIVINGAREA_AVG               55.179164
58               APARTMENTS_MODE               50.749729
59             BASEMENTAREA_MODE               58.515956
60  YEARS_BEGINEXPLUATATION_MODE               48.781019
61              YEARS_BUILD_MODE               66.497784
62               COMMONAREA_MODE               69.872297
63                ELEVATORS_MODE               53.295980
64                ENTRANCES_MODE               50.348768
65                FLOORSMAX_MODE               49.760822
66                FLOORSMIN_MODE               67.848630
67                 LANDAREA_MODE               59.376738
68         LIVINGAPARTMENTS_MODE               68.354953
69               LIVINGAREA_MODE               50.193326
70      NONLIVINGAPARTMENTS_MODE               69.432963
71            NONLIVINGAREA_MODE               55.179164
72               APARTMENTS_MEDI               50.749729
73             BASEMENTAREA_MEDI               58.515956
74  YEARS_BEGINEXPLUATATION_MEDI               48.781019
75              YEARS_BUILD_MEDI               66.497784
76               COMMONAREA_MEDI               69.872297
77                ELEVATORS_MEDI               53.295980
78                ENTRANCES_MEDI               50.348768
79                FLOORSMAX_MEDI               49.760822
80                FLOORSMIN_MEDI               67.848630
81                 LANDAREA_MEDI               59.376738
82         LIVINGAPARTMENTS_MEDI               68.354953
```

```
83              LIVINGAREA_MEDI                50.193326
84      NONLIVINGAPARTMENTS_MEDI                69.432963
85           NONLIVINGAREA_MEDI                55.179164
86           FONDKAPREMONT_MODE                68.386172
87               HOUSETYPE_MODE                50.176091
88               TOTALAREA_MODE                48.268517
89           WALLSMATERIAL_MODE                50.840783
90          EMERGENCYSTATE_MODE                47.398304
```

[17]:
```
len(nullcol_40_application)
```

[17]:
```
49
```

[18]:
```
mn.matrix(previousDF)
plt.show()
```



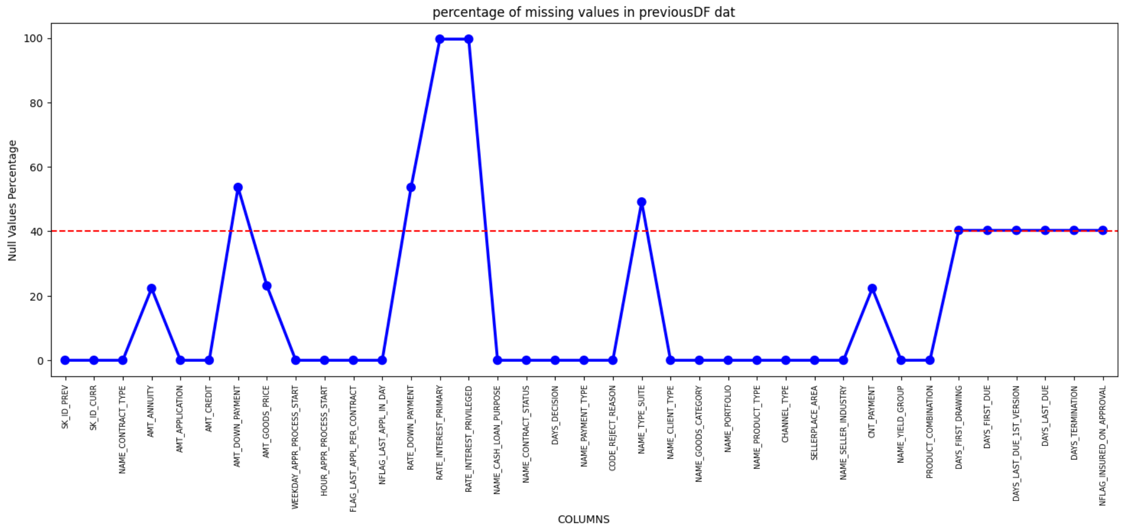
[19]:
```
round(previousDF.isnull().sum()/previousDF.shape[0]*100.00,2)
```

[19]:
```
SK_ID_PREV                    0.00
SK_ID_CURR                    0.00
NAME_CONTRACT_TYPE            0.00
AMT_ANNUITY                  22.29
AMT_APPLICATION               0.00
AMT_CREDIT                    0.00
AMT_DOWN_PAYMENT             53.64
AMT_GOODS_PRICE              23.08
WEEKDAY_APPR_PROCESS_START    0.00
HOUR_APPR_PROCESS_START       0.00
```

```
FLAG_LAST_APPL_PER_CONTRACT     0.00
NFLAG_LAST_APPL_IN_DAY          0.00
RATE_DOWN_PAYMENT              53.64
RATE_INTEREST_PRIMARY          99.64
RATE_INTEREST_PRIVILEGED       99.64
NAME_CASH_LOAN_PURPOSE          0.00
NAME_CONTRACT_STATUS            0.00
DAYS_DECISION                   0.00
NAME_PAYMENT_TYPE               0.00
CODE_REJECT_REASON              0.00
NAME_TYPE_SUITE                49.12
NAME_CLIENT_TYPE                0.00
NAME_GOODS_CATEGORY             0.00
NAME_PORTFOLIO                  0.00
NAME_PRODUCT_TYPE               0.00
CHANNEL_TYPE                    0.00
SELLERPLACE_AREA                0.00
NAME_SELLER_INDUSTRY            0.00
CNT_PAYMENT                    22.29
NAME_YIELD_GROUP                0.00
PRODUCT_COMBINATION             0.02
DAYS_FIRST_DRAWING             40.30
DAYS_FIRST_DUE                 40.30
DAYS_LAST_DUE_1ST_VERSION      40.30
DAYS_LAST_DUE                  40.30
DAYS_TERMINATION               40.30
NFLAG_INSURED_ON_APPROVAL      40.30
dtype: float64
```

[20]:

```
null_previousDF=pd.DataFrame((previousDF.isnull().sum()*100/previousDF.
 ↪shape[0]).reset_index())
null_previousDF.columns = ['Column Name','Null Values Percentage']
fig = plt.figure(figsize=(18,6))
ax = sns.pointplot(x='Column Name',y='Null Values Percentage',data =␣
 ↪null_previousDF,color='blue')
plt.xticks(rotation = 90,fontsize=7)
ax.axhline(40,ls='--',color='red')
plt.title("percentage of missing values in previousDF dat")
plt.ylabel('Null Values Percentage')
plt.xlabel('COLUMNS')
plt.show()
```



[21]:
```
null_40_previous = null_previousDF[null_previousDF["Null Values␣
 ↪Percentage"]>=40]
null_40_previous
```

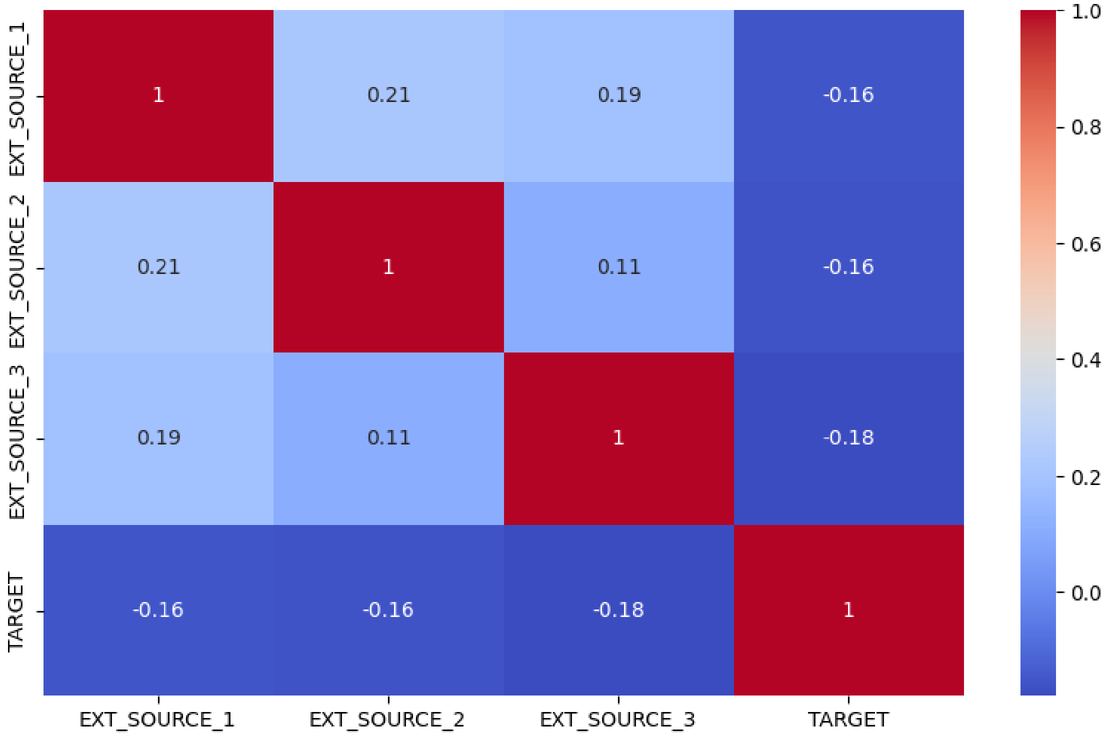
[21]:
```
                  Column Name  Null Values Percentage
6             AMT_DOWN_PAYMENT               53.636480
12           RATE_DOWN_PAYMENT               53.636480
13       RATE_INTEREST_PRIMARY               99.643698
14    RATE_INTEREST_PRIVILEGED               99.643698
20              NAME_TYPE_SUITE               49.119754
31          DAYS_FIRST_DRAWING               40.298129
32              DAYS_FIRST_DUE               40.298129
33   DAYS_LAST_DUE_1ST_VERSION               40.298129
34               DAYS_LAST_DUE               40.298129
35            DAYS_TERMINATION               40.298129
36   NFLAG_INSURED_ON_APPROVAL               40.298129
```

[22]:
```
len(null_40_previous)
```

[22]:
```
11
```

[23]:
```
Source = applicationDF[['EXT_SOURCE_1','EXT_SOURCE_2','EXT_SOURCE_3','TARGET']]
source_corr = Source.corr()
plt.figure(figsize=(10,6))
ax = sns.heatmap(source_corr,
                 xticklabels=source_corr.columns,
                 yticklabels=source_corr.columns,
                 annot = True,
                 cmap="coolwarm")
```

```
plt.show()
```

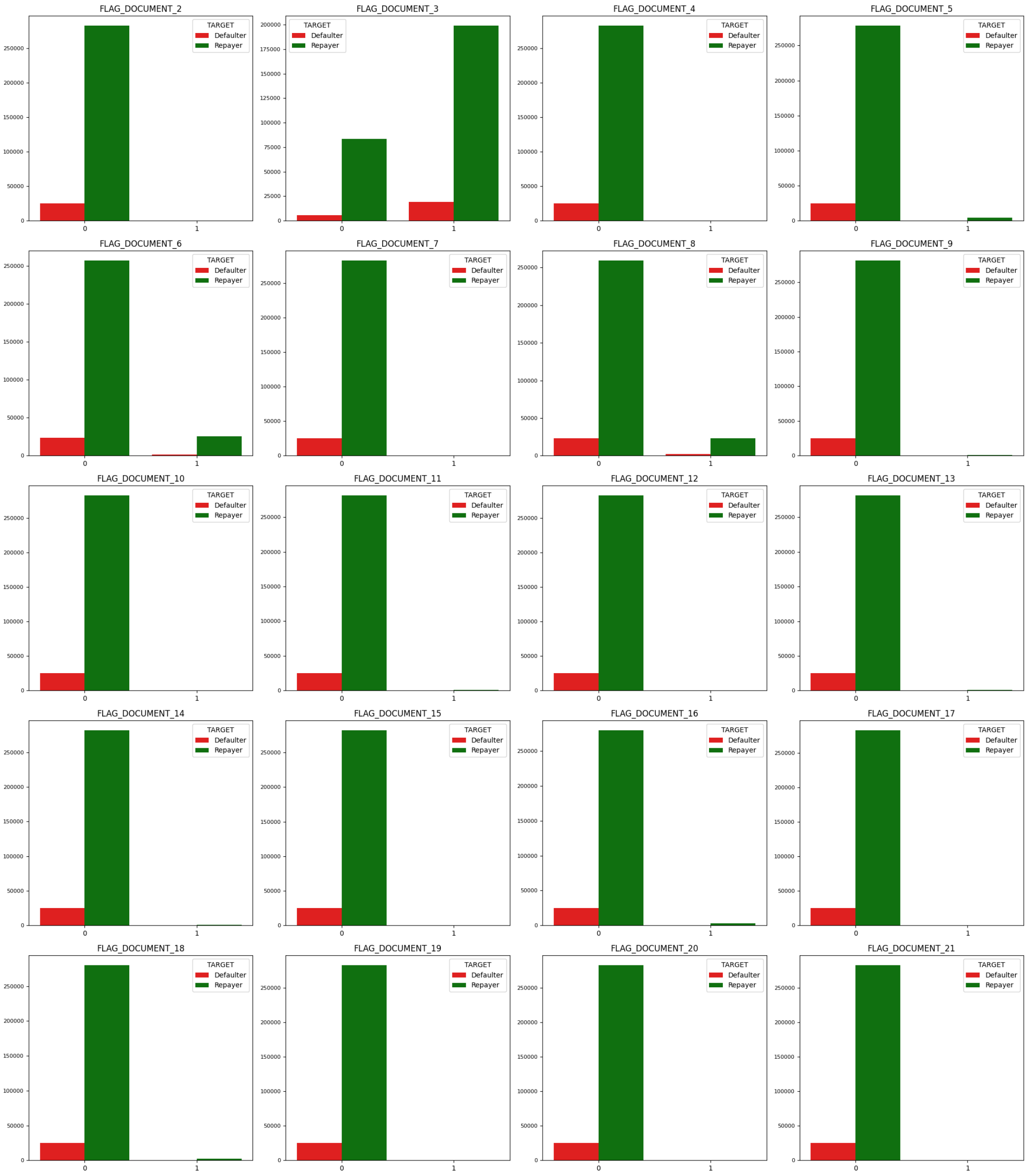


[24]:
```
Unwanted_application = nullcol_40_application["Column Name"].
 ↪tolist()+['EXT_SOURCE_2','EXT_SOURCE_3']
```

[25]:
```
len(Unwanted_application)
```

[25]:
```
51
```

[26]:
```
col_Doc = ['FLAG_DOCUMENT_2', 'FLAG_DOCUMENT_3','FLAG_DOCUMENT_4',␣
 ↪'FLAG_DOCUMENT_5', 'FLAG_DOCUMENT_6','FLAG_DOCUMENT_7',
           'FLAG_DOCUMENT_8', 'FLAG_DOCUMENT_9','FLAG_DOCUMENT_10',␣
 ↪'FLAG_DOCUMENT_11', 'FLAG_DOCUMENT_12','FLAG_DOCUMENT_13',
           'FLAG_DOCUMENT_14', 'FLAG_DOCUMENT_15','FLAG_DOCUMENT_16',␣
 ↪'FLAG_DOCUMENT_17', 'FLAG_DOCUMENT_18',
           'FLAG_DOCUMENT_19', 'FLAG_DOCUMENT_20', 'FLAG_DOCUMENT_21']
df_flag = applicationDF[col_Doc+["TARGET"]]
length = len(col_Doc)
df_flag["TARGET"]=df_flag["TARGET"].replace({1:"Defaulter",0:"Repayer"})
fig = plt.figure(figsize=(21,24))
for i,j in itertools.zip_longest(col_Doc,range(length)):
    plt.subplot(5,4,j+1)
    ax = sns.countplot(data=df_flag,x=i,hue="TARGET",palette=["r","g"])
    plt.yticks(fontsize=8)
    plt.xlabel("")
    plt.ylabel("")
    plt.title(i)

plt.tight_layout()
plt.show()
```



[27]:

```
col_Doc.remove('FLAG_DOCUMENT_3')
Unwanted_application = Unwanted_application+col_Doc
```

[28]:

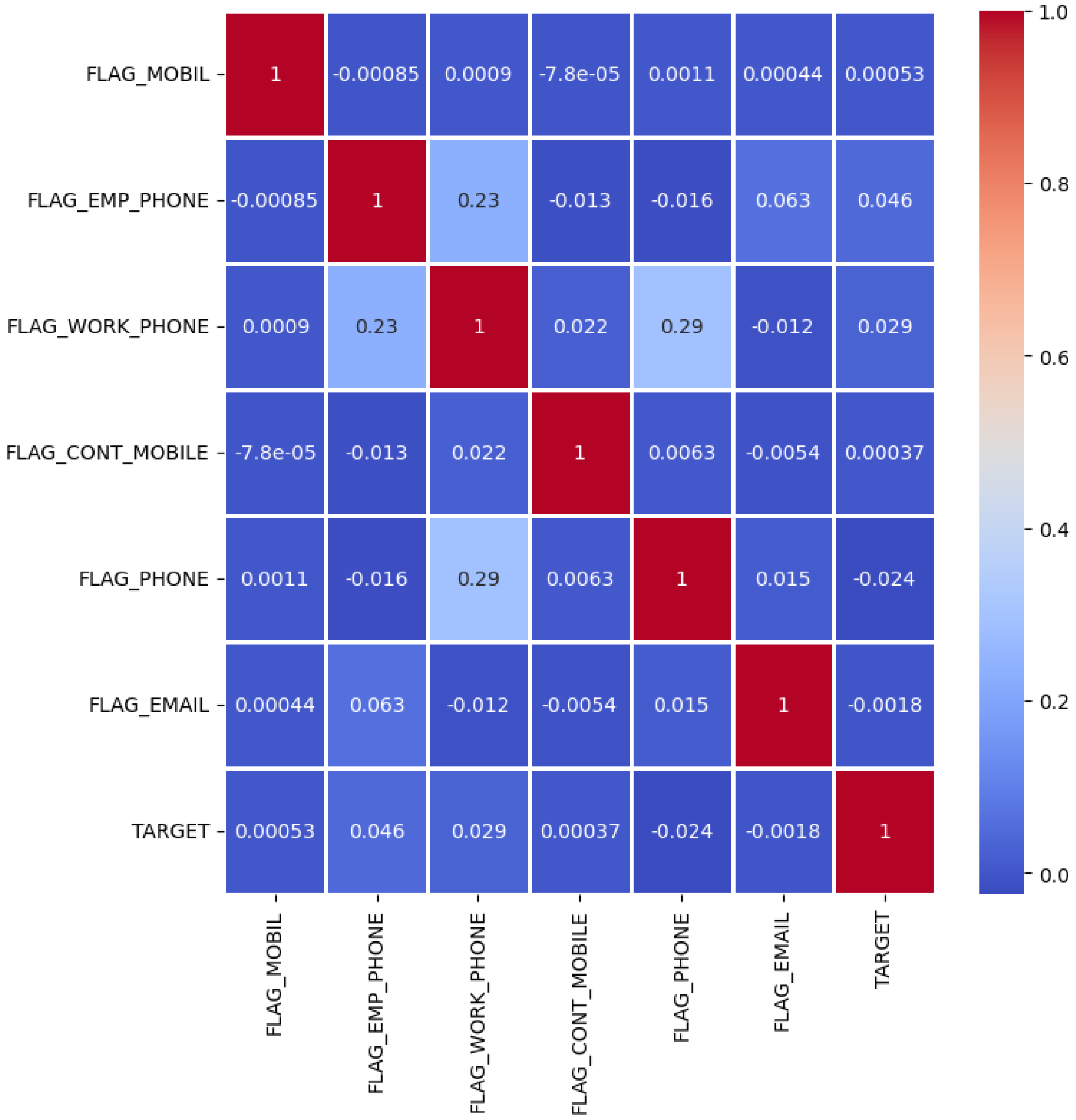
```
len(Unwanted_application)
```

[28]:

```
70
```

[29]:

```
contact_col = ['FLAG_MOBIL', 'FLAG_EMP_PHONE', 'FLAG_WORK_PHONE',␣
 ↪'FLAG_CONT_MOBILE',
       'FLAG_PHONE', 'FLAG_EMAIL','TARGET']
Contact_corr = applicationDF[contact_col].corr()
fig = plt.figure(figsize=(8,8))
ax = sns.heatmap(Contact_corr,xticklabels=Contact_corr.
 ↪columns,yticklabels=Contact_corr.columns,annot = True,cmap=␣
 ↪"coolwarm",linewidth=1)
```



[30]:
```
contact_col.remove('TARGET')
Unwanted_application= Unwanted_application+contact_col
len(Unwanted_application)
```

[30]:
```
76
```

[31]:
```
applicationDF.drop(labels=Unwanted_application,axis=1,inplace=True)
```

[32]:
```
applicationDF.shape
```

[32]:
```
(307511, 46)
```

[33]:

```
applicationDF.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 307511 entries, 0 to 307510
Data columns (total 46 columns):
 #   Column                       Non-Null Count   Dtype
---  ------                       --------------   -----
 0   SK_ID_CURR                   307511 non-null  int64
 1   TARGET                       307511 non-null  int64
 2   NAME_CONTRACT_TYPE           307511 non-null  object
 3   CODE_GENDER                  307511 non-null  object
 4   FLAG_OWN_CAR                 307511 non-null  object
 5   FLAG_OWN_REALTY              307511 non-null  object
 6   CNT_CHILDREN                 307511 non-null  int64
 7   AMT_INCOME_TOTAL             307511 non-null  float64
 8   AMT_CREDIT                   307511 non-null  float64
 9   AMT_ANNUITY                  307499 non-null  float64
 10  AMT_GOODS_PRICE              307233 non-null  float64
 11  NAME_TYPE_SUITE              306219 non-null  object
 12  NAME_INCOME_TYPE             307511 non-null  object
 13  NAME_EDUCATION_TYPE          307511 non-null  object
 14  NAME_FAMILY_STATUS           307511 non-null  object
 15  NAME_HOUSING_TYPE            307511 non-null  object
 16  REGION_POPULATION_RELATIVE   307511 non-null  float64
 17  DAYS_BIRTH                   307511 non-null  int64
 18  DAYS_EMPLOYED                307511 non-null  int64
 19  DAYS_REGISTRATION            307511 non-null  float64
 20  DAYS_ID_PUBLISH              307511 non-null  int64
 21  OCCUPATION_TYPE              211120 non-null  object
 22  CNT_FAM_MEMBERS              307509 non-null  float64
 23  REGION_RATING_CLIENT         307511 non-null  int64
 24  REGION_RATING_CLIENT_W_CITY  307511 non-null  int64
 25  WEEKDAY_APPR_PROCESS_START   307511 non-null  object
 26  HOUR_APPR_PROCESS_START      307511 non-null  int64
 27  REG_REGION_NOT_LIVE_REGION   307511 non-null  int64
 28  REG_REGION_NOT_WORK_REGION   307511 non-null  int64
 29  LIVE_REGION_NOT_WORK_REGION  307511 non-null  int64
 30  REG_CITY_NOT_LIVE_CITY       307511 non-null  int64
 31  REG_CITY_NOT_WORK_CITY       307511 non-null  int64
 32  LIVE_CITY_NOT_WORK_CITY      307511 non-null  int64
 33  ORGANIZATION_TYPE            307511 non-null  object
 34  OBS_30_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 35  DEF_30_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 36  OBS_60_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 37  DEF_60_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 38  DAYS_LAST_PHONE_CHANGE       307510 non-null  float64
 39  FLAG_DOCUMENT_3              307511 non-null  int64
 40   AMT_REQ_CREDIT_BUREAU_HOUR   265992 non-null  float64
 41   AMT_REQ_CREDIT_BUREAU_DAY    265992 non-null  float64
 42   AMT_REQ_CREDIT_BUREAU_WEEK   265992 non-null  float64
 43   AMT_REQ_CREDIT_BUREAU_MON    265992 non-null  float64
 44   AMT_REQ_CREDIT_BUREAU_QRT    265992 non-null  float64
 45   AMT_REQ_CREDIT_BUREAU_YEAR   265992 non-null  float64
dtypes: float64(18), int64(16), object(12)
memory usage: 107.9+ MB
```

[34]:
```
Unwanted_previous = null_40_previous["Column Name"].tolist()
Unwanted_previous
```

[34]:
```
['AMT_DOWN_PAYMENT',
 'RATE_DOWN_PAYMENT',
 'RATE_INTEREST_PRIMARY',
 'RATE_INTEREST_PRIVILEGED',
 'NAME_TYPE_SUITE',
 'DAYS_FIRST_DRAWING',
 'DAYS_FIRST_DUE',
 'DAYS_LAST_DUE_1ST_VERSION',
 'DAYS_LAST_DUE',
 'DAYS_TERMINATION',
 'NFLAG_INSURED_ON_APPROVAL']
```

[35]:
```
Unnecessary_previous = ['WEEKDAY_APPR_PROCESS_START','HOUR_APPR_PROCESS_START',
                        'FLAG_LAST_APPL_PER_CONTRACT','NFLAG_LAST_APPL_IN_DAY']
```

[36]:
```
Unwanted_previous =Unwanted_previous + Unnecessary_previous
```

[37]:
```
len(Unwanted_previous)
```

[37]:
```
15
```

[38]:
```
previousDF.drop(labels=Unwanted_previous,axis=1,inplace=True)
```

[39]:
```
previousDF.shape
```

[39]:
```
(1670214, 22)
```

[40]:
```
previousDF.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1670214 entries, 0 to 1670213
Data columns (total 22 columns):
 #   Column                       Non-Null Count    Dtype
---  ------                       --------------    -----
 0   SK_ID_PREV                   1670214 non-null  int64
 1   SK_ID_CURR                   1670214 non-null  int64
 2   NAME_CONTRACT_TYPE      1670214 non-null  object
 3   AMT_ANNUITY             1297979 non-null  float64
 4   AMT_APPLICATION         1670214 non-null  float64
 5   AMT_CREDIT              1670213 non-null  float64
 6   AMT_GOODS_PRICE         1284699 non-null  float64
 7   NAME_CASH_LOAN_PURPOSE  1670214 non-null  object
 8   NAME_CONTRACT_STATUS    1670214 non-null  object
 9   DAYS_DECISION           1670214 non-null  int64
 10  NAME_PAYMENT_TYPE       1670214 non-null  object
 11  CODE_REJECT_REASON      1670214 non-null  object
 12  NAME_CLIENT_TYPE        1670214 non-null  object
 13  NAME_GOODS_CATEGORY     1670214 non-null  object
 14  NAME_PORTFOLIO          1670214 non-null  object
 15  NAME_PRODUCT_TYPE       1670214 non-null  object
 16  CHANNEL_TYPE            1670214 non-null  object
 17  SELLERPLACE_AREA        1670214 non-null  int64
 18  NAME_SELLER_INDUSTRY    1670214 non-null  object
 19  CNT_PAYMENT             1297984 non-null  float64
 20  NAME_YIELD_GROUP        1670214 non-null  object
 21  PRODUCT_COMBINATION     1669868 non-null  object
dtypes: float64(5), int64(4), object(13)
memory usage: 280.3+ MB
```

[41]:

```
date_col =  ['DAYS_BIRTH','DAYS_EMPLOYED','DAYS_REGISTRATION','DAYS_ID_PUBLISH']

for col in date_col:
    applicationDF[col] = abs(applicationDF[col])
```

[42]:

```
applicationDF['AMT_INCOME_TOTAL']=applicationDF['AMT_INCOME_TOTAL']/100000

bins = [0,1,2,3,4,5,6,7,8,9,10,11]
slot = ['0-100K','100K-200K',␣
  ↪'200k-300k','300k-400k','400k-500k','500k-600k','600k-700k','700k-800k','800k-900k','900k-1
  ↪'1M Above']

applicationDF['AMT_INCOME_RANGE']=pd.
  ↪cut(applicationDF['AMT_INCOME_TOTAL'],bins,labels=slot)
```

[43]:

```
applicationDF['AMT_INCOME_RANGE'].value_counts(normalize=True)*100
```

[43]:

```
100K-200K    50.735000
200k-300k    21.210691
0-100K       20.729695
300k-400k     4.776116
400k-500k     1.744669
500k-600k     0.356354
600k-700k     0.282805
```

```
800k-900k     0.096980
700k-800k     0.052721
900k-1M       0.009112
1M Above      0.005858
Name: AMT_INCOME_RANGE, dtype: float64
```

[44]:

```
applicationDF['AMT_CREDIT'] = applicationDF['AMT_CREDIT']/100000

bins=[0,1,2,3,4,5,6,7,8,9,10,100]
slots = ['0-100K','100K-200K',␣
 ↪'200k-300k','300k-400k','400k-500k','500k-600k','600k-700k','700k-800k',
       '800k-900k','900k-1M', '1M Above']
applicationDF['AMT_CREDIT_RANGE'] = pd.cut(applicationDF['AMT_CREDIT'],bins =␣
 ↪bins,labels=slots)
```

[45]:

```
applicationDF['AMT_CREDIT_RANGE'].value_counts(normalize=True)*100
```

[45]:

```
200k-300k    17.824728
1M Above     16.254703
500k-600k    11.131960
400k-500k    10.418489
100K-200K     9.801275
300k-400k     8.564897
600k-700k     7.820533
800k-900k     7.086576
700k-800k     6.241403
900k-1M       2.902986
0-100K        1.952450
Name: AMT_CREDIT_RANGE, dtype: float64
```

[46]:

```
applicationDF['AGE'] = applicationDF['DAYS_BIRTH']//365
bins = [0,20,30,40,50,100]
slots = ['0-20','20-30','30-40','40-50','50 above']

applicationDF['AGE_GROUP']=pd.cut(applicationDF['AGE'],bins=bins,labels=slots)
```

[47]:

```
applicationDF['AGE_GROUP'].value_counts(normalize=True)*100
```

[47]:

```
50 above    31.604398
30-40       27.028952
40-50       24.194582
20-30       17.171743
0-20         0.000325
Name: AGE_GROUP, dtype: float64
```

[48]:

```
applicationDF['YEARS_EMPLOYED'] = applicationDF['DAYS_EMPLOYED']//365
bins = [0,5,10,20,30,40,50,60,150]
```

```
slots = ['0-5','5-10','10-20','20-30','30-40','40-50','50-60','60 above']

applicationDF['EMPLOYMENT_YEAR'] = pd.
 ↪cut(applicationDF['YEARS_EMPLOYED'],bins=bins,labels=slots)
```

[49]:

```
applicationDF['EMPLOYMENT_YEAR'].value_counts(normalize=True)*100
```

[49]:

```
0-5         55.582363
5-10        24.966441
10-20       14.564315
20-30        3.750117
30-40        1.058720
40-50        0.078044
50-60        0.000000
60 above     0.000000
Name: EMPLOYMENT_YEAR, dtype: float64
```

[50]:

```
applicationDF.nunique().sort_values()
```

[50]:

```
LIVE_CITY_NOT_WORK_CITY            2
TARGET                             2
NAME_CONTRACT_TYPE                 2
REG_REGION_NOT_LIVE_REGION         2
FLAG_OWN_CAR                       2
FLAG_OWN_REALTY                    2
REG_REGION_NOT_WORK_REGION         2
LIVE_REGION_NOT_WORK_REGION        2
FLAG_DOCUMENT_3                    2
REG_CITY_NOT_LIVE_CITY             2
REG_CITY_NOT_WORK_CITY             2
REGION_RATING_CLIENT               3
CODE_GENDER                        3
REGION_RATING_CLIENT_W_CITY        3
AMT_REQ_CREDIT_BUREAU_HOUR         5
NAME_EDUCATION_TYPE                5
AGE_GROUP                          5
NAME_FAMILY_STATUS                 6
NAME_HOUSING_TYPE                  6
EMPLOYMENT_YEAR                    6
WEEKDAY_APPR_PROCESS_START         7
NAME_TYPE_SUITE                    7
NAME_INCOME_TYPE                   8
AMT_REQ_CREDIT_BUREAU_WEEK         9
AMT_REQ_CREDIT_BUREAU_DAY          9
DEF_60_CNT_SOCIAL_CIRCLE           9
DEF_30_CNT_SOCIAL_CIRCLE          10
AMT_CREDIT_RANGE                  11
```

```
AMT_INCOME_RANGE                   11
AMT_REQ_CREDIT_BUREAU_QRT          11
CNT_CHILDREN                       15
CNT_FAM_MEMBERS                    17
OCCUPATION_TYPE                    18
HOUR_APPR_PROCESS_START            24
AMT_REQ_CREDIT_BUREAU_MON          24
AMT_REQ_CREDIT_BUREAU_YEAR         25
OBS_60_CNT_SOCIAL_CIRCLE           33
OBS_30_CNT_SOCIAL_CIRCLE           33
AGE                                50
YEARS_EMPLOYED                     51
ORGANIZATION_TYPE                  58
REGION_POPULATION_RELATIVE         81
AMT_GOODS_PRICE                  1002
AMT_INCOME_TOTAL                 2548
DAYS_LAST_PHONE_CHANGE           3773
AMT_CREDIT                       5603
DAYS_ID_PUBLISH                  6168
DAYS_EMPLOYED                   12574
AMT_ANNUITY                     13672
DAYS_REGISTRATION               15688
DAYS_BIRTH                      17460
SK_ID_CURR                     307511
dtype: int64
```

[51]:
```
applicationDF.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 307511 entries, 0 to 307510
Data columns (total 52 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   SK_ID_CURR                    307511 non-null  int64
 1   TARGET                        307511 non-null  int64
 2   NAME_CONTRACT_TYPE            307511 non-null  object
 3   CODE_GENDER                   307511 non-null  object
 4   FLAG_OWN_CAR                  307511 non-null  object
 5   FLAG_OWN_REALTY               307511 non-null  object
 6   CNT_CHILDREN                  307511 non-null  int64
 7   AMT_INCOME_TOTAL              307511 non-null  float64
 8   AMT_CREDIT                    307511 non-null  float64
 9   AMT_ANNUITY                   307499 non-null  float64
 10  AMT_GOODS_PRICE               307233 non-null  float64
 11  NAME_TYPE_SUITE               306219 non-null  object
 12  NAME_INCOME_TYPE              307511 non-null  object
 13  NAME_EDUCATION_TYPE           307511 non-null  object
 14  NAME_FAMILY_STATUS           307511 non-null  object
 15  NAME_HOUSING_TYPE            307511 non-null  object
 16  REGION_POPULATION_RELATIVE   307511 non-null  float64
 17  DAYS_BIRTH                   307511 non-null  int64
 18  DAYS_EMPLOYED                307511 non-null  int64
 19  DAYS_REGISTRATION            307511 non-null  float64
 20  DAYS_ID_PUBLISH              307511 non-null  int64
 21  OCCUPATION_TYPE              211120 non-null  object
 22  CNT_FAM_MEMBERS              307509 non-null  float64
 23  REGION_RATING_CLIENT         307511 non-null  int64
 24  REGION_RATING_CLIENT_W_CITY  307511 non-null  int64
 25  WEEKDAY_APPR_PROCESS_START   307511 non-null  object
 26  HOUR_APPR_PROCESS_START      307511 non-null  int64
 27  REG_REGION_NOT_LIVE_REGION   307511 non-null  int64
 28  REG_REGION_NOT_WORK_REGION   307511 non-null  int64
 29  LIVE_REGION_NOT_WORK_REGION  307511 non-null  int64
 30  REG_CITY_NOT_LIVE_CITY       307511 non-null  int64
 31  REG_CITY_NOT_WORK_CITY       307511 non-null  int64
 32  LIVE_CITY_NOT_WORK_CITY      307511 non-null  int64
 33  ORGANIZATION_TYPE            307511 non-null  object
 34  OBS_30_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 35  DEF_30_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 36  OBS_60_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 37  DEF_60_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 38  DAYS_LAST_PHONE_CHANGE       307510 non-null  float64
 39  FLAG_DOCUMENT_3              307511 non-null  int64
 40  AMT_REQ_CREDIT_BUREAU_HOUR   265992 non-null  float64
 41  AMT_REQ_CREDIT_BUREAU_DAY    265992 non-null  float64
 42  AMT_REQ_CREDIT_BUREAU_WEEK   265992 non-null  float64
 43  AMT_REQ_CREDIT_BUREAU_MON    265992 non-null  float64
 44  AMT_REQ_CREDIT_BUREAU_QRT    265992 non-null  float64
 45  AMT_REQ_CREDIT_BUREAU_YEAR   265992 non-null  float64
 46  AMT_INCOME_RANGE             307279 non-null  category
 47  AMT_CREDIT_RANGE             307511 non-null  category
 48  AGE                          307511 non-null  int64
 49  AGE_GROUP                    307511 non-null  category
 50  YEARS_EMPLOYED               307511 non-null  int64
 51  EMPLOYMENT_YEAR              224233 non-null  category
dtypes: category(4), float64(18), int64(18), object(12)
memory usage: 113.8+ MB
```

[52]:

```
categorical_columns =␣
 ↪['NAME_CONTRACT_TYPE','CODE_GENDER','NAME_TYPE_SUITE','NAME_INCOME_TYPE','NAME_EDUCATION_TY
                       ␣
 ↪'NAME_FAMILY_STATUS','NAME_HOUSING_TYPE','OCCUPATION_TYPE','WEEKDAY_APPR_PROCESS_START',
                       ␣
 ↪'ORGANIZATION_TYPE','FLAG_OWN_CAR','FLAG_OWN_REALTY','LIVE_CITY_NOT_WORK_CITY',
                                                 ␣
↪'REG_CITY_NOT_LIVE_CITY','REG_CITY_NOT_WORK_CITY','REG_REGION_NOT_WORK_REGION',
                                                 ␣
↪'LIVE_REGION_NOT_WORK_REGION','REGION_RATING_CLIENT','WEEKDAY_APPR_PROCESS_START',
                        'REGION_RATING_CLIENT_W_CITY']

for col in categorical_columns:
    applicationDF[col] = pd.Categorical(applicationDF[col])
```

[53]:

```
applicationDF.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 307511 entries, 0 to 307510
Data columns (total 52 columns):
 #   Column                       Non-Null Count   Dtype
---  ------                       --------------   -----
 0   SK_ID_CURR                   307511 non-null  int64
 1   TARGET                       307511 non-null  int64
 2   NAME_CONTRACT_TYPE           307511 non-null  category
 3   CODE_GENDER                  307511 non-null  category
 4   FLAG_OWN_CAR                 307511 non-null  category
 5   FLAG_OWN_REALTY              307511 non-null  category
 6   CNT_CHILDREN                 307511 non-null  int64
 7   AMT_INCOME_TOTAL             307511 non-null  float64
 8   AMT_CREDIT                   307511 non-null  float64
 9   AMT_ANNUITY                  307499 non-null  float64
 10  AMT_GOODS_PRICE              307233 non-null  float64
 11  NAME_TYPE_SUITE              306219 non-null  category
 12  NAME_INCOME_TYPE             307511 non-null  category
 13  NAME_EDUCATION_TYPE          307511 non-null  category
 14  NAME_FAMILY_STATUS           307511 non-null  category
 15  NAME_HOUSING_TYPE            307511 non-null  category
 16  REGION_POPULATION_RELATIVE   307511 non-null  float64
 17  DAYS_BIRTH                   307511 non-null  int64
 18  DAYS_EMPLOYED                307511 non-null  int64
 19  DAYS_REGISTRATION            307511 non-null  float64
 20  DAYS_ID_PUBLISH              307511 non-null  int64
 21  OCCUPATION_TYPE              211120 non-null  category
 22  CNT_FAM_MEMBERS              307509 non-null  float64
 23  REGION_RATING_CLIENT         307511 non-null  category
 24  REGION_RATING_CLIENT_W_CITY  307511 non-null  category
 25  WEEKDAY_APPR_PROCESS_START   307511 non-null  category
 26  HOUR_APPR_PROCESS_START      307511 non-null  int64
 27  REG_REGION_NOT_LIVE_REGION   307511 non-null  int64
 28  REG_REGION_NOT_WORK_REGION   307511 non-null  category
 29  LIVE_REGION_NOT_WORK_REGION  307511 non-null  category
 30  REG_CITY_NOT_LIVE_CITY       307511 non-null  category
 31  REG_CITY_NOT_WORK_CITY       307511 non-null  category
 32  LIVE_CITY_NOT_WORK_CITY      307511 non-null  category
 33  ORGANIZATION_TYPE            307511 non-null  category
 34  OBS_30_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 35  DEF_30_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 36  OBS_60_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 37  DEF_60_CNT_SOCIAL_CIRCLE     306490 non-null  float64
 38  DAYS_LAST_PHONE_CHANGE       307510 non-null  float64
 39  FLAG_DOCUMENT_3              307511 non-null  int64
 40  AMT_REQ_CREDIT_BUREAU_HOUR   265992 non-null  float64
 41  AMT_REQ_CREDIT_BUREAU_DAY    265992 non-null  float64
 42  AMT_REQ_CREDIT_BUREAU_WEEK   265992 non-null  float64
 43  AMT_REQ_CREDIT_BUREAU_MON    265992 non-null  float64
 44  AMT_REQ_CREDIT_BUREAU_QRT    265992 non-null  float64
 45  AMT_REQ_CREDIT_BUREAU_YEAR   265992 non-null  float64
 46  AMT_INCOME_RANGE             307279 non-null  category
 47  AMT_CREDIT_RANGE             307511 non-null  category
 48  AGE                          307511 non-null  int64
 49  AGE_GROUP                    307511 non-null  category
 50  YEARS_EMPLOYED               307511 non-null  int64
 51  EMPLOYMENT_YEAR              224233 non-null  category
dtypes: category(23), float64(18), int64(11)
memory usage: 74.8 MB
```

[54]:
```
previousDF.nunique().sort_values()
```

[54]:
```
NAME_PRODUCT_TYPE              3
NAME_PAYMENT_TYPE              4
NAME_CONTRACT_TYPE             4
NAME_CLIENT_TYPE               4
NAME_CONTRACT_STATUS           4
NAME_PORTFOLIO                 5
NAME_YIELD_GROUP               5
CHANNEL_TYPE                   8
CODE_REJECT_REASON             9
NAME_SELLER_INDUSTRY          11
PRODUCT_COMBINATION           17
NAME_CASH_LOAN_PURPOSE        25
NAME_GOODS_CATEGORY           28
CNT_PAYMENT                   49
SELLERPLACE_AREA            2097
DAYS_DECISION               2922
AMT_CREDIT                 86803
AMT_GOODS_PRICE            93885
AMT_APPLICATION            93885
SK_ID_CURR                338857
AMT_ANNUITY               357959
```

```
SK_ID_PREV                 1670214
dtype: int64
```

[55]:
```
previousDF.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1670214 entries, 0 to 1670213
Data columns (total 22 columns):
 #   Column                   Non-Null Count    Dtype
---  ------                   --------------    -----
 0   SK_ID_PREV               1670214 non-null  int64
 1   SK_ID_CURR               1670214 non-null  int64
 2   NAME_CONTRACT_TYPE       1670214 non-null  object
 3   AMT_ANNUITY              1297979 non-null  float64
 4   AMT_APPLICATION          1670214 non-null  float64
 5   AMT_CREDIT               1670213 non-null  float64
 6   AMT_GOODS_PRICE          1284699 non-null  float64
 7   NAME_CASH_LOAN_PURPOSE   1670214 non-null  object
 8   NAME_CONTRACT_STATUS     1670214 non-null  object
 9   DAYS_DECISION            1670214 non-null  int64
 10  NAME_PAYMENT_TYPE        1670214 non-null  object
 11  CODE_REJECT_REASON       1670214 non-null  object
 12  NAME_CLIENT_TYPE         1670214 non-null  object
 13  NAME_GOODS_CATEGORY      1670214 non-null  object
 14  NAME_PORTFOLIO           1670214 non-null  object
 15  NAME_PRODUCT_TYPE        1670214 non-null  object
 16  CHANNEL_TYPE             1670214 non-null  object
 17  SELLERPLACE_AREA         1670214 non-null  int64
 18  NAME_SELLER_INDUSTRY     1670214 non-null  object
 19  CNT_PAYMENT              1297984 non-null  float64
 20  NAME_YIELD_GROUP         1670214 non-null  object
 21  PRODUCT_COMBINATION      1669868 non-null  object
dtypes: float64(5), int64(4), object(13)
memory usage: 280.3+ MB
```

[56]:
```
previousDF['DAYS_DECISION'] = abs(previousDF['DAYS_DECISION'])
```

[57]:
```
previousDF['DAYS_DECISION_GROUP'] =␣
  ↪(previousDF['DAYS_DECISION']-(previousDF['DAYS_DECISION'] % 400)).
  ↪astype(str)+'-'+ ((previousDF['DAYS_DECISION'] -␣
  ↪(previousDF['DAYS_DECISION'] % 400)) + (previousDF['DAYS_DECISION'] % 400) +␣
  ↪(400 - (previousDF['DAYS_DECISION'] % 400))).astype(str)
```

[58]:
```
previousDF['DAYS_DECISION_GROUP'].value_counts(normalize=True)*100
```

[58]:
```
0-400        37.490525
400-800      22.944724
```

```
800-1200     12.444753
1200-1600     7.904556
2400-2800     6.297456
1600-2000     5.795784
2000-2400     5.684960
2800-3200     1.437241
Name: DAYS_DECISION_GROUP, dtype: float64
```

[59]:

```
Catgorical_col_p =␣
 ↪['NAME_CASH_LOAN_PURPOSE','NAME_CONTRACT_STATUS','NAME_PAYMENT_TYPE',
                    ␣
 ↪'CODE_REJECT_REASON','NAME_CLIENT_TYPE','NAME_GOODS_CATEGORY','NAME_PORTFOLIO',
                   ␣
 ↪'NAME_PRODUCT_TYPE','CHANNEL_TYPE','NAME_SELLER_INDUSTRY','NAME_YIELD_GROUP','PRODUCT_COMBI
                      'NAME_CONTRACT_TYPE','DAYS_DECISION_GROUP']
for col in Catgorical_col_p:
    previousDF[col] = pd.Categorical(previousDF[col])
```

[60]:

```
previousDF.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1670214 entries, 0 to 1670213
Data columns (total 23 columns):
 #   Column                  Non-Null Count    Dtype
---  ------                  --------------    -----
 0   SK_ID_PREV              1670214 non-null  int64
 1   SK_ID_CURR              1670214 non-null  int64
 2   NAME_CONTRACT_TYPE      1670214 non-null  category
 3   AMT_ANNUITY             1297979 non-null  float64
 4   AMT_APPLICATION         1670214 non-null  float64
 5   AMT_CREDIT              1670213 non-null  float64
 6   AMT_GOODS_PRICE         1284699 non-null  float64
 7   NAME_CASH_LOAN_PURPOSE  1670214 non-null  category
 8   NAME_CONTRACT_STATUS    1670214 non-null  category
 9   DAYS_DECISION           1670214 non-null  int64
 10  NAME_PAYMENT_TYPE       1670214 non-null  category
 11  CODE_REJECT_REASON      1670214 non-null  category
 12  NAME_CLIENT_TYPE        1670214 non-null  category
 13  NAME_GOODS_CATEGORY     1670214 non-null  category
 14  NAME_PORTFOLIO          1670214 non-null  category
 15  NAME_PRODUCT_TYPE       1670214 non-null  category
 16  CHANNEL_TYPE            1670214 non-null  category
 17  SELLERPLACE_AREA        1670214 non-null  int64
 18  NAME_SELLER_INDUSTRY    1670214 non-null  category
 19  CNT_PAYMENT             1297984 non-null  float64
 20  NAME_YIELD_GROUP        1670214 non-null  category
 21  PRODUCT_COMBINATION     1669868 non-null  category
 22  DAYS_DECISION_GROUP     1670214 non-null  category
dtypes: category(14), float64(5), int64(4)
memory usage: 137.0 MB
```

[61]:
```
round(applicationDF.isnull().sum()/applicationDF.shape[0]*100.00,2)
```

[61]:
```
SK_ID_CURR                      0.00
TARGET                          0.00
NAME_CONTRACT_TYPE              0.00
CODE_GENDER                     0.00
FLAG_OWN_CAR                    0.00
FLAG_OWN_REALTY                 0.00
CNT_CHILDREN                    0.00
AMT_INCOME_TOTAL                0.00
AMT_CREDIT                      0.00
AMT_ANNUITY                     0.00
AMT_GOODS_PRICE                 0.09
NAME_TYPE_SUITE                 0.42
NAME_INCOME_TYPE                0.00
NAME_EDUCATION_TYPE             0.00
NAME_FAMILY_STATUS              0.00
NAME_HOUSING_TYPE               0.00
REGION_POPULATION_RELATIVE      0.00
DAYS_BIRTH                      0.00
DAYS_EMPLOYED                   0.00
DAYS_REGISTRATION               0.00
DAYS_ID_PUBLISH                 0.00
OCCUPATION_TYPE                31.35
CNT_FAM_MEMBERS                 0.00
REGION_RATING_CLIENT            0.00
REGION_RATING_CLIENT_W_CITY     0.00
WEEKDAY_APPR_PROCESS_START      0.00
HOUR_APPR_PROCESS_START         0.00
REG_REGION_NOT_LIVE_REGION      0.00
REG_REGION_NOT_WORK_REGION      0.00
LIVE_REGION_NOT_WORK_REGION     0.00
REG_CITY_NOT_LIVE_CITY          0.00
REG_CITY_NOT_WORK_CITY          0.00
LIVE_CITY_NOT_WORK_CITY         0.00
ORGANIZATION_TYPE               0.00
OBS_30_CNT_SOCIAL_CIRCLE        0.33
DEF_30_CNT_SOCIAL_CIRCLE        0.33
OBS_60_CNT_SOCIAL_CIRCLE        0.33
DEF_60_CNT_SOCIAL_CIRCLE        0.33
DAYS_LAST_PHONE_CHANGE          0.00
FLAG_DOCUMENT_3                 0.00
AMT_REQ_CREDIT_BUREAU_HOUR     13.50
```

```
AMT_REQ_CREDIT_BUREAU_DAY      13.50
AMT_REQ_CREDIT_BUREAU_WEEK     13.50
AMT_REQ_CREDIT_BUREAU_MON      13.50
AMT_REQ_CREDIT_BUREAU_QRT      13.50
AMT_REQ_CREDIT_BUREAU_YEAR     13.50
AMT_INCOME_RANGE                0.08
AMT_CREDIT_RANGE                0.00
AGE                             0.00
AGE_GROUP                       0.00
YEARS_EMPLOYED                  0.00
EMPLOYMENT_YEAR                27.08
dtype: float64
```

```
[62]: applicationDF['NAME_TYPE_SUITE'].describe()
```

```
[62]: count              306219
      unique                  7
      top       Unaccompanied
      freq               248526
      Name: NAME_TYPE_SUITE, dtype: object
```

```
[63]: applicationDF['NAME_TYPE_SUITE'].fillna((applicationDF['NAME_TYPE_SUITE'].
        ↪mode()[0]),inplace = True)
```

```
[64]: applicationDF['OCCUPATION_TYPE'] = applicationDF['OCCUPATION_TYPE'].cat.
        ↪add_categories('Unknown')
      applicationDF['OCCUPATION_TYPE'].fillna('Unknown',inplace=True)
```

```
[65]: applicationDF[['AMT_REQ_CREDIT_BUREAU_HOUR','AMT_REQ_CREDIT_BUREAU_DAY',
                     'AMT_REQ_CREDIT_BUREAU_WEEK','AMT_REQ_CREDIT_BUREAU_MON',
                     'AMT_REQ_CREDIT_BUREAU_QRT','AMT_REQ_CREDIT_BUREAU_YEAR']].
        ↪describe()
```

```
[65]:        AMT_REQ_CREDIT_BUREAU_HOUR  AMT_REQ_CREDIT_BUREAU_DAY  \
      AMT_REQ_CREDIT_BUREAU_WEEK  AMT_REQ_CREDIT_BUREAU_MON  AMT_REQ_CREDIT_BUREAU_QRT  \
      AMT_REQ_CREDIT_BUREAU_YEAR
      count                 265992.000000              265992.000000
      265992.000000              265992.000000              265992.000000
      265992.000000
      mean                       0.006402                   0.007000
      0.034362                   0.267395                   0.265474
      1.899974
      std                        0.083849                   0.110757
      0.204685                   0.916002                   0.794056
      1.869295
      min                        0.000000                   0.000000
      0.000000                   0.000000                   0.000000
```

```
0.000000
25%                          0.000000                    0.000000
0.000000                       0.000000                    0.000000
0.000000
50%                          0.000000                    0.000000
0.000000                       0.000000                    0.000000
1.000000
75%                          0.000000                    0.000000
0.000000                       0.000000                    0.000000
3.000000
max                          4.000000                    9.000000
8.000000                      27.000000                  261.000000
25.000000
```

[66]:
```
amount = ['AMT_REQ_CREDIT_BUREAU_HOUR',␣
 ↪'AMT_REQ_CREDIT_BUREAU_DAY','AMT_REQ_CREDIT_BUREAU_WEEK','AMT_REQ_CREDIT_BUREAU_MON',
         'AMT_REQ_CREDIT_BUREAU_QRT','AMT_REQ_CREDIT_BUREAU_YEAR']
for col in amount:
    applicationDF[col].fillna(applicationDF[col].median(),inplace = True)
```

[67]:
```
round(applicationDF.isnull().sum()/previousDF.shape[0]*100.00,2)
```

[67]:
```
SK_ID_CURR                     0.00
TARGET                         0.00
NAME_CONTRACT_TYPE             0.00
CODE_GENDER                    0.00
FLAG_OWN_CAR                   0.00
FLAG_OWN_REALTY                0.00
CNT_CHILDREN                   0.00
AMT_INCOME_TOTAL               0.00
AMT_CREDIT                     0.00
AMT_ANNUITY                    0.00
AMT_GOODS_PRICE                0.02
NAME_TYPE_SUITE                0.00
NAME_INCOME_TYPE               0.00
NAME_EDUCATION_TYPE            0.00
NAME_FAMILY_STATUS             0.00
NAME_HOUSING_TYPE              0.00
REGION_POPULATION_RELATIVE     0.00
DAYS_BIRTH                     0.00
DAYS_EMPLOYED                  0.00
DAYS_REGISTRATION              0.00
DAYS_ID_PUBLISH                0.00
OCCUPATION_TYPE                0.00
CNT_FAM_MEMBERS                0.00
REGION_RATING_CLIENT           0.00
REGION_RATING_CLIENT_W_CITY    0.00
```

```
WEEKDAY_APPR_PROCESS_START     0.00
HOUR_APPR_PROCESS_START        0.00
REG_REGION_NOT_LIVE_REGION     0.00
REG_REGION_NOT_WORK_REGION     0.00
LIVE_REGION_NOT_WORK_REGION    0.00
REG_CITY_NOT_LIVE_CITY         0.00
REG_CITY_NOT_WORK_CITY         0.00
LIVE_CITY_NOT_WORK_CITY        0.00
ORGANIZATION_TYPE              0.00
OBS_30_CNT_SOCIAL_CIRCLE       0.06
DEF_30_CNT_SOCIAL_CIRCLE       0.06
OBS_60_CNT_SOCIAL_CIRCLE       0.06
DEF_60_CNT_SOCIAL_CIRCLE       0.06
DAYS_LAST_PHONE_CHANGE         0.00
FLAG_DOCUMENT_3                0.00
AMT_REQ_CREDIT_BUREAU_HOUR     0.00
AMT_REQ_CREDIT_BUREAU_DAY      0.00
AMT_REQ_CREDIT_BUREAU_WEEK     0.00
AMT_REQ_CREDIT_BUREAU_MON      0.00
AMT_REQ_CREDIT_BUREAU_QRT      0.00
AMT_REQ_CREDIT_BUREAU_YEAR     0.00
AMT_INCOME_RANGE               0.01
AMT_CREDIT_RANGE               0.00
AGE                            0.00
AGE_GROUP                      0.00
YEARS_EMPLOYED                 0.00
EMPLOYMENT_YEAR                4.99
dtype: float64
```

[68]:

```
round(previousDF.isnull().sum()/previousDF.shape[0]*100.00,2)
```

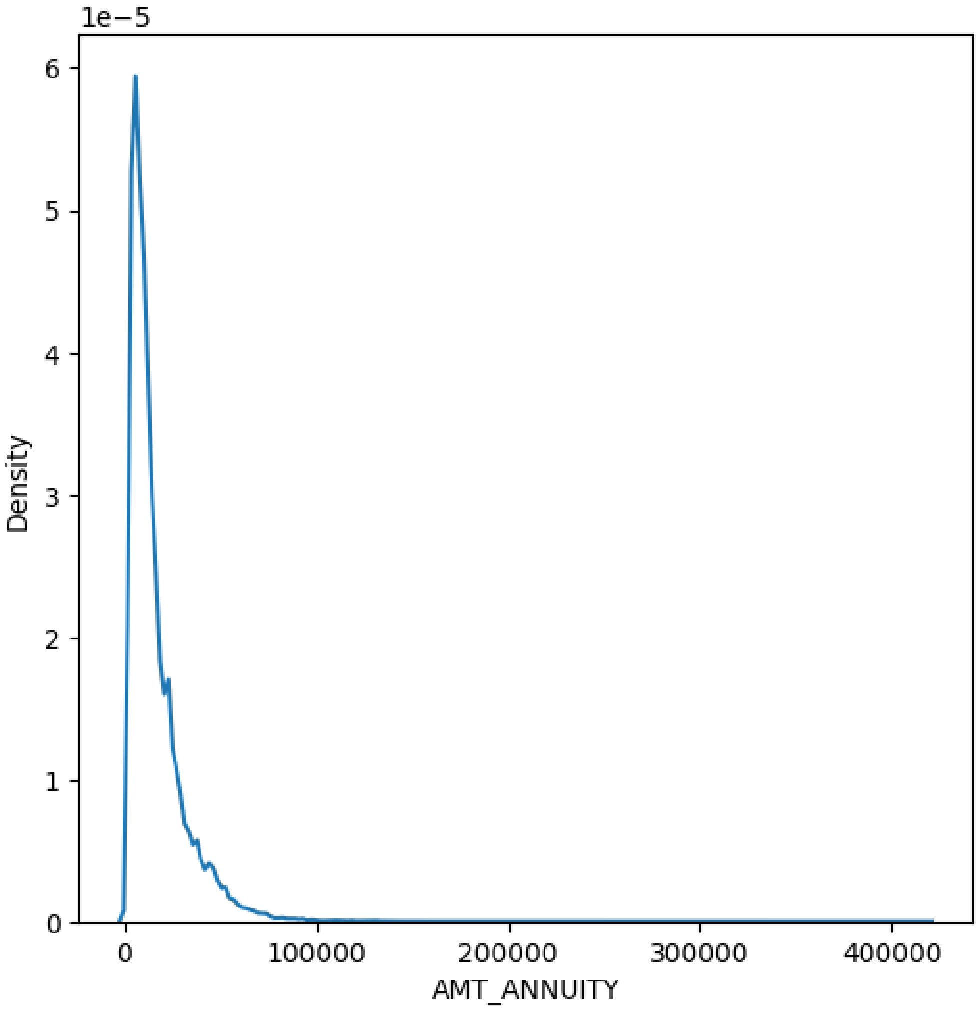
[68]:

```
SK_ID_PREV                 0.00
SK_ID_CURR                 0.00
NAME_CONTRACT_TYPE         0.00
AMT_ANNUITY               22.29
AMT_APPLICATION            0.00
AMT_CREDIT                 0.00
AMT_GOODS_PRICE           23.08
NAME_CASH_LOAN_PURPOSE     0.00
NAME_CONTRACT_STATUS       0.00
DAYS_DECISION              0.00
NAME_PAYMENT_TYPE          0.00
CODE_REJECT_REASON         0.00
NAME_CLIENT_TYPE           0.00
NAME_GOODS_CATEGORY        0.00
NAME_PORTFOLIO             0.00
NAME_PRODUCT_TYPE          0.00
```

```
CHANNEL_TYPE                0.00
SELLERPLACE_AREA            0.00
NAME_SELLER_INDUSTRY        0.00
CNT_PAYMENT                22.29
NAME_YIELD_GROUP            0.00
PRODUCT_COMBINATION         0.02
DAYS_DECISION_GROUP         0.00
dtype: float64
```

[69]:

```
plt.figure(figsize=(6,6))
sns.kdeplot(previousDF['AMT_ANNUITY'])
plt.show()
```

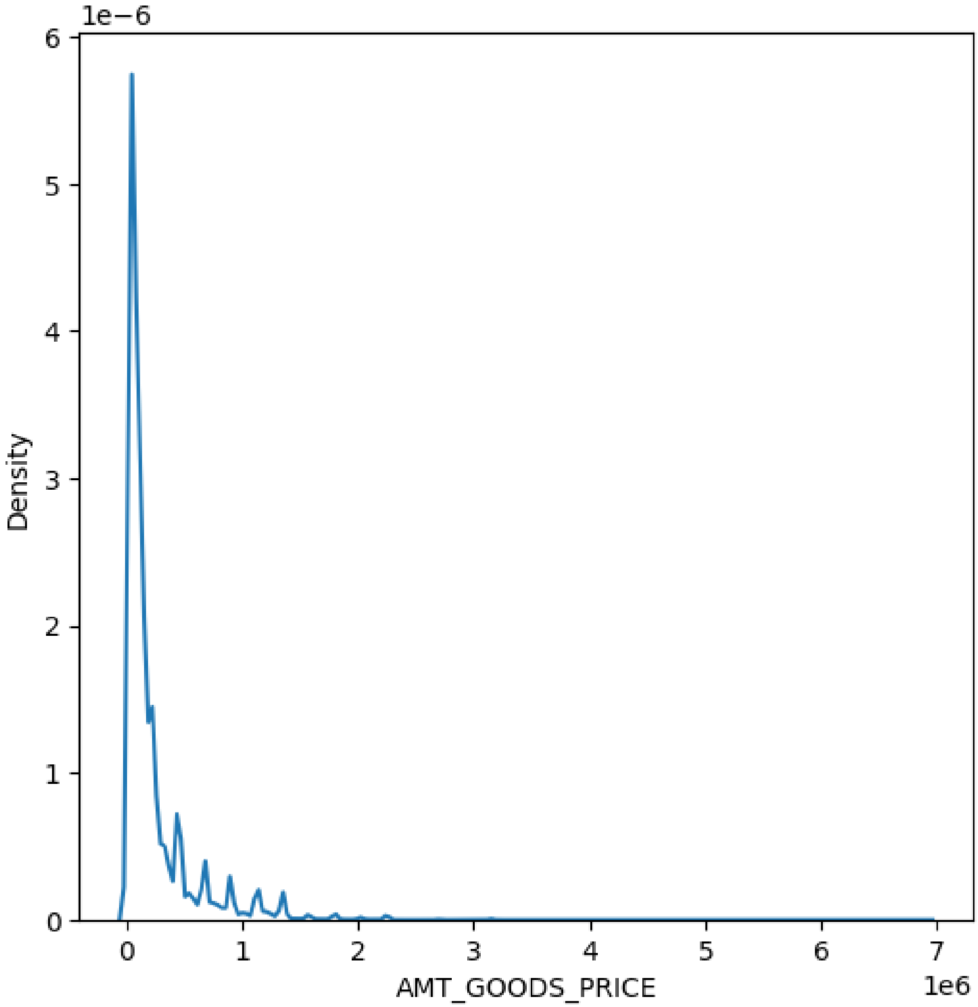


[70]:

```
previousDF['AMT_ANNUITY'].fillna(previousDF['AMT_ANNUITY'].
  ↪median(),inplace=True)
```

[71]:

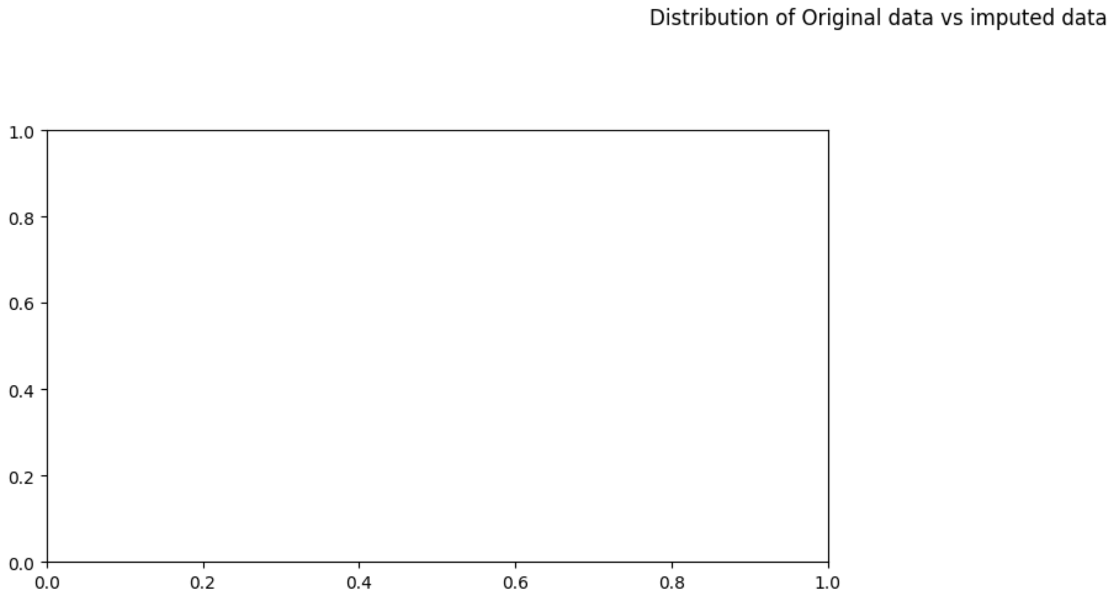
```
plt.figure(figsize=(6,6))
sns.kdeplot(previousDF['AMT_GOODS_PRICE'][pd.
  ↪notnull(previousDF['AMT_GOODS_PRICE'])])
plt.show()
```

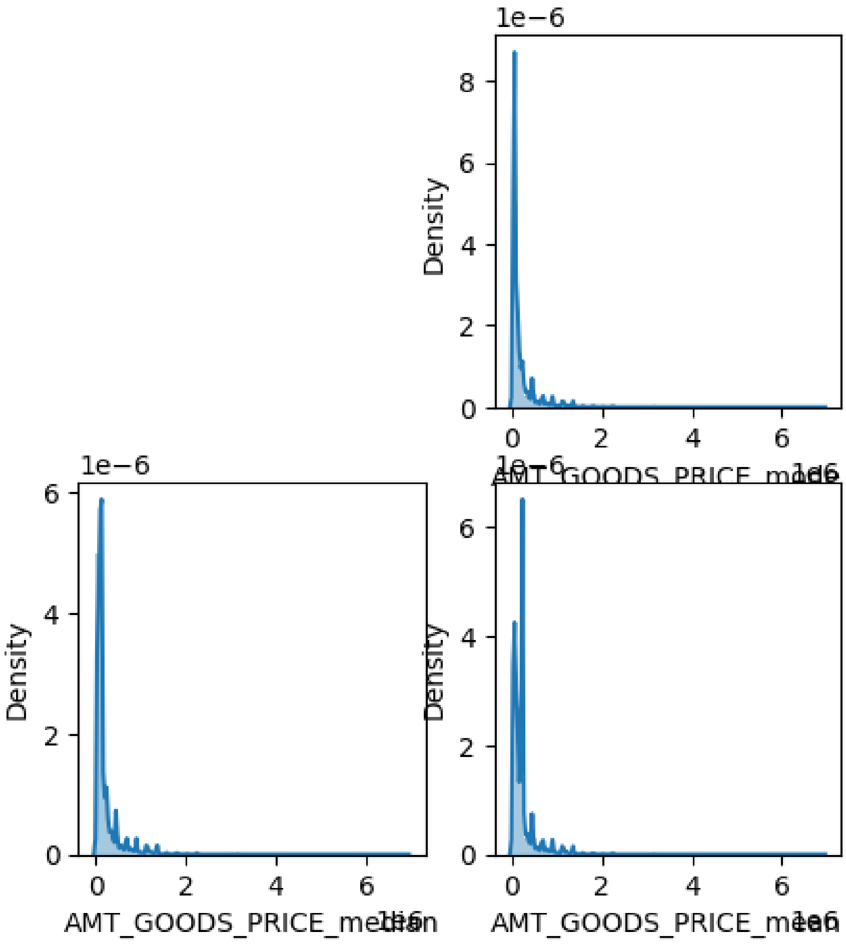


[72]:

```
statsDF = pd.DataFrame()
statsDF['AMT_GOODS_PRICE_mode'] = previousDF['AMT_GOODS_PRICE'].
  ↪fillna(previousDF['AMT_GOODS_PRICE'].mode()[0])
statsDF['AMT_GOODS_PRICE_median'] = previousDF['AMT_GOODS_PRICE'].
  ↪fillna(previousDF['AMT_GOODS_PRICE'].median())
statsDF['AMT_GOODS_PRICE_mean'] = previousDF['AMT_GOODS_PRICE'].
  ↪fillna(previousDF['AMT_GOODS_PRICE'].mean())

cols = ['AMT_GOODS_PRICE_mode', 'AMT_GOODS_PRICE_median','AMT_GOODS_PRICE_mean']
```

```
plt.figure(figsize=(18,10))
plt.suptitle('Distribution of Original data vs imputed data')
plt.subplot(221)
sns.displot(previousDF['AMT_GOODS_PRICE'][pd.
 ↪notnull(previousDF['AMT_GOODS_PRICE'])]);
for i in enumerate(cols):
    plt.subplot(2,2,i[0]+2)
    sns.distplot(statsDF[i[1]])
```





[73]:
```
previousDF['AMT_GOODS_PRICE'].fillna(previousDF['AMT_GOODS_PRICE'].
  ↪mode()[0],inplace=True)
```

[74]:
```
previousDF.loc[previousDF['CNT_PAYMENT'].isnull(),'NAME_CONTRACT_STATUS'].
  ↪value_counts()
```

[74]:
```
Canceled        305805
Refused          40897
Unused offer     25524
Approved             4
Name: NAME_CONTRACT_STATUS, dtype: int64
```

[75]:
```
previousDF['CNT_PAYMENT'].fillna(0,inplace = True)
```

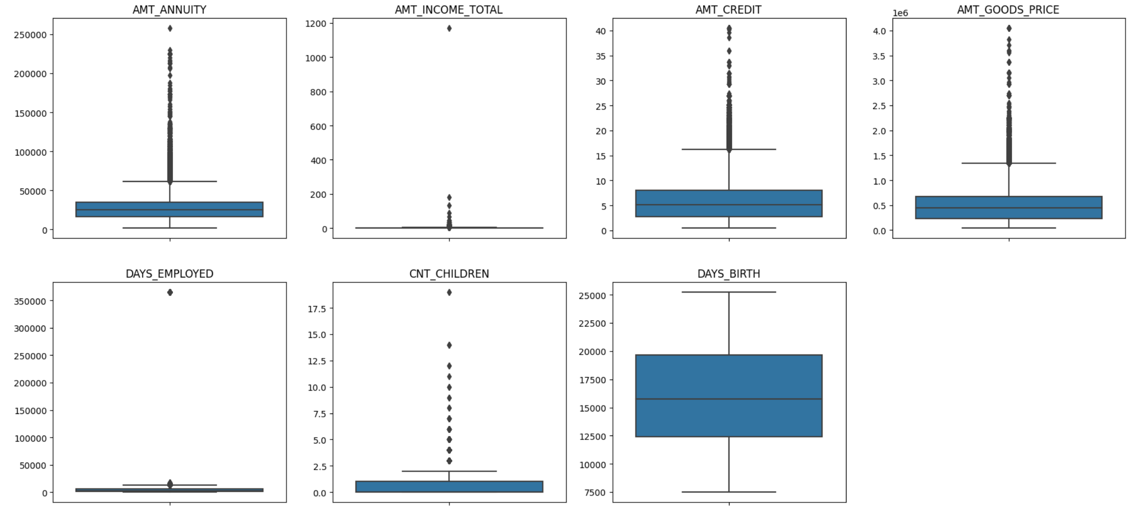
[76]:
```
round(previousDF.isnull().sum()/previousDF.shape[0]*100.00,2)
```

[76]:

```
SK_ID_PREV                0.00
SK_ID_CURR                0.00
NAME_CONTRACT_TYPE        0.00
AMT_ANNUITY               0.00
AMT_APPLICATION           0.00
AMT_CREDIT                0.00
AMT_GOODS_PRICE           0.00
NAME_CASH_LOAN_PURPOSE    0.00
NAME_CONTRACT_STATUS      0.00
DAYS_DECISION             0.00
NAME_PAYMENT_TYPE         0.00
CODE_REJECT_REASON        0.00
NAME_CLIENT_TYPE          0.00
NAME_GOODS_CATEGORY       0.00
NAME_PORTFOLIO            0.00
NAME_PRODUCT_TYPE         0.00
CHANNEL_TYPE              0.00
SELLERPLACE_AREA          0.00
NAME_SELLER_INDUSTRY      0.00
CNT_PAYMENT               0.00
NAME_YIELD_GROUP          0.00
PRODUCT_COMBINATION       0.02
DAYS_DECISION_GROUP       0.00
dtype: float64
```

[77]:

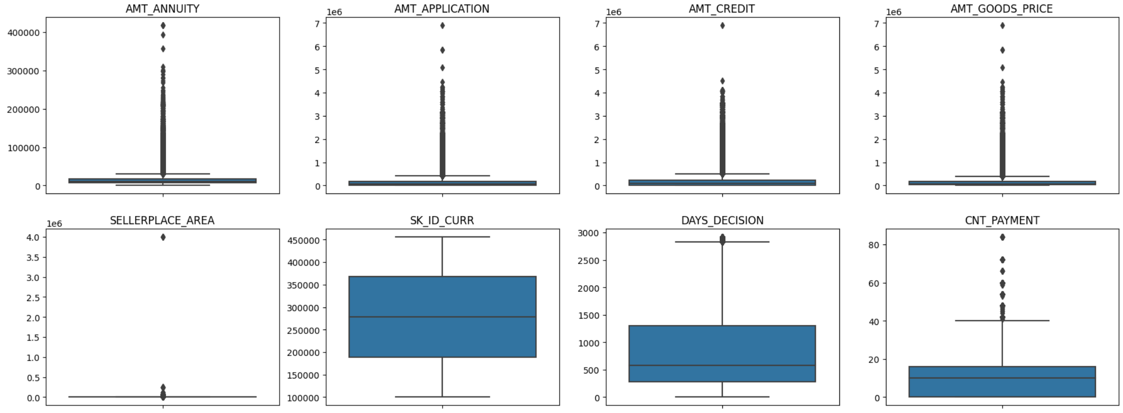
```
plt.figure(figsize=(22,10))
app_outlier_col_1 =␣
 ↪['AMT_ANNUITY','AMT_INCOME_TOTAL','AMT_CREDIT','AMT_GOODS_PRICE','DAYS_EMPLOYED']
app_outlier_col_2 = ['CNT_CHILDREN','DAYS_BIRTH']
for i in enumerate(app_outlier_col_1):
    plt.subplot(2,4,i[0]+1)
    sns.boxplot(y=applicationDF[i[1]])
    plt.title(i[1])
    plt.ylabel("")

for i in enumerate(app_outlier_col_2):
    plt.subplot(2,4,i[0]+6)
    sns.boxplot(y=applicationDF[i[1]])
    plt.title(i[1])
    plt.ylabel("")
```



[78]:
```
applicationDF[['AMT_ANNUITY', 'AMT_INCOME_TOTAL', 'AMT_CREDIT',␣
↪'AMT_GOODS_PRICE', 'DAYS_BIRTH','CNT_CHILDREN','DAYS_EMPLOYED']].describe()
```

[78]:
```
         AMT_ANNUITY  AMT_INCOME_TOTAL     AMT_CREDIT  AMT_GOODS_PRICE  \
DAYS_BIRTH   CNT_CHILDREN  DAYS_EMPLOYED
count  307499.000000     307511.000000  307511.000000     3.072330e+05
307511.000000  307511.000000  307511.000000
mean    27108.573909          1.687979       5.990260     5.383962e+05
16036.995067       0.417052   67724.742149
std     14493.737315          2.371231       4.024908     3.694465e+05
4363.988632       0.722121  139443.751806
min      1615.500000          0.256500       0.450000     4.050000e+04
7489.000000       0.000000       0.000000
25%     16524.000000          1.125000       2.700000     2.385000e+05
12413.000000       0.000000     933.000000
50%     24903.000000          1.471500       5.135310     4.500000e+05
15750.000000       0.000000    2219.000000
75%     34596.000000          2.025000       8.086500     6.795000e+05
19682.000000       1.000000    5707.000000
max    258025.500000       1170.000000      40.500000     4.050000e+06
25229.000000      19.000000  365243.000000
```

[79]:
```
plt.figure(figsize=(22,8))

prev_outlier_col_1=['AMT_ANNUITY','AMT_APPLICATION','AMT_CREDIT','AMT_GOODS_PRICE','SELLERPLAC
prev_outlier_col_2= ['SK_ID_CURR','DAYS_DECISION','CNT_PAYMENT']

for i in enumerate (prev_outlier_col_1):
    plt.subplot(2,4,i[0]+1)
    sns.boxplot(y=previousDF[i[1]])
    plt.title(i[1])
    plt.ylabel("")

for i in enumerate (prev_outlier_col_2):
    plt.subplot(2,4,i[0]+6)
    sns.boxplot(y=previousDF[i[1]])
    plt.title(i[1])
    plt.ylabel("")
```

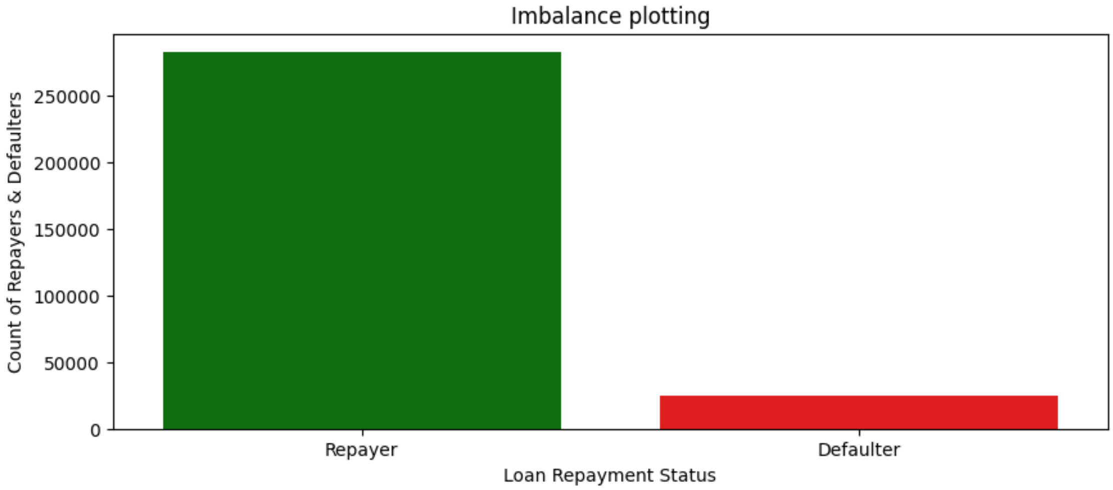


[80]:
```
previousDF[['AMT_ANNUITY', 'AMT_APPLICATION', 'AMT_CREDIT', 'AMT_GOODS_PRICE',␣
 ↪'SELLERPLACE_AREA','CNT_PAYMENT','DAYS_DECISION']].describe()
```

[80]:
```
        AMT_ANNUITY  AMT_APPLICATION    AMT_CREDIT  AMT_GOODS_PRICE  \
SELLERPLACE_AREA   CNT_PAYMENT  DAYS_DECISION
count  1.670214e+06     1.670214e+06  1.670213e+06     1.670214e+06
1.670214e+06  1.670214e+06   1.670214e+06
mean   1.490651e+04     1.752339e+05  1.961140e+05     1.856429e+05
3.139511e+02  1.247621e+01   8.806797e+02
std    1.317751e+04     2.927798e+05  3.185746e+05     2.871413e+05
7.127443e+03  1.447588e+01   7.790997e+02
min    0.000000e+00     0.000000e+00  0.000000e+00     0.000000e+00
-1.000000e+00  0.000000e+00   1.000000e+00
25%    7.547096e+03     1.872000e+04  2.416050e+04     4.500000e+04
-1.000000e+00  0.000000e+00   2.800000e+02
50%    1.125000e+04     7.104600e+04  8.054100e+04     7.105050e+04
3.000000e+00  1.000000e+01   5.810000e+02
75%    1.682403e+04     1.803600e+05  2.164185e+05     1.804050e+05
8.200000e+01  1.600000e+01   1.300000e+03
max    4.180581e+05     6.905160e+06  6.905160e+06     6.905160e+06
4.000000e+06  8.400000e+01   2.922000e+03
```

[81]:

```
Imbalance = applicationDF["TARGET"].value_counts().reset_index()

plt.figure(figsize=(10,4))
x=['Repayer','Defaulter']
sns.barplot(x=x, y="TARGET",data=Imbalance,palette=['g','r'])
plt.xlabel("Loan Repayment Status")
plt.ylabel("Count of Repayers & Defaulters")
plt.title("Imbalance plotting")
plt.show()
```



[82]:

```
count_0 = Imbalance.iloc[0]["TARGET"]
count_1 = Imbalance.iloc[1]["TARGET"]
count_0_perc = round(count_0/(count_0+count_1)*100,2)
count_1_perc = round(count_1/(count_0+count_1)*100,2)

print('Ratios of imbalance in percentage with respect to Repayer and Defaulter␣
  ↪datas are: %.2f and %.2f'%(count_0_perc,count_1_perc))
print('Ratios of imbalance in relative with respect to Repayer and Defaulter␣
  ↪datas is %.2f : 1 (approx)'%(count_0/count_1))
```

```
Ratios of imbalance in percentage with respect to Repayer and Defaulter datas
are: 91.93 and 8.07
Ratios of imbalance in relative with respect to Repayer and Defaulter datas is
11.39 : 1 (approx)
```

[83]:

```
def␣
  ↪univariate_categorical(feature,ylog=False,label_rotation=False,horizontal_layout=True):
  ↪
    temp = applicationDF[feature].value_counts()
    df1 = pd.DataFrame({feature:temp.index,'Number of contracts':temp.values})
    cat_perc = applicationDF[[feature, 'TARGET']].
↪groupby([feature],as_index=False).mean()
    cat_perc["TARGET"] = cat_perc["TARGET"]*100
    cat_perc.sort_values(by='TARGET', ascending=False, inplace=True)

    if(horizontal_layout):
        fig,(ax1,ax2)=plt.subplots(ncols=2, figsize=(12,6))
    else:
         fig,(ax1,ax2)=plt.subplots(ncols=2, figsize=(20,24))


    s= sns.countplot(ax=ax1,
                    x = feature,
                    data=applicationDF,
                    hue ="TARGET",
                    order=cat_perc[feature],
                    palette=['g','r'])

    ax1.set_title(feature, fontdict={'fontsize' : 10, 'fontweight' : 3, 'color'␣
↪: 'Blue'})
    ax1.legend(['Repayer','Defaulter'])

    if ylog:
        ax1.set_yscale('log')
        ax1.set_ylabel("Count (log)",fontdict={'fontsize' : 10, 'fontweight' :␣
↪3, 'color' : 'Blue'})


    if(label_rotation):
          s.set_xticklabels(s.get_xticklabels(),rotation=90)


    s = sns.barplot(ax=ax2,
                    x = feature,
                    y='TARGET',
                    order=cat_perc[feature],
                    data=cat_perc,
                    palette='Set2')

    if(label_rotation):
        s.set_xticklabels(s.get_xticklabels(),rotation=90)
    plt.ylabel('Percent of Defaulters [%]', fontsize=10)
    plt.tick_params(axis='both', which='major', labelsize=10)
    ax2.set_title(feature + " Defaulter %", fontdict={'fontsize' : 15,␣
↪'fontweight' : 5, 'color' : 'Blue'})
```

```
    plt.show();
```

[84]:

```
def bivariate_bar(x,y,df,hue,figsize):

    plt.figure(figsize=figsize)
    sns.barplot(x=x,
                  y=y,
                  data=df,
                  hue=hue,
                  palette =['g','r'])


    plt.xlabel(x,fontdict={'fontsize' : 10, 'fontweight' : 3, 'color' : 'Blue'})
    plt.ylabel(y,fontdict={'fontsize' : 10, 'fontweight' : 3, 'color' : 'Blue'})
    plt.title(col, fontdict={'fontsize' : 15, 'fontweight' : 5, 'color' : 'Blue'})
    plt.xticks(rotation=90, ha='right')
    plt.legend(labels = ['Repayer','Defaulter'])
    plt.show()
```

[85]:

```
def bivariate_real(x,y,data,hue,kind,palette,legend,figsize):

    plt.figure(figsize)
    sns.replot(x=x,
              y=y,
              data=applicationDF,
              hue="TARGET",
              kind=kind,
              palette = ['g','r'],
              legend = False)
    plt.legend(['Repayer','Defaulter'])
    plt.xticks(rotation=90,ha='right')
    plt.show()
```

[86]:

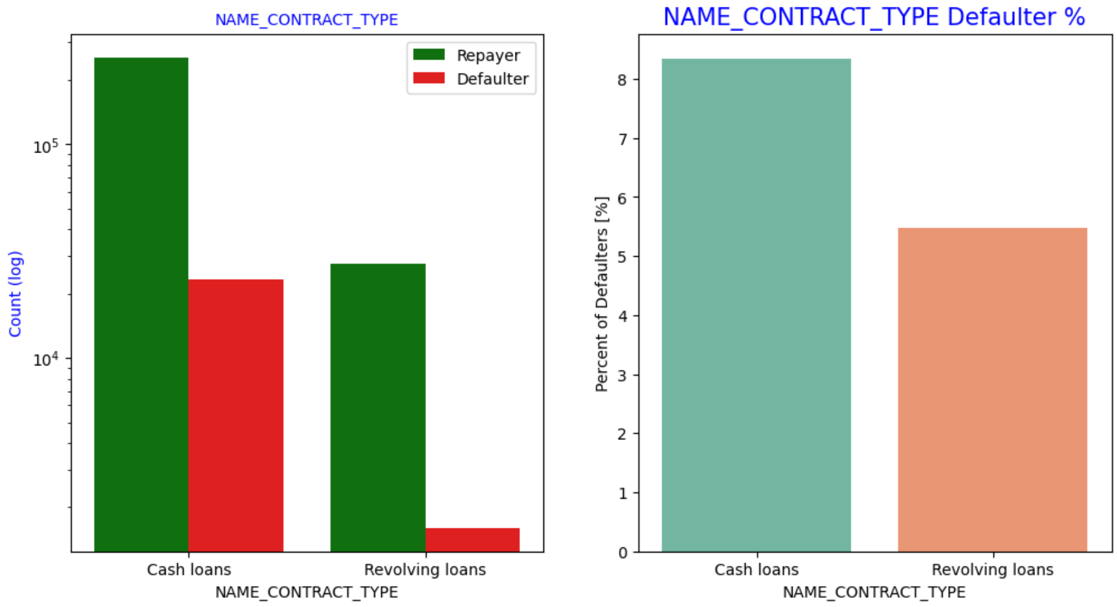
```
def univariate_merged(col,df,hue,palette,ylog,figsize):
    plt.figure(figsize=figsize)
    ax=sns.countplot(x=col,
                    data=df,
                    hue=hue,
                    palette=palette,
                    order = df[col].value_counts().index)
    if ylog:
        plt.yscale('log')
        plt.ylabel("Count(log)",fontdict={'fontsize':10,'fontweight':3,'color':'Blue'})

    else:
        plt.ylabel("Count",fontdict={'fontsize':15,'fontweight':5,'color':
↪'Blue'})
        plt.legend(loc="upper right")
        plt.xticks(rotation=90,ha='right')

        plt.show()
```

[87]:

```
def merged_pointplot(x,y):
    plt.figure(figsize=(8,4))
    sns.pointplot(x=x,
                 y=y,
                 hue="TARGET",
                 data=loan_process_df,
                 palette=['g','r'])
```

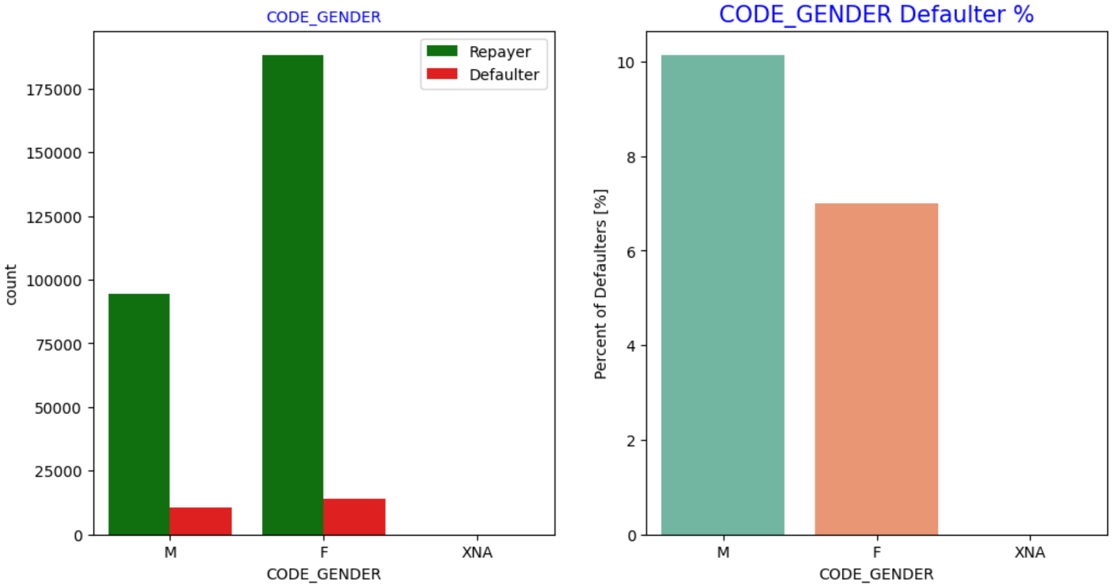
[88]:

```
univariate_categorical('NAME_CONTRACT_TYPE',True)
```

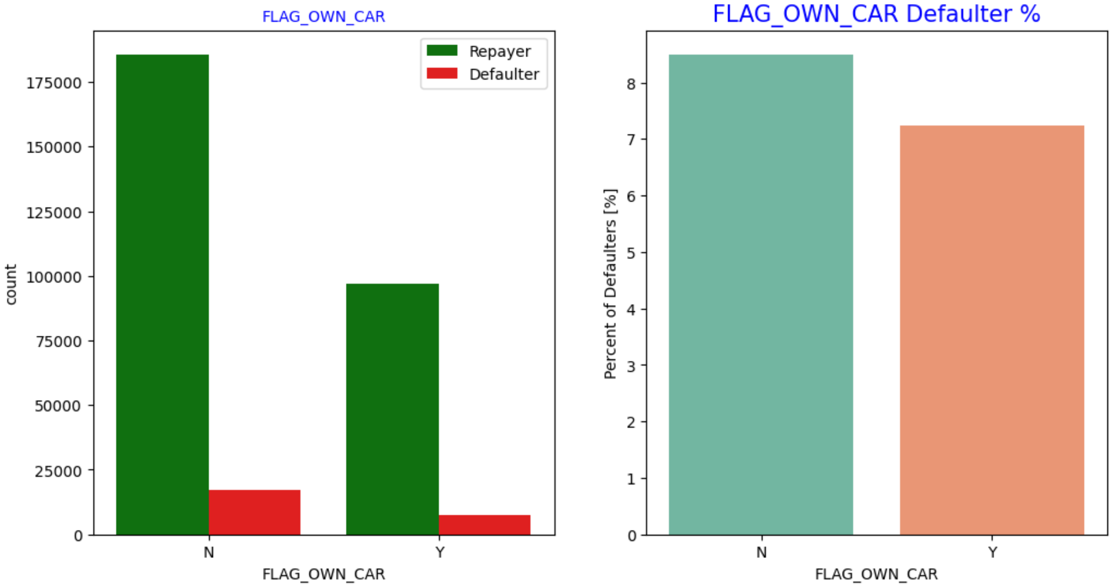


[89]:

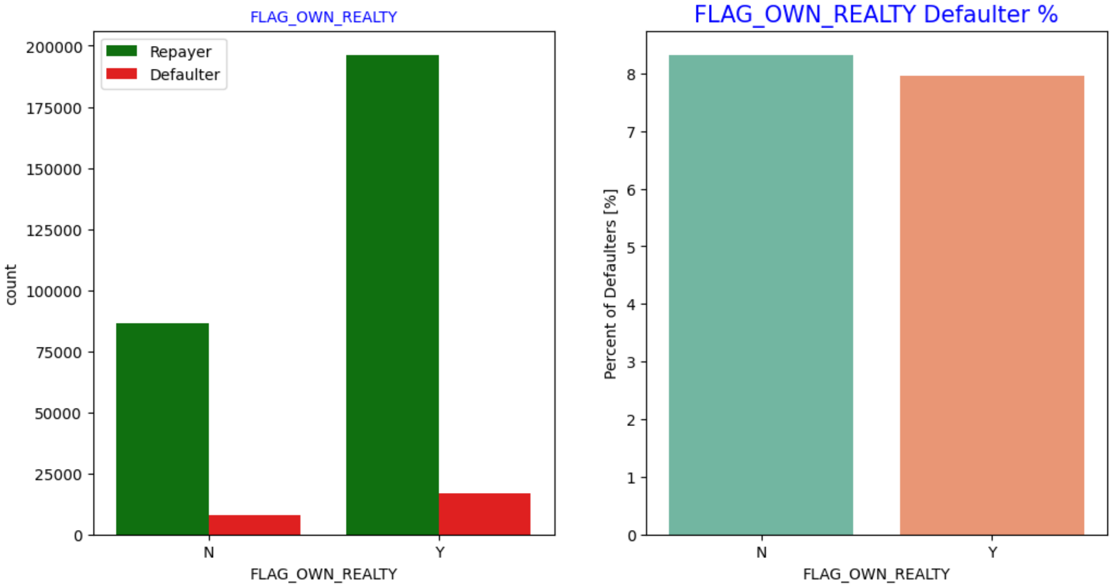
```
univariate_categorical('CODE_GENDER')
```



[90]:
```
univariate_categorical('FLAG_OWN_CAR')
```

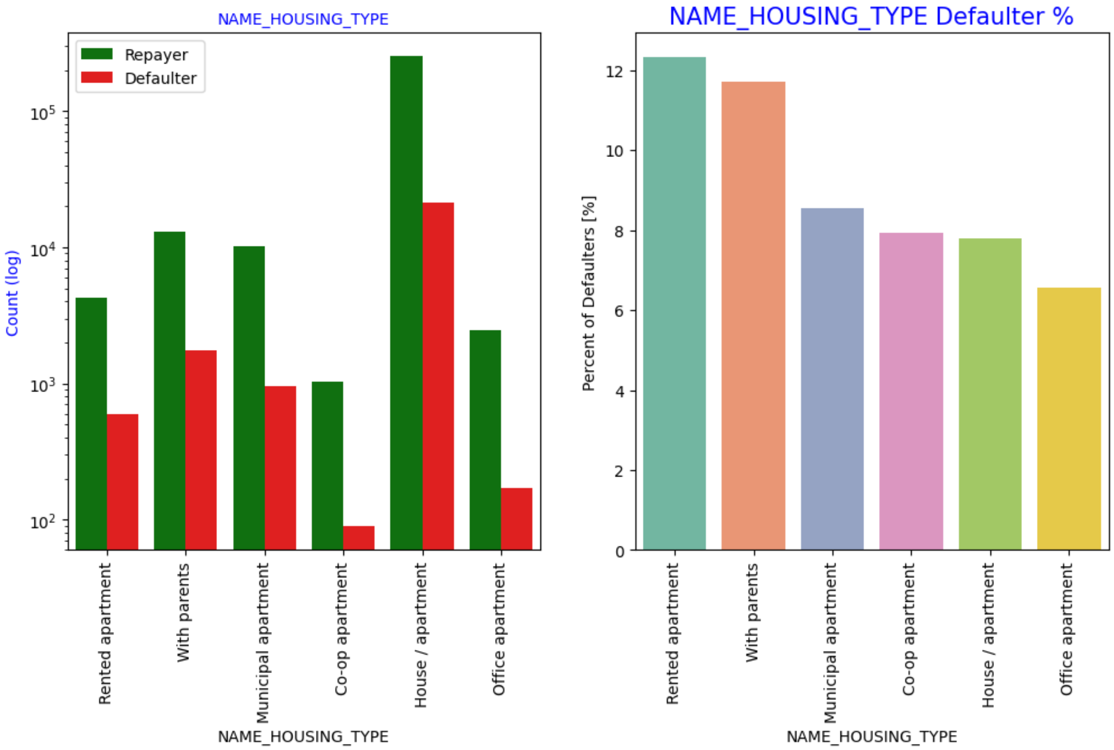


[91]:
```
univariate_categorical('FLAG_OWN_REALTY')
```



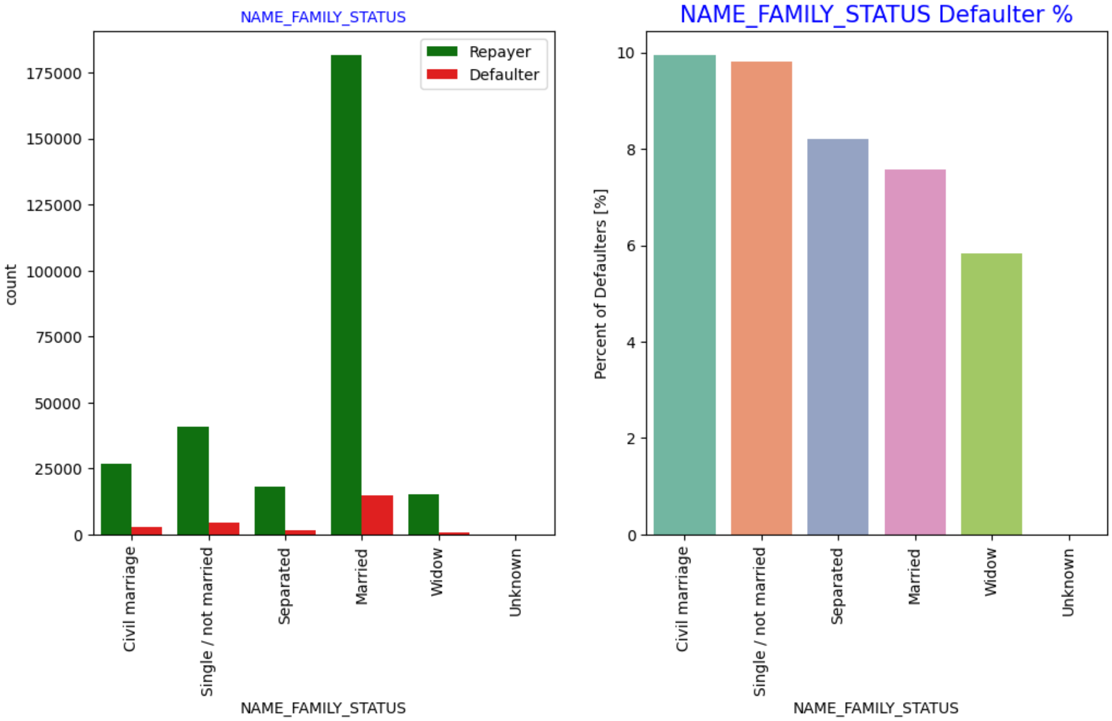
[92]:

```
univariate_categorical("NAME_HOUSING_TYPE",True,True,True)
```



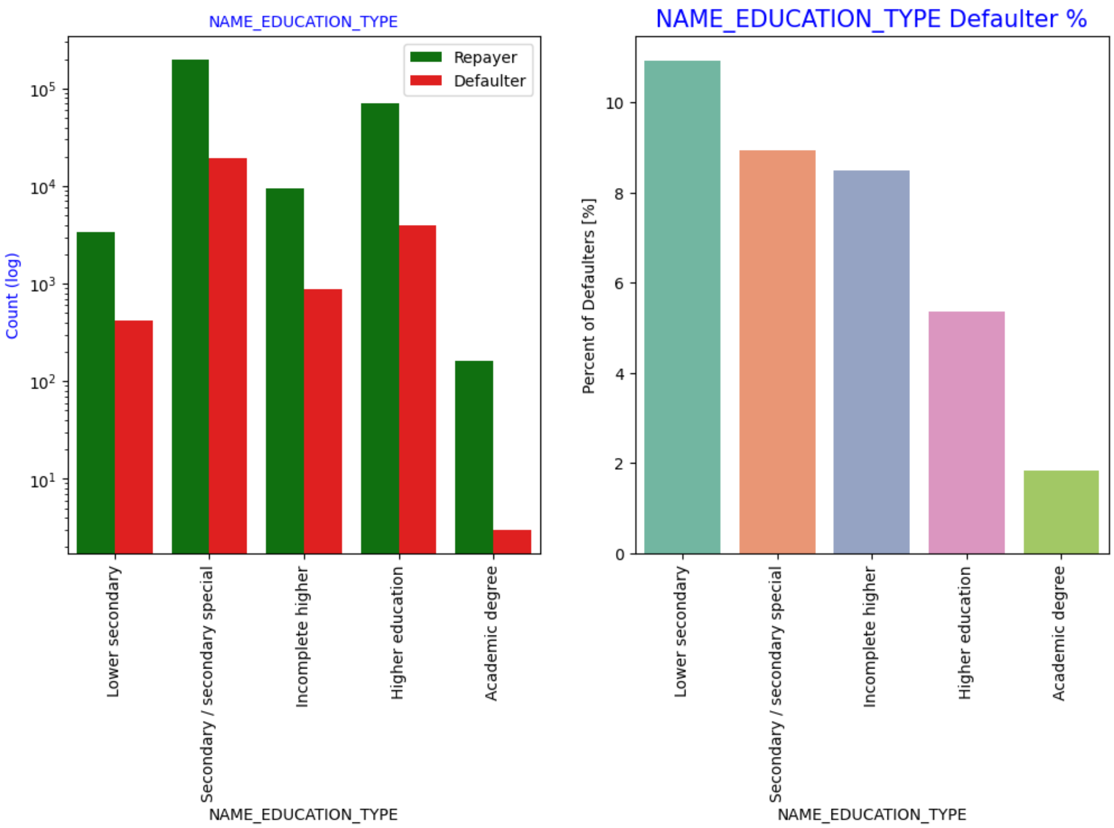
[93]:

```
univariate_categorical("NAME_FAMILY_STATUS",False,True,True)
```

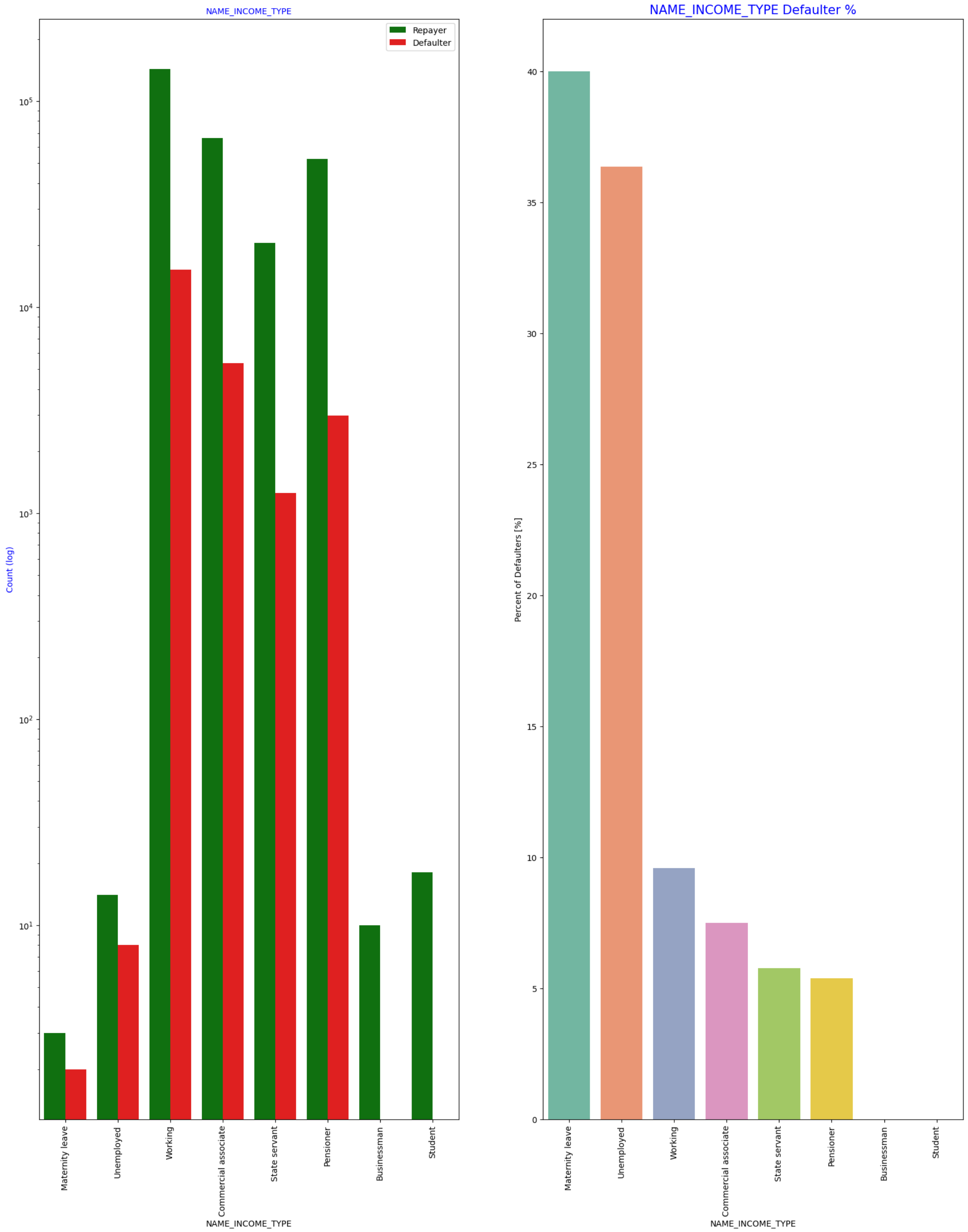


[94]:

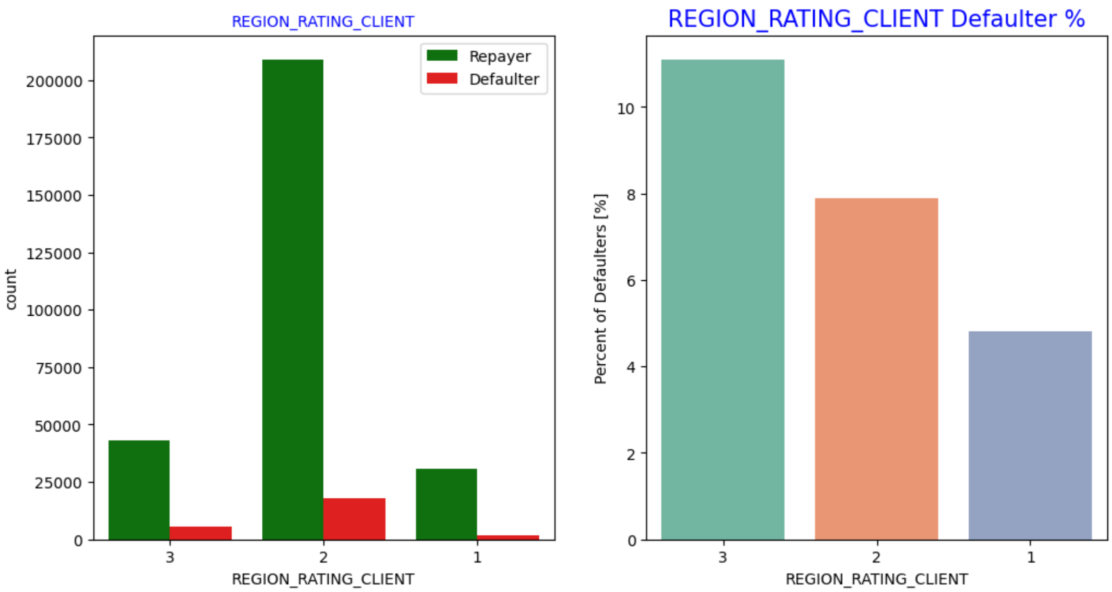
```
univariate_categorical("NAME_EDUCATION_TYPE",True,True,True)
```



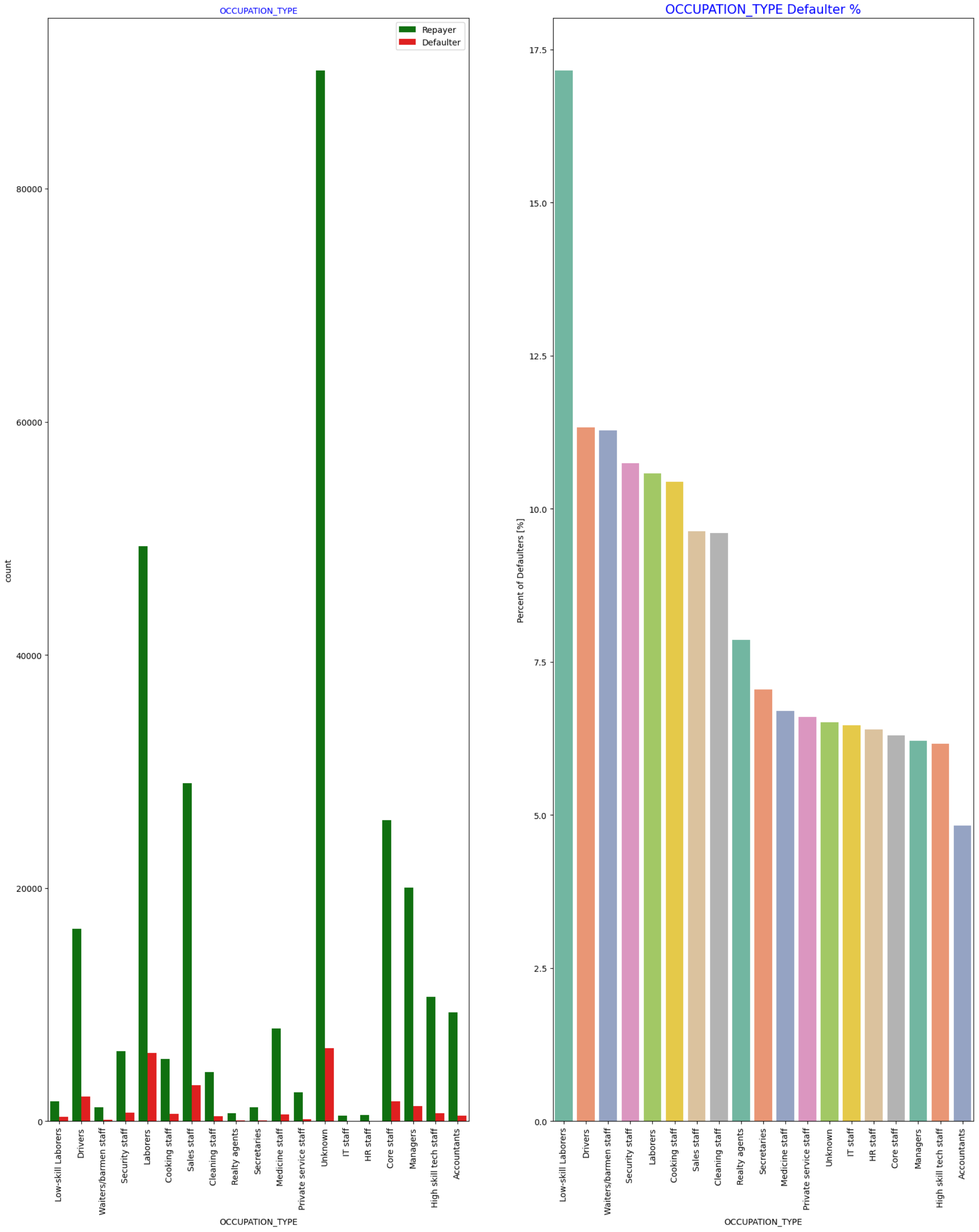
[95]:
```
univariate_categorical("NAME_INCOME_TYPE",True,True,False)
```



[96]:
```
univariate_categorical("REGION_RATING_CLIENT",False,False,True)
```

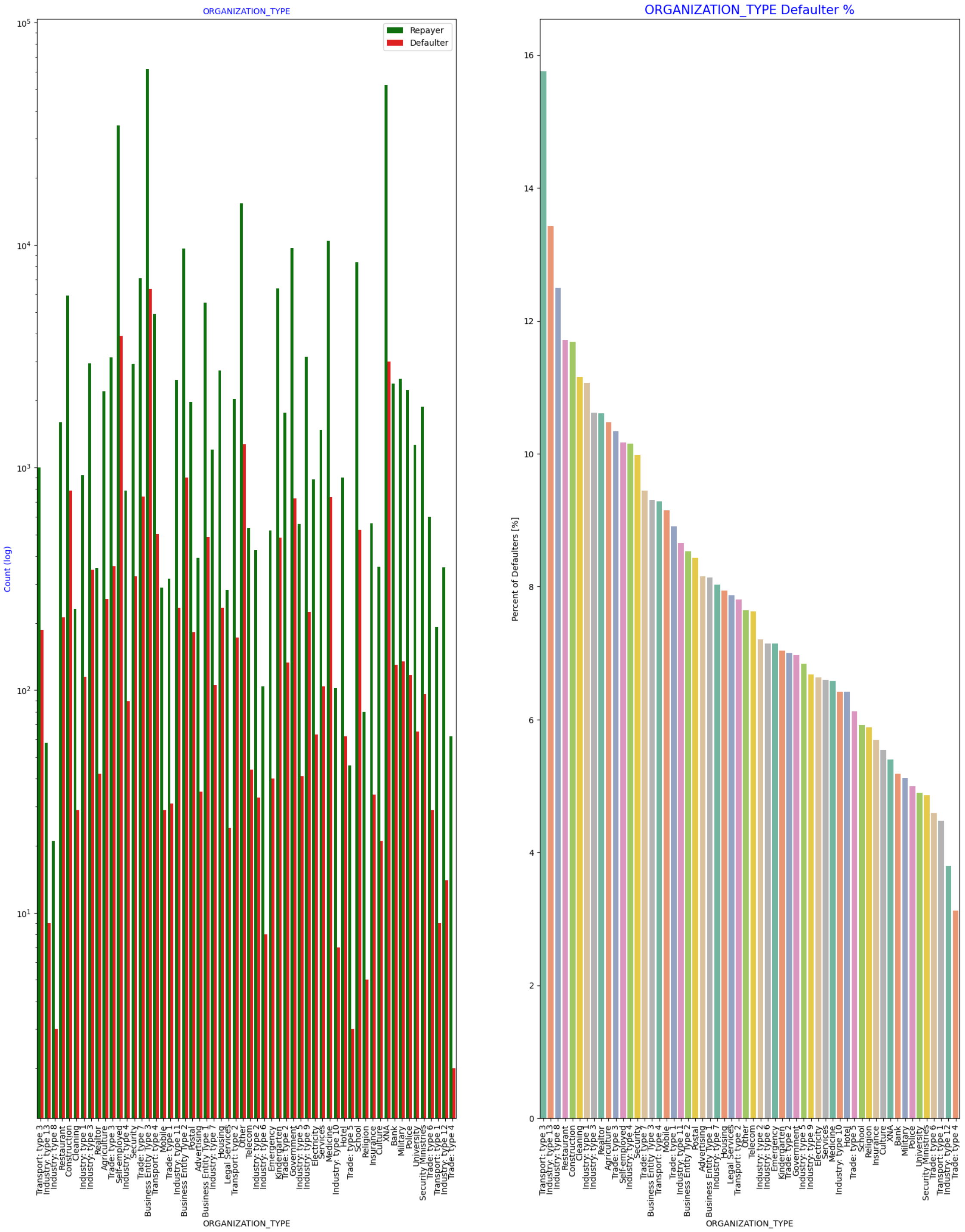


```
[97]: univariate_categorical("OCCUPATION_TYPE",False,True,False)
```



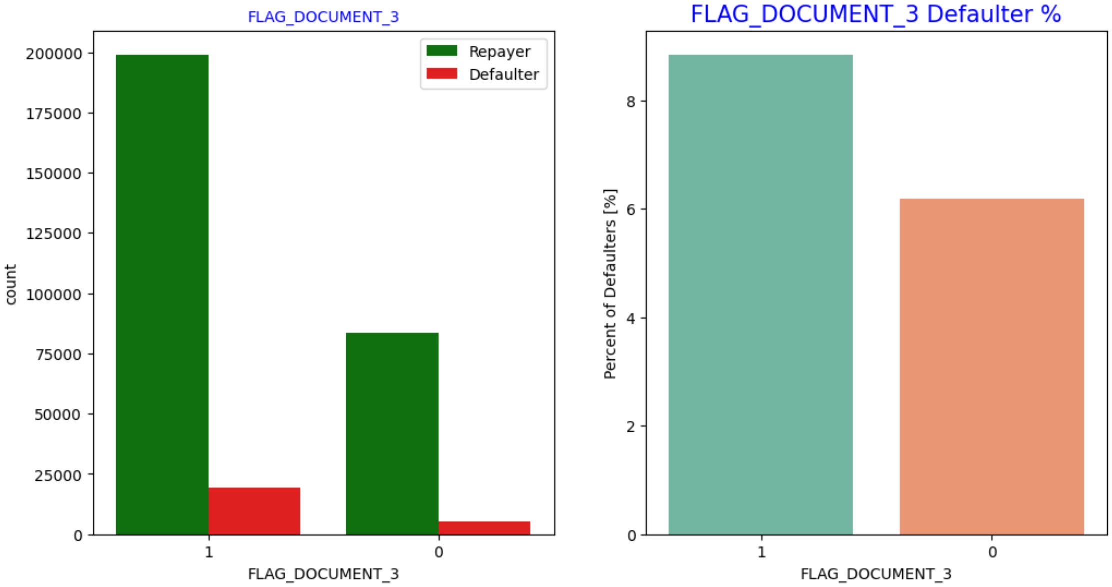
[98]:

```
univariate_categorical("ORGANIZATION_TYPE",True,True,False)
```



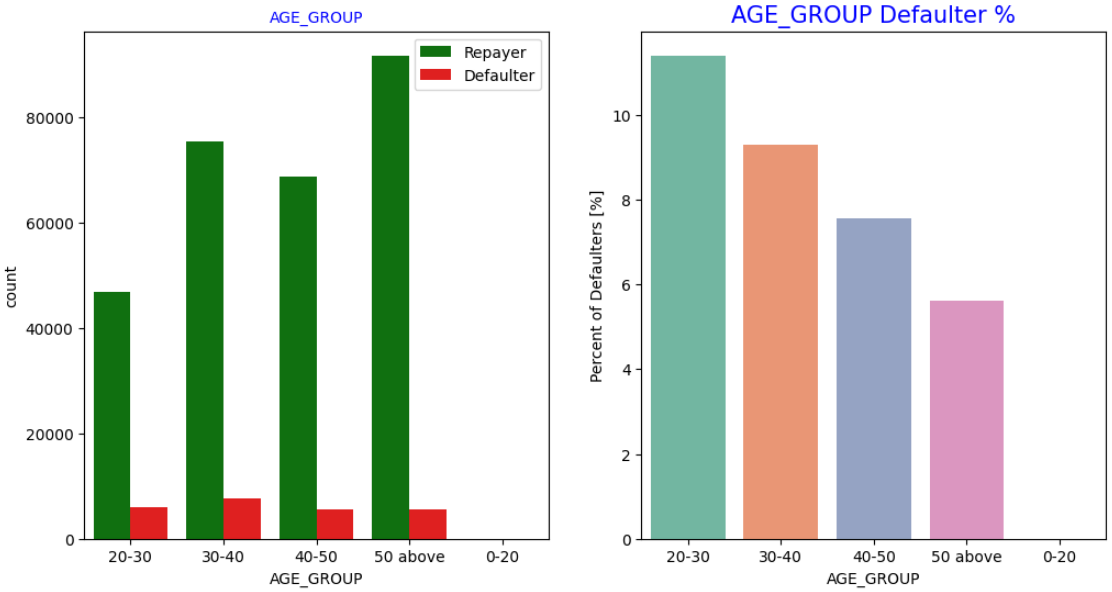
[99]:

```
univariate_categorical("FLAG_DOCUMENT_3",False,False,True)
```



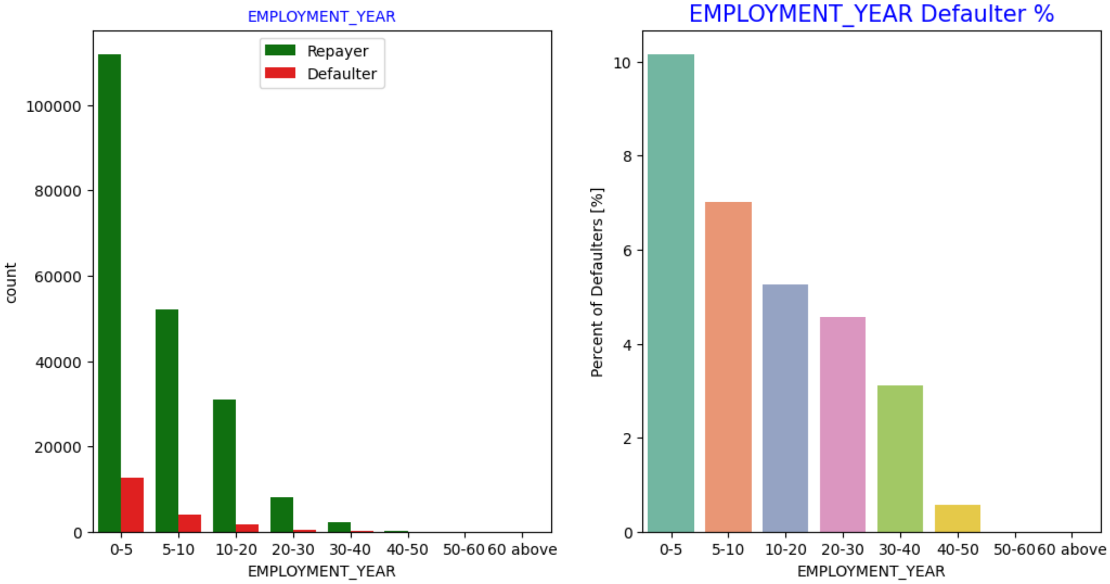
[100]:

```
univariate_categorical("AGE_GROUP",False,False,True)
```

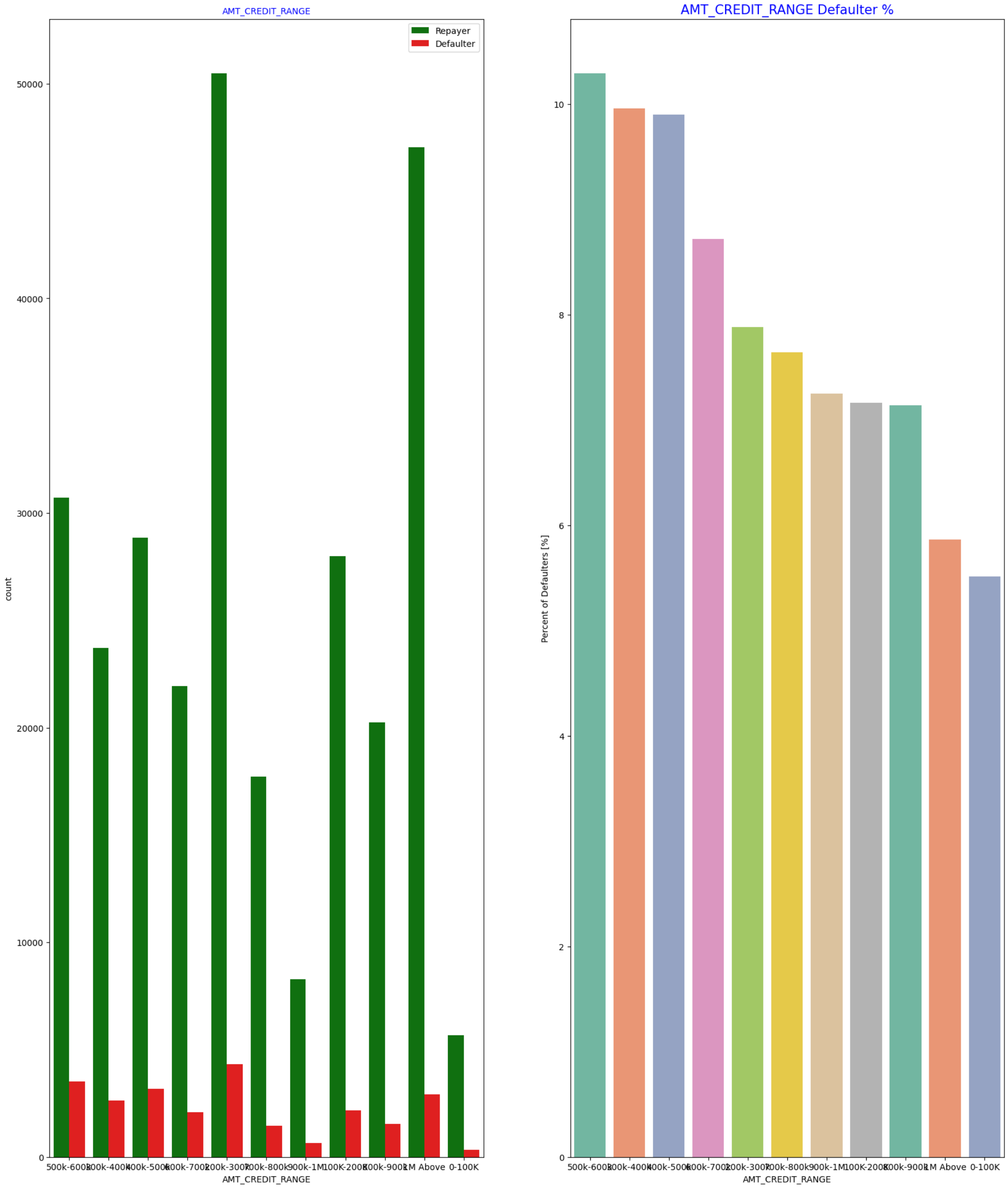


[101]:

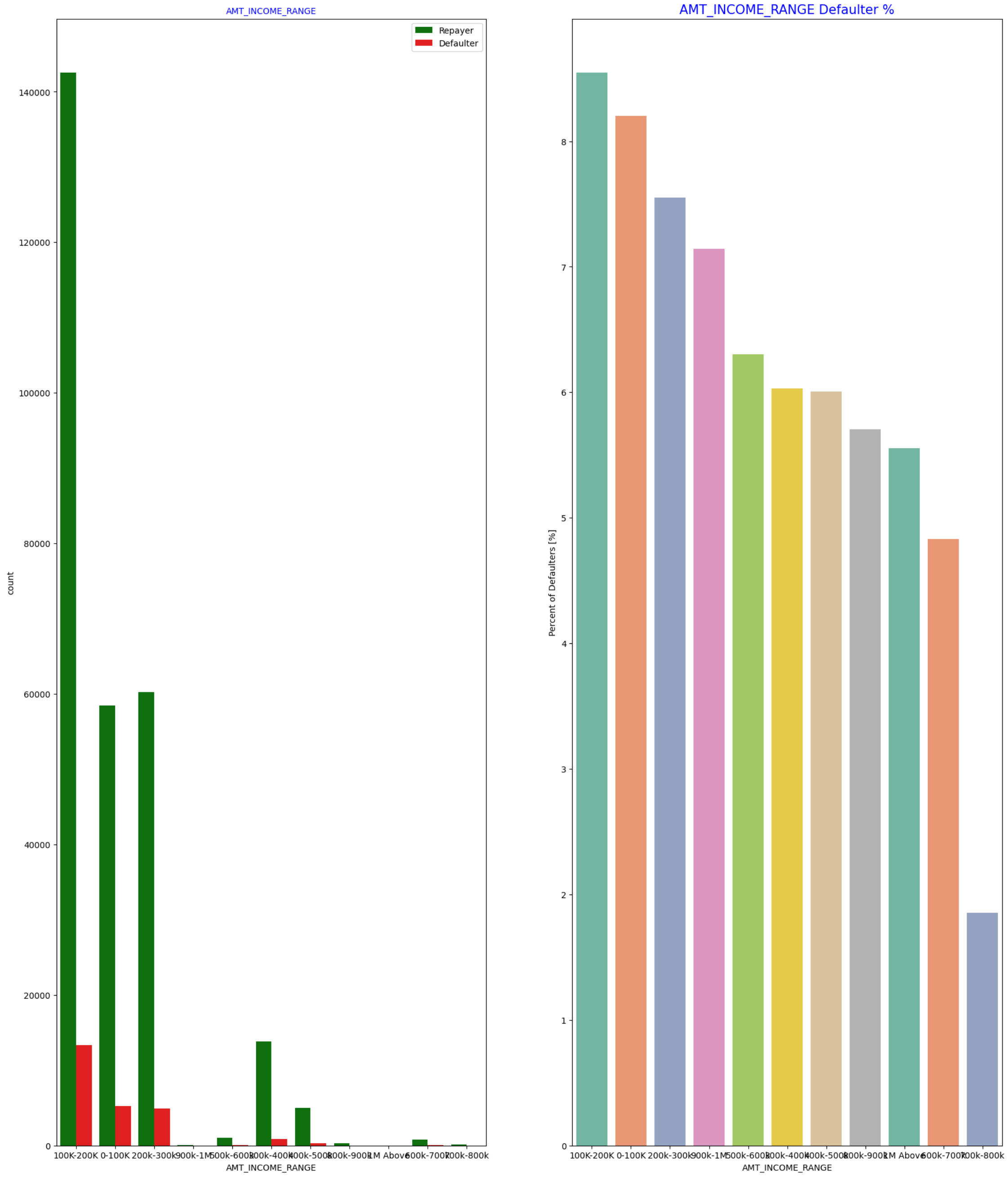
```
univariate_categorical("EMPLOYMENT_YEAR",False,False,True)
```



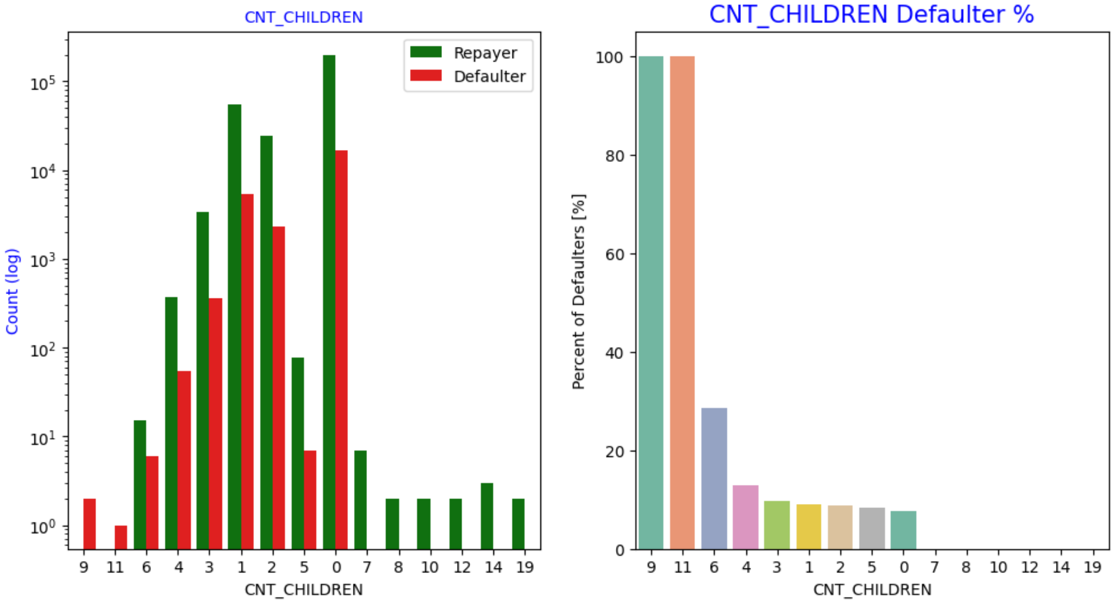
```
[102]: univariate_categorical("AMT_CREDIT_RANGE",False,False,False)
```



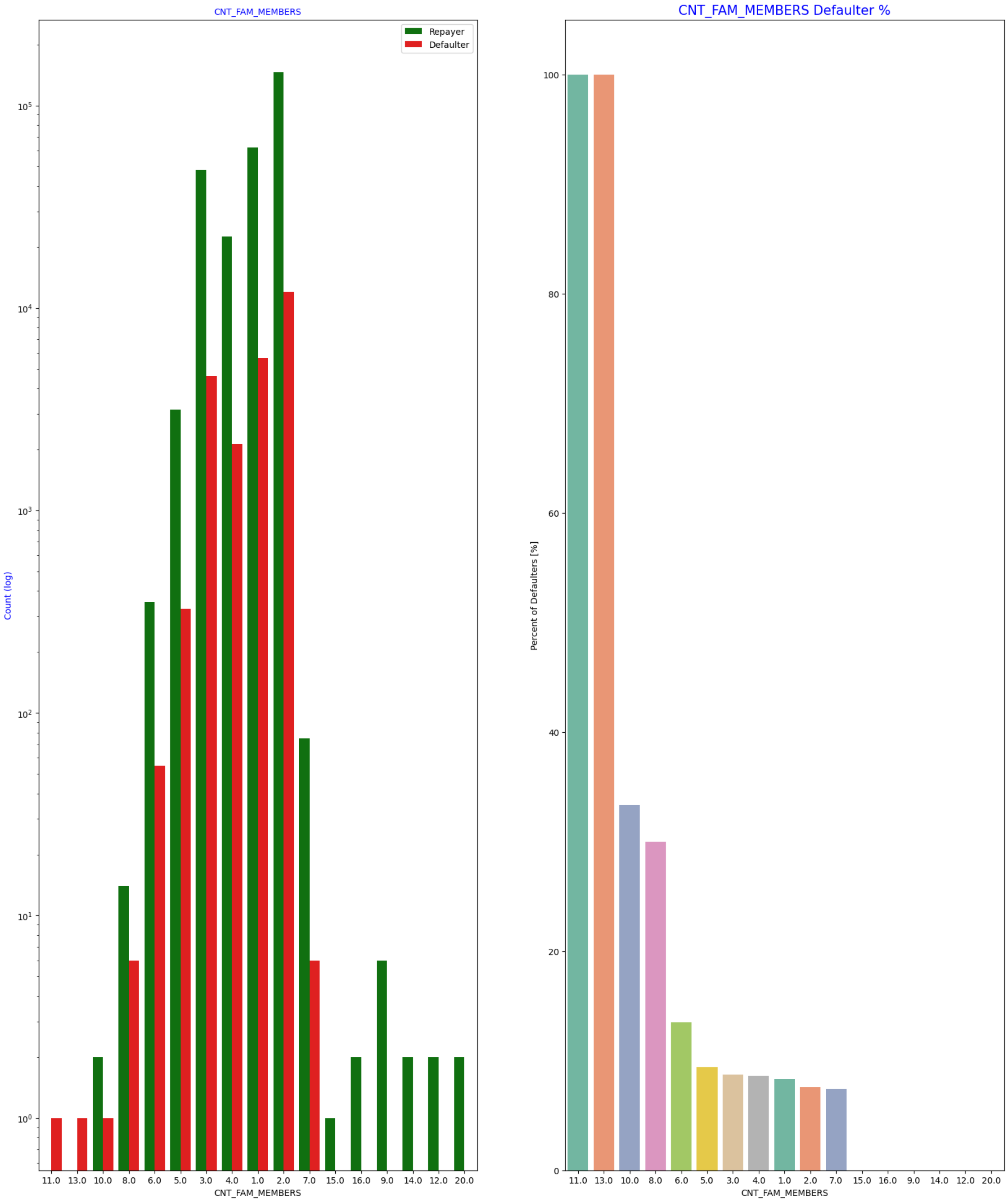
[103]:
```
univariate_categorical("AMT_INCOME_RANGE",False,False,False)
```



[104]:
```
univariate_categorical("CNT_CHILDREN",True)
```



[105]:
```
univariate_categorical("CNT_FAM_MEMBERS",True,False,False)
```

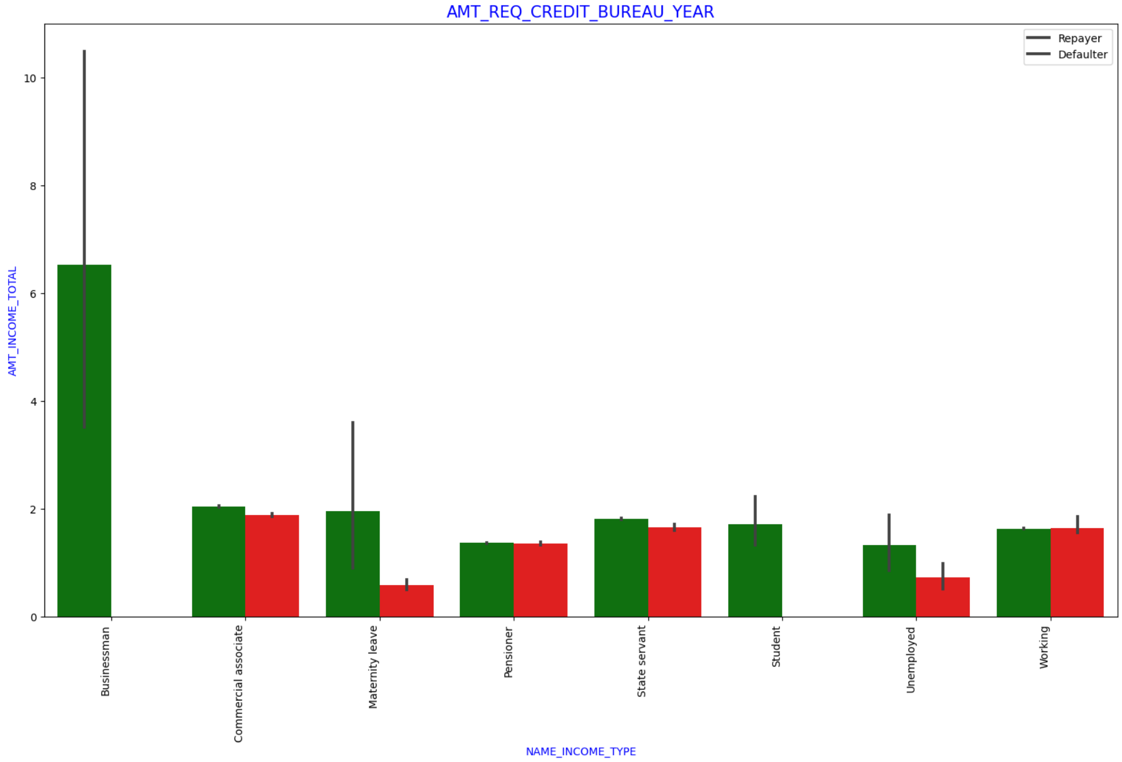


[106]:
```
applicationDF.groupby('NAME_INCOME_TYPE')['AMT_INCOME_TOTAL'].describe()
```

[106]:
```
                                  count       mean        std     min     25%      50%
75%        max
NAME_INCOME_TYPE
Businessman                        10.0   6.525000   6.272260  1.8000   2.250   4.9500
8.43750    22.5000
```

```
Commercial associate   71617.0  2.029553  1.479742  0.2655  1.350  1.8000
2.25000   180.0009
Maternity leave            5.0  1.404000  1.268569  0.4950  0.675  0.9000
1.35000     3.6000
Pensioner              55362.0  1.364013  0.766503  0.2565  0.900  1.1700
1.66500    22.5000
State servant          21703.0  1.797380  1.008806  0.2700  1.125  1.5750
2.25000    31.5000
Student                   18.0  1.705000  1.066447  0.8100  1.125  1.5750
1.78875     5.6250
Unemployed                22.0  1.105364  0.880551  0.2655  0.540  0.7875
1.35000     3.3750
Working               158774.0  1.631699  3.075777  0.2565  1.125  1.3500
2.02500  1170.0000
```

```
[107]: bivariate_bar("NAME_INCOME_TYPE","AMT_INCOME_TOTAL",applicationDF,"TARGET",(18,10))
```



```
[108]: applicationDF.columns
```

```
[108]: Index(['SK_ID_CURR', 'TARGET', 'NAME_CONTRACT_TYPE', 'CODE_GENDER',
       'FLAG_OWN_CAR', 'FLAG_OWN_REALTY', 'CNT_CHILDREN', 'AMT_INCOME_TOTAL',
       'AMT_CREDIT', 'AMT_ANNUITY', 'AMT_GOODS_PRICE', 'NAME_TYPE_SUITE',
       'NAME_INCOME_TYPE', 'NAME_EDUCATION_TYPE', 'NAME_FAMILY_STATUS',
       'NAME_HOUSING_TYPE', 'REGION_POPULATION_RELATIVE', 'DAYS_BIRTH',
       'DAYS_EMPLOYED', 'DAYS_REGISTRATION', 'DAYS_ID_PUBLISH', 'OCCUPATION_TYPE',
       'CNT_FAM_MEMBERS', 'REGION_RATING_CLIENT', 'REGION_RATING_CLIENT_W_CITY',
       'WEEKDAY_APPR_PROCESS_START', 'HOUR_APPR_PROCESS_START',
       'REG_REGION_NOT_LIVE_REGION', 'REG_REGION_NOT_WORK_REGION',
       'LIVE_REGION_NOT_WORK_REGION', 'REG_CITY_NOT_LIVE_CITY',
       'REG_CITY_NOT_WORK_CITY', 'LIVE_CITY_NOT_WORK_CITY', 'ORGANIZATION_TYPE',
       'OBS_30_CNT_SOCIAL_CIRCLE', 'DEF_30_CNT_SOCIAL_CIRCLE',
       'OBS_60_CNT_SOCIAL_CIRCLE', 'DEF_60_CNT_SOCIAL_CIRCLE',
       'DAYS_LAST_PHONE_CHANGE', 'FLAG_DOCUMENT_3', 'AMT_REQ_CREDIT_BUREAU_HOUR',
       'AMT_REQ_CREDIT_BUREAU_DAY', 'AMT_REQ_CREDIT_BUREAU_WEEK',
              'AMT_REQ_CREDIT_BUREAU_MON', 'AMT_REQ_CREDIT_BUREAU_QRT',
       'AMT_REQ_CREDIT_BUREAU_YEAR', 'AMT_INCOME_RANGE', 'AMT_CREDIT_RANGE', 'AGE',
       'AGE_GROUP', 'YEARS_EMPLOYED', 'EMPLOYMENT_YEAR'],
             dtype='object')
```

[109]:

```
cols_for_correlation=['NAME_CONTRACT_TYPE', 'CODE_GENDER', 'FLAG_OWN_CAR',␣
 ↪'FLAG_OWN_REALTY',
                        'CNT_CHILDREN', 'AMT_INCOME_TOTAL', 'AMT_CREDIT',␣
 ↪'AMT_ANNUITY', 'AMT_GOODS_PRICE',
                        'NAME_TYPE_SUITE', 'NAME_INCOME_TYPE',␣
 ↪'NAME_EDUCATION_TYPE', 'NAME_FAMILY_STATUS',
                        'NAME_HOUSING_TYPE', 'REGION_POPULATION_RELATIVE',␣
 ↪'DAYS_BIRTH', 'DAYS_EMPLOYED',
                        'DAYS_REGISTRATION', 'DAYS_ID_PUBLISH',␣
 ↪'OCCUPATION_TYPE', 'CNT_FAM_MEMBERS', 'REGION_RATING_CLIENT',
                        'REGION_RATING_CLIENT_W_CITY',␣
 ↪'WEEKDAY_APPR_PROCESS_START', 'HOUR_APPR_PROCESS_START',
                        'REG_REGION_NOT_LIVE_REGION',␣
 ↪'REG_REGION_NOT_WORK_REGION', 'LIVE_REGION_NOT_WORK_REGION',
                        'REG_CITY_NOT_LIVE_CITY', 'REG_CITY_NOT_WORK_CITY',␣
 ↪'LIVE_CITY_NOT_WORK_CITY', 'ORGANIZATION_TYPE',
                        'OBS_60_CNT_SOCIAL_CIRCLE', 'DEF_60_CNT_SOCIAL_CIRCLE',␣
 ↪'DAYS_LAST_PHONE_CHANGE', 'FLAG_DOCUMENT_3',
                        'AMT_REQ_CREDIT_BUREAU_HOUR',␣
 ↪'AMT_REQ_CREDIT_BUREAU_DAY', 'AMT_REQ_CREDIT_BUREAU_WEEK',
                        'AMT_REQ_CREDIT_BUREAU_MON',␣
 ↪'AMT_REQ_CREDIT_BUREAU_QRT', 'AMT_REQ_CREDIT_BUREAU_YEAR']


Repayer_df = applicationDF.loc[applicationDF['TARGET']==0,cols_for_correlation]
Defaulter_df = applicationDF.
 ↪loc[applicationDF['TARGET']==1,cols_for_correlation]
```

[110]:

```
corr_repayer = Repayer_df.corr()
corr_repayer = corr_repayer.where(np.triu(np.ones(corr_repayer.shape),k=1).
 ↪astype(bool))
```

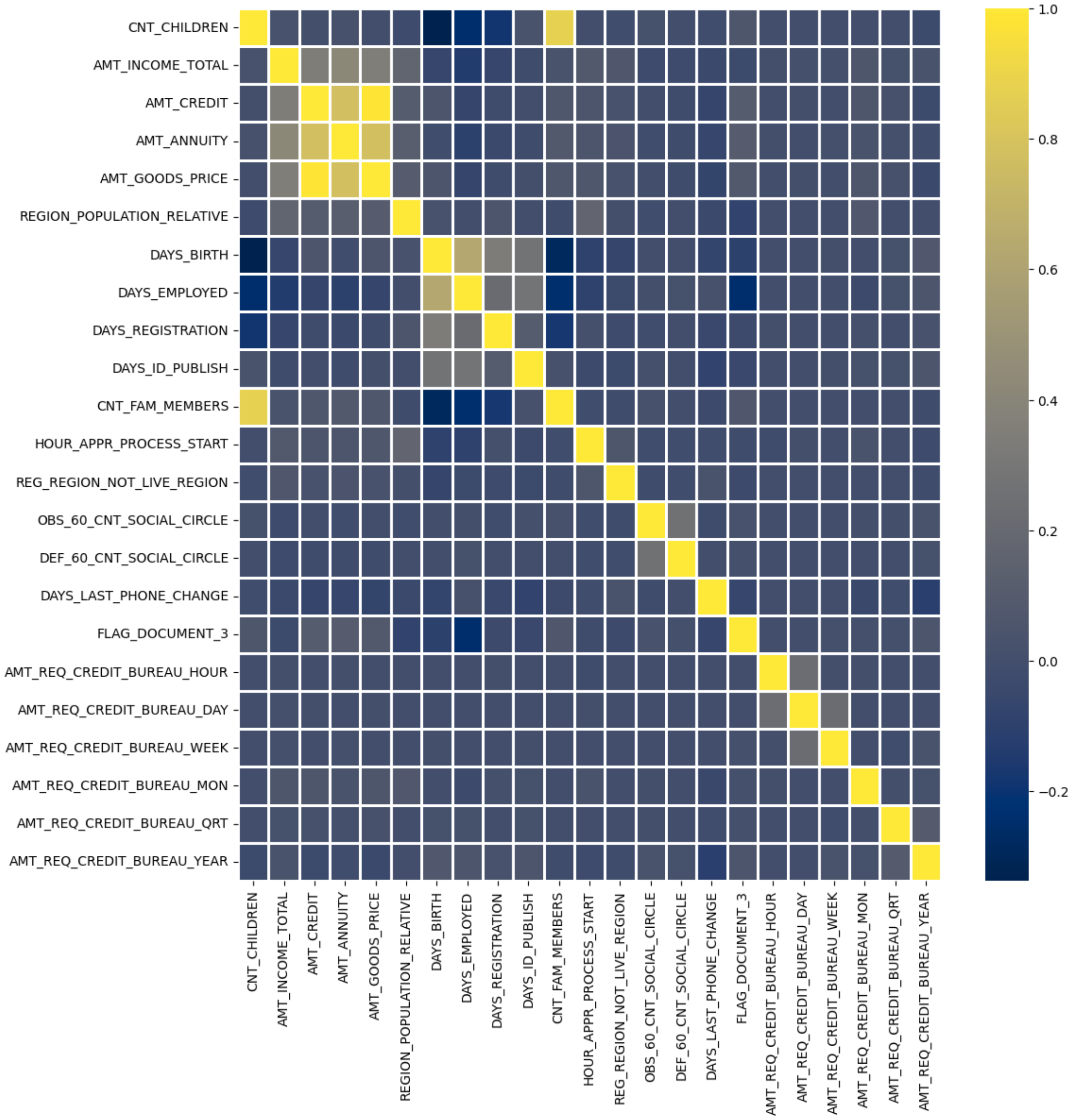
```
corr_df_repayer = corr_repayer.unstack().reset_index()
corr_df_repayer.columns =['VAR1','VAR2','Correlation']
corr_df_repayer.dropna(subset = ["Correlation"], inplace = True)
corr_df_repayer["Correlation"]=corr_df_repayer["Correlation"].abs()
corr_df_repayer.sort_values(by='Correlation', ascending=False, inplace=True)
corr_df_repayer.head(10)
```

[110]:

```
                 VAR1              VAR2  Correlation
94     AMT_GOODS_PRICE        AMT_CREDIT     0.987250
230     CNT_FAM_MEMBERS      CNT_CHILDREN     0.878571
95     AMT_GOODS_PRICE       AMT_ANNUITY     0.776686
71         AMT_ANNUITY        AMT_CREDIT     0.771309
167      DAYS_EMPLOYED        DAYS_BIRTH     0.626114
70         AMT_ANNUITY  AMT_INCOME_TOTAL     0.418953
93     AMT_GOODS_PRICE  AMT_INCOME_TOTAL     0.349462
47          AMT_CREDIT  AMT_INCOME_TOTAL     0.342799
138         DAYS_BIRTH      CNT_CHILDREN     0.336966
190  DAYS_REGISTRATION        DAYS_BIRTH     0.333151
```

[111]:

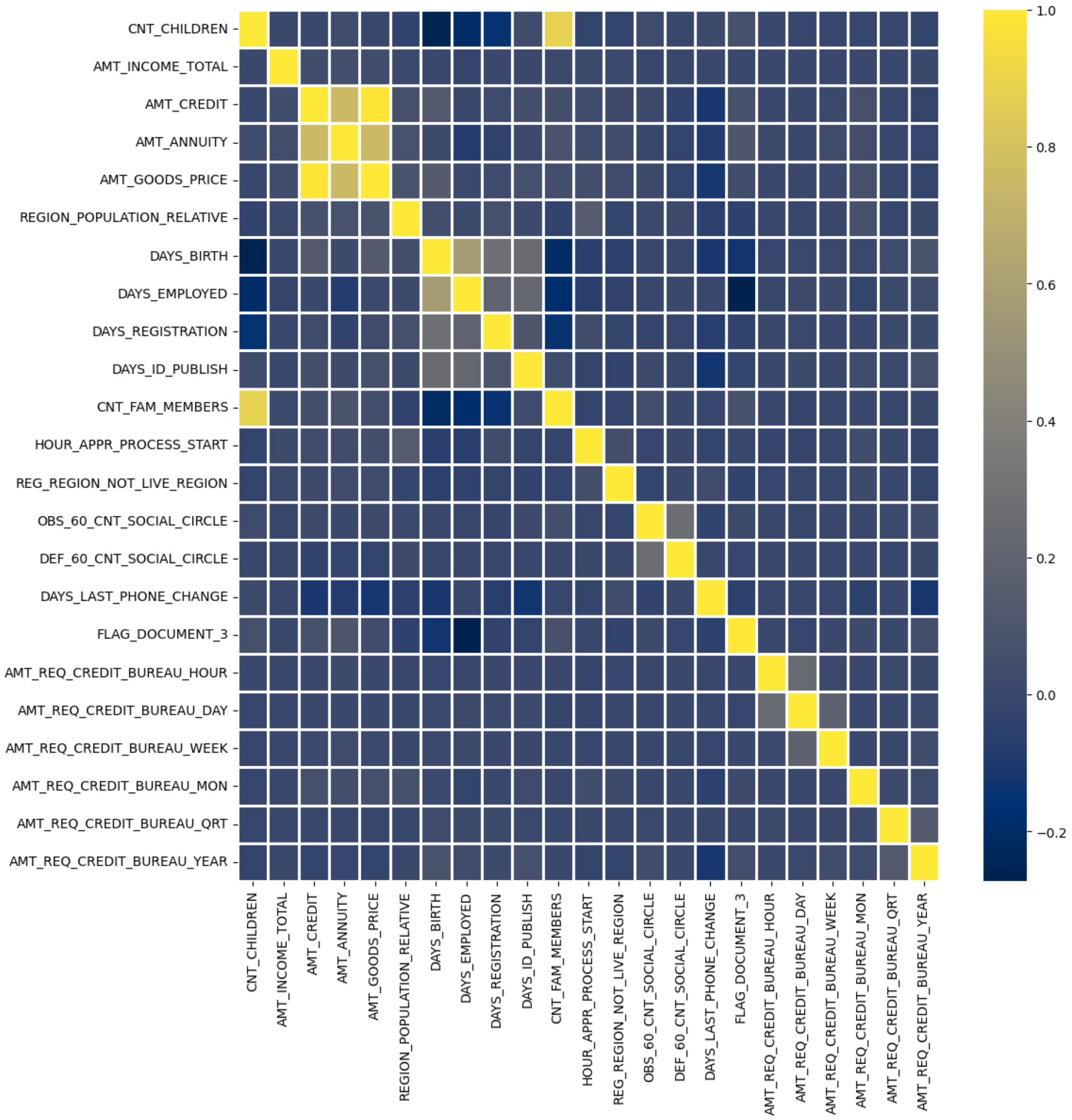
```
fig = plt.figure(figsize=(12,12))
ax = sns.heatmap(Repayer_df.corr(),cmap="cividis",annot=False,linewidth=1)
```



[112]:
```
corr_Defaulter = Defaulter_df.corr()
corr_Defaulter = corr_Defaulter.where(np.triu(np.ones(corr_Defaulter.
 ↪shape),k=1).astype(bool))
corr_df_Defaulter = corr_Defaulter.unstack().reset_index()
corr_df_Defaulter.columns =['VAR1','VAR2','Correlation']
corr_df_Defaulter.dropna(subset = ["Correlation"], inplace = True)
corr_df_Defaulter["Correlation"]=corr_df_Defaulter["Correlation"].abs()
corr_df_Defaulter.sort_values(by='Correlation', ascending=False, inplace=True)
corr_df_Defaulter.head(10)
```

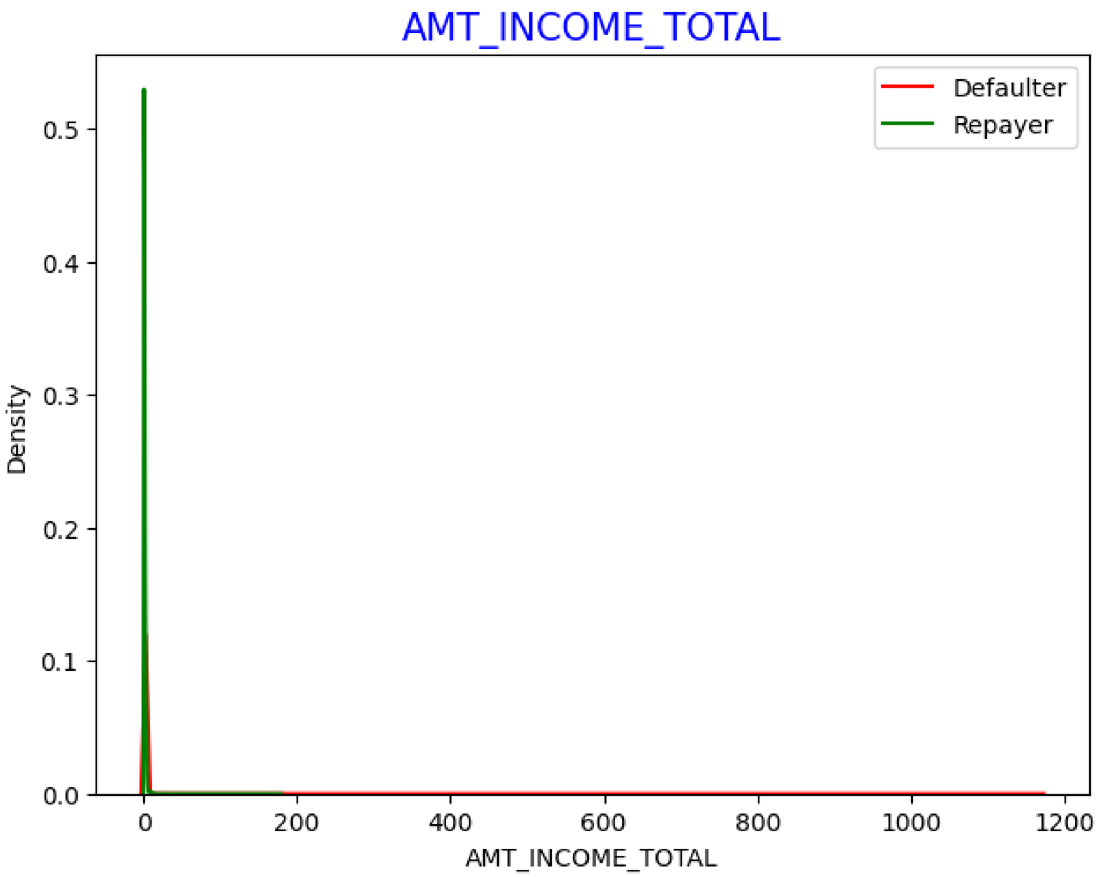
```
[112]:                         VAR1                        VAR2  Correlation
        94              AMT_GOODS_PRICE                  AMT_CREDIT     0.983103
        230             CNT_FAM_MEMBERS                CNT_CHILDREN     0.885484
        95              AMT_GOODS_PRICE                 AMT_ANNUITY     0.752699
        71                  AMT_ANNUITY                  AMT_CREDIT     0.752195
        167               DAYS_EMPLOYED                  DAYS_BIRTH     0.582185
        190           DAYS_REGISTRATION                  DAYS_BIRTH     0.289114
        375             FLAG_DOCUMENT_3               DAYS_EMPLOYED     0.272169
        335    DEF_60_CNT_SOCIAL_CIRCLE    OBS_60_CNT_SOCIAL_CIRCLE     0.264159
        138                  DAYS_BIRTH                CNT_CHILDREN     0.259109
        213             DAYS_ID_PUBLISH                  DAYS_BIRTH     0.252863
```

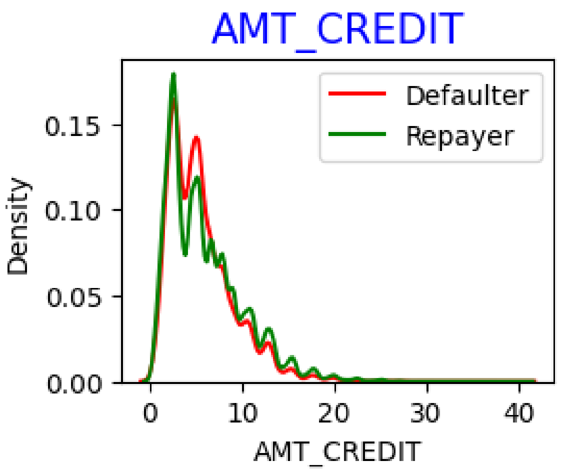
```
[113]: fig = plt.figure(figsize=(12,12))
       ax = sns.heatmap(Defaulter_df.corr(),cmap="cividis",annot=False,linewidth=1)
```

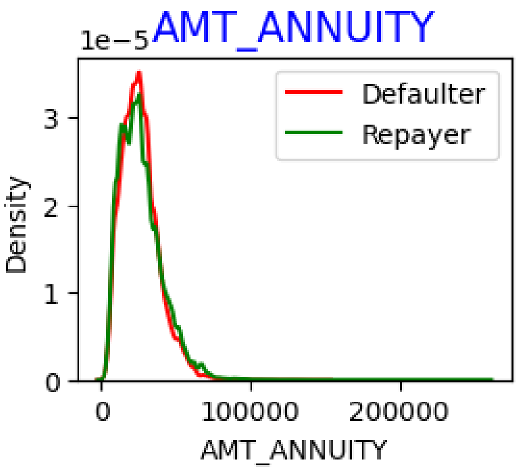


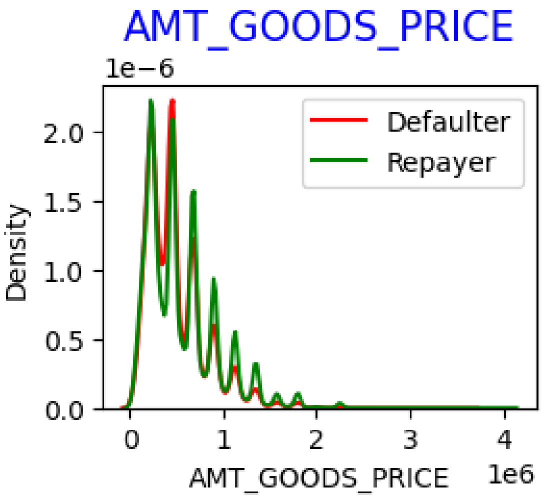
[114]:

```
amount = applicationDF[['AMT_INCOME_TOTAL','AMT_CREDIT','AMT_ANNUITY',␣
 ↪'AMT_GOODS_PRICE']]
fig = plt.figure(figsize=(16,12))
for i in enumerate(amount):
    plt.subplot(2,2,i[0]+1)
    sns.distplot(Defaulter_df[i[1]], hist=False, color='r',label ="Defaulter")
    sns.distplot(Repayer_df[i[1]], hist=False, color='g', label ="Repayer")
    plt.title(i[1], fontdict={'fontsize' : 15, 'fontweight' : 5, 'color' :␣
 ↪'Blue'})

    plt.legend()
    plt.show()
```



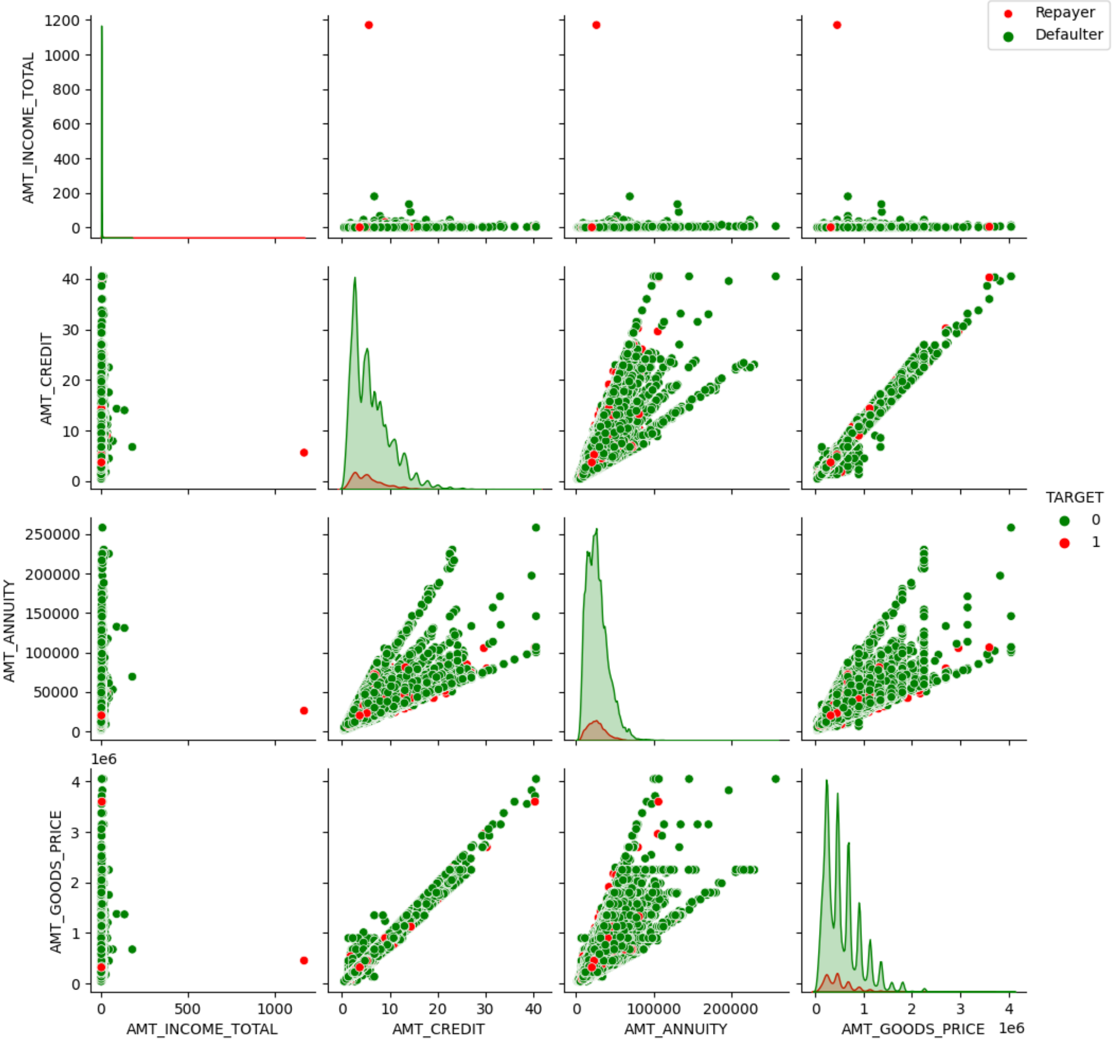

AMT_CREDIT


AMT_ANNUITY


AMT_GOODS_PRICE

[115]:

```
amount = applicationDF[['AMT_INCOME_TOTAL','AMT_CREDIT',
                        'AMT_ANNUITY', 'AMT_GOODS_PRICE','TARGET']]
amount = amount[(amount["AMT_GOODS_PRICE"].notnull()) & (amount["AMT_ANNUITY"].
 ↪notnull())]
ax= sns.pairplot(amount,hue="TARGET",palette=["g","r"])
ax.fig.legend(labels=['Repayer','Defaulter'])
plt.show()
```



[116]:

```
loan_process_df = pd.merge(applicationDF,previousDF,how='inner',on='SK_ID_CURR')
loan_process_df.head()
```

```
[116]:    SK_ID_CURR  TARGET NAME_CONTRACT_TYPE_x CODE_GENDER FLAG_OWN_CAR
FLAG_OWN_REALTY  CNT_CHILDREN  AMT_INCOME_TOTAL  AMT_CREDIT_x  AMT_ANNUITY_x
AMT_GOODS_PRICE_x NAME_TYPE_SUITE NAME_INCOME_TYPE
NAME_EDUCATION_TYPE    NAME_FAMILY_STATUS  NAME_HOUSING_TYPE
REGION_POPULATION_RELATIVE  DAYS_BIRTH  DAYS_EMPLOYED  DAYS_REGISTRATION
DAYS_ID_PUBLISH OCCUPATION_TYPE  CNT_FAM_MEMBERS REGION_RATING_CLIENT
REGION_RATING_CLIENT_W_CITY WEEKDAY_APPR_PROCESS_START  HOUR_APPR_PROCESS_START
REG_REGION_NOT_LIVE_REGION REG_REGION_NOT_WORK_REGION
LIVE_REGION_NOT_WORK_REGION REG_CITY_NOT_LIVE_CITY REG_CITY_NOT_WORK_CITY
LIVE_CITY_NOT_WORK_CITY       ORGANIZATION_TYPE  OBS_30_CNT_SOCIAL_CIRCLE
DEF_30_CNT_SOCIAL_CIRCLE  OBS_60_CNT_SOCIAL_CIRCLE  DEF_60_CNT_SOCIAL_CIRCLE
DAYS_LAST_PHONE_CHANGE  FLAG_DOCUMENT_3  AMT_REQ_CREDIT_BUREAU_HOUR
AMT_REQ_CREDIT_BUREAU_DAY  AMT_REQ_CREDIT_BUREAU_WEEK  AMT_REQ_CREDIT_BUREAU_MON
AMT_REQ_CREDIT_BUREAU_QRT  AMT_REQ_CREDIT_BUREAU_YEAR AMT_INCOME_RANGE
AMT_CREDIT_RANGE  AGE AGE_GROUP  YEARS_EMPLOYED EMPLOYMENT_YEAR  SK_ID_PREV
NAME_CONTRACT_TYPE_y  AMT_ANNUITY_y  AMT_APPLICATION  AMT_CREDIT_y
AMT_GOODS_PRICE_y NAME_CASH_LOAN_PURPOSE NAME_CONTRACT_STATUS  DAYS_DECISION
NAME_PAYMENT_TYPE CODE_REJECT_REASON NAME_CLIENT_TYPE   NAME_GOODS_CATEGORY
NAME_PORTFOLIO NAME_PRODUCT_TYPE             CHANNEL_TYPE  SELLERPLACE_AREA
NAME_SELLER_INDUSTRY  CNT_PAYMENT NAME_YIELD_GROUP          PRODUCT_COMBINATION
DAYS_DECISION_GROUP
0      100002       1           Cash loans           M            N
Y             0             2.025      4.065975        24700.5
351000.0   Unaccompanied          Working  Secondary / secondary special  Single
/ not married  House / apartment                    0.018801        9461
637             3648.0             2120        Laborers              1.0
2                           2                  WEDNESDAY
10                           0                          0
0                      0                      0                       0
Business Entity Type 3                       2.0                       2.0
2.0                       2.0                 -1134.0                1
0.0                        0.0                         0.0
0.0                        0.0                         1.0        200k-300k
400k-500k   25     20-30               1             0-5     1038818
Consumer loans       9251.775         179055.0      179055.0          179055.0
XAP             Approved            606                    XNA
XAP              New              Vehicles            POS               XNA
Stone               500       Auto technology         24.0       low_normal
POS other with interest             400-800
1      100003       0           Cash loans           F            N
N             0             2.700     12.935025        35698.5
1129500.0          Family    State servant               Higher education
Married  House / apartment                    0.003541       16765
1188             1186.0              291      Core staff              2.0
1                           1                     MONDAY
11                           0                          0
0                      0                      0                       0
```

```
School                       1.0                       0.0
1.0                       0.0                  -828.0                1
0.0                        0.0                         0.0
0.0                        0.0                         0.0        200k-300k
1M Above   45     40-50               3             0-5     1810518
Cash loans      98356.995         900000.0     1035882.0           900000.0
XNA             Approved            746                    XNA
XAP         Repeater                   XNA           Cash            x-sell
Credit and cash offices                -1                   XNA         12.0
low_normal             Cash X-Sell: low             400-800
2      100003       0           Cash loans           F            N
N             0             2.700     12.935025        35698.5
1129500.0          Family    State servant               Higher education
Married  House / apartment                    0.003541       16765
1188             1186.0              291      Core staff              2.0
1                           1                     MONDAY
11                           0                          0
0                      0                      0                       0
School                       1.0                       0.0
1.0                       0.0                  -828.0                1
0.0                        0.0                         0.0
0.0                        0.0                         0.0        200k-300k
1M Above   45     40-50               3             0-5     2636178
Consumer loans      64567.665         337500.0      348637.5           337500.0
XAP             Approved            828  Cash through the bank
XAP        Refreshed             Furniture            POS               XNA
Stone              1400             Furniture          6.0           middle
POS industry with interest            800-1200
3      100003       0           Cash loans           F            N
N             0             2.700     12.935025        35698.5
1129500.0          Family    State servant               Higher education
Married  House / apartment                    0.003541       16765
1188             1186.0              291      Core staff              2.0
1                           1                     MONDAY
11                           0                          0
0                      0                      0                       0
School                       1.0                       0.0
1.0                       0.0                  -828.0                1
0.0                        0.0                         0.0
0.0                        0.0                         0.0        200k-300k
1M Above   45     40-50               3             0-5     2396755
Consumer loans       6737.310          68809.5       68053.5            68809.5
XAP             Approved           2341  Cash through the bank
XAP        Refreshed  Consumer Electronics            POS               XNA
Country-wide               200  Consumer electronics         12.0
middle  POS household with interest           2000-2400
4      100004       0      Revolving loans           M            Y
```

```
Y             0             0.675      1.350000         6750.0
135000.0   Unaccompanied          Working  Secondary / secondary special  Single
/ not married  House / apartment                    0.010032       19046
225             4260.0             2531         Laborers              1.0
2                           2                     MONDAY
9                           0                          0
0                      0                      0                        0
Government                       0.0                       0.0
0.0                       0.0                 -815.0               0
0.0                        0.0                         0.0
0.0                        0.0                         0.0             0-100K
100K-200K   52  50 above               0             NaN     1564014
Consumer loans       5357.250          24282.0       20106.0            24282.0
XAP             Approved            815  Cash through the bank
XAP              New                Mobile            POS               XNA
Regional / Local                30          Connectivity          4.0
middle  POS mobile without interest            800-1200
```

[117]:
```
loan_process_df.shape
```

[117]:
```
(1413701, 74)
```

[118]:
```
loan_process_df.size
```

[118]:
```
104613874
```

[119]:
```
loan_process_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1413701 entries, 0 to 1413700
Data columns (total 74 columns):
 #   Column                        Non-Null Count    Dtype
---  ------                        --------------    -----
 0   SK_ID_CURR                    1413701 non-null  int64
 1   TARGET                        1413701 non-null  int64
 2   NAME_CONTRACT_TYPE_x          1413701 non-null  category
 3   CODE_GENDER                   1413701 non-null  category
 4   FLAG_OWN_CAR                  1413701 non-null  category
 5   FLAG_OWN_REALTY               1413701 non-null  category
 6   CNT_CHILDREN                  1413701 non-null  int64
 7   AMT_INCOME_TOTAL              1413701 non-null  float64
 8   AMT_CREDIT_x                  1413701 non-null  float64
 9   AMT_ANNUITY_x                 1413608 non-null  float64
 10  AMT_GOODS_PRICE_x             1412493 non-null  float64
 11  NAME_TYPE_SUITE               1413701 non-null  category
 12  NAME_INCOME_TYPE              1413701 non-null  category
 13  NAME_EDUCATION_TYPE           1413701 non-null  category
```

```
14  NAME_FAMILY_STATUS          1413701 non-null  category
15  NAME_HOUSING_TYPE           1413701 non-null  category
16  REGION_POPULATION_RELATIVE  1413701 non-null  float64
17  DAYS_BIRTH                  1413701 non-null  int64
18  DAYS_EMPLOYED               1413701 non-null  int64
19  DAYS_REGISTRATION           1413701 non-null  float64
20  DAYS_ID_PUBLISH             1413701 non-null  int64
21  OCCUPATION_TYPE             1413701 non-null  category
22  CNT_FAM_MEMBERS             1413701 non-null  float64
23  REGION_RATING_CLIENT        1413701 non-null  category
24  REGION_RATING_CLIENT_W_CITY 1413701 non-null  category
25  WEEKDAY_APPR_PROCESS_START  1413701 non-null  category
26  HOUR_APPR_PROCESS_START     1413701 non-null  int64
27  REG_REGION_NOT_LIVE_REGION  1413701 non-null  int64
28  REG_REGION_NOT_WORK_REGION  1413701 non-null  category
29  LIVE_REGION_NOT_WORK_REGION 1413701 non-null  category
30  REG_CITY_NOT_LIVE_CITY      1413701 non-null  category
31  REG_CITY_NOT_WORK_CITY      1413701 non-null  category
32  LIVE_CITY_NOT_WORK_CITY     1413701 non-null  category
33  ORGANIZATION_TYPE           1413701 non-null  category
34  OBS_30_CNT_SOCIAL_CIRCLE    1410555 non-null  float64
35  DEF_30_CNT_SOCIAL_CIRCLE    1410555 non-null  float64
36  OBS_60_CNT_SOCIAL_CIRCLE    1410555 non-null  float64
37  DEF_60_CNT_SOCIAL_CIRCLE    1410555 non-null  float64
38  DAYS_LAST_PHONE_CHANGE      1413701 non-null  float64
39  FLAG_DOCUMENT_3             1413701 non-null  int64
40  AMT_REQ_CREDIT_BUREAU_HOUR  1413701 non-null  float64
41  AMT_REQ_CREDIT_BUREAU_DAY   1413701 non-null  float64
42  AMT_REQ_CREDIT_BUREAU_WEEK  1413701 non-null  float64
43  AMT_REQ_CREDIT_BUREAU_MON   1413701 non-null  float64
44  AMT_REQ_CREDIT_BUREAU_QRT   1413701 non-null  float64
45  AMT_REQ_CREDIT_BUREAU_YEAR  1413701 non-null  float64
46  AMT_INCOME_RANGE            1413024 non-null  category
47  AMT_CREDIT_RANGE            1413701 non-null  category
48  AGE                         1413701 non-null  int64
49  AGE_GROUP                   1413701 non-null  category
50  YEARS_EMPLOYED              1413701 non-null  int64
51  EMPLOYMENT_YEAR             1032756 non-null  category
52  SK_ID_PREV                  1413701 non-null  int64
53  NAME_CONTRACT_TYPE_y        1413701 non-null  category
54  AMT_ANNUITY_y               1413701 non-null  float64
55  AMT_APPLICATION             1413701 non-null  float64
56  AMT_CREDIT_y                1413700 non-null  float64
57  AMT_GOODS_PRICE_y           1413701 non-null  float64
58  NAME_CASH_LOAN_PURPOSE      1413701 non-null  category
59  NAME_CONTRACT_STATUS        1413701 non-null  category
60  DAYS_DECISION               1413701 non-null  int64
61  NAME_PAYMENT_TYPE           1413701 non-null  category
```

```
 62  CODE_REJECT_REASON           1413701 non-null  category
 63  NAME_CLIENT_TYPE             1413701 non-null  category
 64  NAME_GOODS_CATEGORY          1413701 non-null  category
 65  NAME_PORTFOLIO               1413701 non-null  category
 66  NAME_PRODUCT_TYPE            1413701 non-null  category
 67  CHANNEL_TYPE                 1413701 non-null  category
 68  SELLERPLACE_AREA             1413701 non-null  int64
 69  NAME_SELLER_INDUSTRY         1413701 non-null  category
 70  CNT_PAYMENT                  1413701 non-null  float64
 71  NAME_YIELD_GROUP             1413701 non-null  category
 72  PRODUCT_COMBINATION          1413388 non-null  category
 73  DAYS_DECISION_GROUP          1413701 non-null  category
dtypes: category(37), float64(23), int64(14)
memory usage: 459.8 MB
```

```
[120]: loan_process_df.describe()
```

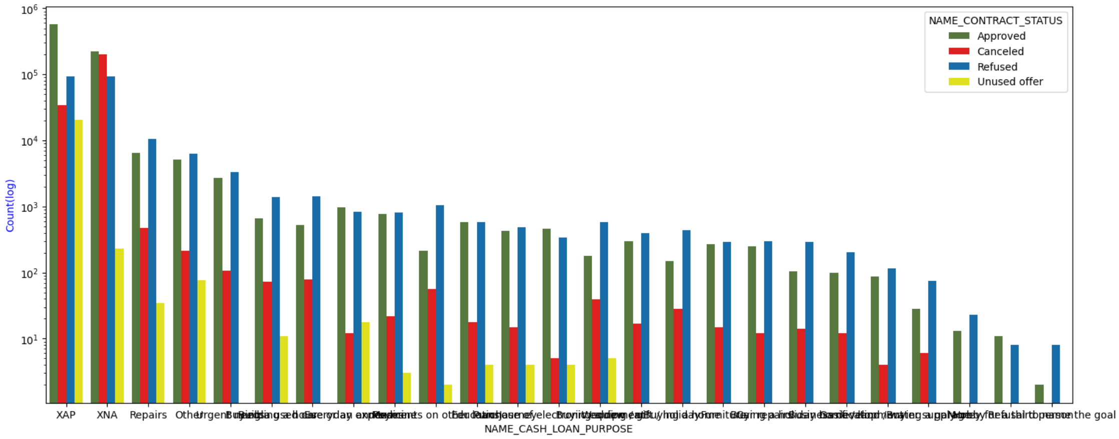
```
[120]:          SK_ID_CURR        TARGET  CNT_CHILDREN  AMT_INCOME_TOTAL  AMT_CREDIT_x
       AMT_ANNUITY_x  AMT_GOODS_PRICE_x  REGION_POPULATION_RELATIVE    DAYS_BIRTH
       DAYS_EMPLOYED  DAYS_REGISTRATION  DAYS_ID_PUBLISH  CNT_FAM_MEMBERS
       HOUR_APPR_PROCESS_START  REG_REGION_NOT_LIVE_REGION  OBS_30_CNT_SOCIAL_CIRCLE
       DEF_30_CNT_SOCIAL_CIRCLE  OBS_60_CNT_SOCIAL_CIRCLE  DEF_60_CNT_SOCIAL_CIRCLE
       DAYS_LAST_PHONE_CHANGE  FLAG_DOCUMENT_3  AMT_REQ_CREDIT_BUREAU_HOUR
       AMT_REQ_CREDIT_BUREAU_DAY  AMT_REQ_CREDIT_BUREAU_WEEK  AMT_REQ_CREDIT_BUREAU_MON
       AMT_REQ_CREDIT_BUREAU_QRT  AMT_REQ_CREDIT_BUREAU_YEAR           AGE
       YEARS_EMPLOYED    SK_ID_PREV  AMT_ANNUITY_y  AMT_APPLICATION  AMT_CREDIT_y
       AMT_GOODS_PRICE_y  DAYS_DECISION  SELLERPLACE_AREA   CNT_PAYMENT
       count  1.413701e+06  1.413701e+06  1.413701e+06      1.413701e+06  1.413701e+06
       1.413608e+06       1.412493e+06                1.413701e+06  1.413701e+06
       1.413701e+06       1.413701e+06     1.413701e+06     1.413701e+06
       1.413701e+06                1.413701e+06              1.410555e+06
       1.410555e+06              1.410555e+06              1.410555e+06
       1.413701e+06     1.413701e+06                1.413701e+06
       1.413701e+06                1.413701e+06               1.413701e+06
       1.413701e+06                1.413701e+06  1.413701e+06    1.413701e+06
       1.413701e+06   1.413701e+06     1.413701e+06  1.413700e+06       1.413701e+06
       1.413701e+06      1.413701e+06  1.413701e+06
       mean   2.784813e+05  8.655296e-02  4.048933e-01      1.733160e+00  5.875537e+00
       2.701702e+04       5.277186e+05                2.074985e-02  1.632105e+04
       7.266347e+04       5.003233e+03     3.034563e+03     2.150501e+00
       1.198433e+01                1.207327e-02              1.544176e+00
       1.540436e-01              1.526303e+00              1.080426e-01
       -1.084701e+03     7.385600e-01                5.484894e-03
       6.028149e-03                3.410198e-02               2.664913e-01
       3.196935e-01                2.691239e+00  4.421384e+01    1.985500e+02
       1.922744e+06   1.484032e+04     1.752436e+05  1.963541e+05       1.854396e+05
       8.803670e+02      3.149878e+02  1.256367e+01
```

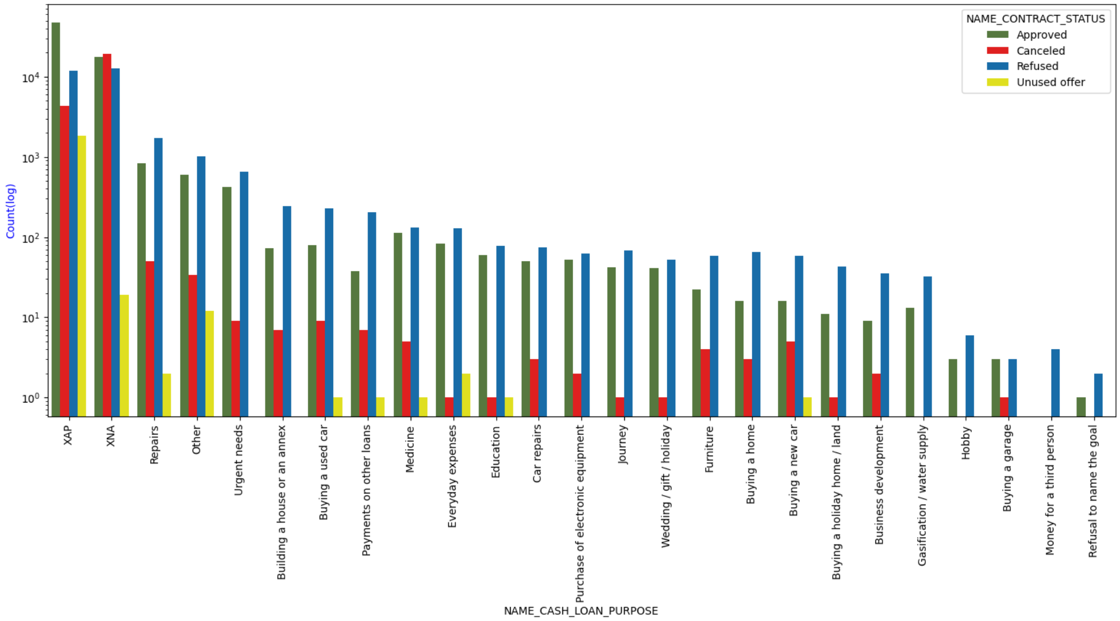
```
std    1.028118e+05  2.811789e-01  7.173454e-01      1.985734e+00  3.849173e+00
1.395116e+04       3.532465e+05                1.334702e-02  4.344557e+03
1.433374e+05       3.551051e+03     1.507376e+03     9.006787e-01
3.232181e+00                1.092132e-01              2.530715e+00
4.658973e-01              2.508953e+00              3.790588e-01
7.999369e+02     4.394192e-01                7.702591e-02
1.001966e-01                2.012902e-01               9.268428e-01
8.781444e-01                2.157176e+00  1.190217e+01    3.926378e+02
5.327153e+05   1.316370e+04     2.936222e+05  3.194813e+05       2.881244e+05
7.835402e+02      7.695082e+03  1.448807e+01
min    1.000020e+05  0.000000e+00  0.000000e+00      2.565000e-01  4.500000e-01
1.615500e+03       4.050000e+04                2.900000e-04  7.489000e+03
0.000000e+00       0.000000e+00     0.000000e+00     1.000000e+00
0.000000e+00                0.000000e+00              0.000000e+00
0.000000e+00              0.000000e+00              0.000000e+00
-4.292000e+03     0.000000e+00                0.000000e+00
0.000000e+00                0.000000e+00               0.000000e+00
0.000000e+00                0.000000e+00  2.000000e+01    0.000000e+00
1.000001e+06   0.000000e+00     0.000000e+00  0.000000e+00       0.000000e+00
1.000000e+00     -1.000000e+00  0.000000e+00
25%    1.893640e+05  0.000000e+00  0.000000e+00      1.125000e+00  2.700000e+00
1.682100e+04       2.385000e+05                1.003200e-02  1.273900e+04
1.042000e+03       2.001000e+03     1.783000e+03     2.000000e+00
1.000000e+01                0.000000e+00              0.000000e+00
0.000000e+00              0.000000e+00              0.000000e+00
-1.683000e+03     0.000000e+00                0.000000e+00
0.000000e+00                0.000000e+00               0.000000e+00
0.000000e+00                1.000000e+00  3.400000e+01    2.000000e+00
1.461346e+06   7.406055e+03     1.975050e+04  2.488050e+04       4.500000e+04
2.710000e+02     -1.000000e+00  0.000000e+00
50%    2.789920e+05  0.000000e+00  0.000000e+00      1.575000e+00  5.084955e+00
2.492550e+04       4.500000e+05                1.885000e-02  1.604400e+04
2.401000e+03       4.508000e+03     3.330000e+03     2.000000e+00
1.200000e+01                0.000000e+00              0.000000e+00
0.000000e+00              0.000000e+00              0.000000e+00
-1.011000e+03     1.000000e+00                0.000000e+00
0.000000e+00                0.000000e+00               0.000000e+00
0.000000e+00                2.000000e+00  4.300000e+01    6.000000e+00
1.922698e+06   1.125000e+04     7.087050e+04  8.059500e+04       7.087500e+04
5.820000e+02      4.000000e+00  1.000000e+01
75%    3.675560e+05  0.000000e+00  1.000000e+00      2.070000e+00  8.079840e+00
3.454200e+04       6.795000e+05                2.866300e-02  1.998000e+04
6.313000e+03       7.510000e+03     4.319000e+03     3.000000e+00
1.400000e+01                0.000000e+00              2.000000e+00
0.000000e+00              2.000000e+00              0.000000e+00
-3.960000e+02     1.000000e+00                0.000000e+00
0.000000e+00                0.000000e+00               0.000000e+00
```

```
0.000000e+00                4.000000e+00  5.400000e+01    1.700000e+01
2.384012e+06   1.674797e+04     1.800000e+05  2.156400e+05       1.800000e+05
1.313000e+03      8.500000e+01  1.800000e+01
max    4.562550e+05  1.000000e+00  1.900000e+01      1.170000e+03  4.050000e+01
2.250000e+05       4.050000e+06                7.250800e-02  2.520100e+04
3.652430e+05       2.467200e+04     7.197000e+03     2.000000e+01
2.300000e+01                1.000000e+00             3.480000e+02
3.400000e+01              3.440000e+02             2.400000e+01
0.000000e+00     1.000000e+00               4.000000e+00
9.000000e+00                8.000000e+00              2.700000e+01
2.610000e+02                2.500000e+01  6.900000e+01    1.000000e+03
2.845381e+06   4.180581e+05     5.850000e+06  4.509688e+06       5.850000e+06
2.922000e+03      4.000000e+06  8.400000e+01
```

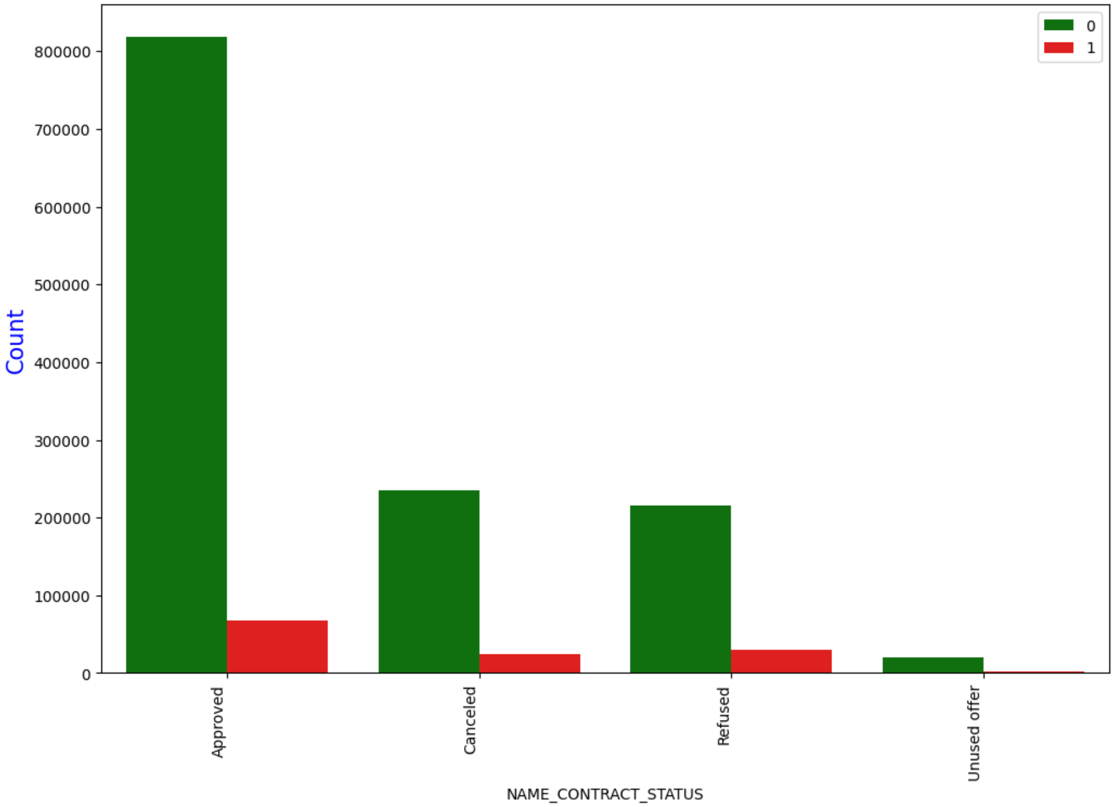
[123]:
```
L0 = loan_process_df[loan_process_df['TARGET']==0]
L1 = loan_process_df[loan_process_df['TARGET']==1]
```

[137]:
```
univariate_merged("NAME_CASH_LOAN_PURPOSE",L0,"NAME_CONTRACT_STATUS",["#548235","#FF0000","#00
univariate_merged("NAME_CASH_LOAN_PURPOSE",L1,"NAME_CONTRACT_STATUS",["#548235","#FF0000","#00
plt.xticks(list(range(0,25)), rotation='vertical')
plt.show()
```



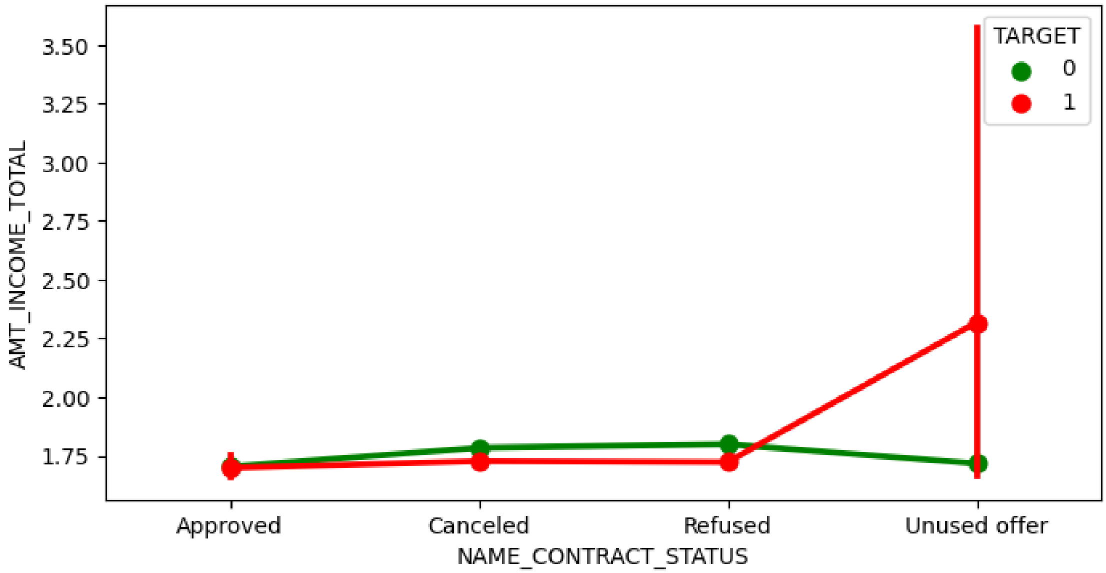


```
[140]: univariate_merged("NAME_CONTRACT_STATUS",loan_process_df,"TARGET",['g','r'],False,(12,8))
       g=loan_process_df.groupby("NAME_CONTRACT_STATUS")["TARGET"]
       df1 = pd.concat([g.value_counts(),round(g.value_counts(normalize=True).
        ↪mul(100),2)],axis=1,keys=('Counts','percentage'))
       df1['percentage']=df1['percentage'].astype(str)+"%"
       print(df1)
```

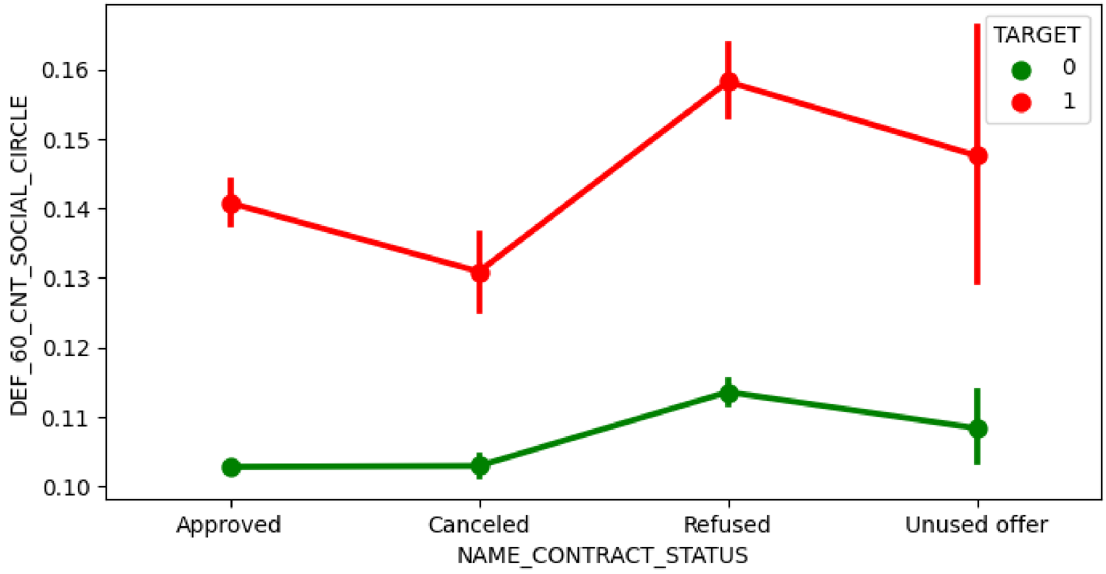


```
                              Counts percentage
NAME_CONTRACT_STATUS TARGET
Approved             0       818856     92.41%
                     1        67243      7.59%
Canceled             0       235641     90.83%
                     1        23800      9.17%
Refused              0       215952      88.0%
                     1        29438      12.0%
Unused offer         0        20892     91.75%
                     1         1879      8.25%
```

[141]:
```
merged_pointplot("NAME_CONTRACT_STATUS",'AMT_INCOME_TOTAL')
```



```
[142]: merged_pointplot("NAME_CONTRACT_STATUS",'DEF_60_CNT_SOCIAL_CIRCLE')
```



```
[ ]:
```