Basics

Defining vectors

```
x <- c(1, 2, 3, 4, 5)
y <- c(1, 1, 2, 2, 4)

n <- length(x) #x and y have the same length so it will work either way
```

```
x values:  1 2 3 4 5
```

```
y values:  1 1 2 2 4
```

```
n(sample size):  5
```

Sums

```
sum_x <- sum(x)
sum_y <- sum(y)

sum_x2 <- sum(x^2)
sum_y2 <- sum(y^2)

sum_xy <- sum(x*y) #same as sum of y*x
```

```
sum of x-values:  15
```

```
sum of y-values:  10
```

sum of x-values squared: 55

sum of y-values squared: 26

sum of x-values times y-values: 37

Means

```r
x_bar <- mean(x)
y_bar <- mean(y)
```

x̄ : 3

ȳ : 2

SS formulars

```r
SS_yy = sum_y2 - n * (y_bar)^2
SS_xx = sum_x2 - n * (x_bar)^2
SS_xy = sum_xy - n * x_bar * y_bar
```

SSxx : 10

SSyy: 6

SSxy: 7

Slope and Intercept of the least squares model

```r
b1_hat <- SS_xy / SS_xx

b0_hat <- y_bar - b1_hat * x_bar
```

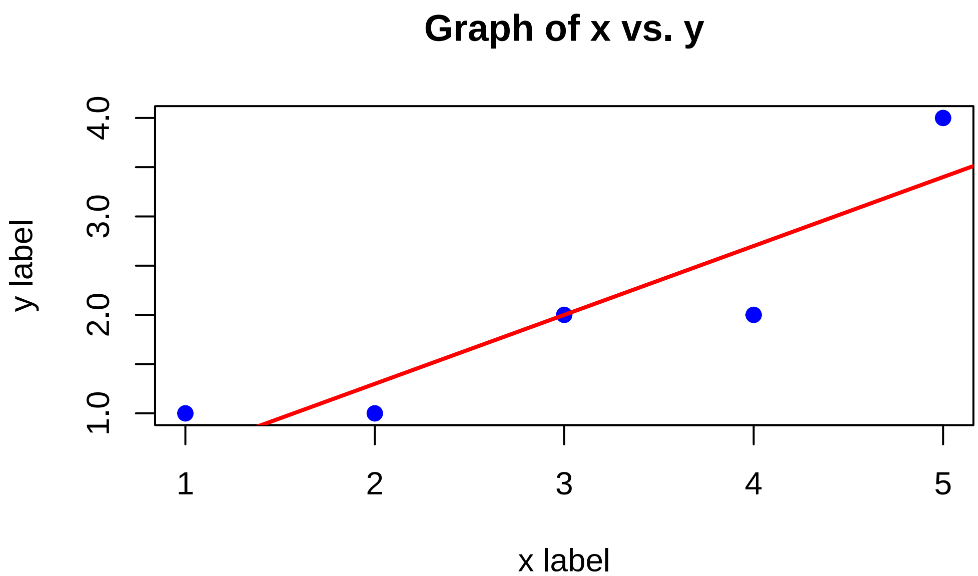
b1 hat : 0.7

b0 hat: -0.1

Scatter Plot

```
plot(
  x, y,
     main = "Graph of x vs. y",
     xlab = "x label",
     ylab = "y label",
     pch = 19,
     col = "blue"
  )

abline(
  a = b0_hat,
  b = b1_hat,
  col = "red",
  lwd = 2
)
```



Residual Analyses and Standard errors

Predicted values

```
y_hat <- b0_hat + b1_hat * x
```

```
y hat :  0.6 1.3 2 2.7 3.4
```

Residuals

```
residuals <- y - y_hat

SSE <- sum(residuals^2)
```

```
Residuals :  0.4 -0.3 0 -0.7 0.6

SSE:  1.1
```

Mean Squared Error

```
k <- 2 #for the degrees of freedom

MSE <- SSE / (n-k)
```

```
MSE :  0.3666667
```

Test statistic

```
# Standard error of b1_hat
SE_b1 <- sqrt(MSE / SS_xx)

t <- (b1_hat - 0) / SE_b1
```

```
SE b1 :  0.1914854

t:  3.655631
```

Correlation Coefficient

```
r <- SS_xy / sqrt(SS_xx * SS_yy)
```

```
r:  0.9036961
```

Correlation of Determination

```
r_squared <- r^2

# using textbook formula
r_sq <- 1 - (SSE / SS_yy)
```

```
r squared :  0.8166667
```

```
r squared(using textbook formula) :  0.8166667
```

Built in least squares method

```r
sample_model <- lm(y ~ x)

print(summary(sample_model))
```

```
Call:
lm(formula = y ~ x)

Residuals:
         1          2          3          4          5 
 4.000e-01 -3.000e-01 -5.551e-17 -7.000e-01  6.000e-01 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)  
(Intercept)  -0.1000     0.6351  -0.157   0.8849  
x             0.7000     0.1915   3.656   0.0354 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6055 on 3 degrees of freedom
Multiple R-squared:  0.8167,    Adjusted R-squared:  0.7556 
F-statistic: 13.36 on 1 and 3 DF,  p-value: 0.03535
```