

# Exploring Numerical Quantities

This lesson will focus on exploring the numerical quantities and finding out general trends from these quantities.

## WE'LL COVER THE FOLLOWING ^

- Scatter plots
- Binning numerical data
  - AGE
- Quiz

A very important part of exploratory data analysis is finding out general trends or patterns in the data. We can find out different relationships between two quantities that can be very helpful in making decisions at the end. We will use the cleaned version of the dataset from the lesson [Inconsistent Data](#). The details of individual columns are mentioned below.

```
# Default of Credit Card Clients Dataset
# There are 25 variables:

# ID: ID of each client
# LIMIT_BAL: Amount of given credit in NT dollars (includes individual and family/supplemental)
# GENDER: Gender (male,female)
# EDUCATION: (1=graduate school, 2=university, 3=high school, 4=others)
# MARRIAGE: Marital status (married, single, others)
# AGE: Age in years
# PAY_1: Repayment status in September, 2005 (0=pay duly, 1=payment delay for one month, 2=payment delay for two months, 3=payment delay for three months, 4=payment delay for four months, 5=payment delay for five months, 6=payment delay for six months, 7=payment delay for seven months, 8=payment delay for eight months, 9=payment delay for nine months, 10=payment delay for ten months, 11=payment delay for eleven months, 12=payment delay for twelve months, 13=payment delay for thirteen months, 14=payment delay for fourteen months, 15=payment delay for fifteen months, 16=payment delay for sixteen months, 17=payment delay for seventeen months, 18=payment delay for eighteen months, 19=payment delay for nineteen months, 20=payment delay for twenty months, 21=payment delay for twenty one months, 22=payment delay for twenty two months, 23=payment delay for twenty three months, 24=payment delay for twenty four months, 25=payment delay for twenty five months, 26=payment delay for twenty six months, 27=payment delay for twenty seven months, 28=payment delay for twenty eight months, 29=payment delay for twenty nine months, 30=payment delay for thirty months, 31=payment delay for thirty one months, 32=payment delay for thirty two months, 33=payment delay for thirty three months, 34=payment delay for thirty four months, 35=payment delay for thirty five months, 36=payment delay for thirty six months, 37=payment delay for thirty seven months, 38=payment delay for thirty eight months, 39=payment delay for thirty nine months, 40=payment delay for forty months, 41=payment delay for forty one months, 42=payment delay for forty two months, 43=payment delay for forty three months, 44=payment delay for forty four months, 45=payment delay for forty five months, 46=payment delay for forty six months, 47=payment delay for forty seven months, 48=payment delay for forty eight months, 49=payment delay for forty nine months, 50=payment delay for fifty months, 51=payment delay for fifty one months, 52=payment delay for fifty two months, 53=payment delay for fifty three months, 54=payment delay for fifty four months, 55=payment delay for fifty five months, 56=payment delay for fifty six months, 57=payment delay for fifty seven months, 58=payment delay for fifty eight months, 59=payment delay for fifty nine months, 60=payment delay for sixty months, 61=payment delay for sixty one months, 62=payment delay for sixty two months, 63=payment delay for sixty three months, 64=payment delay for sixty four months, 65=payment delay for sixty five months, 66=payment delay for sixty six months, 67=payment delay for sixty seven months, 68=payment delay for sixty eight months, 69=payment delay for sixty nine months, 70=payment delay for seventy months, 71=payment delay for seventy one months, 72=payment delay for seventy two months, 73=payment delay for seventy three months, 74=payment delay for seventy four months, 75=payment delay for seventy five months, 76=payment delay for seventy six months, 77=payment delay for seventy seven months, 78=payment delay for seventy eight months, 79=payment delay for seventy nine months, 80=payment delay for eighty months, 81=payment delay for eighty one months, 82=payment delay for eighty two months, 83=payment delay for eighty three months, 84=payment delay for eighty four months, 85=payment delay for eighty five months, 86=payment delay for eighty six months, 87=payment delay for eighty seven months, 88=payment delay for eighty eight months, 89=payment delay for eighty nine months, 90=payment delay for ninety months, 91=payment delay for ninety one months, 92=payment delay for ninety two months, 93=payment delay for ninety three months, 94=payment delay for ninety four months, 95=payment delay for ninety five months, 96=payment delay for ninety six months, 97=payment delay for ninety seven months, 98=payment delay for ninety eight months, 99=payment delay for ninety nine months, 100=payment delay for one hundred months)
# PAY_2: Repayment status in August, 2005 (scale same as above)
# PAY_3: Repayment status in July, 2005 (scale same as above)
# PAY_4: Repayment status in June, 2005 (scale same as above)
# PAY_5: Repayment status in May, 2005 (scale same as above)
# PAY_6: Repayment status in April, 2005 (scale same as above)
# BILL_AMT1: Amount of bill statement in September, 2005 (NT dollar)
# BILL_AMT2: Amount of bill statement in August, 2005 (NT dollar)
# BILL_AMT3: Amount of bill statement in July, 2005 (NT dollar)
# BILL_AMT4: Amount of bill statement in June, 2005 (NT dollar)
# BILL_AMT5: Amount of bill statement in May, 2005 (NT dollar)
# BILL_AMT6: Amount of bill statement in April, 2005 (NT dollar)
# PAY_AMT1: Amount of previous payment in September, 2005 (NT dollar)
# PAY_AMT2: Amount of previous payment in August, 2005 (NT dollar)
# PAY_AMT3: Amount of previous payment in July, 2005 (NT dollar)
# PAY_AMT4: Amount of previous payment in June, 2005 (NT dollar)
```

```
# PAY_AMT5: Amount of previous payment in May, 2005 (NT dollar)
# PAY_AMT6: Amount of previous payment in April, 2005 (NT dollar)
# default.payment.next.month: Default payment (yes,no)
```

## Scatter plots #

Scatter Plots are a very useful way of visualizing the *inverse* and *direct* relationships between two variables. In a **direct** relationship between two quantities, an *increase/decrease* in one quantity leads to a corresponding *increase/decrease* in the other quantity, whereas in an **inverse** relationship, an *increase/decrease* in one quantity leads to a corresponding *increase/decrease* in the other quantity.

However, in real data, we do not observe strict direct or inverse relationships, rather we observe relationships or patterns that look like direct or linear relationships because there are many external factors that affect a quantity.

```
import pandas as pd
import matplotlib.pyplot as plt
df = pd.read_csv('credit_card_cleaned.csv')

# Filter dataset
cols_to_select = ['BILL_AMT1', 'BILL_AMT2', 'BILL_AMT3', 'BILL_AMT4', 'BILL_AMT5', 'BILL_AMT6', 'LIMIT_BAL']
df = df[cols_to_select]

# Scatter plots
pd.scatter_matrix(df, figsize = (15,15))
plt.show()
```

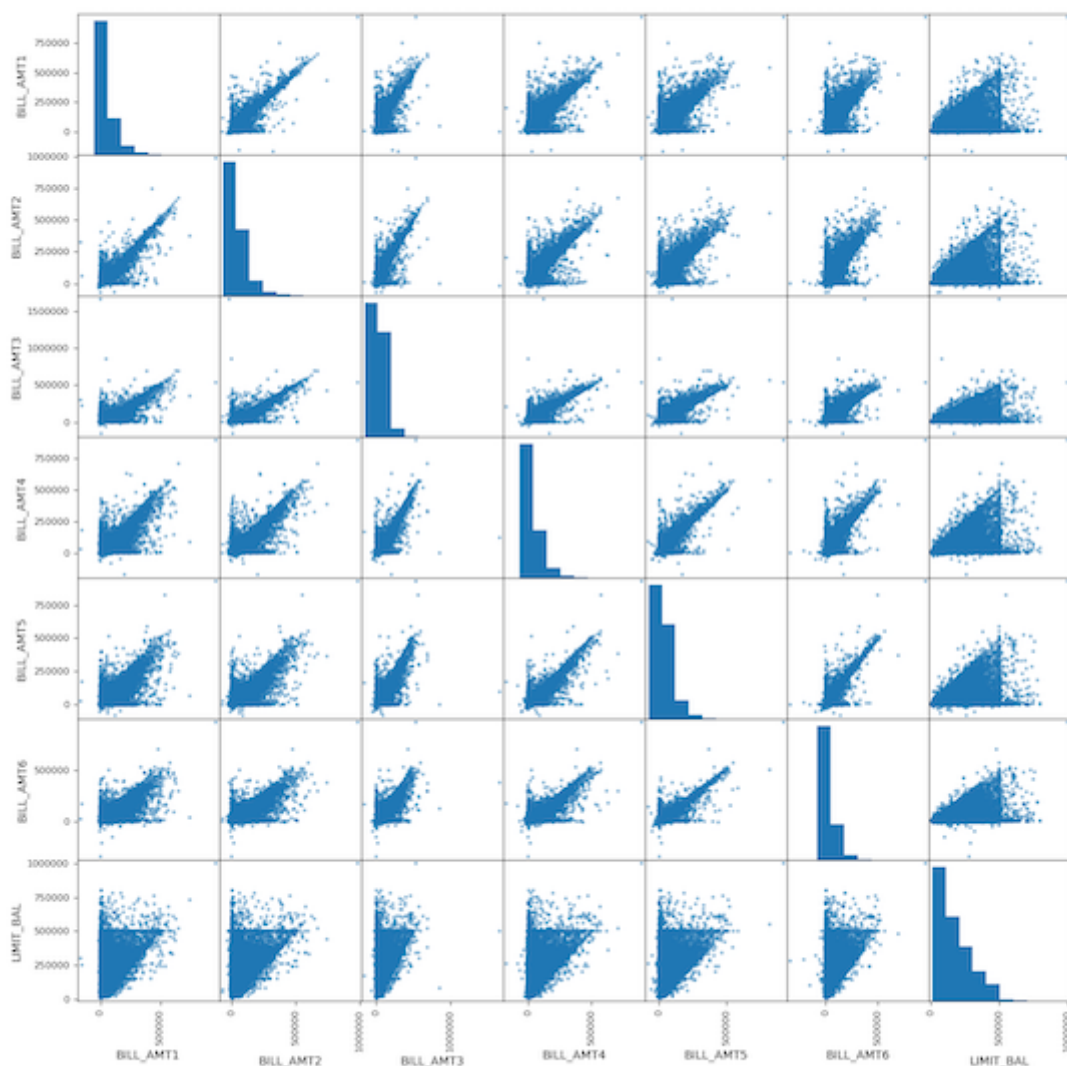


We are interested in finding out the spending habits of people from month to month, whether they generally spend the same every month, or if there are some months in which they spend extra, and how the amount of credit given ( **LIMIT\_BAL** ) varies with the bills.

We write the billed amount columns ( **BILL\_AMT1** , **BILL\_AMT2** ,...) and **LIMIT\_BAL** in **line 6** in a list, and filter using this list in **line 7**. Then we use the pandas function **scatter\_matrix** in **line 8** which draws the scatter plots between all the variables in the dataframe.

Keep in mind that **scatter\_matrix** is not a function that is called on a dataframe. Rather it is provided a dataframe as an argument

dataframe. Rather it is provided a dataframe as an argument.



By looking at the last row of the scatter matrix, we can see that there is a kind of linear relationship between `LIMIT_BAL` and all other bill amount variables. As we increase the bill amounts, the credit given is increased. This means that the bank gives more credit to people who spend more usually. But there are a few exceptions that can be seen from the plots. There are a few people who spend very little yet are given high credits.

Another observation that we can make from the scatter matrix is that as we increase the amount of bills in a month, we are likely to see an increase in the amount of bills the next month. For instance, look at the plot where `BILL_AMT6` (The amount of Bills in April 2005) is at the x-axis and `BILL_AMT5` (The amount of Bills in May 2005) is at the y-axis. We see a pattern similar to a direct relationship. We can see the same pattern between `BILL_AMT5` and `BILL_AMT4`,

`BILL_AMT4` and `BILL_AMT3` and so on. This tells us that people usually spend

similar amounts of money in these months and if they spend a certain amount in one month, they are expected to spend similar amounts in the next month.

## Binning numerical data #

We can divide our numerical data in bins and see how many people in each bin default.

`AGE` #

```
import pandas as pd
import matplotlib.pyplot as plt
df = pd.read_csv('credit_card_cleaned.csv')

# Create bins and data in bins
custom_bins = [20,25,30,35,40,45,50,55,60,65,70,75,80]
binned = pd.cut(df['AGE'],bins = custom_bins)
print(binned.head())
df['AGE_BIN'] = binned

# Group using bins
grouped_df = df.groupby(['AGE_BIN', 'default.payment.next.month']).size()
grouped_df = grouped_df.unstack()

print(grouped_df)

# Calculate probabilities
grouped_df['prob_default'] = grouped_df['yes'] / (grouped_df['no'] + grouped_df['yes'])

print('\n\n',grouped_df[['prob_default']])

# Plot probabilities
grouped_df['prob_default'].plot(kind = 'bar',figsize = (15,15))

plt.show()
```



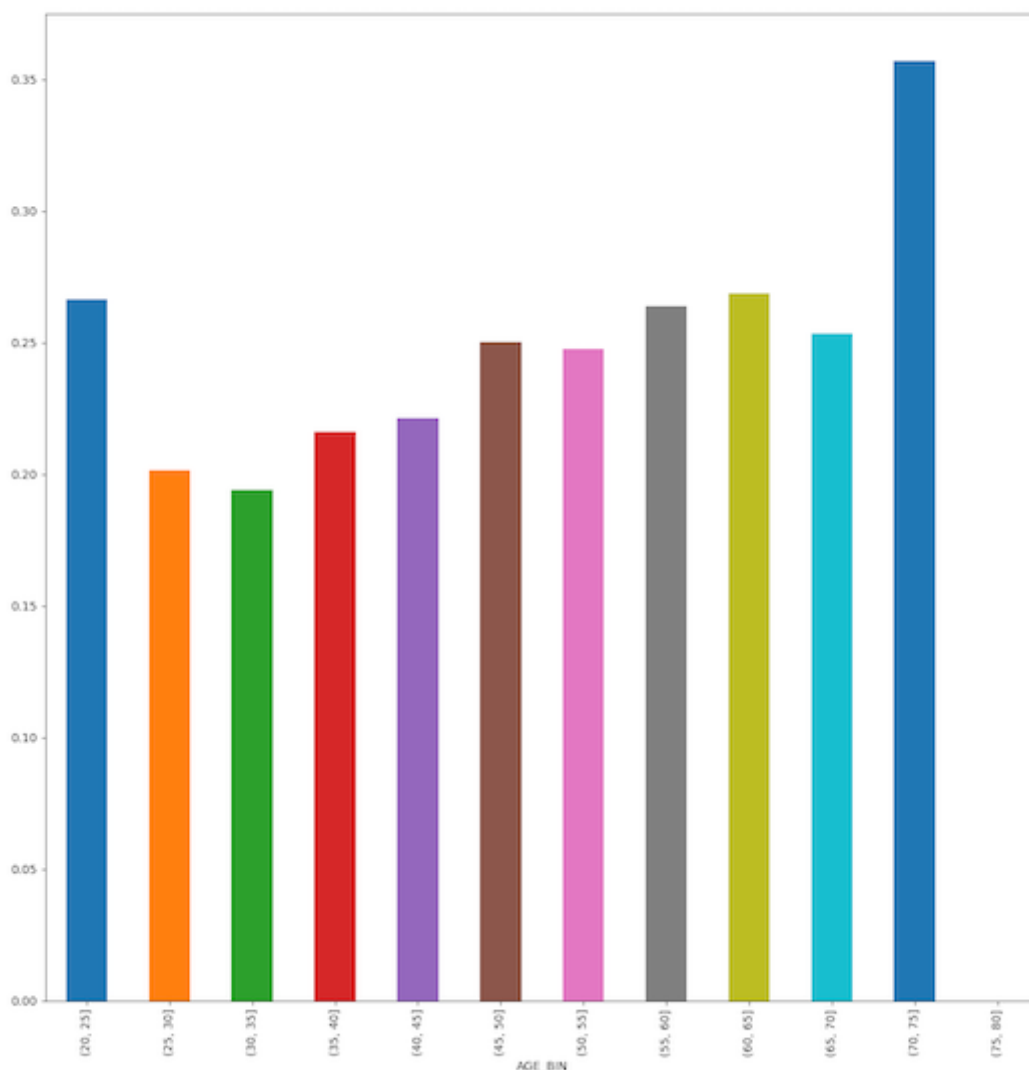
We divide the ages into bins. We use the pandas function `cut` and give it the column that we want to divide as the first argument, and give the bins we made as `bins = custom_bins` in **line 7**. This gives us a series in which we have the age bin against every row. We then add this to our dataframe as a new column (`AGE_BIN`) in **line 9**. Now we have both `AGE` and `AGE_BIN` for every row in the dataset.

After this, we group the data by `AGE_BIN` and `default.payment.next.month`, and

call `size()` on the groups to obtain the number of default and non-defaults in

each age bin in **line 12**. After this, we use the function `unstack` to change the groups into a dataframe and name the columns as `yes` and `no`.

Then, we calculate the probability of defaulting for each age bin using the simple formula we used in the last lesson in **line 18** and save these as a new column in the dataset named `prob_default`. We plot the probabilities of each age group defaulting in **line 23**.



From the plot of the probabilities for defaulting in each age group, it is visible that very young people and very old people are more likely to default.

## Quiz #

You have a quiz below. You are also provided an empty code window. You

have to answer the quiz questions by writing code and finding answers to the questions.

```
import pandas as pd
df = pd.read_csv('credit_card_cleaned.csv')
```

# Write your code here



1

How many people lie in the interval (0, 100000] of **LIMIT\_BAL** who have defaulted?

COMPLETED 0%

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These were some techniques to explore numerical data. There is another mathematical way of exploring the relationships between quantities known as *correlation* which we will study in the next lesson.