Part_I_exploration

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1 Part I - Prosper Loan Dataset Exploration

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1.2 Introduction

The dataset we're going to use in this project is Loan Data from Prosper. This data set contains 113,937 loans with 81 variables on each loan, including loan amount, borrower rate (or interest rate), current loan status, borrower income, and many others.

1.3 Preliminary Wrangling

```
In [1]: # import all packages and set plots to be embedded inline
        import numpy as np
        import pandas as pd
        import matplotlib.pyplot as plt
        import seaborn as sb

        %matplotlib inline
```

Data Gathering

```
In [2]: # Load data
        loan_data = pd.read_csv('prosperLoanData.csv')
```

Assessing Data

```
In [3]: # Display the first few lines
        loan_data.head()
```

```
Out[3]:                 ListingKey  ListingNumber           ListingCreationDate  \
        0  1021339766868145413AB3B         193129  2007-08-26 19:09:29.263000000
        1  1027360249950330 8B223C1        1209647  2014-02-27 08:28:07.900000000
        2  0EE9337825851032864889A           81716  2007-01-05 15:00:47.090000000
        3  0EF5356002482715299901A          658116  2012-10-22 11:02:35.010000000
        4  0F023589499656230C5E3E2          909464  2013-09-14 18:38:39.097000000

          CreditGrade  Term LoanStatus           ClosedDate  BorrowerAPR  \
```

```
0           C    36  Completed  2009-08-14 00:00:00      0.16516
1         NaN    36    Current                  NaN      0.12016
2          HR    36  Completed  2009-12-17 00:00:00      0.28269
3         NaN    36    Current                  NaN      0.12528
4         NaN    36    Current                  NaN      0.24614

   BorrowerRate  LenderYield    ...     LP_ServiceFees  LP_CollectionFees  \
0        0.1580       0.1380    ...            -133.18                0.0
1        0.0920       0.0820    ...               0.00                0.0
2        0.2750       0.2400    ...             -24.20                0.0
3        0.0974       0.0874    ...            -108.01                0.0
4        0.2085       0.1985    ...             -60.27                0.0

   LP_GrossPrincipalLoss  LP_NetPrincipalLoss LP_NonPrincipalRecoverypayments  \
0                    0.0                  0.0                              0.0
1                    0.0                  0.0                              0.0
2                    0.0                  0.0                              0.0
3                    0.0                  0.0                              0.0
4                    0.0                  0.0                              0.0

   PercentFunded  Recommendations InvestmentFromFriendsCount  \
0            1.0               0                          0
1            1.0               0                          0
2            1.0               0                          0
3            1.0               0                          0
4            1.0               0                          0

  InvestmentFromFriendsAmount Investors
0                         0.0       258
1                         0.0         1
2                         0.0        41
3                         0.0       158
4                         0.0        20

[5 rows x 81 columns]
```

In [4]:
```
# Get the shape of the data
loan_data.shape
```

Out[4]:
```
(113937, 81)
```

In [5]:
```
# Get data's infos
loan_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 113937 entries, 0 to 113936
Data columns (total 81 columns):
ListingKey                          113937 non-null object
ListingNumber                       113937 non-null int64
```

```
ListingCreationDate                  113937 non-null object
CreditGrade                          28953 non-null object
Term                                 113937 non-null int64
LoanStatus                           113937 non-null object
ClosedDate                           55089 non-null object
BorrowerAPR                          113912 non-null float64
BorrowerRate                         113937 non-null float64
LenderYield                          113937 non-null float64
EstimatedEffectiveYield              84853 non-null float64
EstimatedLoss                        84853 non-null float64
EstimatedReturn                      84853 non-null float64
ProsperRating (numeric)              84853 non-null float64
ProsperRating (Alpha)                84853 non-null object
ProsperScore                         84853 non-null float64
ListingCategory (numeric)            113937 non-null int64
BorrowerState                        108422 non-null object
Occupation                           110349 non-null object
EmploymentStatus                     111682 non-null object
EmploymentStatusDuration             106312 non-null float64
IsBorrowerHomeowner                  113937 non-null bool
CurrentlyInGroup                     113937 non-null bool
GroupKey                             13341 non-null object
DateCreditPulled                     113937 non-null object
CreditScoreRangeLower                113346 non-null float64
CreditScoreRangeUpper                113346 non-null float64
FirstRecordedCreditLine              113240 non-null object
CurrentCreditLines                   106333 non-null float64
OpenCreditLines                      106333 non-null float64
TotalCreditLinespast7years           113240 non-null float64
OpenRevolvingAccounts                113937 non-null int64
OpenRevolvingMonthlyPayment          113937 non-null float64
InquiriesLast6Months                 113240 non-null float64
TotalInquiries                       112778 non-null float64
CurrentDelinquencies                 113240 non-null float64
AmountDelinquent                     106315 non-null float64
DelinquenciesLast7Years              112947 non-null float64
PublicRecordsLast10Years             113240 non-null float64
PublicRecordsLast12Months            106333 non-null float64
RevolvingCreditBalance               106333 non-null float64
BankcardUtilization                  106333 non-null float64
AvailableBankcardCredit              106393 non-null float64
TotalTrades                          106393 non-null float64
TradesNeverDelinquent (percentage)   106393 non-null float64
TradesOpenedLast6Months              106393 non-null float64
DebtToIncomeRatio                    105383 non-null float64
IncomeRange                          113937 non-null object
IncomeVerifiable                     113937 non-null bool
StatedMonthlyIncome                  113937 non-null float64
```

```
LoanKey                                113937 non-null object
TotalProsperLoans                      22085 non-null float64
TotalProsperPaymentsBilled             22085 non-null float64
OnTimeProsperPayments                  22085 non-null float64
ProsperPaymentsLessThanOneMonthLate    22085 non-null float64
ProsperPaymentsOneMonthPlusLate        22085 non-null float64
ProsperPrincipalBorrowed               22085 non-null float64
ProsperPrincipalOutstanding            22085 non-null float64
ScorexChangeAtTimeOfListing            18928 non-null float64
LoanCurrentDaysDelinquent              113937 non-null int64
LoanFirstDefaultedCycleNumber          16952 non-null float64
LoanMonthsSinceOrigination             113937 non-null int64
LoanNumber                             113937 non-null int64
LoanOriginalAmount                     113937 non-null int64
LoanOriginationDate                    113937 non-null object
LoanOriginationQuarter                 113937 non-null object
MemberKey                              113937 non-null object
MonthlyLoanPayment                     113937 non-null float64
LP_CustomerPayments                    113937 non-null float64
LP_CustomerPrincipalPayments           113937 non-null float64
LP_InterestandFees                     113937 non-null float64
LP_ServiceFees                         113937 non-null float64
LP_CollectionFees                      113937 non-null float64
LP_GrossPrincipalLoss                  113937 non-null float64
LP_NetPrincipalLoss                    113937 non-null float64
LP_NonPrincipalRecoverypayments        113937 non-null float64
PercentFunded                          113937 non-null float64
Recommendations                        113937 non-null int64
InvestmentFromFriendsCount             113937 non-null int64
InvestmentFromFriendsAmount            113937 non-null float64
Investors                              113937 non-null int64
dtypes: bool(3), float64(50), int64(11), object(17)
memory usage: 68.1+ MB
```

```
In [6]: loan_data.columns
```

```
Out[6]: Index(['ListingKey', 'ListingNumber', 'ListingCreationDate', 'CreditGrade',
               'Term', 'LoanStatus', 'ClosedDate', 'BorrowerAPR', 'BorrowerRate',
               'LenderYield', 'EstimatedEffectiveYield', 'EstimatedLoss',
               'EstimatedReturn', 'ProsperRating (numeric)', 'ProsperRating (Alpha)',
               'ProsperScore', 'ListingCategory (numeric)', 'BorrowerState',
               'Occupation', 'EmploymentStatus', 'EmploymentStatusDuration',
               'IsBorrowerHomeowner', 'CurrentlyInGroup', 'GroupKey',
               'DateCreditPulled', 'CreditScoreRangeLower', 'CreditScoreRangeUpper',
               'FirstRecordedCreditLine', 'CurrentCreditLines', 'OpenCreditLines',
               'TotalCreditLinespast7years', 'OpenRevolvingAccounts',
               'OpenRevolvingMonthlyPayment', 'InquiriesLast6Months', 'TotalInquiries',
```

```
       'CurrentDelinquencies', 'AmountDelinquent', 'DelinquenciesLast7Years',
       'PublicRecordsLast10Years', 'PublicRecordsLast12Months',
       'RevolvingCreditBalance', 'BankcardUtilization',
       'AvailableBankcardCredit', 'TotalTrades',
       'TradesNeverDelinquent (percentage)', 'TradesOpenedLast6Months',
       'DebtToIncomeRatio', 'IncomeRange', 'IncomeVerifiable',
       'StatedMonthlyIncome', 'LoanKey', 'TotalProsperLoans',
       'TotalProsperPaymentsBilled', 'OnTimeProsperPayments',
       'ProsperPaymentsLessThanOneMonthLate',
       'ProsperPaymentsOneMonthPlusLate', 'ProsperPrincipalBorrowed',
       'ProsperPrincipalOutstanding', 'ScorexChangeAtTimeOfListing',
       'LoanCurrentDaysDelinquent', 'LoanFirstDefaultedCycleNumber',
       'LoanMonthsSinceOrigination', 'LoanNumber', 'LoanOriginalAmount',
       'LoanOriginationDate', 'LoanOriginationQuarter', 'MemberKey',
       'MonthlyLoanPayment', 'LP_CustomerPayments',
       'LP_CustomerPrincipalPayments', 'LP_InterestandFees', 'LP_ServiceFees',
       'LP_CollectionFees', 'LP_GrossPrincipalLoss', 'LP_NetPrincipalLoss',
       'LP_NonPrincipalRecoverypayments', 'PercentFunded', 'Recommendations',
       'InvestmentFromFriendsCount', 'InvestmentFromFriendsAmount',
       'Investors'],
      dtype='object')
```

In [7]:
```
# Check for Missing values
loan_data.isna().sum()
```

Out[7]:
```
ListingKey                          0
ListingNumber                       0
ListingCreationDate                 0
CreditGrade                     84984
Term                                0
LoanStatus                          0
ClosedDate                      58848
BorrowerAPR                        25
BorrowerRate                        0
LenderYield                         0
EstimatedEffectiveYield         29084
EstimatedLoss                   29084
EstimatedReturn                 29084
ProsperRating (numeric)         29084
ProsperRating (Alpha)           29084
ProsperScore                    29084
ListingCategory (numeric)           0
BorrowerState                    5515
Occupation                       3588
EmploymentStatus                 2255
EmploymentStatusDuration         7625
IsBorrowerHomeowner                 0
CurrentlyInGroup                    0
```

```
GroupKey                                100596
DateCreditPulled                             0
CreditScoreRangeLower                      591
CreditScoreRangeUpper                      591
FirstRecordedCreditLine                    697
CurrentCreditLines                        7604
OpenCreditLines                           7604
                                           ...
TotalProsperLoans                        91852
TotalProsperPaymentsBilled               91852
OnTimeProsperPayments                    91852
ProsperPaymentsLessThanOneMonthLate      91852
ProsperPaymentsOneMonthPlusLate          91852
ProsperPrincipalBorrowed                 91852
ProsperPrincipalOutstanding              91852
ScorexChangeAtTimeOfListing              95009
LoanCurrentDaysDelinquent                    0
LoanFirstDefaultedCycleNumber            96985
LoanMonthsSinceOrigination                   0
LoanNumber                                   0
LoanOriginalAmount                           0
LoanOriginationDate                          0
LoanOriginationQuarter                       0
MemberKey                                    0
MonthlyLoanPayment                           0
LP_CustomerPayments                          0
LP_CustomerPrincipalPayments                 0
LP_InterestandFees                           0
LP_ServiceFees                               0
LP_CollectionFees                            0
LP_GrossPrincipalLoss                        0
LP_NetPrincipalLoss                          0
LP_NonPrincipalRecoverypayments              0
PercentFunded                                0
Recommendations                              0
InvestmentFromFriendsCount                   0
InvestmentFromFriendsAmount                  0
Investors                                    0
Length: 81, dtype: int64
```

Quality Issues

- Missing values
- Incorrect Data types

Data Cleaning

In [8]:
```
# Make a copy from the data
loan_data_clean = loan_data.copy()
```

Issue #1: Missing values

Define

- Drop columns with more than half of their values are missing.
- Drop rows with more than half of their values are missing.

Code

```
In [9]: # Drop columns with more than half of their values are missing
        loan_data_clean.dropna(axis = 'columns', thresh = 113937*0.5, inplace= True)

In [10]: # Drop rows with more than half of their values are missing
         loan_data_clean.dropna(axis = 'rows', inplace= True)
```

Test

```
In [11]: # Data's new shape
         loan_data_clean.shape

Out[11]: (76216, 69)

In [12]: loan_data.columns

Out[12]: Index(['ListingKey', 'ListingNumber', 'ListingCreationDate', 'CreditGrade',
                'Term', 'LoanStatus', 'ClosedDate', 'BorrowerAPR', 'BorrowerRate',
                'LenderYield', 'EstimatedEffectiveYield', 'EstimatedLoss',
                'EstimatedReturn', 'ProsperRating (numeric)', 'ProsperRating (Alpha)',
                'ProsperScore', 'ListingCategory (numeric)', 'BorrowerState',
                'Occupation', 'EmploymentStatus', 'EmploymentStatusDuration',
                'IsBorrowerHomeowner', 'CurrentlyInGroup', 'GroupKey',
                'DateCreditPulled', 'CreditScoreRangeLower', 'CreditScoreRangeUpper',
                'FirstRecordedCreditLine', 'CurrentCreditLines', 'OpenCreditLines',
                'TotalCreditLinespast7years', 'OpenRevolvingAccounts',
                'OpenRevolvingMonthlyPayment', 'InquiriesLast6Months', 'TotalInquiries',
                'CurrentDelinquencies', 'AmountDelinquent', 'DelinquenciesLast7Years',
                'PublicRecordsLast10Years', 'PublicRecordsLast12Months',
                'RevolvingCreditBalance', 'BankcardUtilization',
                'AvailableBankcardCredit', 'TotalTrades',
                'TradesNeverDelinquent (percentage)', 'TradesOpenedLast6Months',
                'DebtToIncomeRatio', 'IncomeRange', 'IncomeVerifiable',
                'StatedMonthlyIncome', 'LoanKey', 'TotalProsperLoans',
                'TotalProsperPaymentsBilled', 'OnTimeProsperPayments',
                'ProsperPaymentsLessThanOneMonthLate',
                'ProsperPaymentsOneMonthPlusLate', 'ProsperPrincipalBorrowed',
                'ProsperPrincipalOutstanding', 'ScorexChangeAtTimeOfListing',
                'LoanCurrentDaysDelinquent', 'LoanFirstDefaultedCycleNumber',
                'LoanMonthsSinceOrigination', 'LoanNumber', 'LoanOriginalAmount',
                'LoanOriginationDate', 'LoanOriginationQuarter', 'MemberKey',
```

```
       'MonthlyLoanPayment', 'LP_CustomerPayments',
       'LP_CustomerPrincipalPayments', 'LP_InterestandFees', 'LP_ServiceFees',
       'LP_CollectionFees', 'LP_GrossPrincipalLoss', 'LP_NetPrincipalLoss',
       'LP_NonPrincipalRecoverypayments', 'PercentFunded', 'Recommendations',
       'InvestmentFromFriendsCount', 'InvestmentFromFriendsAmount',
       'Investors'],
      dtype='object')
```

Issue #2: Incorrect Data types

Define

- Change Datetime variables' types from object to Datetime.

Code

```
In [13]: def obj_to_datetime(object):
             loan_data_clean[object] = loan_data_clean[object].astype('datetime64[ns]')

         list_date_var = ['ListingCreationDate','LoanOriginationDate','DateCreditPulled','FirstR
         for var in list_date_var:
             obj_to_datetime(var)
```

Test

```
In [14]: loan_data_clean.info()

<class 'pandas.core.frame.DataFrame'>
Int64Index: 76216 entries, 1 to 113936
Data columns (total 69 columns):
ListingKey                          76216 non-null object
ListingNumber                       76216 non-null int64
ListingCreationDate                 76216 non-null datetime64[ns]
Term                                76216 non-null int64
LoanStatus                          76216 non-null object
BorrowerAPR                         76216 non-null float64
BorrowerRate                        76216 non-null float64
LenderYield                         76216 non-null float64
EstimatedEffectiveYield             76216 non-null float64
EstimatedLoss                       76216 non-null float64
EstimatedReturn                     76216 non-null float64
ProsperRating (numeric)             76216 non-null float64
ProsperRating (Alpha)               76216 non-null object
ProsperScore                        76216 non-null float64
ListingCategory (numeric)           76216 non-null int64
BorrowerState                       76216 non-null object
Occupation                          76216 non-null object
EmploymentStatus                    76216 non-null object
```

```
EmploymentStatusDuration              76216 non-null float64
IsBorrowerHomeowner                   76216 non-null bool
CurrentlyInGroup                      76216 non-null bool
DateCreditPulled                      76216 non-null datetime64[ns]
CreditScoreRangeLower                 76216 non-null float64
CreditScoreRangeUpper                 76216 non-null float64
FirstRecordedCreditLine               76216 non-null datetime64[ns]
CurrentCreditLines                    76216 non-null float64
OpenCreditLines                       76216 non-null float64
TotalCreditLinespast7years            76216 non-null float64
OpenRevolvingAccounts                 76216 non-null int64
OpenRevolvingMonthlyPayment           76216 non-null float64
InquiriesLast6Months                  76216 non-null float64
TotalInquiries                        76216 non-null float64
CurrentDelinquencies                  76216 non-null float64
AmountDelinquent                      76216 non-null float64
DelinquenciesLast7Years               76216 non-null float64
PublicRecordsLast10Years              76216 non-null float64
PublicRecordsLast12Months             76216 non-null float64
RevolvingCreditBalance                76216 non-null float64
BankcardUtilization                   76216 non-null float64
AvailableBankcardCredit               76216 non-null float64
TotalTrades                           76216 non-null float64
TradesNeverDelinquent (percentage)    76216 non-null float64
TradesOpenedLast6Months               76216 non-null float64
DebtToIncomeRatio                     76216 non-null float64
IncomeRange                           76216 non-null object
IncomeVerifiable                      76216 non-null bool
StatedMonthlyIncome                   76216 non-null float64
LoanKey                               76216 non-null object
LoanCurrentDaysDelinquent             76216 non-null int64
LoanMonthsSinceOrigination            76216 non-null int64
LoanNumber                            76216 non-null int64
LoanOriginalAmount                    76216 non-null int64
LoanOriginationDate                   76216 non-null datetime64[ns]
LoanOriginationQuarter                76216 non-null object
MemberKey                             76216 non-null object
MonthlyLoanPayment                    76216 non-null float64
LP_CustomerPayments                   76216 non-null float64
LP_CustomerPrincipalPayments          76216 non-null float64
LP_InterestandFees                    76216 non-null float64
LP_ServiceFees                        76216 non-null float64
LP_CollectionFees                     76216 non-null float64
LP_GrossPrincipalLoss                 76216 non-null float64
LP_NetPrincipalLoss                   76216 non-null float64
LP_NonPrincipalRecoverypayments       76216 non-null float64
PercentFunded                         76216 non-null float64
Recommendations                       76216 non-null int64
```

```
InvestmentFromFriendsCount            76216 non-null int64
InvestmentFromFriendsAmount           76216 non-null float64
Investors                             76216 non-null int64
dtypes: bool(3), datetime64[ns](4), float64(41), int64(11), object(10)
memory usage: 39.2+ MB
```

1.3.1 What is the structure of your dataset?

The dataset contains 113937 rows and 81 columns. The columns are mostly numeric except a few of them. - ProsperRate, BorrowerState, Occupation, EmploymentStatus, LoanStatus, and CreditGrade are categorical. - IsBorrowerHomeowner, CurrentlyInGroup, and IncomeVerifiable are boolean. - ListingCreationDate, LoanOriginationDate, DateCreditPulled, and FirstRecordedCreditLine are Datetime.

1.3.2 What is/are the main feature(s) of interest in your dataset?

Prosper rating, interest rates, term, loan original amount are interessting features.

1.3.3 What features in the dataset do you think will help support your investigation into your feature(s) of interest?

Analyzing credit score, employment status, income range, stated monthly income, loan category, and so on can help better understand main factors.

1.4 Univariate Exploration

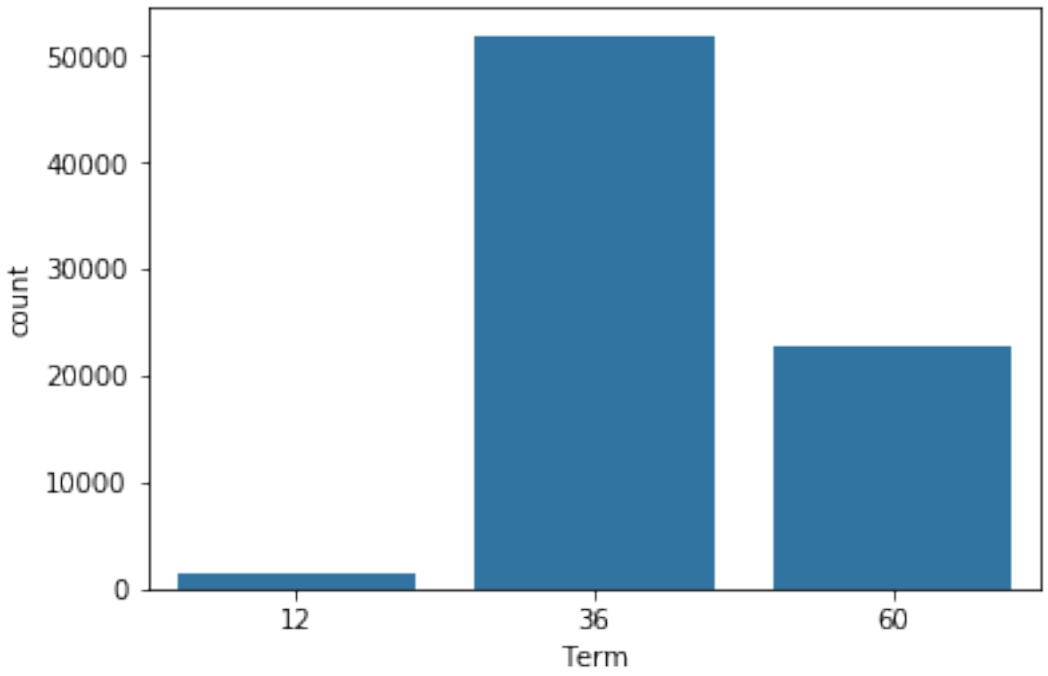
In this section, I'm gonna explore borrower related variables.

Question #1

What's the term chosen by borrowers?

Visualization

```
In [15]: default_color = sb.color_palette()[0]
         sb.countplot(data = loan_data_clean, x = 'Term', color = default_color);
```



Observation

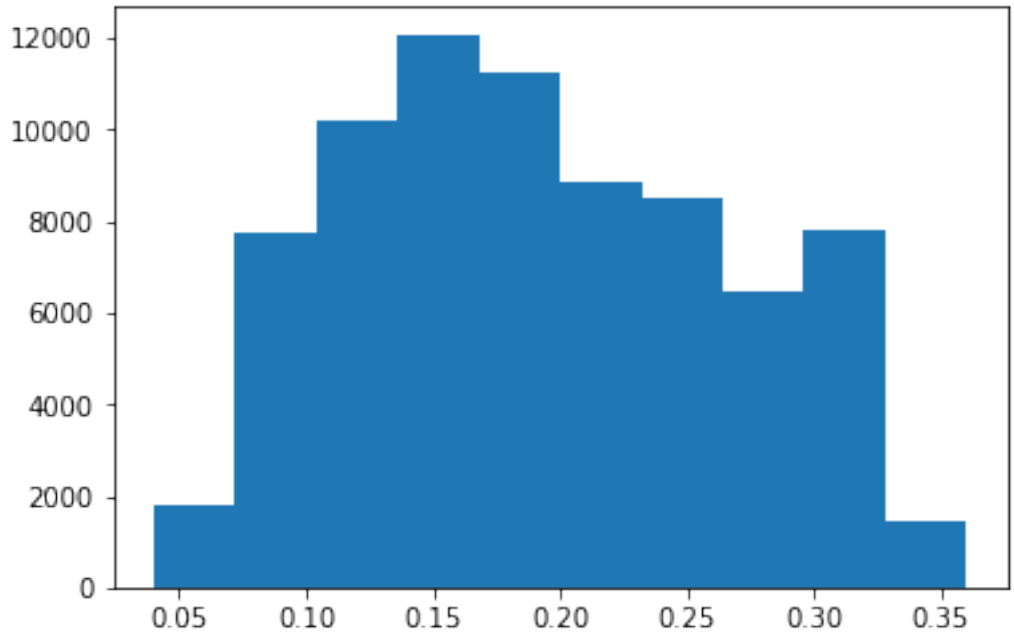
It seems like borrowers prefer the 36 term.

Question #2

What's the range of BorrowerRate?

Visualization

```
In [16]: plt.hist(data = loan_data_clean, x = 'BorrowerRate');
```



Observation

BorrwerRate ranges from 0.05 to 0.35.

Question #3:

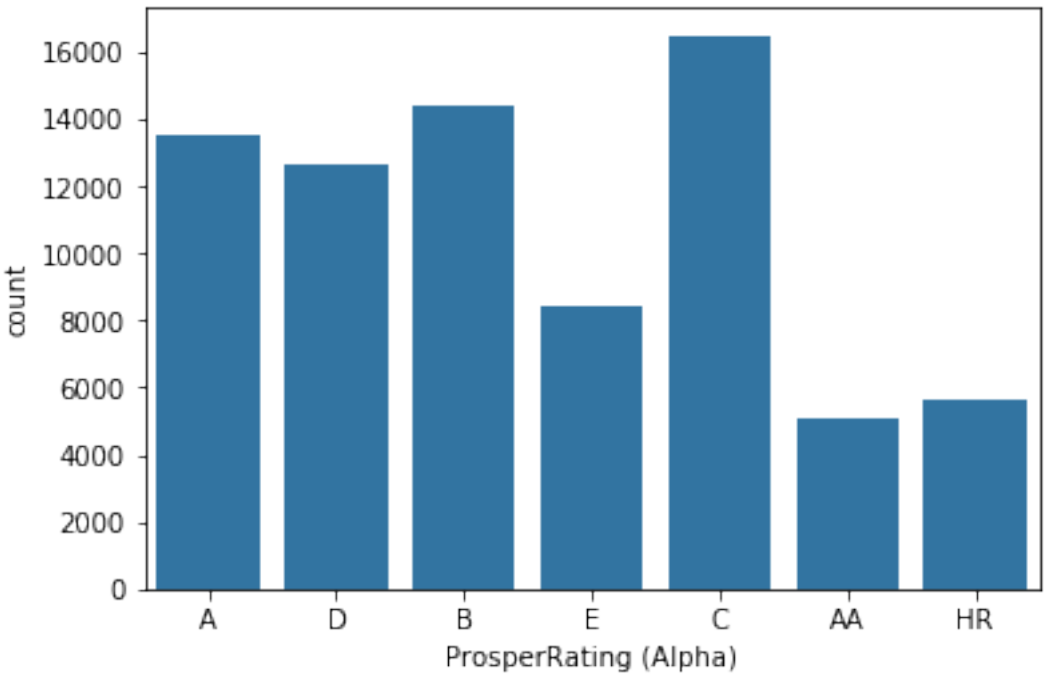
what are the levels of prosper ratings available and what is the most common rating given to borrowers?

Visualization

```
In [17]: loan_data_clean['ProsperRating (Alpha)'].value_counts()
```

```
Out[17]: C     16499
         B     14379
         A     13490
         D     12629
         E      8443
         HR     5680
         AA     5096
         Name: ProsperRating (Alpha), dtype: int64
```

```
In [18]: sb.countplot(data = loan_data_clean, x = 'ProsperRating (Alpha)', color = default_color
```



Observation

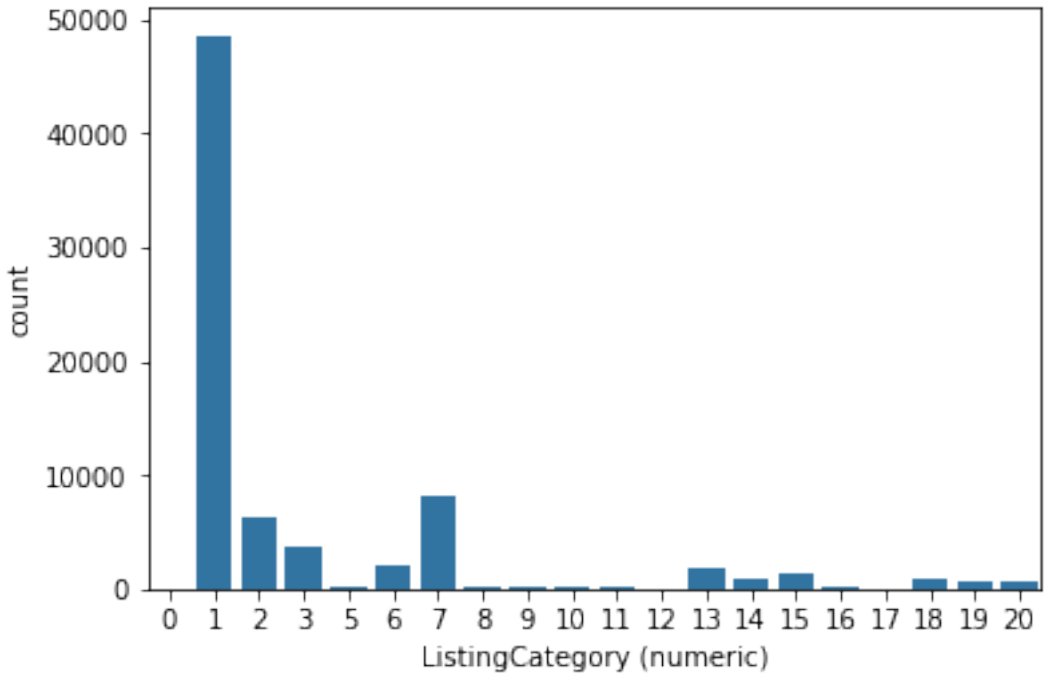
The most common prosper ratings are A,B,C, and D.

Question #4

For what purpose borrowers are taking loans?

Visualization

```
In [19]: sb.countplot(data = loan_data_clean, x = 'ListingCategory (numeric)', color = default_c
```



Observation

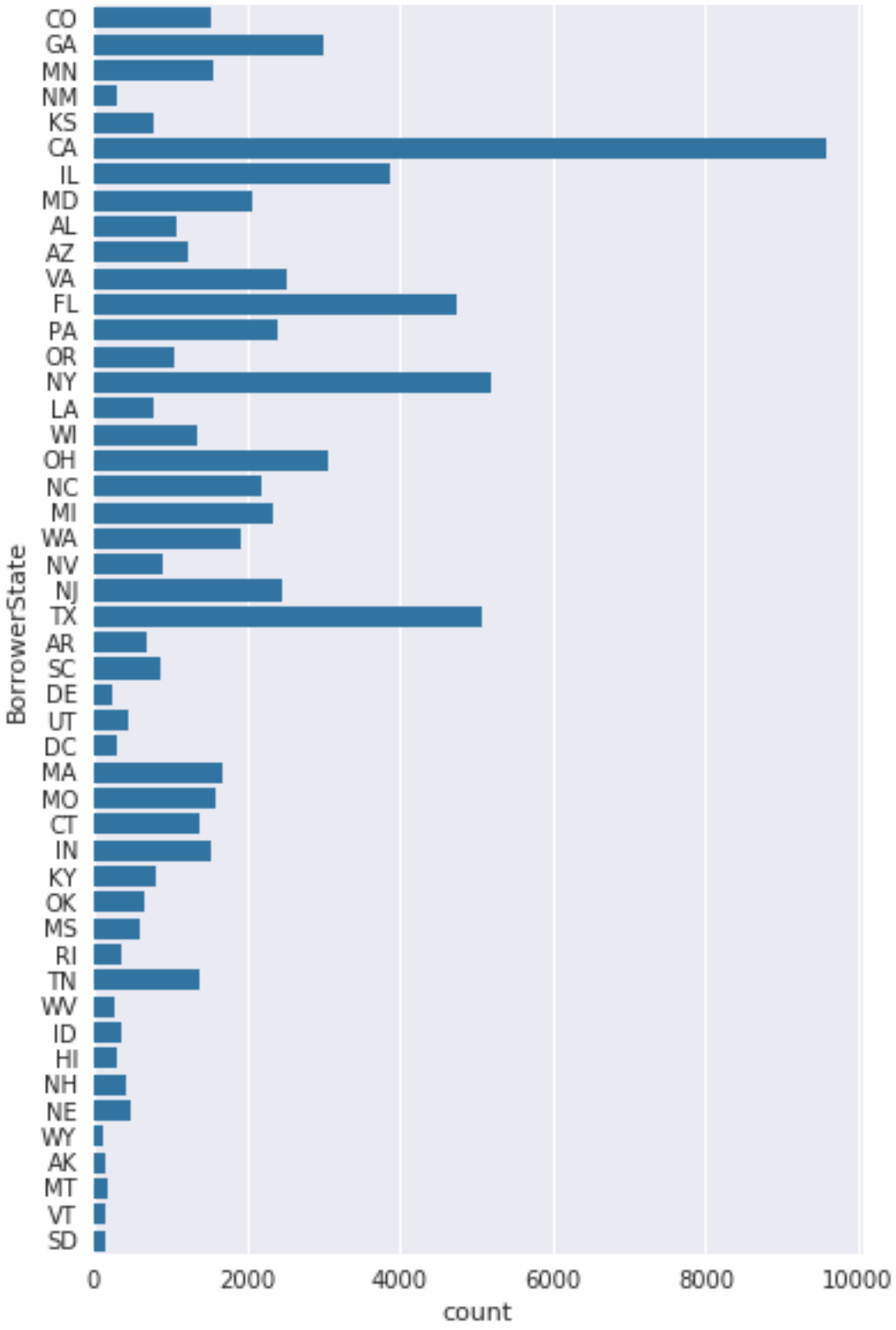
It seems like most borrowers take loans for the purpose of Debt consolidation

Question #5

How are borrowers geographically distributed?

Visualization

```
In [20]: sb.set(rc={"figure.figsize":(6, 10)}) #width=8, height=4
         sb.countplot(data = loan_data_clean, y = 'BorrowerState', color = default_color);
```


BorrowerState
CO
GA
MN
NM
KS
CA
IL
MD
AL
AZ
VA
FL
PA
OR
NY
LA
WI
OH
NC
MI
WA
NV
NJ
TX
AR
SC
DE
UT
DC
MA
MO
CT
IN
KY
OK
MS
RI
TN
WV
ID
HI
NH
NE
WY
AK
MT
VT
SD
0
2000
4000
6000
8000
10000
count

Observation

Mostly used states are CA, FL, GA, IL, NY, and TX.

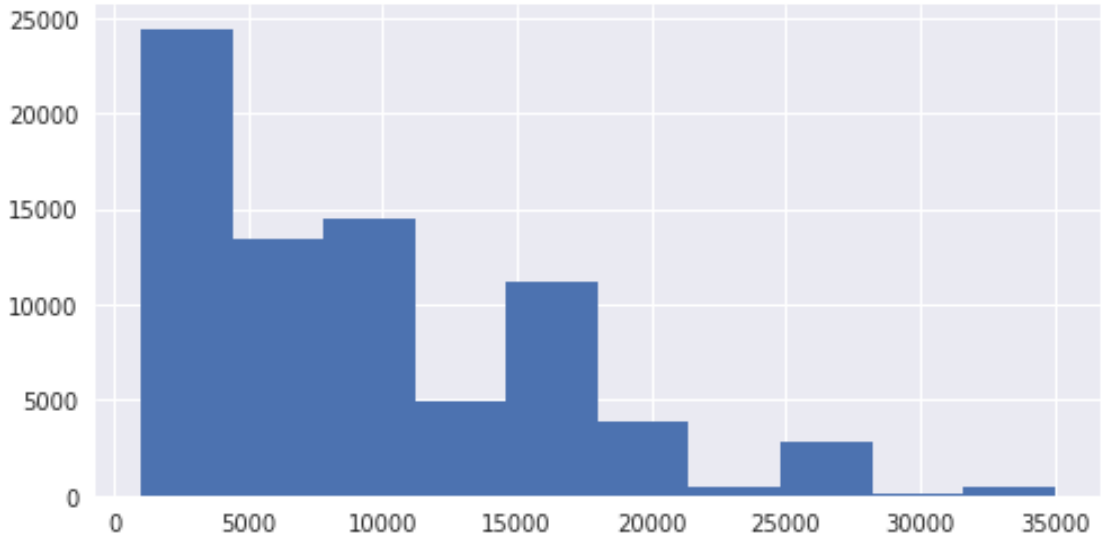
Question #6

What's the range of loan amounts the borrowers are requesting?

Visualization

```
In [21]: sb.set(rc={"figure.figsize":(8, 4)}) #width=8, height=4

         plt.hist(data = loan_data_clean, x = 'LoanOriginalAmount');
```



Observation

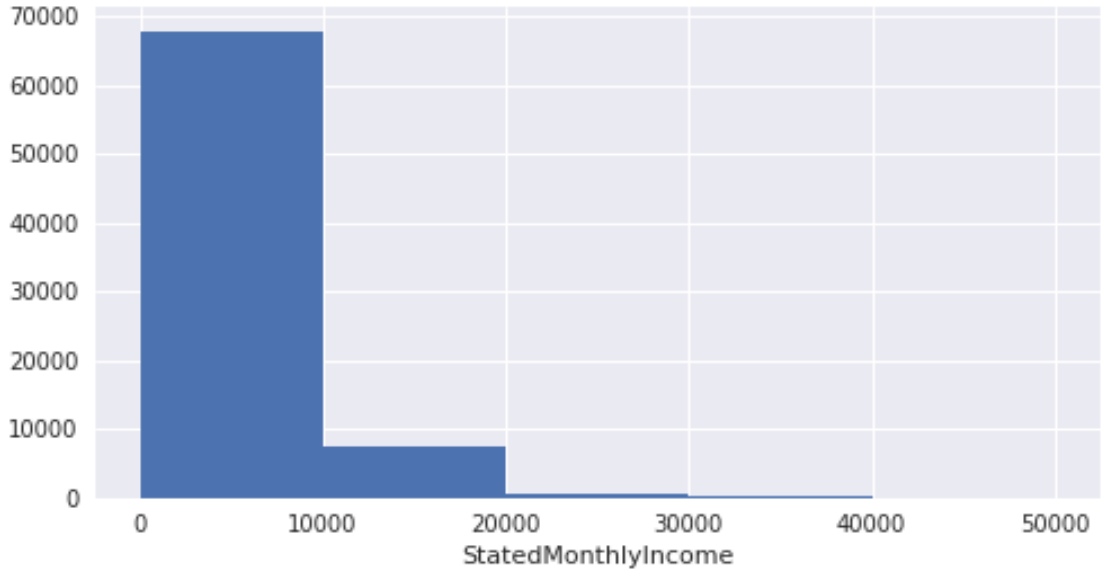
the range is from 1000 to 35000.

Question #7

What the range of the borrowers stated monthly income?

Visualization

```
In [22]: x = loan_data_clean.StatedMonthlyIncome
         plt.hist(data = loan_data_clean, x = 'StatedMonthlyIncome', bins = [0,10000,20000,30000
         plt.xlabel('StatedMonthlyIncome');
```



Observation

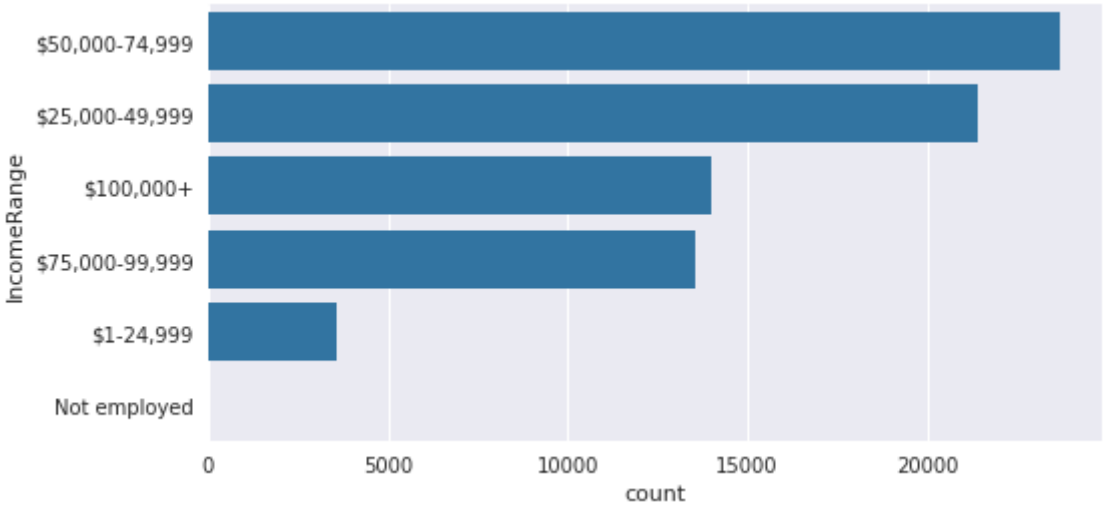
The range is from 0 to 40000.

Question #8

From which range of income most borrowers are?

Visualization

```
In [23]: sb.countplot(data = loan_data_clean, y = 'IncomeRange', color = default_color);
```



Observation

Most people with the income range from 25,000-74,999 took loans.

1.5 Bivariate Exploration

In this section, investigate relationships between pairs of variables in your data. Make sure the variables that you cover here have been introduced in some fashion in the previous section (univariate exploration).

Question #9

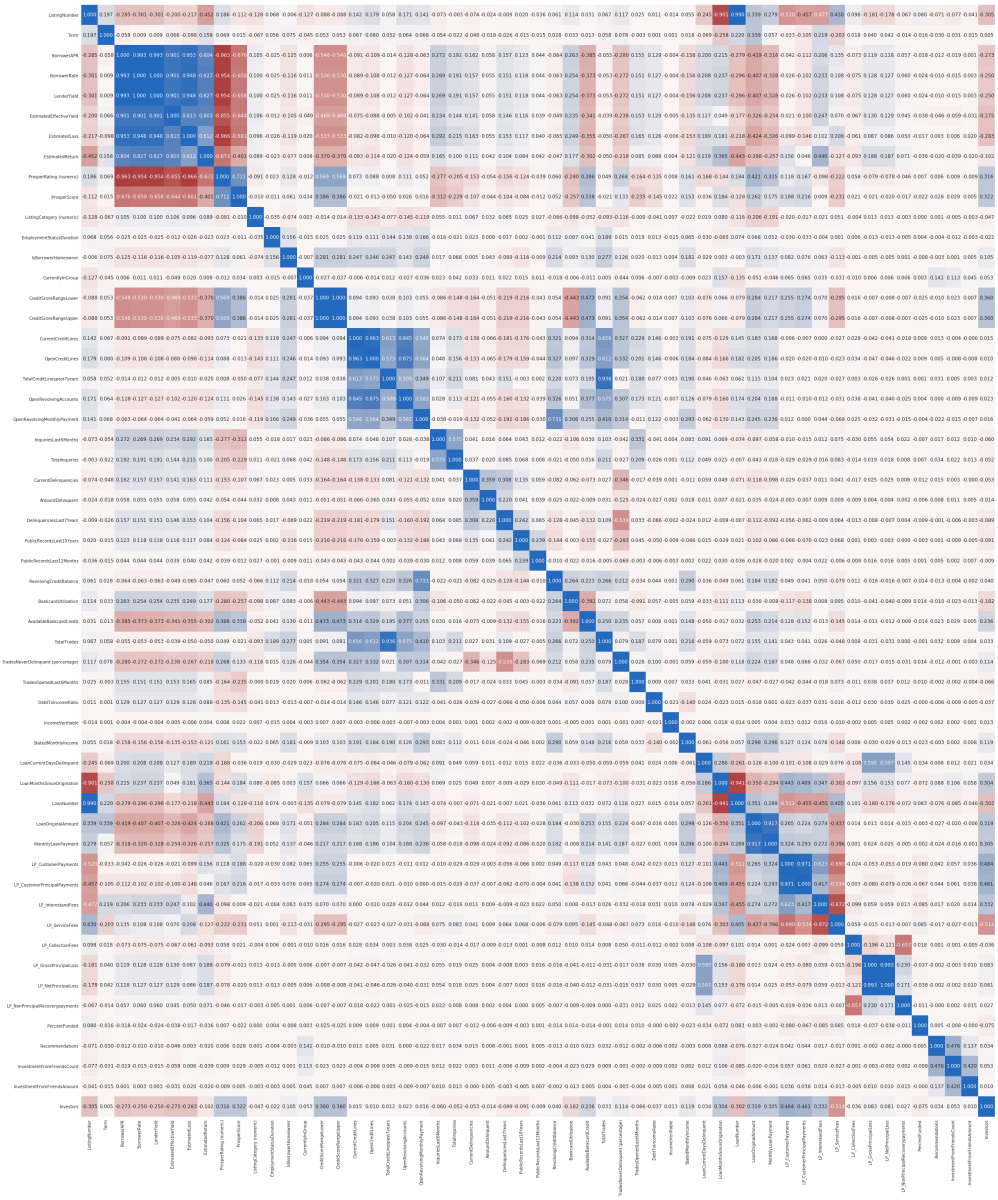
how are the variables correlated?

Visualization

```
In [24]: numeric_vars = loan_data_clean._get_numeric_data().columns
         numeric_vars
```

```
Out[24]: Index(['ListingNumber', 'Term', 'BorrowerAPR', 'BorrowerRate', 'LenderYield',
                'EstimatedEffectiveYield', 'EstimatedLoss', 'EstimatedReturn',
                'ProsperRating (numeric)', 'ProsperScore', 'ListingCategory (numeric)',
                'EmploymentStatusDuration', 'IsBorrowerHomeowner', 'CurrentlyInGroup',
                'CreditScoreRangeLower', 'CreditScoreRangeUpper', 'CurrentCreditLines',
                'OpenCreditLines', 'TotalCreditLinespast7years',
                'OpenRevolvingAccounts', 'OpenRevolvingMonthlyPayment',
                'InquiriesLast6Months', 'TotalInquiries', 'CurrentDelinquencies',
                'AmountDelinquent', 'DelinquenciesLast7Years',
                'PublicRecordsLast10Years', 'PublicRecordsLast12Months',
                'RevolvingCreditBalance', 'BankcardUtilization',
                'AvailableBankcardCredit', 'TotalTrades',
                'TradesNeverDelinquent (percentage)', 'TradesOpenedLast6Months',
                'DebtToIncomeRatio', 'IncomeVerifiable', 'StatedMonthlyIncome',
                'LoanCurrentDaysDelinquent', 'LoanMonthsSinceOrigination', 'LoanNumber',
                'LoanOriginalAmount', 'MonthlyLoanPayment', 'LP_CustomerPayments',
                'LP_CustomerPrincipalPayments', 'LP_InterestandFees', 'LP_ServiceFees',
                'LP_CollectionFees', 'LP_GrossPrincipalLoss', 'LP_NetPrincipalLoss',
                'LP_NonPrincipalRecoverypayments', 'PercentFunded', 'Recommendations',
                'InvestmentFromFriendsCount', 'InvestmentFromFriendsAmount',
                'Investors'],
               dtype='object')
```

```
In [25]: # correlation plot
         plt.figure(figsize = [50, 50])
         sb.heatmap(loan_data_clean[numeric_vars].corr(), annot = True, fmt = '.3f',
                    cmap = 'vlag_r', center = 0)
         plt.show()
```



Observation

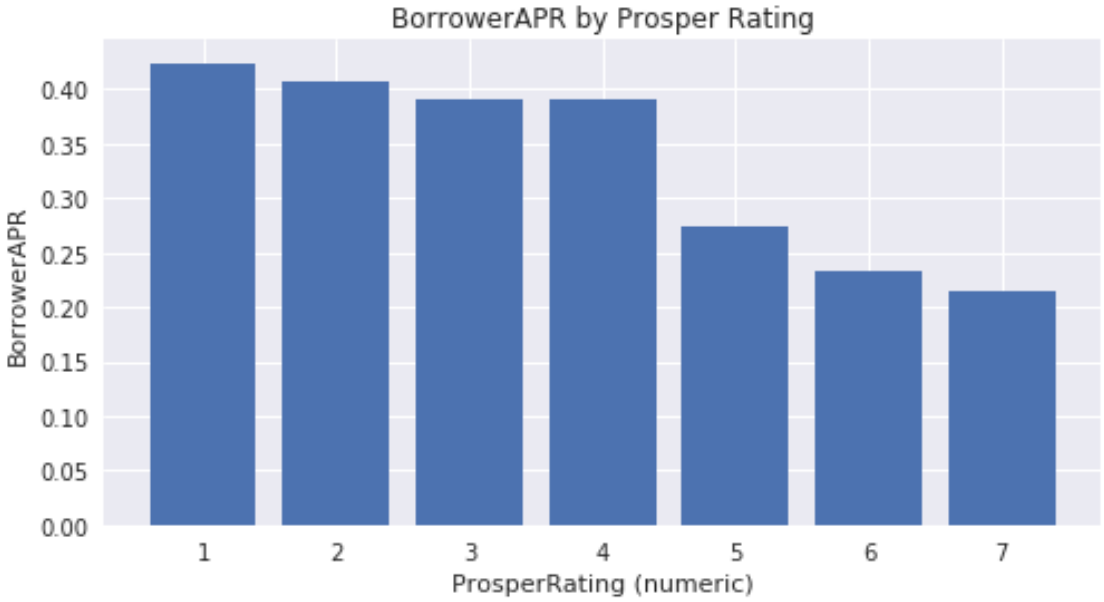
ProsperScore, ProsperRating,EstimatedReturn, EstimatedLoss, EstimatedEffectiveYield, LenderYield, BorrowerRate, and BorrowerAPR are strongly correlated between each other.

Question #10

What's the relationship between BorrowerAPR and Prosper Rating?

Visualization

```
In [26]: plt.figure(figsize = [8, 6])
         x = loan_data_clean['ProsperRating (numeric)']
         y = loan_data_clean['BorrowerAPR']
         plt.bar(x,y);
         plt.xlabel('ProsperRating (numeric)')
         plt.ylabel('BorrowerAPR')
         plt.title('BorrowerAPR by Prosper Rating')
         plt.show()
```



Observation

Borrower's APR is highly dependent on proper rating. We can see that BorrowerAPR is increasing as prosper rating decreasing.

Question #11

What's the relationship between BorrowerAPR and Prosper Rating?

Visualization

```
In [28]: plt.figure(figsize = [8, 6])
         x = loan_data_clean['ProsperRating (numeric)']
         y = loan_data_clean['BorrowerRate']
         plt.bar(x,y);
         plt.xlabel('ProsperRating (numeric)')
```

```
plt.ylabel('Borrower Rate')
plt.title('Borrower Rate by Prosper Rating')
plt.show()
```

Observation

Borrower's rate is highly dependent on proper rating. We can see that BorrowerRate is increasing as prosper rating decreasing.

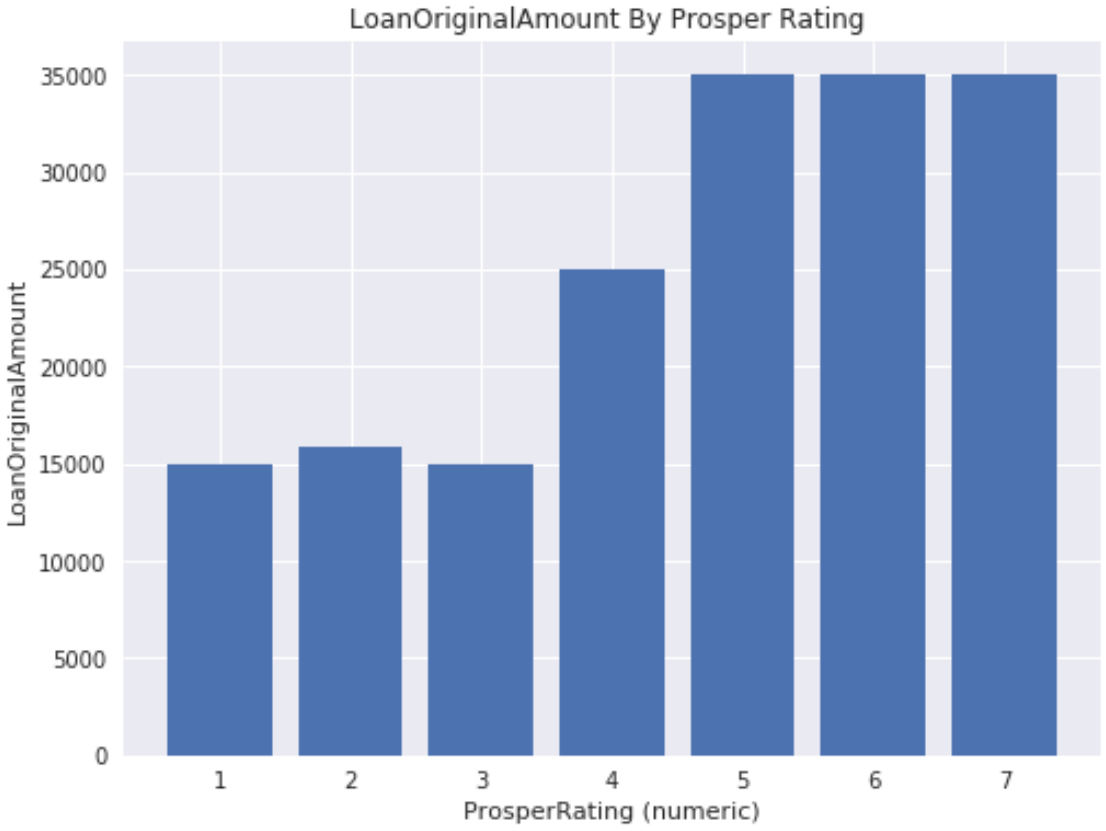
Question #12

What's the relationship between LoanOriginalAmount and Prosper Rating?

Visualization

```
In [31]: plt.figure(figsize = [8, 6])
         x = loan_data_clean['ProsperRating (numeric)']
         y = loan_data_clean['LoanOriginalAmount']
         plt.bar(x,y);
         plt.xlabel('ProsperRating (numeric)')
```

```
plt.ylabel('LoanOriginalAmount')
plt.title('LoanOriginalAmount By Prosper Rating ')
plt.show()
```



Observation

ProsperRating is highly dependent on LoanOriginalAmout . We can see that Prosper-Rating rate is increasing as LoanOriginalAmout increasing.

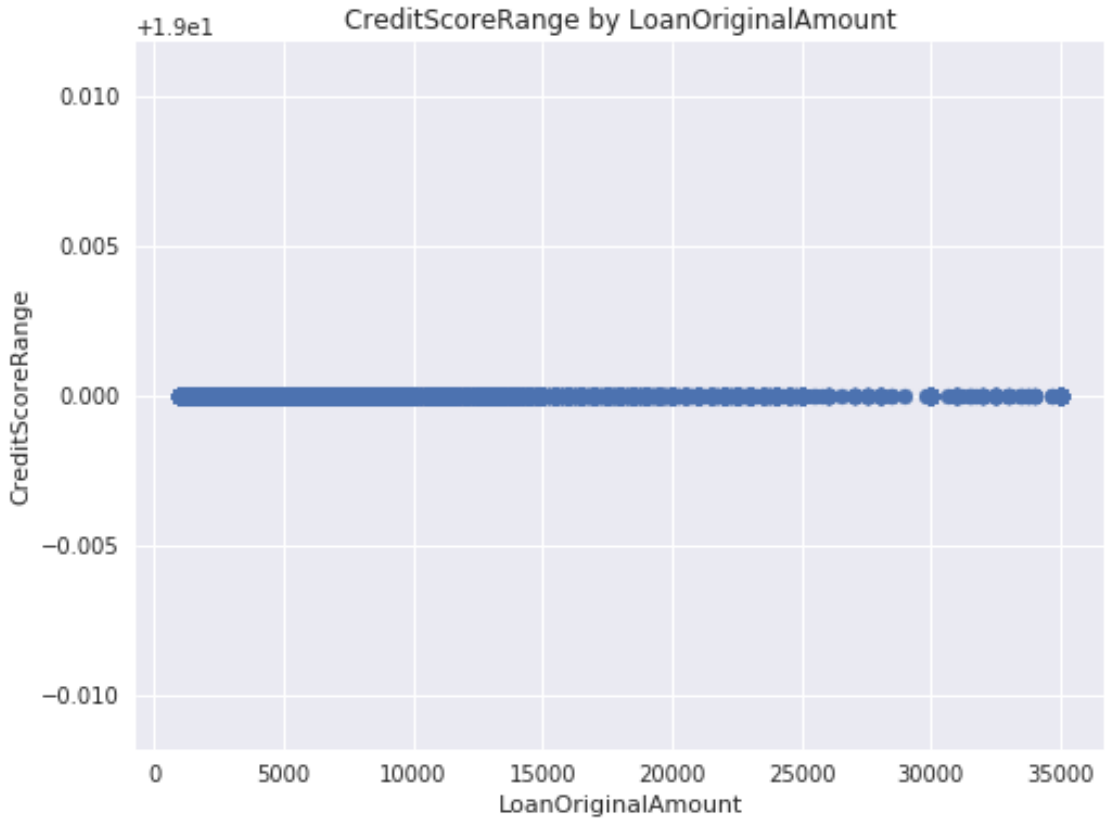
Question #13

What's the relationship between LoanOriginalAmount and CreditScoreRange?

Visualization

```
In [32]: loan_data_clean['CreditScoreRange'] = loan_data_clean['CreditScoreRangeUpper'] - loan_d
```

```
In [33]: plt.figure(figsize = [8, 6])
         plt.scatter(data = loan_data_clean, y = 'CreditScoreRange', x = 'LoanOriginalAmount');
         plt.ylabel('CreditScoreRange')
         plt.xlabel('LoanOriginalAmount')
         plt.title('CreditScoreRange by LoanOriginalAmount')
         plt.show()
```



Observation

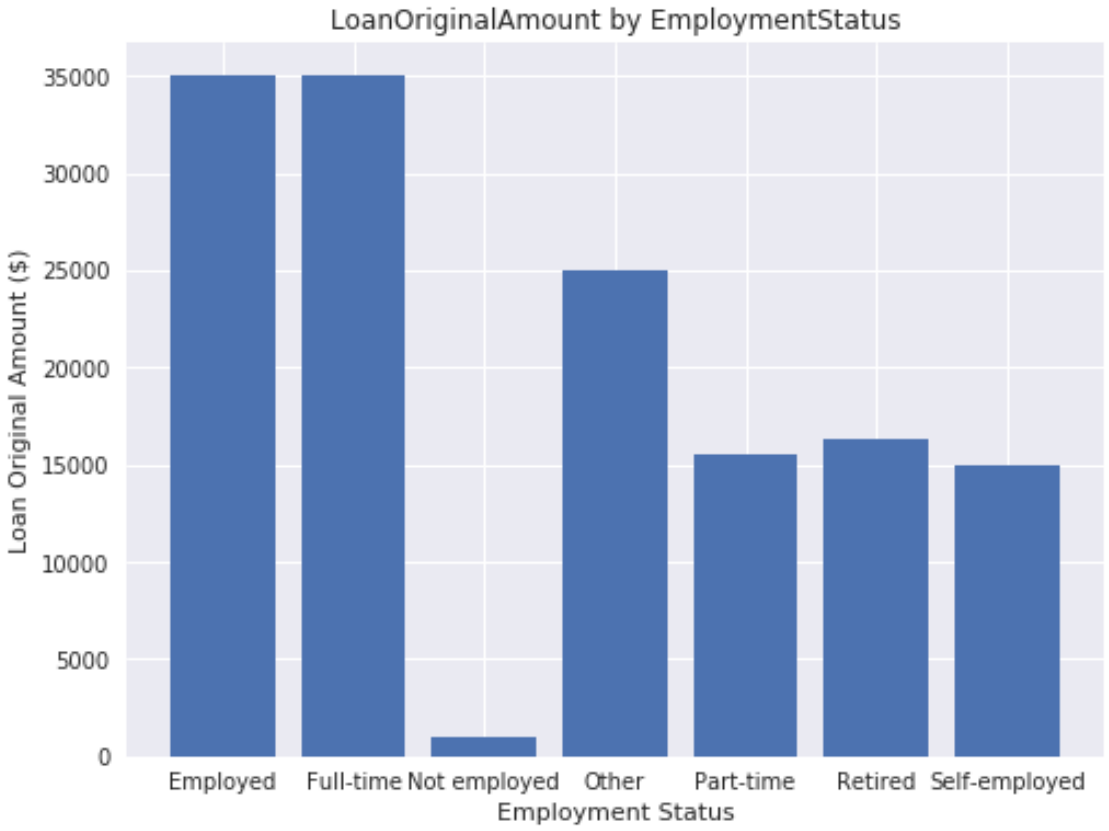
The CreditScoreRange is constant.

Question #14

What's the relationship between Emploment Status and LoanOriginalAmount?

Visualization

```
In [35]: plt.figure(figsize = [8, 6])
         y = loan_data_clean['LoanOriginalAmount']
         x = loan_data_clean['EmploymentStatus']
         plt.bar(x,y);
         plt.ylabel('Loan Original Amount ($)')
         plt.xlabel('Employment Status')
         plt.title('LoanOriginalAmount by EmploymentStatus')
         plt.show()
```



Observation

Employed people and Full-time workers tend to request more money than the others.

1.5.1 Talk about some of the relationships you observed in this part of the investigation.

ProsperScore, ProsperRating,EstimatedReturn, EstimatedLoss, EstimatedEffectiveYield, LenderYield, BorrowerRate, and BorrowerAPR are strongly correlated between each other.

ProsperRating is highly dependent on LoanOriginalAmount.

BorrowerRate and BorrowerAPR are dependent on ProsperRating.

LoanOriginalAmount is dependent on EmploymentStatus.

1.5.2 Did you observe any interesting relationships between the other features (not the main feature(s) of interest)?

CreditScoreRange is constant

1.6 Multivariate Exploration

Create plots of three or more variables to investigate your data even further. Make sure that your investigations are justified, and follow from your work in the previous sections.

Question #15

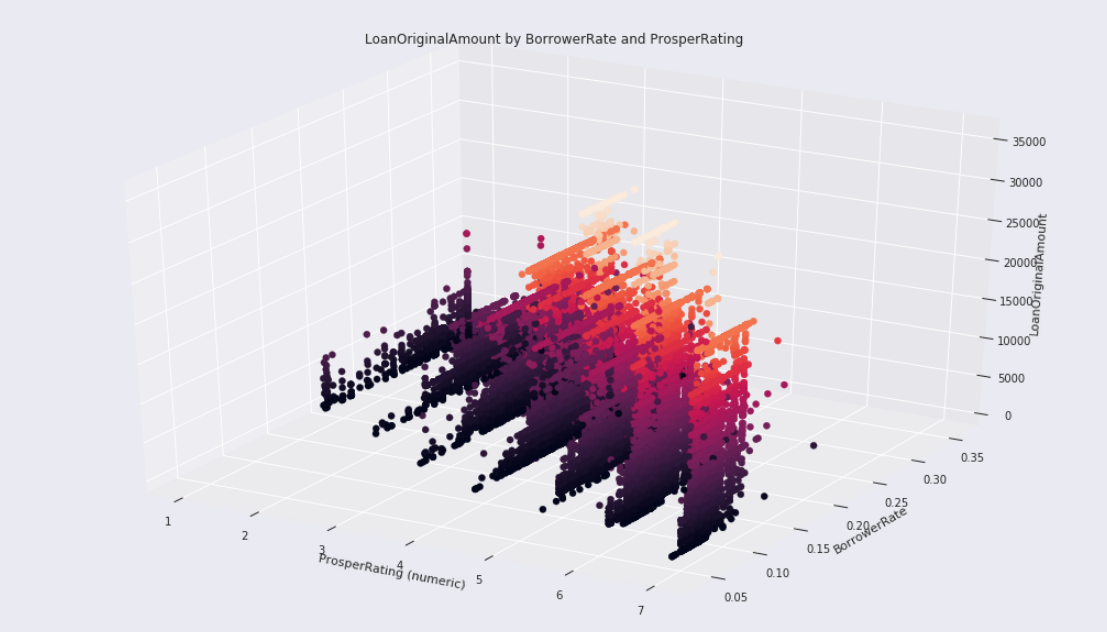
How ProsperRating and BorrowerRate influence LoanOriginalAmount?

Visualization

In [36]:
```
# LoanOriginalAmount by BorrowerRate and ProsperRating
from mpl_toolkits.mplot3d import Axes3D

plt.rcParams["figure.figsize"] = [14.00, 8.00]
plt.rcParams["figure.autolayout"] = True
fig = plt.figure()
ax = Axes3D(fig)
x = loan_data_clean['ProsperRating (numeric)']
y = loan_data_clean.BorrowerRate
z = loan_data_clean.LoanOriginalAmount
ax.scatter3D(x, y, z, c=z, alpha=1, marker='.', s=150);
plt.xlabel('ProsperRating (numeric)')
plt.ylabel('BorrowerRate')
ax.set_zlabel('LoanOriginalAmount')
plt.title('LoanOriginalAmount by BorrowerRate and ProsperRating')
plt.show();
```

```
/opt/conda/lib/python3.6/site-packages/matplotlib/figure.py:1999: UserWarning: This figure inclu
  warnings.warn("This figure includes Axes that are not compatible "
```



Observation

Borrowers who have good prosper rating have an opportunity to avail lower borrower rates and at the same time, they can take higher loans.

1.6.1 Talk about some of the relationships you observed in this part of the investigation. Were there features that strengthened each other in terms of looking at your feature(s) of interest?

Borrowers who have good prosper rating have an opportunity to avail lower borrower rates and at the same time, they can take higher loans.

1.7 Conclusions

Borrowers who have good prosper rating have an opportunity to avail lower borrower rates and at the same time, they can take higher loans.

ProsperScore, ProsperRating,EstimatedReturn, EstimatedLoss, EstimatedEffectiveYield, LenderYield, BorrowerRate, and BorrowerAPR are strongly correlated between each other.

ProsperRating is highly dependent on LoanOriginalAmount.

BorrowerRate and BorrowerAPR are dependent on ProsperRating.

LoanOriginalAmount is dependent on EmploymentStatus.