On the HOME tab click on the Import Data button and select the required spreadsheet file.

4 | WORKING WITH SPREADSHEETS

Script for importing data from the following spreadsheet:

```
Workbook: /Users/juanheinklopper/Documents/MATLAB/MATLAB for Data Science/Data/heart.xlsx
Worksheet: heart
```

Auto-generated by MATLAB on 10-Jun-2024 20:48:44

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Set up the Import Options and import the data

```
clear global
opts = spreadsheetImportOptions("NumVariables", 12);
% Specify sheet and range
opts.Sheet = "heart";
opts.DataRange = "A2:L919";
% Specify column names and types
opts.VariableNames = ["Age", "Sex", "ChestPainType", "RestingBP", "Cholesterol", "FastingBS", "RestingECG", "MaxHR", "Exercise
opts.VariableTypes = ["double", "categorical", "categorical", "double", "double", "double", "categorical", "double", "categori
% Specify file level properties
opts.ImportErrorRule = "error";
% Specify variable properties
opts = setvaropts(opts, ["Sex", "ChestPainType", "RestingECG", "ExerciseAngina", "ST_Slope"], "EmptyFieldRule", "auto");
opts = setvaropts(opts, ["Age", "RestingBP", "Cholesterol", "FastingBS", "MaxHR", "Oldpeak", "HeartDisease"], "TreatAsMissing"
% Import the data
heart = readtable("/Users/juanheinklopper/Documents/MATLAB/MATLAB for Data Science/Data/heart.xlsx", opts, "UseExcel", false);
% Add appropriate units
heart.Properties.VariableUnits = {'Years' '' '' 'mm Hg' 'mg/dL' 'mg/dL' '' 'beats/min' '' '' '' ''}
```

heart = 918×12 table

	Age	Sex	ChestPainType	RestingBP	Cholesterol
1	40	M	ATA	140	289
2	49	F	NAP	160	180
3	37	M	ATA	130	283
4	48	F	ASY	138	214
5	54	M	NAP	150	195
6	39	M	NAP	120	339
7	45	F	ATA	130	237
8	54	M	ATA	110	208
9	37	M	ASY	140	207
10	48	F	ATA	120	284
11	37	F	NAP	130	211
12	58	M	ATA	136	164
13	39	M	ATA	120	204
14	49	M	ASY	140	234
15	42	F	NAP	115	211
16	54	F	ATA	120	273
17	38	M	ASY	110	196
18	43	F	ATA	120	201
19	60	M	ASY	100	248
20	Age 36	M Sex	ATA ChestPainType	RestingBP 120	Cholesterol 267

	Age	Sex	ChestPainType	RestingBP	Cholesterol
21	43	F	TA	100	223
22	44	M	ATA	120	184
23	49	F	ATA	124	201
24	44	M	ATA	150	288
25	40	M	NAP	130	215
26	36	M	NAP	130	209
27	53	M	ASY	124	260
28	52	M	ATA	120	284
29	53	F	ATA	113	468
30	51	M	ATA	125	188
31	53	M	NAP	145	518
32	56	M	NAP	130	167
33	54	M	ASY	125	224
34	41	M	ASY	130	172
35	43	F	ATA	150	186
36	32	M	ATA	125	254
37	65	M	ASY	140	306
38	41	F	ATA	110	250
39	48	F	ATA	120	177
40	48	F	ASY	150	227
41	54	F	ATA	150	230
42	54	F	NAP	130	294
43	35	M	ATA	150	264
44	52	M	NAP	140	259
45	43	M	ASY	120	175
46	59	M	NAP	130	318
47	37	M	ASY	120	223
48	50	M	ATA	140	216
49	36	M	NAP	112	340
50	41	M	ASY	110	289
51	50	M	ASY	130	233
52	47	F	ASY	120	205
53	45	M	ATA	140	224
54	41	F	ATA	130	245
55	52	F	ASY	130	180
56	51	F	ATA	160	194
57	31	M	ASY	120	270
58	58	M	NAP	130	213
59	54	M	ASY	150	365
60	52	M	ASY	112	342
61	49	M	ATA	100	253
62	43	F	NAP	150	254
63	45	M	ASY	140	224
64	46	M	ASY	120	277
65	50	F	ATA	110	202
66	37	F	ATA	120	260
67	45	F	ASY	132	297
68	32	M	ATA	110	225
69	52	M	ASY	160	246
70	44	M	ASY	150	412
71	57	M	ATA	140	265
72	44	M	ATA	130	215
73	52	M	ASY	120	182
74	44	F	ASY	120	218
75	55	M	ASY	140	268
76	46	M	NAP	150	163
77	32	M	ASY	118	529
78	35	F	ASY	140	167
79	52	M	ATA	140	100
80	49	M	ASY	130	206
81	55	M	NAP	110	277

82	54	M	ATA	120	238
83	63	M	ASY	150	223
84	52	M	ATA	160	196
85	56	M	ASY	150	213
86	66	M	ASY	140	139
87	65	M	ASY	170	263
88	53	F	ATA	140	216
89	43	M	TA	120	291
90	55	M	ASY	140	229
91	49	F	ATA	110	208
92	39	M	ASY	130	307
93	52	F	ATA	120	210
94	48	M	ASY	160	329
95	39	F	NAP	110	182
96	58	M	ASY	130	263
97	43	M	ATA	142	207
98	39	M	NAP	160	147
99	56	M	ASY	120	85
100	41	M	ATA	125	269

```
% Clear temporary variables
clear opts
```

Introduction

We use Import Data functionality in MATLAB to import data in a spreadsheet. Once imported we can apply the concepts of exploratory data analysis (EDA) which we considered in the previous chapter.

Summary statistics

We usually consider two types of summary statistics in EDA. That of a single variable and that of comparative summary statistics. In the former, we only consider a single variable as a whole. In the latter, we divided the data set by the unique elements of a categorical variable and summarize another variable by each of the groups formed by the classes of the categorical variable.

Single variable summary statistics

The `summary` function summarizes each column in a `table` object (which contains the data in a spreadsheet which is in long-form tidy format).

```
% Summary statistics of all columns
summary(heart)
```

```
Variables:

    Age: 918×1 double

        Properties:
            Units:  Years
        Values:

            Min          28
            Median       54
            Max          77

    Sex: 918×1 categorical

        Values:
```

Each individual column can be summarized by assigning the `summary` function to a variable. We use the variable name `s_stats` below.

```
% Create a variable of summary statistics
s_stats = summary(heart);
```

Now we can use dot notation to consider a specific column (variable). Note that this form of notation is why we do not allow illegal characters in the names of variables (column headers in the spreadsheet). If a name consists of more than one word, such as `Date of birth` it is best to use camelCase formatting, i.e. `dateOfBirth` (where the first letter is lowercase and each subsequent word starts with an uppercase letter and omitting all spaces). Another commonly used naming convention is snake_case, i.e. `Date_of_birth` (where space are replaced by underscores).

```
% Summary statistics of the Age column (variable)
s_stats.Age
```

```
ans = struct with fields:
           Size: [918 1]
           Type: 'double'
    Description: ''
          Units: 'Years'
     Continuity: []
            Min: 28
         Median: 54
            Max: 77
     NumMissing: 0
```

```
% Summary statistics of Sex
s_stats.Sex
```

```
ans = struct with fields:
           Size: [918 1]
           Type: 'categorical'
    Description: ''
          Units: ''
     Continuity: []
     Categories: {2×1 cell}
         Counts: [2×1 double]
     NumMissing: 0
```

It is sometimes useful to extract the values of a column as a vector and to assign it to a variable. Below, we use the `Age` column and assign it to the variable `age`.

```
% Create a column vector of the Age variable
age = heart.Age;
```

The `mean` function can now be used to calculate the mean of the values in the vector.

```
% Mean of Age
mean(age)
```

```
ans = 53.5109
```

Below, we also calculate the sample variance, the sample standard deviation, minimum, maximum, range, median, first and third quartiles, and the interquartile range of the values in the `age` vector.

```
% Sample variance of Age (for a population variance use var(X,w=1))
var(age)
```

```
ans = 88.9743
```

```
% Sample standard deviation
std(age)
```

```
ans = 9.4326
```

```
% Minimum
min(age)
```

```
ans = 28
```

```
% Maximum
max(age)
```

```
ans = 77
```

```
% Range
max(age) - min(age)
```

```
ans = 49
```

```
% Median
median(age)
```

```
ans = 54
```

```
% First quartile
quantile(age,0.25)
```

```
ans = 47
```

```
% Third quartile
quantile(age,0.75)
```

```
ans = 60
```

```
% IQR
iqr(heart.Age)
```

```
ans = 13
```

```
% Frequency of classes in Sex variable
summary(heart.Sex)
```

```
    F      193
    M      725
```

Summary statistics by classes of a categorical type variable

As mention, we can also calculate comparative summary statistics. We start by using a MATLAB app and summarize the `Age` column by the two unique classes in the `Sex` column. Be sure to name the analysis. Below, we use `age_by_sex`.

Use the Task button on the LIVE EDITOR tab.

```
% Compute group summary
age_by_sex = groupsummary(heart,"Sex",["mean","median","mode","max","min", ...
    "range","std","var","nummissing"],"Age")
```

```
age_by_sex = 2×11 table
```

	Sex	GroupCount	mean_Age	median_Age	mode_Age	max_
1	F	193	52.4922	53	54	
2	M	725	53.7821	55	54	

We also create a table of observed data or contingency table. This is done using a pivot table. We use the classes of the `Sex` column along the rows and the classes of the `ChestPainType` column along the columns. The resultant table shows the joint frequencies of each combination of the classes for the two categorical variables.

```
% Create pivoted table
sex_chestpaintype = pivot(heart, Rows="Sex", Columns="ChestPainType", ...
    IncludeTotals=true, RowLabelPlacement="rownames")
```

sex_chestpaintype = 3×5 table

	ASY	ATA	NAP	TA	Overall_count
1 F	70	60	53	10	193
2 M	426	113	150	36	725
3 Overall_count	496	173	203	46	918

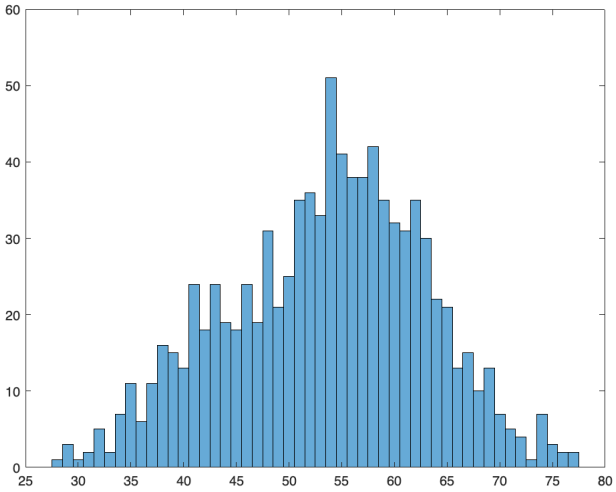
Data visualization

The second important part of EDA is data visualization. We can also us a built-in app found in the Task button on the LIVE EDITOR tab to create plots.

Single variable histogram

We start with histogram of the `Age` column.

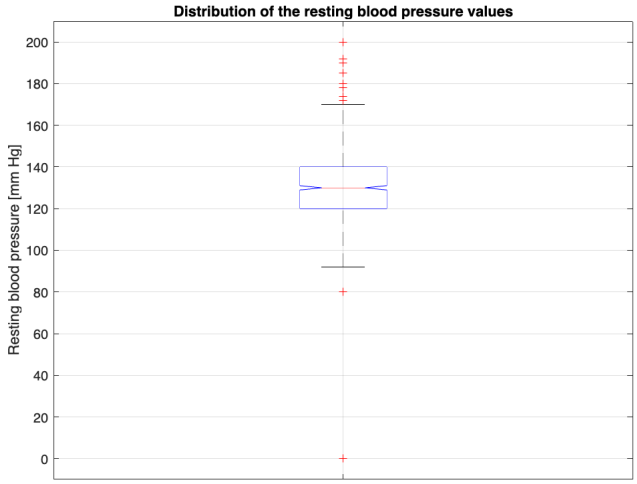
```
% Create histogram of heart.Age
hist_age = histogram(heart.Age,"DisplayName","Age");
```



Single variable box-and-whisker plot

Next we create a box-and-whisker plot of the `RestingBP` column. This variable measures the resting blood pressure in mm of mercury. Instead of an app, we use code to create the plot.

```
% Create a box plot of the RestingBP variable
boxplot(heart.RestingBP,'Notch','on')
grid on
title("Distribution of the resting blood pressure values")
ylabel("Resting blood pressure [mm Hg]")
xticklabels({""})
hold off
```



Note the suspected outliers beyond the lower and upper fences of the whiskers. The fences are at 1.5 times the interquartile range below and above the first and third quartiles respectively.

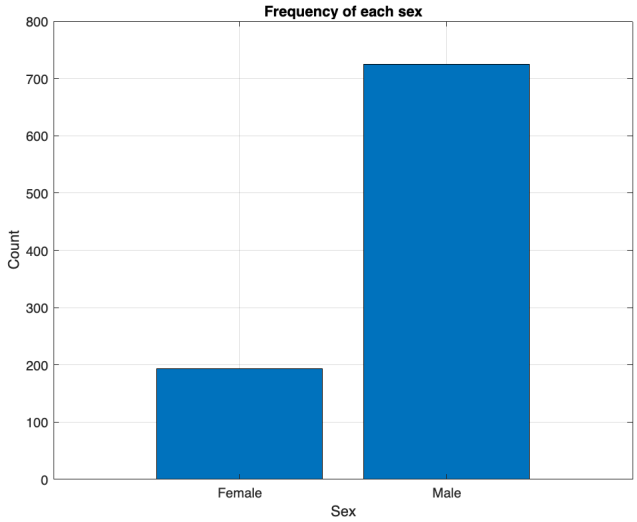
Single variable bar chart

We saw in the previous chapter that bar plots are good for displaying the frequencies or relative frequencies of the classes of a categorical variable. We use the `Sex` column below.

```
% Get frequencies of classes of Sex variable
summary(heart.Sex)
```

```
     F      193
     M      725
```

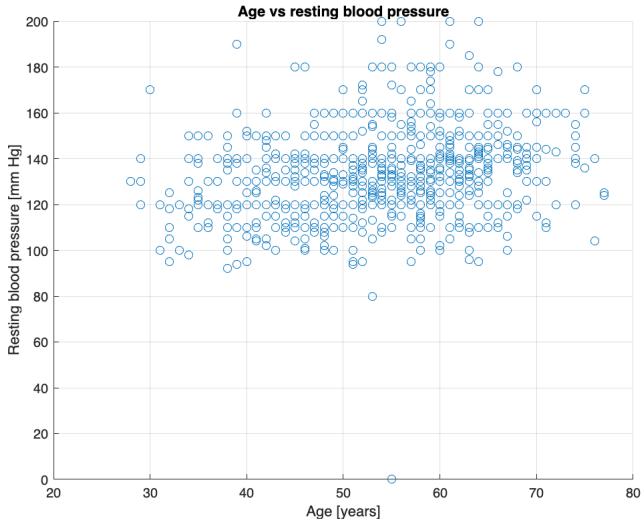
```
bar(["Female","Male"],[193,725])
grid on
title("Frequency of each sex")
xlabel("Sex")
ylabel("Count")
hold off
```



Scatter plot for two-numerical variables

A scatter plot visualizes the relationship between two numerical variables. We start with the `Age` and `RestingBP` columns.

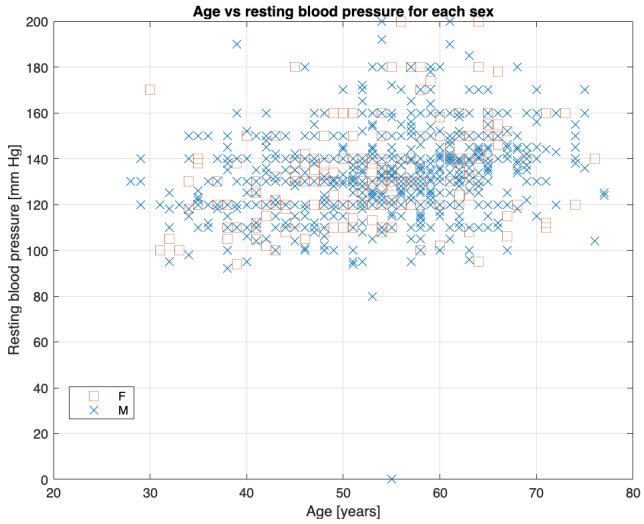
```
% Create a scatter plot of Age vs RestingBP
scatter(heart.Age,heart.RestingBP)
grid on
title("Age vs resting blood pressure")
xlabel("Age [years]")
ylabel("Resting blood pressure [mm Hg]")
hold off
```



Scatter plot for two-numerical variables grouped by class

A scatter plot can also group the data by the unique elements of a categorical variable. Below we group the data by the two unique classes in the `Sex` column.

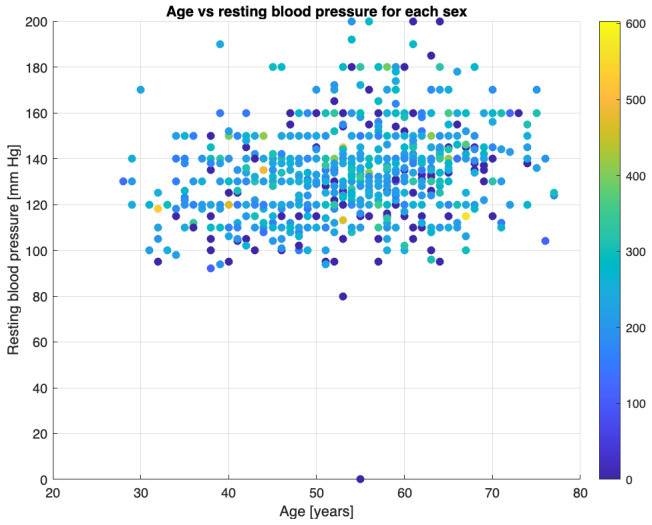
```
% Create a scatter plot of Age vs RestingBP for each class in Sex variable
gscatter(heart.Age,heart.RestingBP,heart.Sex,[0.85 0.325 0.098; 0 0.447 0.741],'sx',[9 9])
grid on
title("Age vs resting blood pressure for each sex")
xlabel("Age [years]")
ylabel("Resting blood pressure [mm Hg]")
hold off
```



Scatter plot of two-numerical variables including a third numerical variable

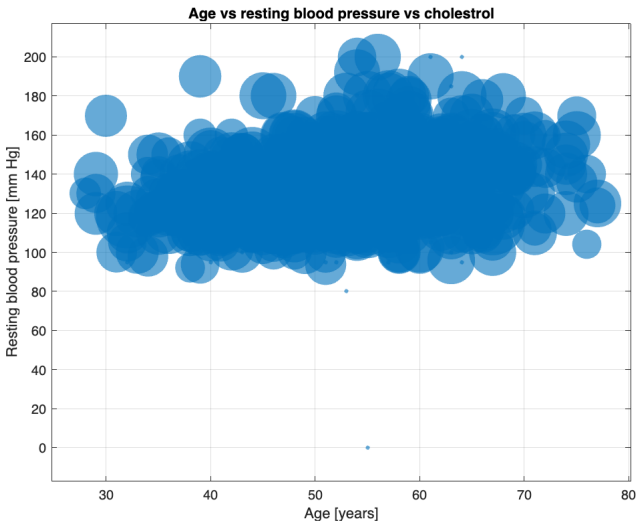
A scatter plot can also visualize a third numerical variable by considering color. Below we use the `Cholesterol` column.

```
% Create a scatter plot of Age vs RestingBP and add the Cholesterol
% variable as numerical grouping column
scatter(heart,'Age','RestingBP','filled','ColorVariable','Cholesterol')
grid on
colorbar
title("Age vs resting blood pressure for each sex")
xlabel("Age [years]")
ylabel("Resting blood pressure [mm Hg]")
hold off
```



A bubble chart can also display a third numerical variable, but uses size as an indicator of the value of the third variable.

```
% Create a scatter plot of Age vs RestingBP and add the Cholesterol
% variable as numerical grouping column
bubblechart(heart,'Age','RestingBP','Cholesterol','MarkerEdgeColor','flat','MarkerEdgeAlpha',0.05)
grid on
title("Age vs resting blood pressure vs cholestrol")
xlabel("Age [years]")
ylabel("Resting blood pressure [mm Hg]")
hold off
```



Box-and-whisker plot grouped by classes

As final example, we group the `Age` values by the two classes in the `Sex` column to create a box-and-whisker plot.

```
% Create a box plot of the Age variable for each of the classes in the Sex
% variable
boxplot(heart.Age,heart.Sex)
grid on
title("Distribution of age for each sex")
xlabel("Sex")
ylabel("Age")
hold off
```