DATA SOCIETY

Intro to Visualization in Python - Static Plots - 1

One should look for what is and not what he thinks should be. (Albert Einstein)

Module completion checklist

Objective	Complete
Prepare data for visualization	
Create histograms, boxplots, and bar charts	

Visualizing data with matplotlib

- `matplotlib` is a popular plotting library among scientists and data analysts
- It is one of the older Python plotting libraries, so it has become quite flexible and ***well-documented (link)***
- Other plotting libraries include `Seaborn` (which is built on `matplotlib`), `ggplot` (the Python version of the popular R plotting library), `Plotly`, `Bokeh`, and many others
- `Pandas` also come with some plotting capabilities, and these are just based on `matplotlib`
- Explore the different types of plots that can be created with `matplotlib` by browsing the ***gallery (link)***

Loading packages

- Load the packages:

```python
import pandas as pd
import numpy as np
import pickle
import os
from pathlib import Path
```

Directory settings

- In order to maximize the efficiency of the workflow, encode the directory structure into `variables`
- Use the `pathlib` library
- The `main_dir` is the variable corresponding to the `course` folder
- The `data_dir` is the variable corresponding to the `data` folder

```
# Set 'main_dir' to location of the project folder
home_dir = Path(".").resolve()
main_dir = home_dir.parent.parent
print(main_dir)
```

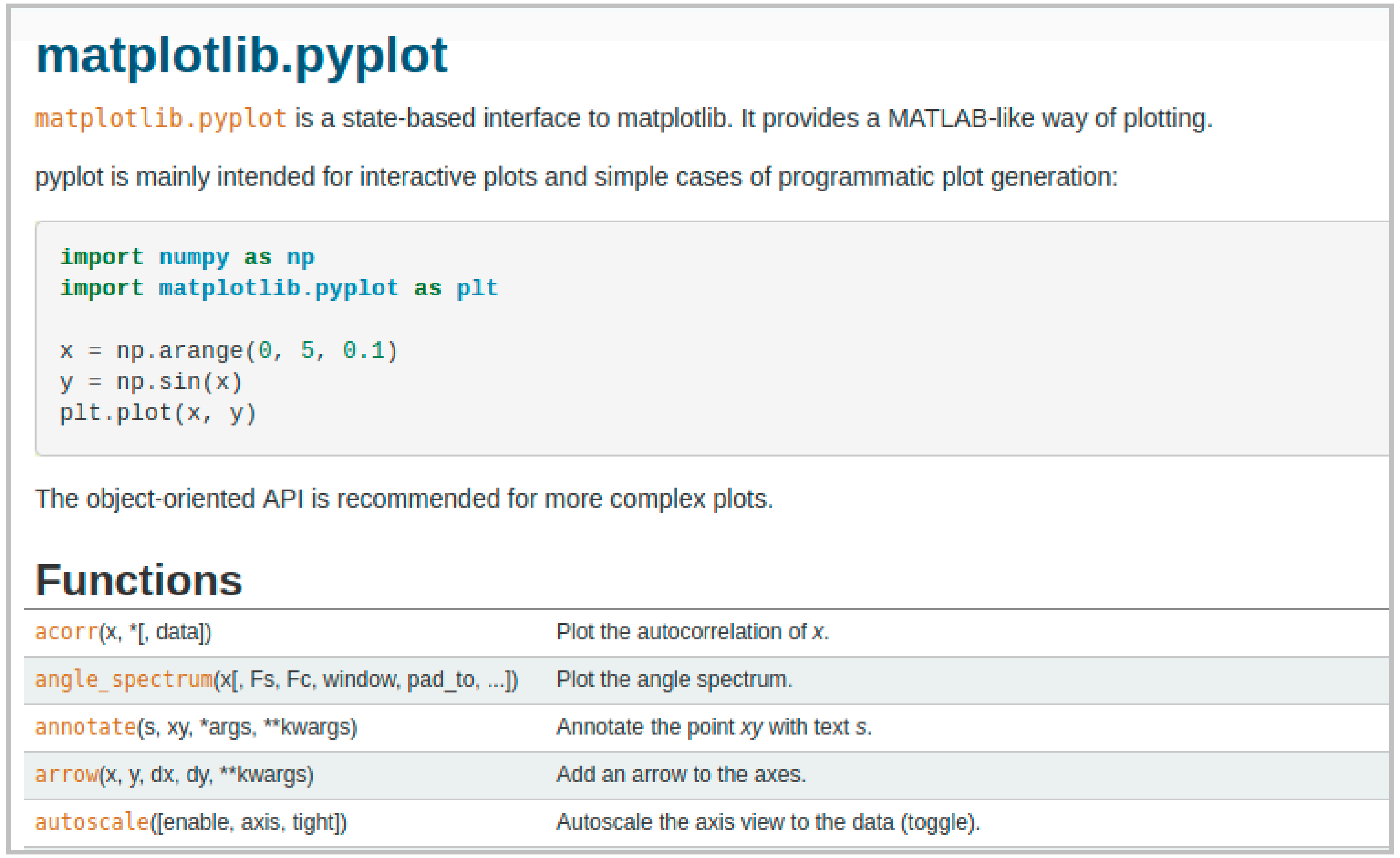
```
data_dir = str(main_dir) + "/data"
print(data_dir)
```

```
plot_dir = str(main_dir) + "/plots"
if not os.path.exists(plot_dir):
    os.makedirs(plot_dir)
print(plot_dir)
```

Importing matplotlib

- Import `pyplot` as `plt` so that `plt.[any_function]()` with appropriate arguments to create a plot
- The `pyplot` module of the `matplotlib` library has a large and diverse set of functions
- It allows the ability to create pretty much any conceivable visualization out there
- See the documentation on `pyplot` *here(link)*

```python
import matplotlib.pyplot as plt
```



matplotlib.pyplot

`matplotlib.pyplot` is a state-based interface to matplotlib. It provides a MATLAB-like way of plotting.

pyplot is mainly intended for interactive plots and simple cases of programmatic plot generation:

```python
import numpy as np
import matplotlib.pyplot as plt

x = np.arange(0, 5, 0.1)
y = np.sin(x)
plt.plot(x, y)
```

The object-oriented API is recommended for more complex plots.

Functions

`acorr`(x, *[, data])	Plot the autocorrelation of *x*.
`angle_spectrum`(x[, Fs, Fc, window, pad_to, ...])	Plot the angle spectrum.
`annotate`(s, xy, *args, **kwargs)	Annotate the point *xy* with text *s*.
`arrow`(x, y, dx, dy, **kwargs)	Add an arrow to the axes.
`autoscale`([enable, axis, tight])	Autoscale the axis view to the data (toggle).

Dataset for visualization

- Load the dataset and save it as `df`

```
# This dataset is of type dataframe. Let's assign this dataset to a variable, so that we can
manipulate it freely.
df = pd.read_csv(str(data_dir)+"/"+ "diabetes.csv")
```

```
print(type(df))  #<- a Pandas DataFrame!
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
print(len(df))   #<- returns the number of rows
```

```
768
```

Subsetting data

- Create a subset of the data so that the variables needed are present
- Name this subset as `df_subset`

```
df_subset = df[['DiabetesPedigreeFunction', 'Glucose', 'BloodPressure', 'Age', 'SkinThickness',
'BMI', 'Insulin', 'Outcome', 'Pregnancies']]
print(df_subset.head())
```

```
   DiabetesPedigreeFunction  Glucose  BloodPressure  Age  SkinThickness   BMI  Insulin
Outcome  Pregnancies
0                     0.627      148             72   50             35  33.6        0
1            6
1                     0.351       85             66   31             29  26.6        0
0            1
2                     0.672      183             64   32              0  23.3        0
1            8
3                     0.167       89             66   21             23  28.1       94
0            1
4                     2.288      137             40   33             35  43.1      168
1            0
```

- These variables are choosen because they illustrate the concepts best
- However, you should be able to work with (and visualize) all of your data

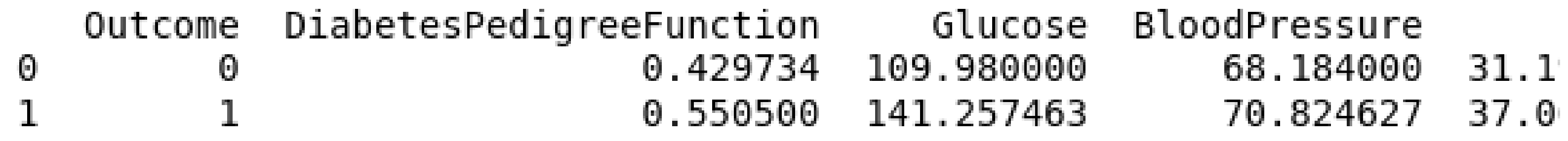
Data reshaping: wide vs. long

- Talking about data reshaping usually refers to converting between what is called either **wide** or **long** data formats
  - **Wide** data is much more visually digestible, which is why it’s more common when using data from some type of report
  - **Long** data is much easier to work with in Pandas, and generally speaking in most data analysis and plotting tools

Data reshaping: wide vs long (cont’d)

- **Wide data** often appears when the values are some type of aggregate (we will use the `mean` of groups)

- Let’s make a typical **wide dataframe** of two rows and eight columns that looks like this:



```
   Outcome  DiabetesPedigreeFunction     Glucose  BloodPressure
0        0                  0.429734  109.980000      68.184000  31.1
1        1                  0.550500  141.257463      70.824627  37.0
```

Prepare data: group and summarize

- After grouping and summarizing data, create a summary dataset that will include the following:
    - Grouped data by `Target` variable
    - Mean value computed on the grouped data that includes the following variables:
        - `DiabetesPedigreeFunction`
        - `Glucose`
        - `BloodPressure`
        - `Age`
        - `SkinThickness`
        - `BMI`
        - `Insulin`

Prepare data: group and summarize (cont’d)

- For demonstration, use the original dataframe `df` to identify the grouping column
- Then use this column to perform the groupby operation and find the mean of the columns present in `df_subset`

```
col_dict = df_subset.nunique().to_dict()
grouping_col = min(col_dict, key=col_dict.get)
# Group data by variable with min levels.
grouped = df_subset.groupby(grouping_col)
```

```
# Compute mean on the listed variables using the grouped data.
df_grouped_mean = grouped.mean()[['DiabetesPedigreeFunction', 'Glucose', 'BloodPressure', 'Age',
'SkinThickness', 'BMI', 'Insulin']]
print(df_grouped_mean)
```

```
         DiabetesPedigreeFunction     Glucose  BloodPressure        Age  SkinThickness
BMI      Insulin
Outcome
0                        0.429734  109.980000      68.184000  31.190000      19.664000
30.304200   68.792000
1                        0.550500  141.257463      70.824627  37.067164      22.164179
35.142537  100.335821
```

Prepare data: group and summarize (cont’d)

```
# Reset index of the dataset.
df_grouped_mean = df_grouped_mean.reset_index()
print(df_grouped_mean)
```

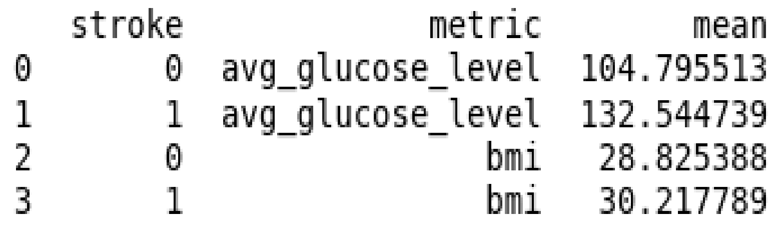
```
   Outcome  DiabetesPedigreeFunction     Glucose  BloodPressure        Age  SkinThickness
BMI     Insulin
0        0                  0.429734  109.980000      68.184000  31.190000      19.664000
30.304200   68.792000
1        1                  0.550500  141.257463      70.824627  37.067164      22.164179
35.142537  100.335821
```

- This dataframe is considered **wide** because each variable has its own column
- It makes the table easier to present, but inconvenient to run analyses on or visualize

Why long?

- Now convert this wide data to the **long format**
  - Leave the `categorical` variable and the mean values as is in their columns
  - All of other variables will appear as a single metric column

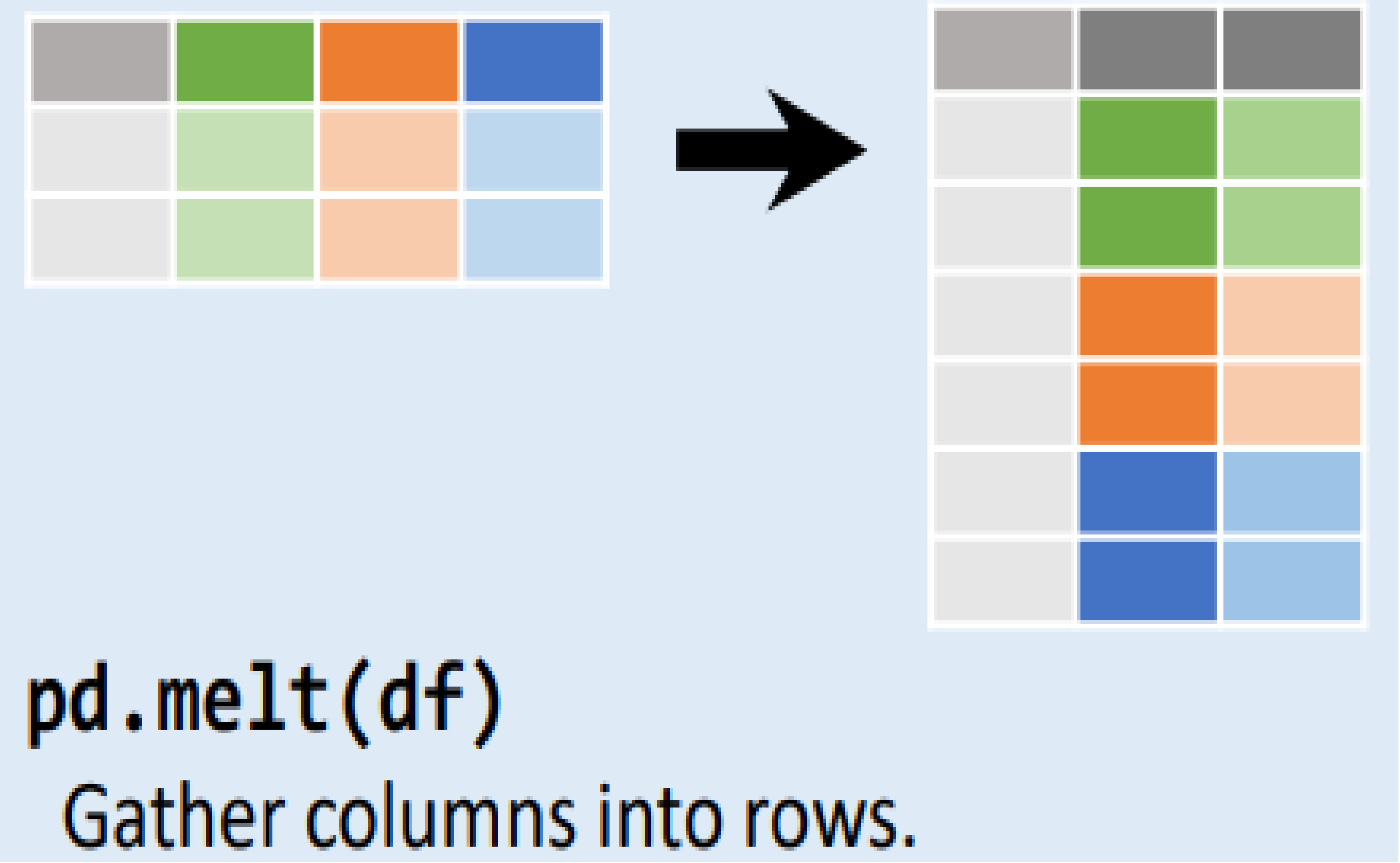
- This format is convenient to work with when running analysis and plot the data



```
   stroke           metric        mean
0       0  avg_glucose_level  104.795513
1       1  avg_glucose_level  132.544739
2       0                bmi   28.825388
3       1                bmi   30.217789
```

Wide to long format: melt

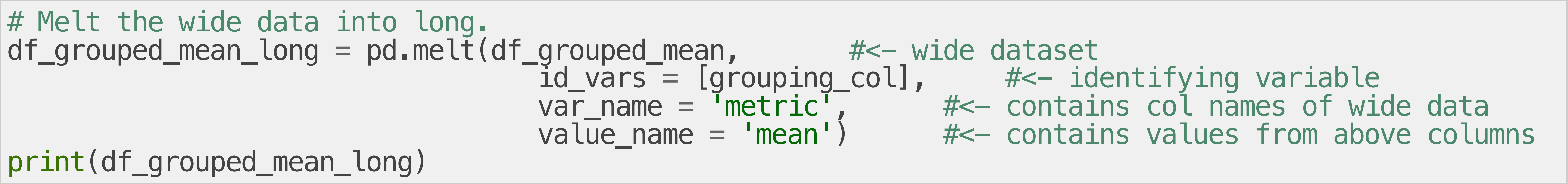
- To **convert from wide to long format**, use the Pandas `melt` function with the following arguments:
    1. Wide dataframe
    2. Variable(s) that will be preserved as the `ids` of the data (like categorical variables)
    3. Name of the variable that will now contain the column names from the wide data selected to melt together
    4. Name of the column that will contain respective values corresponding to the melted columns



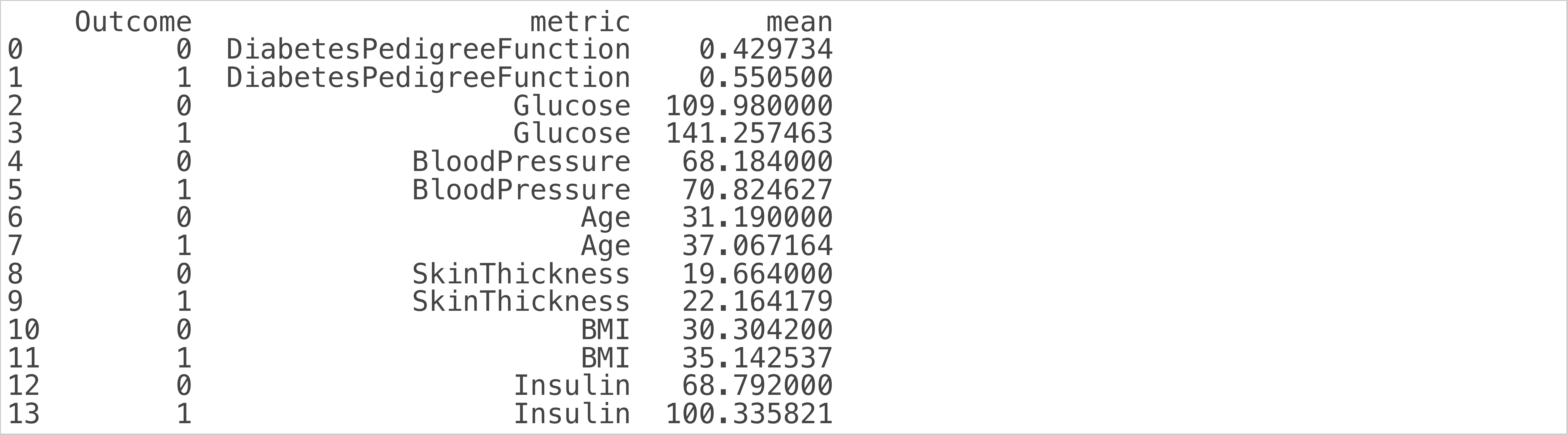
```
pd.melt(df)
```

Gather columns into rows.

Wide to long format: melt (cont’d)



```
# Melt the wide data into long.
df_grouped_mean_long = pd.melt(df_grouped_mean,       #<- wide dataset
                                  id_vars = [grouping_col],     #<- identifying variable
                                  var_name = 'metric',      #<- contains col names of wide data
                                  value_name = 'mean')      #<- contains values from above columns
print(df_grouped_mean_long)
```

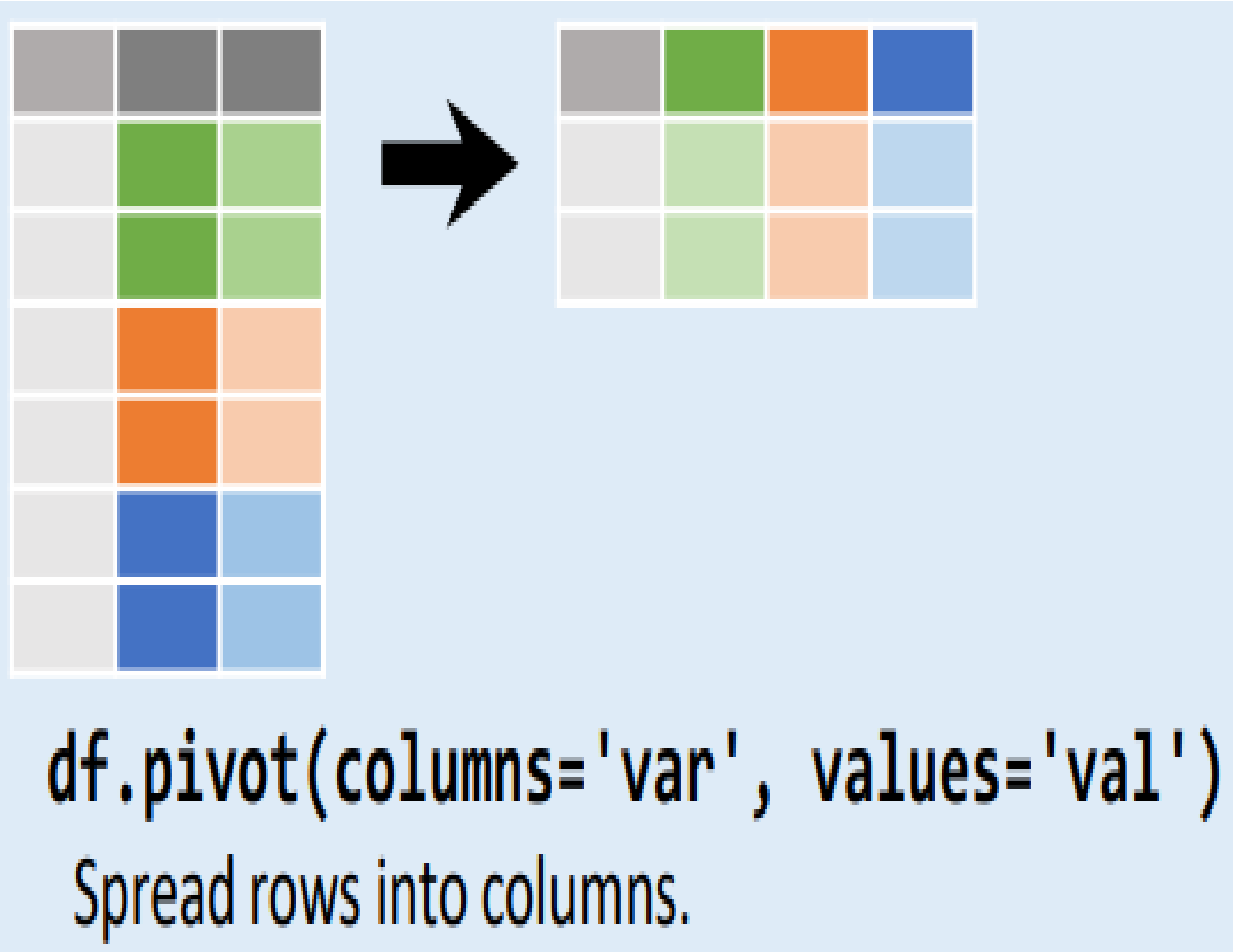


```
    Outcome                    metric        mean
0         0  DiabetesPedigreeFunction    0.429734
1         1  DiabetesPedigreeFunction    0.550500
2         0                   Glucose  109.980000
3         1                   Glucose  141.257463
4         0             BloodPressure   68.184000
5         1             BloodPressure   70.824627
6         0                       Age   31.190000
7         1                       Age   37.067164
8         0             SkinThickness   19.664000
9         1             SkinThickness   22.164179
10        0                       BMI   30.304200
11        1                       BMI   35.142537
12        0                   Insulin   68.792000
13        1                   Insulin  100.335821
```

Long to wide format: pivot

- Convert the **long data back to wide** format with the `.pivot()` method

1. The `index` argument refers to what values will become the `ids` in the new dataframe
2. The `columns` argument refers to the column in which its values will be converted to column names
3. Lastly, supply the `values` argument to fill in the values of the wide data



```
df.pivot(columns='var', values='val')
```

Spread rows into columns.

Long to wide format: pivot (cont’d)

```
# Melt the long data into wide.
df_grouped_mean_wide = df_grouped_mean_long.pivot(
                                                    index = [grouping_col],   #<- identifying
variable
                                                    columns = 'metric', #<- col names of wide data
                                                    values = 'mean')    #<- values from above
columns
print(df_grouped_mean_wide)
```

```
metric          Age        BMI  BloodPressure  DiabetesPedigreeFunction     Glucose
Insulin  SkinThickness
Outcome
0         31.190000   30.304200      68.184000                  0.429734  109.980000
68.792000       19.664000
1         37.067164   35.142537      70.824627                  0.550500  141.257463
100.335821       22.164179
```

Module completion checklist

Objective	Complete
Prepare data for visualization	✔
Create histograms, boxplots, and bar charts	

Univariate plots

- Univariate plots are used to **visualize the distribution of a single variable**

- They are mainly used in the initial stages of EDA when we want to learn more about individual variables in our data

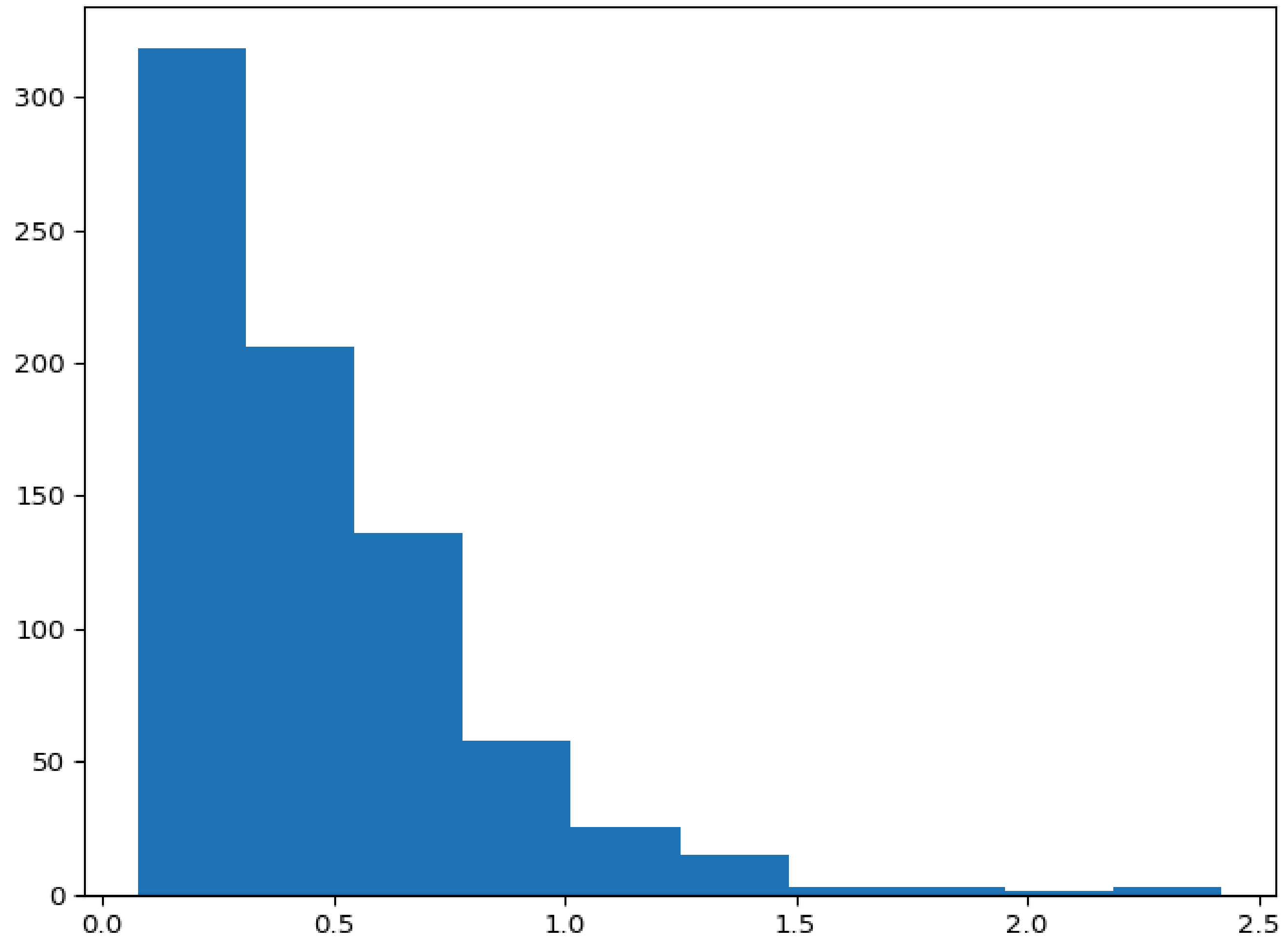
- They are also combined with other univariate plots to compare data distributions of different variables

- Univariate plots include the following popular graphs: `histogram`, `boxplot`, `density curve`, `dot plot`, `QQ plot`, and `bar plot`

Univariate plots: histogram

- A histogram represents the **distribution of numerical data**
- The height of each bar has been calculated as the number of observations in that range
- Use `plt.hist()` to produce a basic histogram of any numeric variable

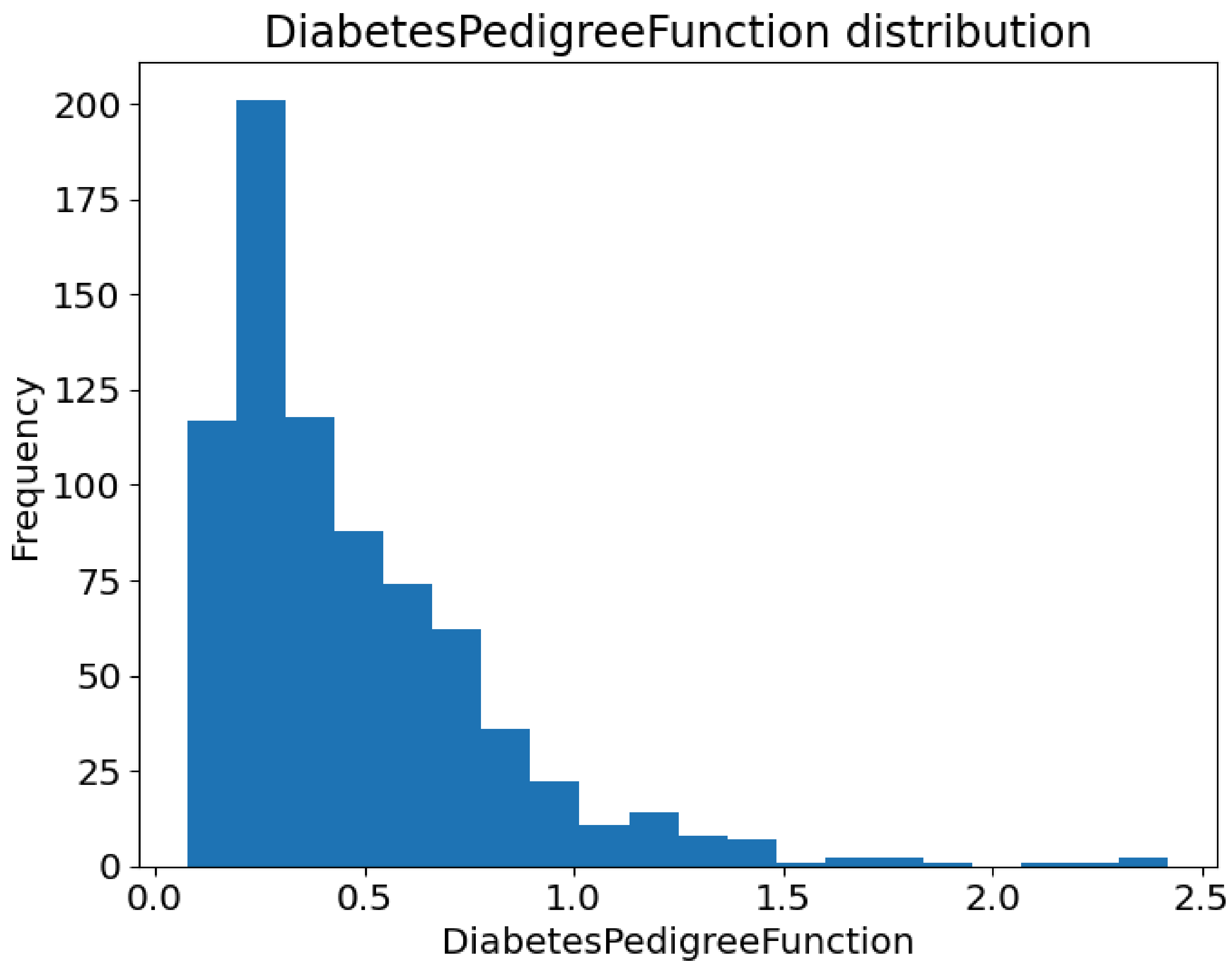
```
plt.rcParams.update({'font.size': 15})
plt.hist(df_subset['DiabetesPedigreeFunction'])
plt.show()
```



Univariate plots: histogram (cont’d)

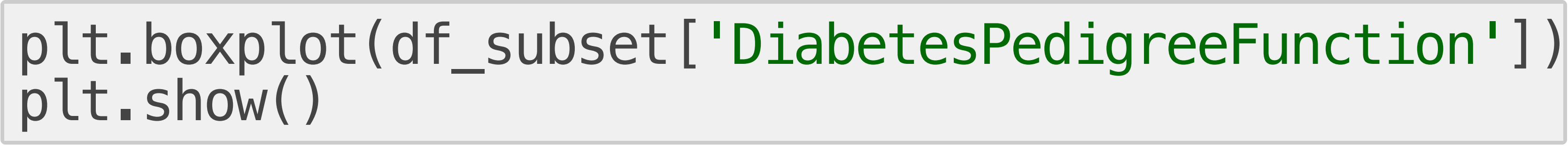
- Bins represent the intervals in which to group the observations
- Control the number of bins with the `bins` parameter
- As the **number of bins increases**, the range of values each bin represents decreases, and so does the height of the bar

```
plt.hist(df_subset['DiabetesPedigreeFunction'],
bins = 20)
plt.xlabel('DiabetesPedigreeFunction')       #<-
label x-axis
plt.ylabel('Frequency')      #<- label y-axis
plt.title('DiabetesPedigreeFunction
distribution')      #<- add plot title
plt.show()
```

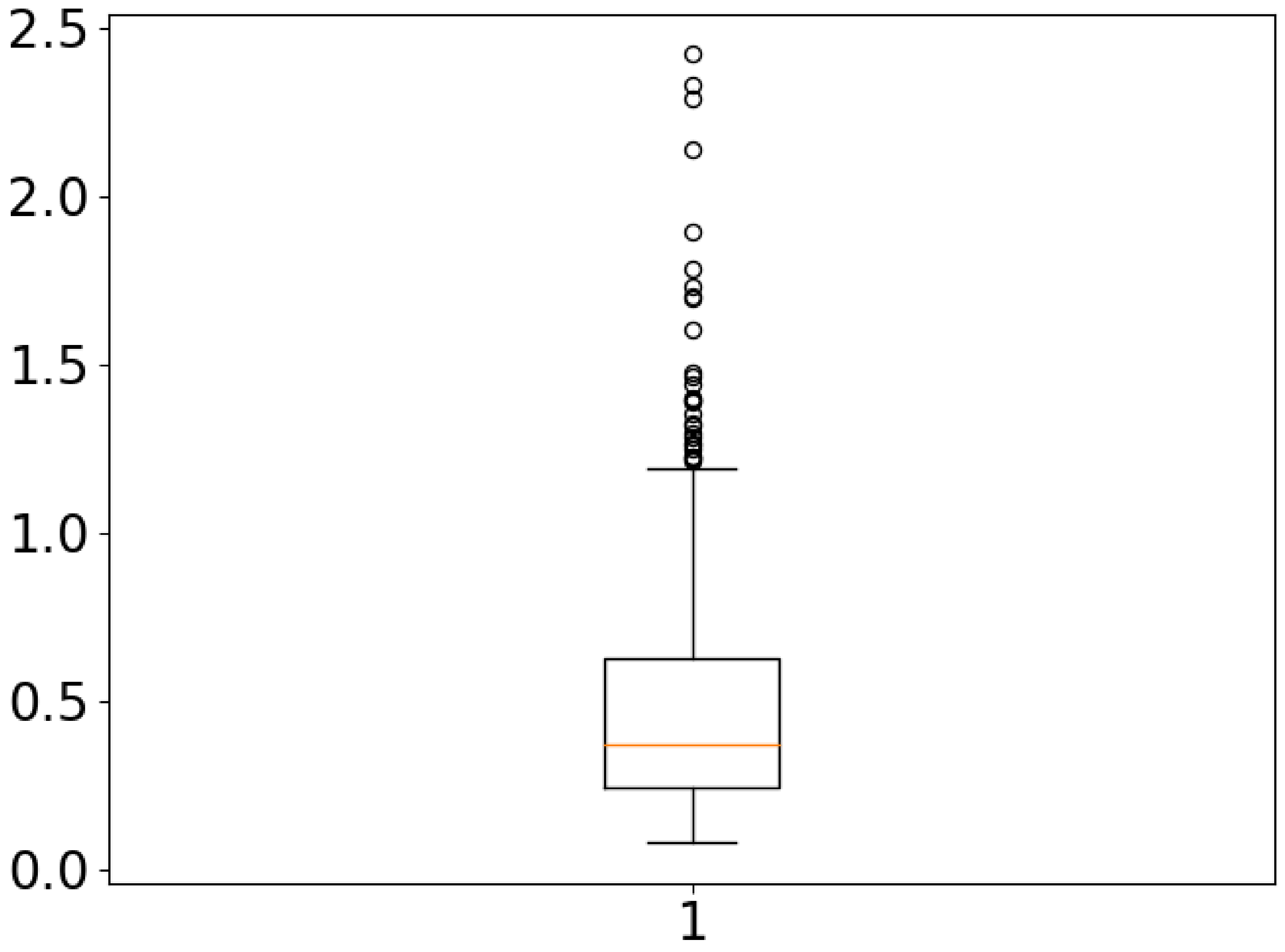


Univariate plots: boxplot

- A boxplot is a visual summary of the **25th, 50th, and 75th percentiles**
- The orange line shows the median of `ppl_total`
- The top and bottom of the box are the `25th` and `75th` percentile respectively
- The outermost lines are called the `whiskers`
- Values beyond whiskers are considered **outliers** - they are substantially outside the rest of the data



```
plt.boxplot(df_subset['DiabetesPedigreeFunction'])
plt.show()
```

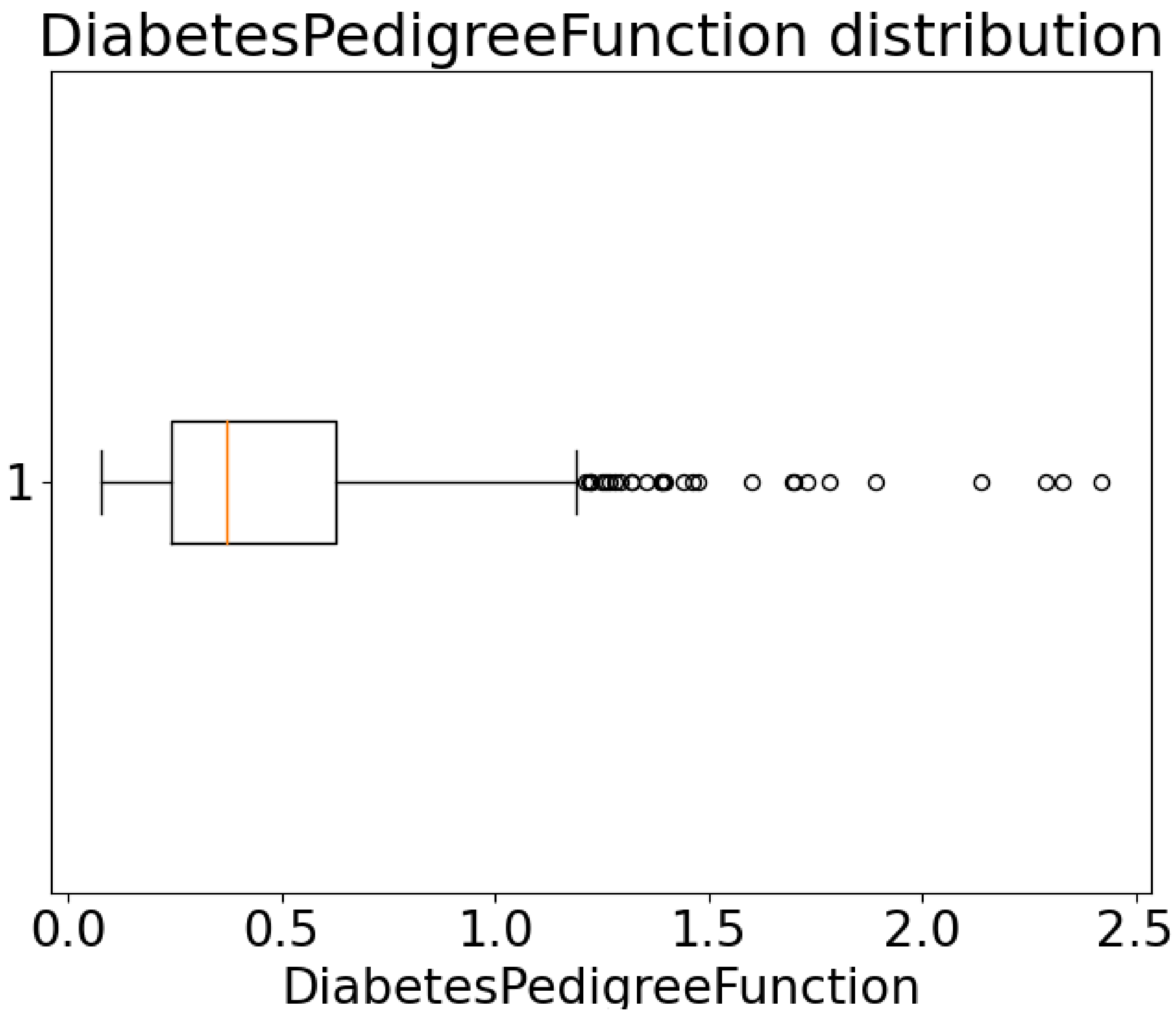


Univariate plots: boxplot (cont’d)

- The orientation of the plot can be set to horizontal by setting `vert = False`

- Answer in chat: By looking at this boxplot, what can be told about the **`'DiabetesPedigreeFunction'`** distribution in the data?

```
plt.boxplot(df_subset['DiabetesPedigreeFunction'],
vert = False)
plt.xlabel('DiabetesPedigreeFunction')       #
label x-axis
plt.title('DiabetesPedigreeFunction
distribution')      # add plot title
plt.show()
```



Univariate plots: bar chart

- A bar chart is a plot where the height of each bar represents **the numeric value of a category**

- Use `plt.bar()` to produce a basic histogram of **any categorical variable**

- Bar charts are most commonly used when visualizing survey data or summary data

- The general syntax for creating a bar chart consists of 3 main variables:
  - position of the bars on the `axis`
  - height of the bars
  - names of categories that are used to label the bars

Univariate plots: bar chart - cont’d

- When plotting bar charts of any complexity, the best type of data to use is **long data**
- First create a simple bar chart of the variable means using the `df_grouped_mean_long` data we created earlier

```
print(df_grouped_mean_long.head())
```

Univariate plots: bar chart - cont’d

- Next, filter `'Outcome'` by a category and only keep two columns: `metric` and `mean`

```
query = 'Outcome' + "==" + str('0')
df_true_means = df_grouped_mean_long.query(query)[['metric','mean']]
print(df_true_means)
```

Univariate plots: bar chart - cont’d

- Now, get the data needed and assign it to the three variables for convenience and clarity:

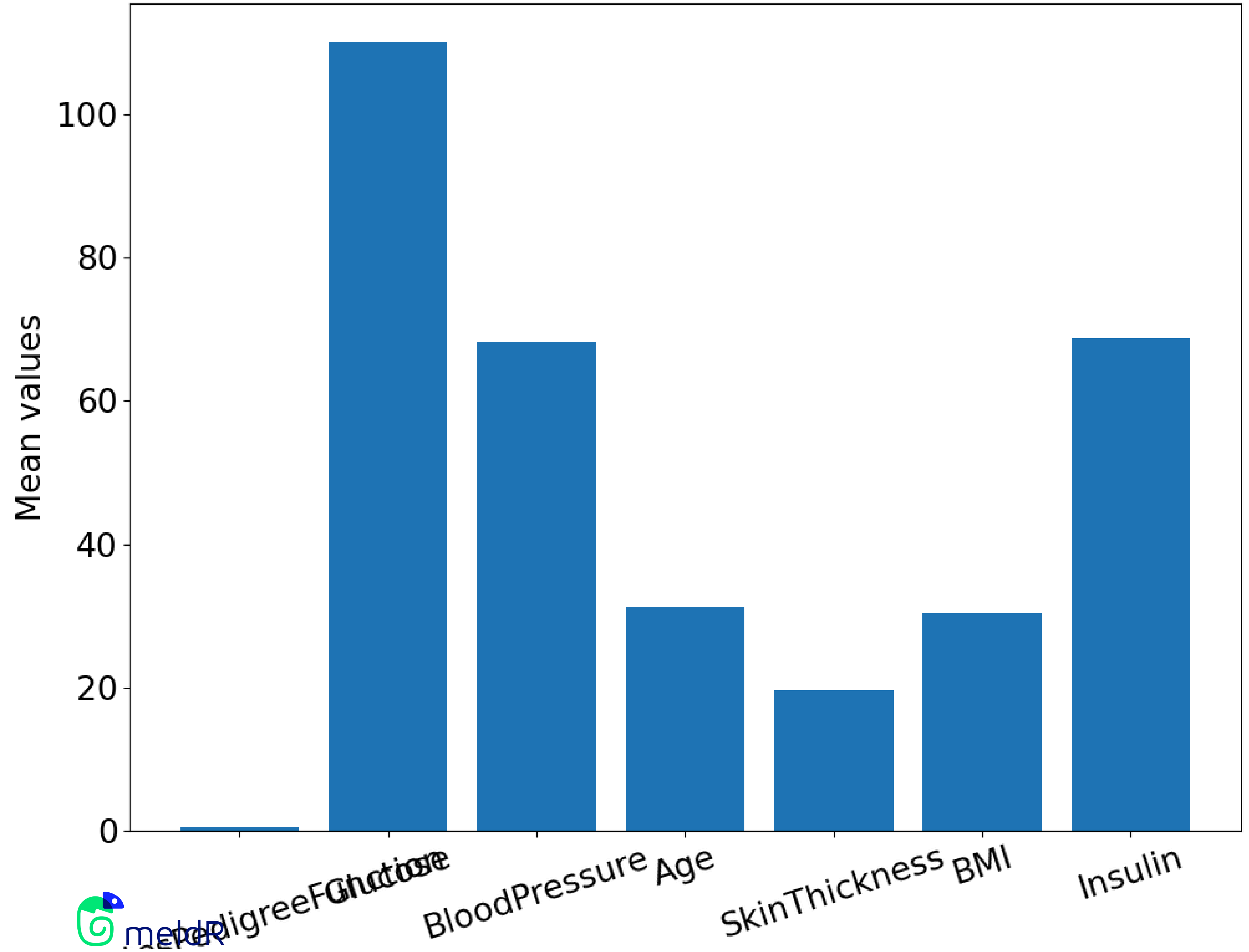
1. **Categories** (i.e., labels) that will represent each bar are all contained in the `metric` column
2. **Bar heights** are contained in the `mean` column for each of the 5 categories
3. **Bar positions** will be a range of numbers based on the number of categories (i.e., bars)

```
bar_labels = df_true_means['metric']     #<- 1
bar_heights = df_true_means['mean']      #<- 2
num_bars = len(bar_heights)
bar_positions = np.arange(num_bars)      #<- 3
```

Univariate plots: bar chart - cont’d

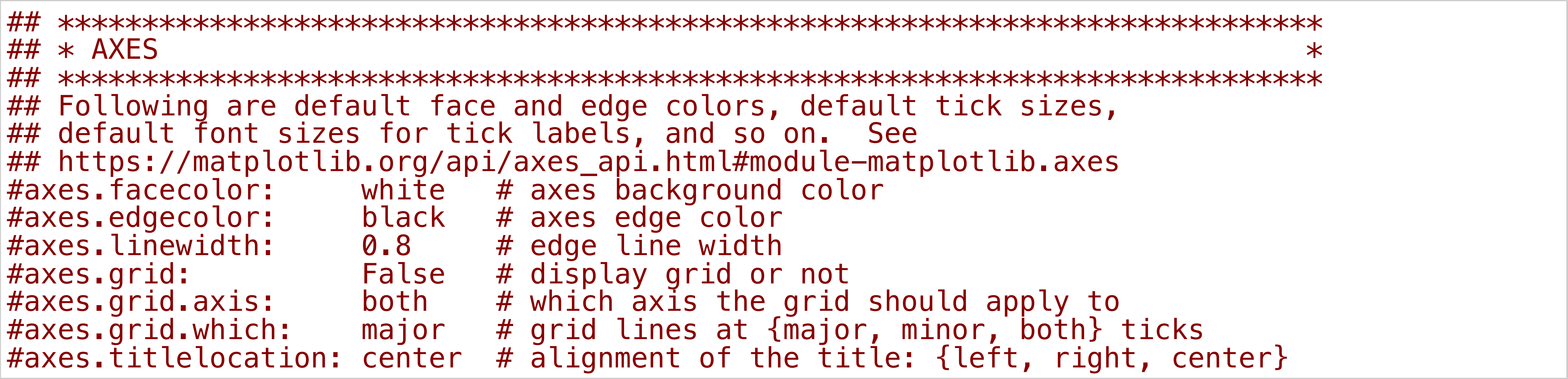
- Labels are tricky to fit sometimes, so either **adjust** the figure size or label orientation

```
plt.figure(figsize = (12, 9))
plt.bar(bar_positions, bar_heights)
plt.xticks(bar_positions,bar_labels,rotation = 18)
plt.ylabel('Mean values')
```



Customize anything

- All possible style customizations are available in a `matplotlibrc` file
- ***This sample (link)*** contains all of them, and any of those parameters can be passed to `rcParams` variable like we did earlier
- This sample contains a script of parameters and their default values
- Here's a part of that file with a sample of all parameters for modifying the style of the `axes`



```
## ***************************************************************************
## * AXES                                                                    *
## ***************************************************************************
## Following are default face and edge colors, default tick sizes,
## default font sizes for tick labels, and so on.  See
## https://matplotlib.org/api/axes_api.html#module-matplotlib.axes
#axes.facecolor:     white   # axes background color
#axes.edgecolor:     black   # axes edge color
#axes.linewidth:     0.8     # edge line width
#axes.grid:          False   # display grid or not
#axes.grid.axis:     both    # which axis the grid should apply to
#axes.grid.which:    major   # grid lines at {major, minor, both} ticks
#axes.titlelocation: center  # alignment of the title: {left, right, center}
```

Knowledge check

Module completion checklist

Objective	Complete
Prepare data for visualization	✔
Create histograms, boxplots, and bar charts	✔

Congratulations on completing this module!

You are now ready to try Tasks 1-13 in the Exercise for this topic