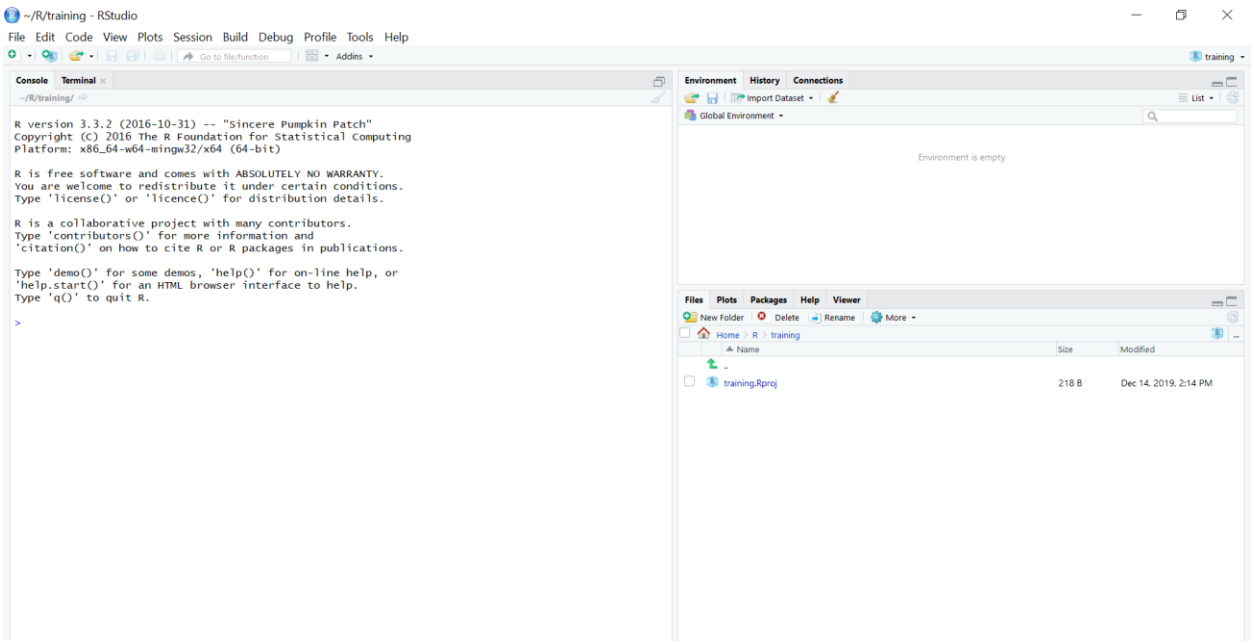
Mini-Tutorials for Creating Graphs in R
Scatterplots

The examples below are intended to instruct you to create statistical graphs in R with minimal initial training in R. You should be able to follow the example codes to obtain graphs by modifying the included code. Some examples (and a key) will be included at the end of the document for practice. The screenshots I will show of the environment use R Studio, which is a free program you can find online. Other R environments will look different, but probably have similar functionality.

When you open up a new project environment in R Studio, it looks like this.



The command line environment is on the left. Images when we construct them will appear on the bottom right. As we add variables, they will appear in the list at the top right (name, dimensions and samples will display, which is useful for checking that you didn't skip entries when entering data by hand).

We are going to start by creating a simple scatter plot graph from raw data. We'll add features as we go such as finding the trendline, making a residual plot and other related graphs.

Copy the commands shown into the command line.

Step 1. Enter the data to be plotted in vector form. For a scatterplot, we need two sets of data to be correlated.

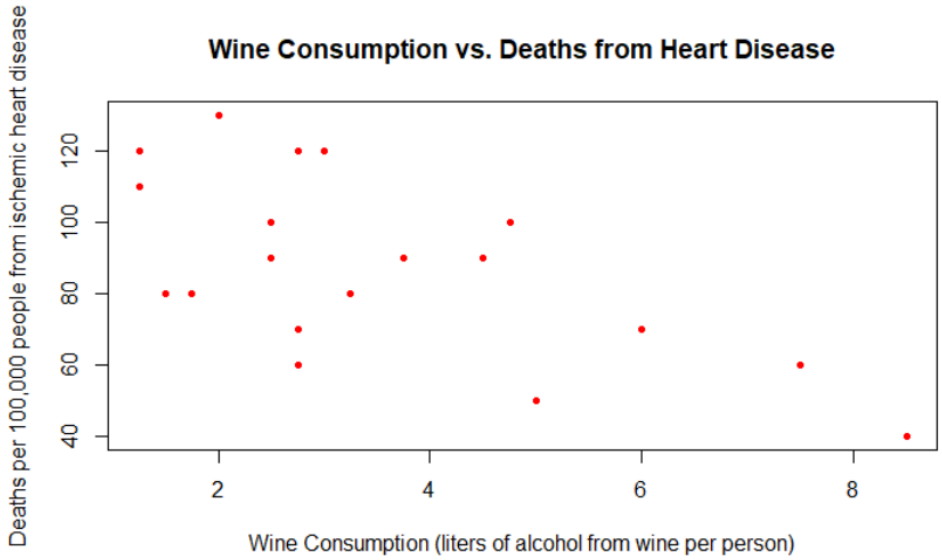
```
wine=c(3.25,4.75,2.75,1.5,4.5,3,8.5,3.75,1.25,2,7.5,2.75,2.5,1.75,5,2.5,6,2.75,1.25)
```

```
heart=c(80,100,60,80,90,120,40,90,110,130,60,70,100,80,50,90,70,120,120)
```

Use the window at the top right, if you are entering the data by hand especially, to ensure that the two sets have the same length.

Step 2. Graph the data.

```
plot(wine, heart, main="Wine Consumption vs. Deaths from Heart Disease", xlab="Wine Consumption (liters of alcohol from wine per person)", ylab="Deaths per 100,000 peopl e from ischemic heart disease", col="red", pch=20)
```



The graph we get is shown. The default plot is a scatterplot when the variables are not sorted, and you can adjust the type of dot appearing at each value by changing the "pch" option, as well as the color. Good graphs should label both axes and have a descriptive title. When listing the variables to be graphed, be sure to list the x-variable first and the y-variable second.

Step 3. In order to add the regression line, we first need to get R to calculate it, and then obtain the coefficients we need to draw the line.

```
reg1=lm(heart~wine)
```

For the regression function, "lm" stands for linear model, and the y-variable goes first. You can use the same function with multiple x's used to predict a single y. Use the summary function to obtain information about the analysis, including the coefficients. The command is shown along with the printed output. (The input is in blue as before, and the output is in black.)

```
summary(reg1)
```

Call:

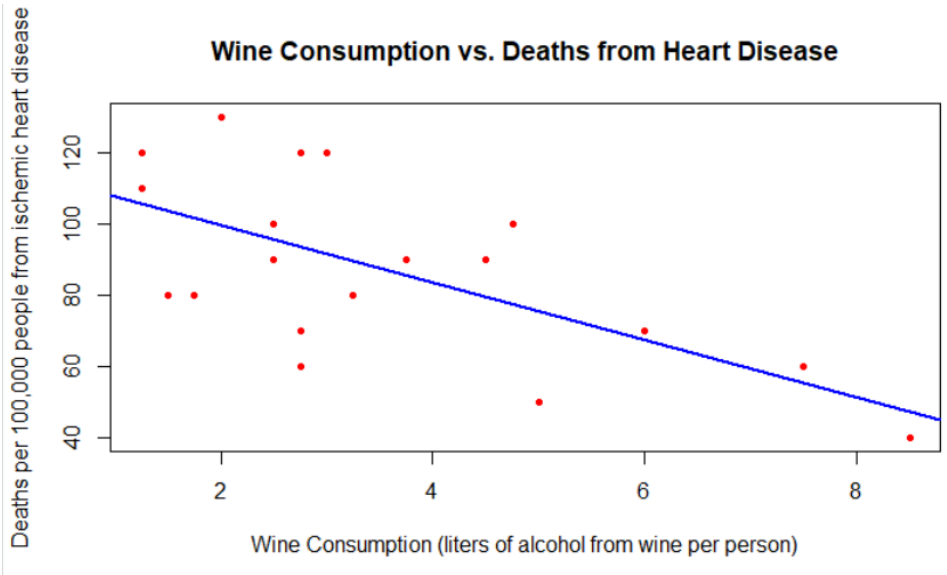
```
lm(formula = heart ~ wine)

Residuals:
   Min     1Q  Median     3Q    Max
-33.724 -15.736   4.202  12.283  30.239

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  115.861      9.399  12.327 6.67e-10 ***
wine          -8.050      2.314  -3.479  0.00287 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 20.11 on 17 degrees of freedom
Multiple R-squared:  0.4159,   Adjusted R-squared:  0.3815
F-statistic:  12.1 on 1 and 17 DF,  p-value: 0.002871
```

I’ve highlighted the two coefficients we need for drawing the equation.

Add the equation to the graph with the command shown, using the coefficient obtained.

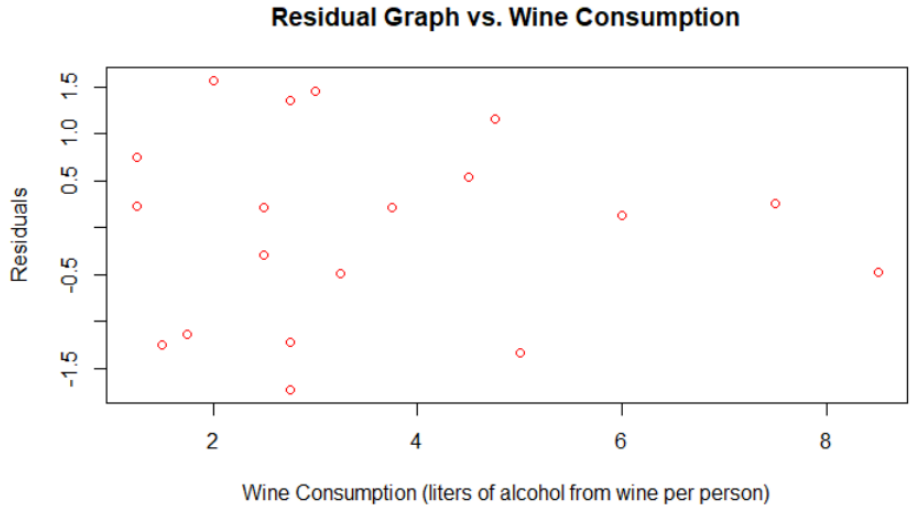
```
abline(a=115.861, b=-8.05,col="blue",lwd=2)
```

The equation graphed is $y = a + bx$, so a is the intercept and b is the slope. The graph produced is shown.



Step 4. To continue the analysis, we can obtain a residual plot. First, calculate the standardized residuals.

```
wine.stdres = rstandard(reg1)
plot(wine, wine.stdres, main="Residual Graph vs. Wine Consumption", xlab="Wine Cons
umption (liters of alcohol from wine per person)", ylab="Residuals", col="red", pch=1)
```



After finding the residuals, we replot them against the x-variable. We expect the residuals to be random if the assumptions of the linear regression are met. If you have multiple variables in your model, you should do this with each input variable.

You can also construct a normal probability plot for the residuals, but we'll leave that for a separate lesson.

Practice.
You are welcome to practice with randomly generated data, but you should expect that the correlations will be extremely low.

1. Two random sets.
   ```
   test1=c(runif(150, min=80, max=100))
   test2=c(rnorm(150, mean=64, sd=3.1))
   ```

The first set is uniformly distributed, while the second is normally distributed numbers with the specified mean and standard deviation. The test sets should be the same size.

2. A second set of real data.
   ```
   nickel=c(5.9, 2.8, 5.3, 4.6, 4.6, 3.5, 3.8, 5, 5.3, 4.2)
   tens_streng=c(948, 859, 921, 909, 915, 876, 828, 964, 964, 900)
   ```

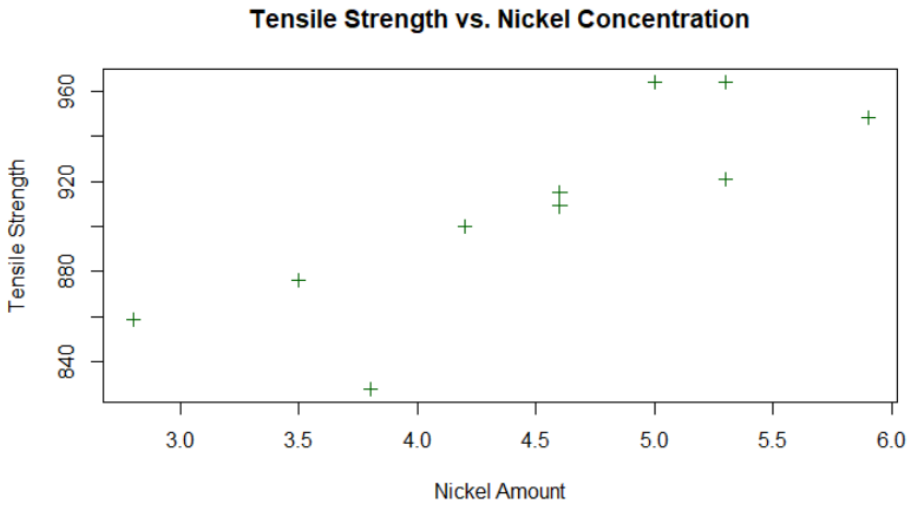
Solutions.

The random test data shows no correlation.

```
plot(test1,test2, main="Test Random Data", xlab="test1", ylab="test2", col="blue", pch=
2)
```

For the second set, there is a correlation.

```
plot(nickel,tens_streng, main="Tensile Strength vs. Nickel Concentration", xlab="Nickel
Amount", ylab="Tensile Strength", col="darkgreen", pch=3)
```



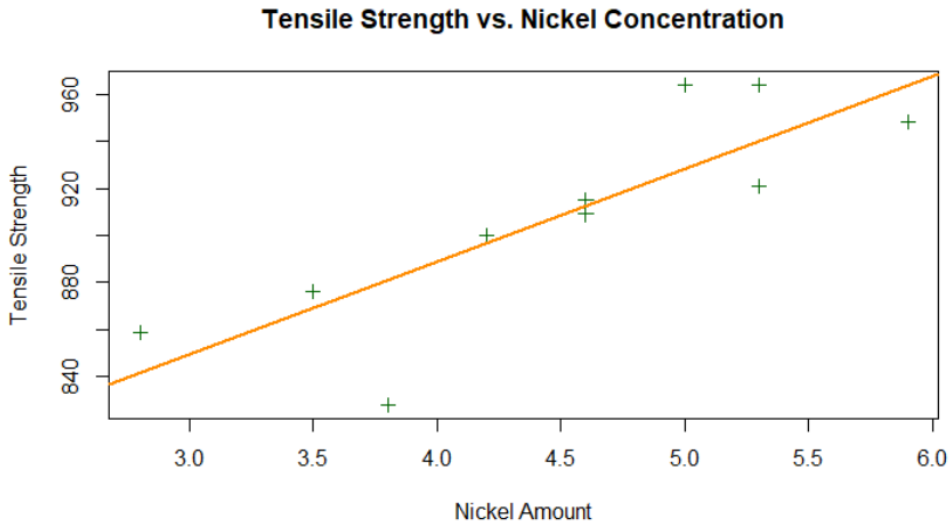
Let's find the regression line.

```
strength.lm = lm(tens_streng ~ nickel)
```

```
summary(strength.lm)

Call:
lm(formula = tens_streng ~ nickel)

Residuals:
   Min     1Q  Median     3Q    Max
-52.882 -12.409   3.031  14.799  35.945

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  731.502     43.147   16.95 1.49e-07 ***
nickel        39.311      9.405    4.18  0.00308 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 26.57 on 8 degrees of freedom
Multiple R-squared:  0.6859,   Adjusted R-squared:  0.6467
F-statistic: 17.47 on 1 and 8 DF,  p-value: 0.00308
```

Make our regression line.

```
abline(a=731.502, b=39.311,col="darkorange",lwd=2)
```



And we can make our residual graph, too.

```
strength.stdres = rstandard(strength.lm)
```

```
plot(nickel,strength.stdres, main="Residuals vs. Nickel Concentration", xlab="Nickel Am
ount", ylab="Residuals", col="brown", pch=4)
```