Data Exploration with the Airquality Data

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Load the data

The airquality data set is built-into R so we can just load it with the data() function. The data set has 154 observations of 6 variables:

- Ozone (ppb)
- Solar.R (langleys)
- Wind (mph)
- Temp (F)
- Month (1-12)
- Day (1-31)

The data was collected from May to September, 1973, in New York. You can learn more about the data by typing **?airquality** at the console.

```
data(airquality)
head(airquality, n=2)
```

```
##   Ozone Solar.R Wind Temp Month Day
## 1    41     190  7.4   67     5   1
## 2    36     118  8.0   72     5   2
```

NAs

Missing data is encoded with NAs. We can count them with the sum() and is.na() functions, nested. The is.na() function returns a TRUE FALSE vector. Then the sum functions adds the TRUE values because TRUE=1 and FALSE=0.

Then we try to take the mean of the Ozone column. The syntax data$col lets us access the column. The mean returned NA because it had NAs in that column. We try it again, and this time add a parameter telling it to ignore NAs.

Try each command one at a time by using ctrl-enter on each line.

```
sum(is.na(airquality$Ozone))
```

```
## [1] 37
```

```
mean(airquality$Ozone)
```

```
## [1] NA
```

```
mean(airquality$Ozone, na.rm=TRUE)
```

```
## [1] 42.12931
```

Dealing with NAs

One option of dealing with NAs is to remove rows that have NAs. Another option is to replace NAs with mean values. We show that second option next. First we make a copy of the airquality data set.

The following syntax selects all rows which have NAs in the Ozone column.

df$Ozone[is.na(df$Ozone)]

These selected elements, and only these, will be replaced by the mean of the column.

```
df <- airquality[]
df$Ozone[is.na(df$Ozone)] <- mean(df$Ozone, na.rm=TRUE)
mean(df$Ozone)
```

```
## [1] 42.12931
```

Plots

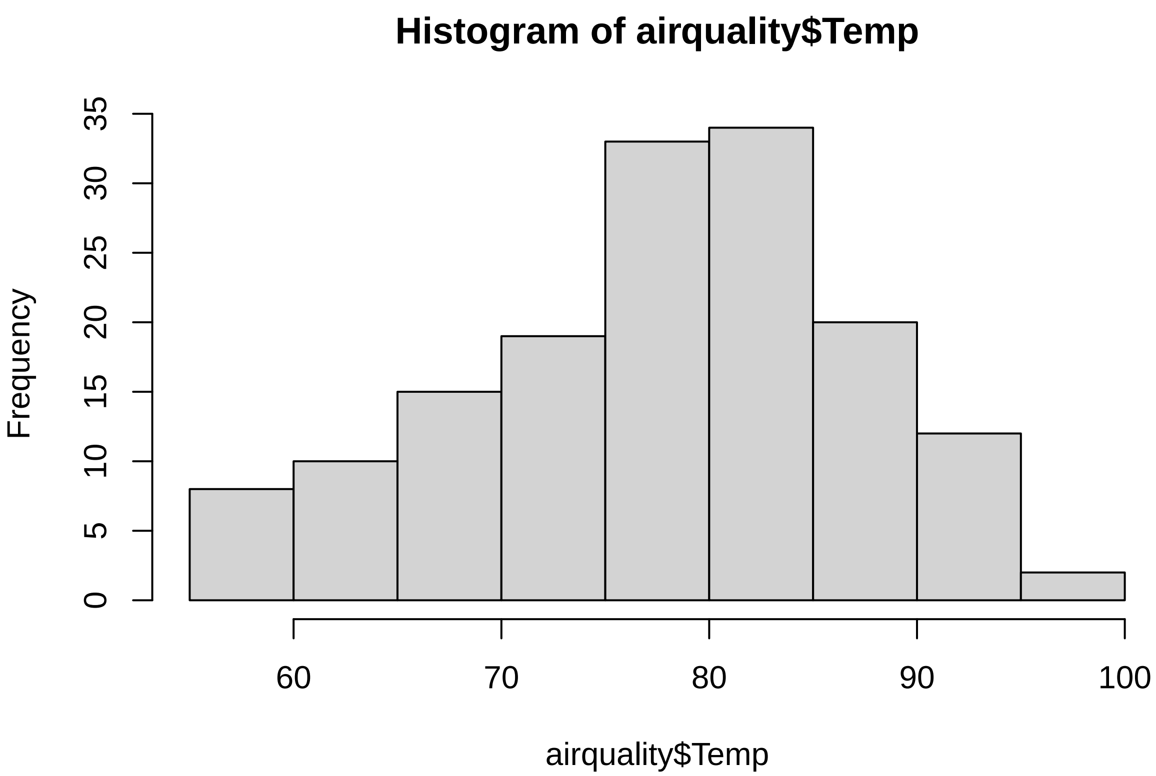
R has a lot of built-in data visualization tools. The first graph in the code below is a histogram of the temperature field. The second graph plots temperature on the y axis and the index of the observation on the x axis. You can see the ups and downs of the temperature. The third plot puts temperature on the x axis and Ozone on the y axis.

These plots are very simple but convey important information. If you want to make more visually appealling graphs there are many options to modify the point color, symbol, size, change the labels, and much more.

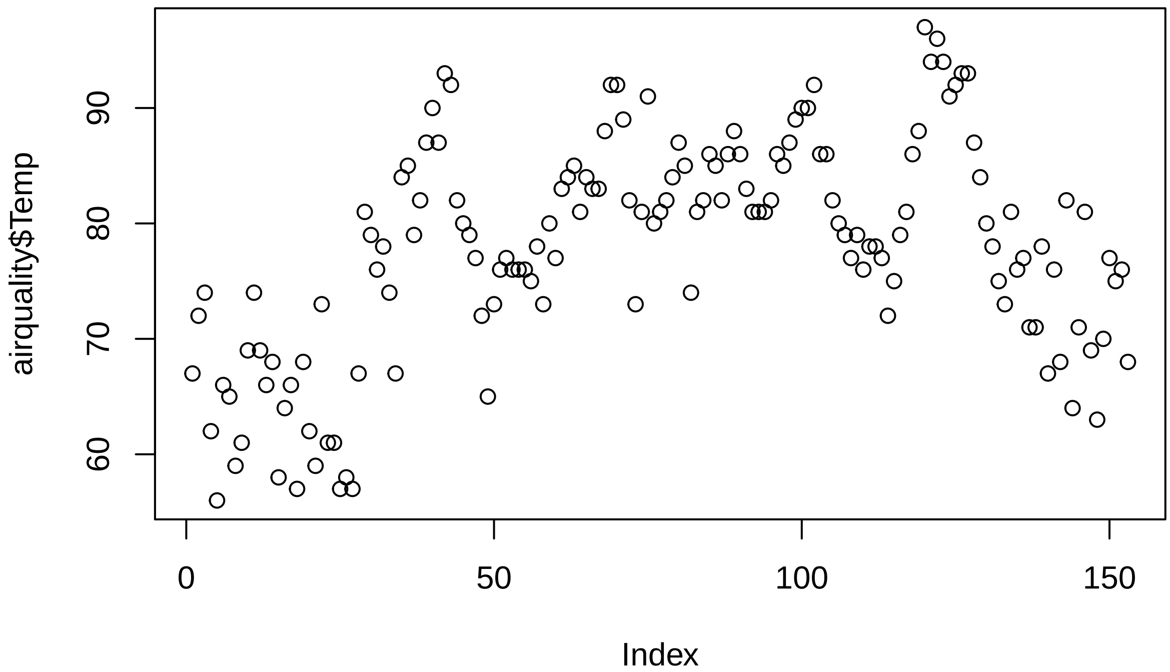
This link describes many graphical parameters.

The final graph below uses some of these parameters.

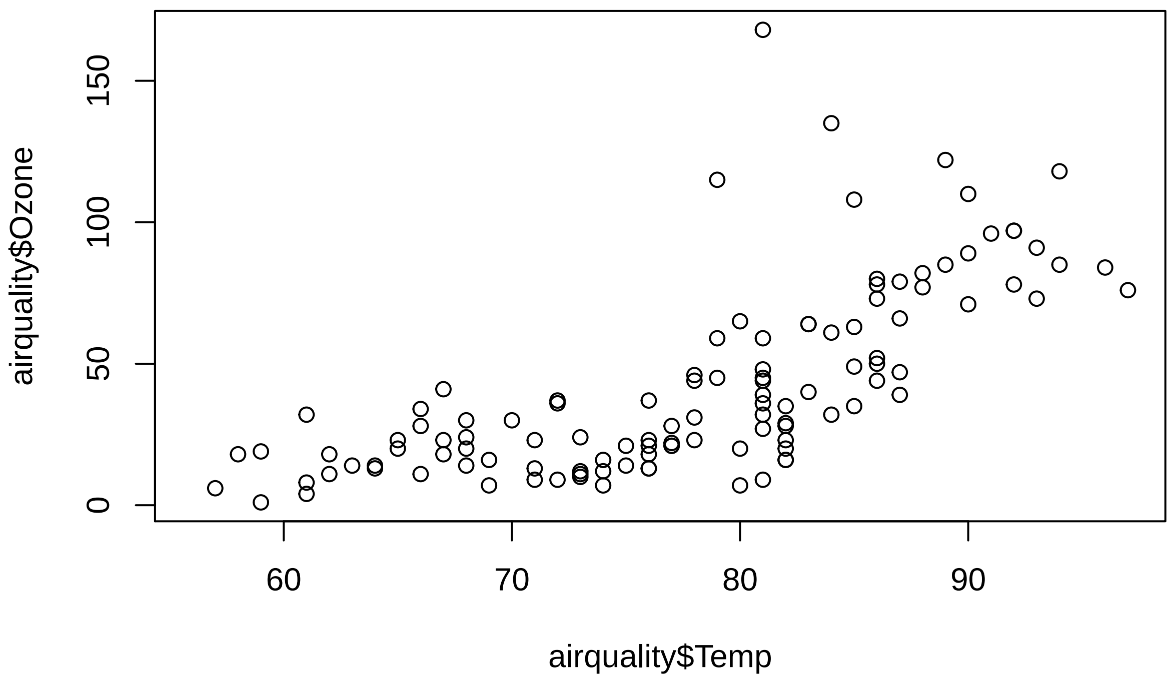
```
hist(airquality$Temp)
```



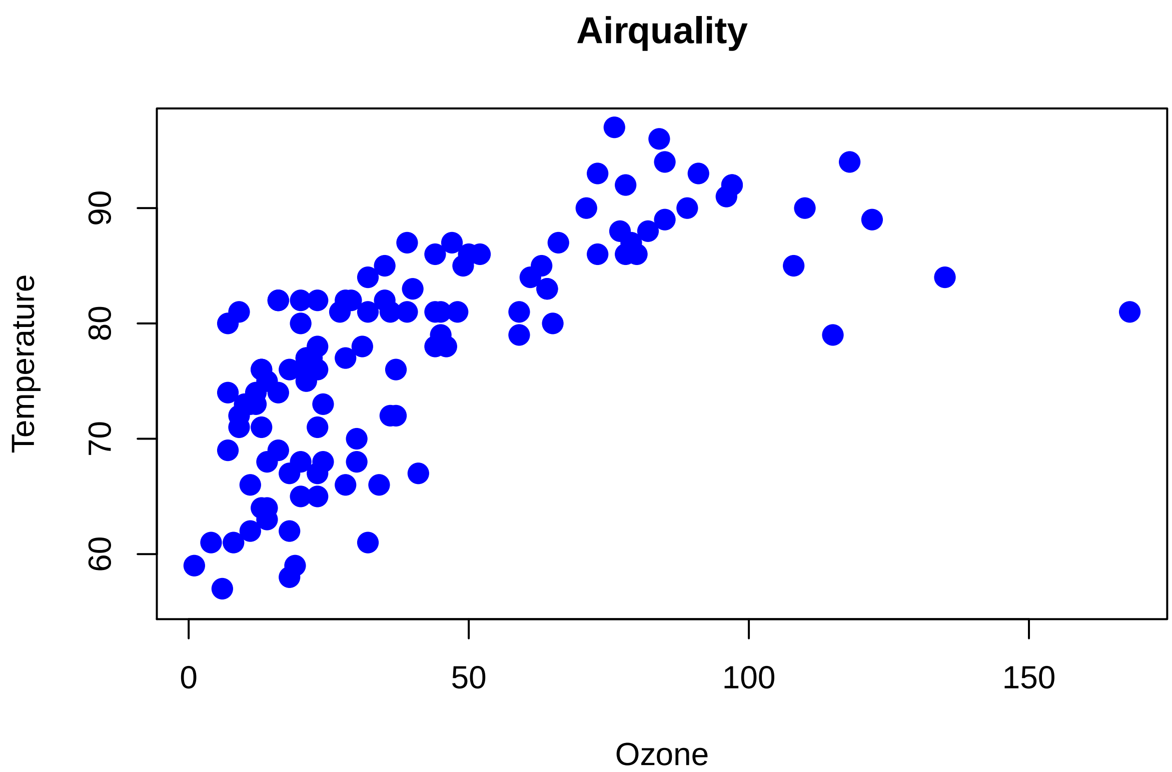

```
plot(airquality$Temp)
```




```r
plot(airquality$Temp, airquality$Ozone)
```




```r
plot(airquality$Ozone, airquality$Temp, pch=16, col="blue", cex=1.5,
        main="Airquality", xlab="Ozone", ylab="Temperature")
```



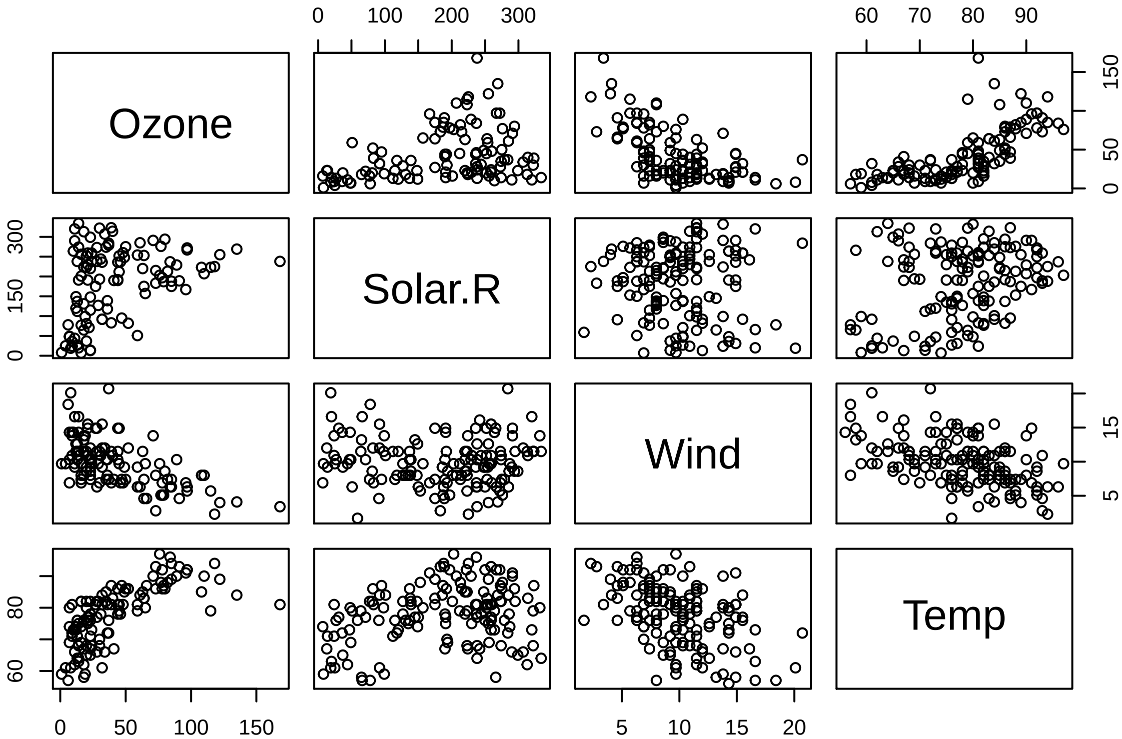
Correlation

We can check for correlation by creating a table with the cor() function or visually look for correlations by plotting pairs(). The **use="complete"** option tells it to ignore NAs.

```
cor(airquality[1:4], use="complete")
```

```
##              Ozone    Solar.R       Wind       Temp
## Ozone    1.0000000  0.3483417 -0.6124966  0.6985414
## Solar.R  0.3483417  1.0000000 -0.1271835  0.2940876
## Wind    -0.6124966 -0.1271835  1.0000000 -0.4971897
## Temp     0.6985414  0.2940876 -0.4971897  1.0000000
```

```
pairs(airquality[1:4])
```



Adding columns to a data frame

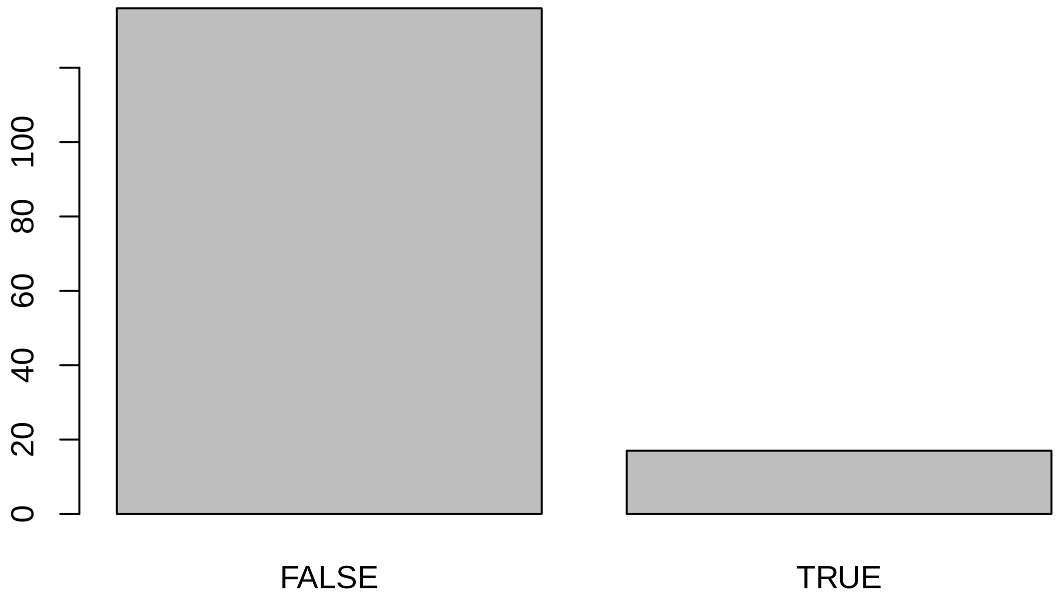
The next code chunk shows how to add a column to a data frame. We first make a copy of the data set. Then we create a new column in which every element is FALSE. Then we select elements where the corresponding element in Temp is over 89, and we classify those as TRUE. Then we display a few rows from the data and plot the new Hot column.

Run these lines one at a time (ctrl-enter) to make sure you understand what each line does. In particular, look at df$Hot after each step by typing **df$Hot** in the console.

```
df <- airquality[]  # copy the data set
df$Hot <- FALSE
df$Hot[df$Temp>89] <- TRUE
df$Hot <- factor(df$Hot)
df$Hot[40:46]
```

```
## [1] TRUE  FALSE TRUE  TRUE  FALSE FALSE FALSE
## Levels: FALSE TRUE
```

```
plot(df$Hot)
```

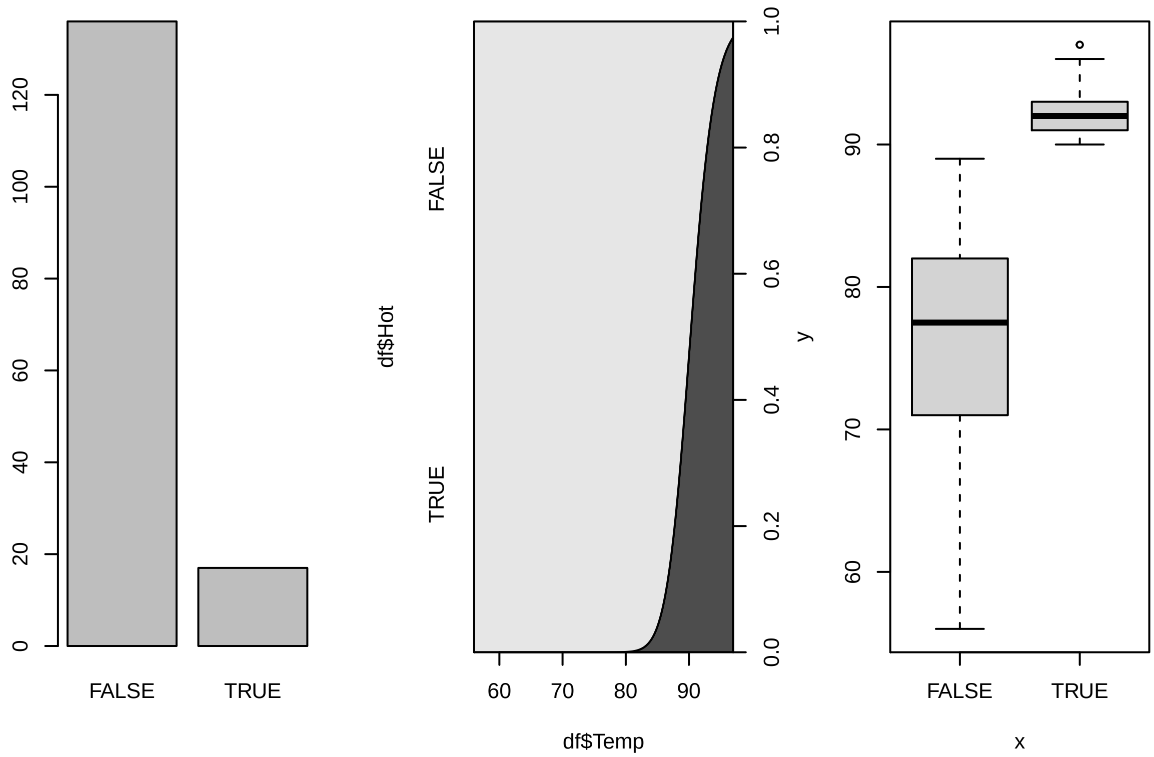


Plotting factors

We have plotted numeric data above but now we are going to create 3 plots for our new factor. First we use the par() function to set up a 1x3 grid to hold the pictures then we create a plot showing the distribution, a conditional density plot, and a box plot.

- the first plot shows us that there were many more not hot days than hot days in the data
- the conditional density plot shows the same idea, with the light grey region representing the hot days
- the box plot shows us the average hot day is above 90, and the average not hot day is in the high 70s; The heavy vertical bar inside the box is the median, the box itself is the 1st through 3rd quartiles and the whiskers on the end of the dotted vertical lines show the range.

```
par(mfrow=c(1,3))
plot(df$Hot)
cdplot(df$Temp, df$Hot)
plot(df$Hot, df$Temp)
```


0
20
40
60
80
100
120
FALSE
TRUE
df$Hot
FALSE
TRUE
60
70
80
90
df$Temp
0.0
0.2
0.4
0.6
0.8
1.0
y
60
70
80
90
FALSE
TRUE
x