Assignment.3-Regression

```
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────── tidyverse 1.
3.2 ──
## ✓ ggplot2 3.3.6      ✓ purrr   0.3.5
## ✓ tibble  3.1.8      ✓ dplyr   1.0.10
## ✓ tidyr   1.2.1      ✓ stringr 1.4.1
## ✓ readr   2.1.3      ✓ forcats 0.5.2
## ── Conflicts ────────────────────────────────────────── tidyverse_conflict
s() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
```

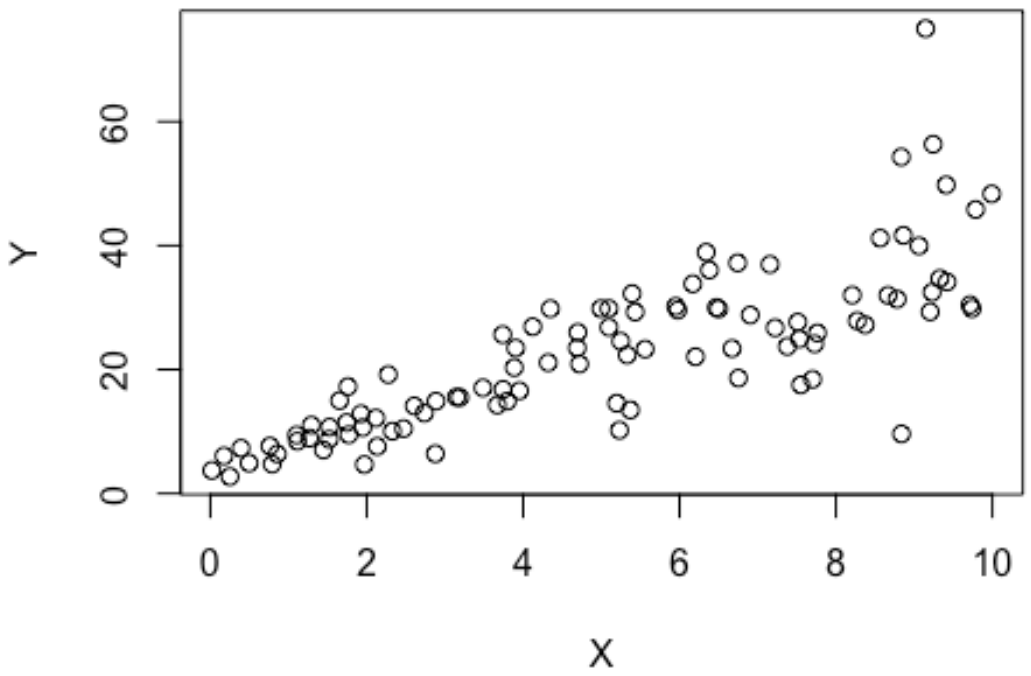
```
library(mlbench)
library(tinytex)
```

#1. Create two variables X and Y

```
set.seed(2017)
X=runif(100)*10
Y=X*4+3.45
Y=rnorm(100)*0.29*Y+Y
```

#1.a)Based on the plot do you think we can fit a linear model to explain Y based on X?

```
plot(Y~X)
```



#From above plot we can observe, the relationship between X and Y shows linear regression pattern. As X increases, Y also increases which states X and Y variables have a positive relationship.

#1.b)Simple linear model of Y based on X

```
Model=lm(Y ~X)

summary(Model)
```

```
##
## Call:
## lm(formula = Y ~ X)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -26.755  -3.846  -0.387   4.318  37.503
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   4.4655     1.5537   2.874  0.00497 **
## X             3.6108     0.2666  13.542  < 2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.756 on 98 degrees of freedom
## Multiple R-squared:  0.6517, Adjusted R-squared:  0.6482
## F-statistic: 183.4 on 1 and 98 DF,  p-value: < 2.2e-16
```

#What is the accuracy of this model? #According above summary, accuracy of model can be derived from R-squared value. R-squared value of above summary is 0.6517. Therefore the accuracy of model is 65.17%.

#Write the equation that explains Y based on X? #Y=3.6108*X+4.4655

#1.c)How the Coefficient of Determination, R2, of the model above is related to the correlation coefficient of X and Y?

```
cor(X,Y)^2
```

```
## [1] 0.6517187
```

#2. Using mtcars dataset

```
head(mtcars)
```

```
##                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

#2.a) Building a model based on James assumption

```
james_model <- lm(hp~wt, data = mtcars)
summary(james_model)
```

```
##
## Call:
## lm(formula = hp ~ wt, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -83.430 -33.596 -13.587   7.913 172.030
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.821     32.325  -0.056    0.955
## wt            46.160      9.625   4.796 4.15e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 52.44 on 30 degrees of freedom
```

```
## Multiple R-squared:  0.4339, Adjusted R-squared:  0.4151
## F-statistic:    23 on 1 and 30 DF,  p-value: 4.146e-05
```

#2.a)Building a model based on Chris assumption

```
chris_model <- lm(hp~mpg, data = mtcars)
summary(chris_model)
```

```
##
## Call:
## lm(formula = hp ~ mpg, data = mtcars)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -59.26 -28.93 -13.45  25.65 143.36
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   324.08      27.43  11.813 8.25e-13 ***
## mpg            -8.83       1.31  -6.742 1.79e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 43.95 on 30 degrees of freedom
## Multiple R-squared:  0.6024, Adjusted R-squared:  0.5892
## F-statistic: 45.46 on 1 and 30 DF,  p-value: 1.788e-07
```

#Is james assumption better or chris is better? #From above we can observe, as per James assumption the model shows accuracy of 43.39% and as per Chris assumption the model shows accuracy of 60.24%. We can conclude that Chris assumption of comparing Horse power to mpg is better.

#2.b) what is the estimated Horse Power of a car with 4 cyl and mpg of 22?

```
calc_model <- lm(hp~mpg+cyl, data = mtcars)
summary(calc_model)
```

```
##
## Call:
## lm(formula = hp ~ mpg + cyl, data = mtcars)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -53.72 -22.18 -10.13  14.47 130.73
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   54.067     86.093   0.628  0.53492
## mpg           -2.775      2.177  -1.275  0.21253
## cyl           23.979      7.346   3.264  0.00281 **
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 38.22 on 29 degrees of freedom
## Multiple R-squared:  0.7093, Adjusted R-squared:  0.6892
## F-statistic: 35.37 on 2 and 29 DF,  p-value: 1.663e-08

predict_model <- predict(calc_model, data.frame(cyl=c(4), mpg=c(22)))
predict_model

##        1
## 88.93618
```

#The estimated Horse power of a car for 4 cyl and 22 mpg is 88.93618.

#3.Viewing data from mlbench library for current question

```
data("BostonHousing")
str(BostonHousing)

## 'data.frame':    506 obs. of  14 variables:
##  $ crim   : num  0.00632 0.02731 0.02729 0.03237 0.06905 ...
##  $ zn     : num  18 0 0 0 0 0 12.5 12.5 12.5 12.5 ...
##  $ indus  : num  2.31 7.07 7.07 2.18 2.18 2.18 7.87 7.87 7.87 7.87 ...
##  $ chas   : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ nox    : num  0.538 0.469 0.469 0.458 0.458 0.458 0.524 0.524 0.524 0.5
24 ...
##  $ rm     : num  6.58 6.42 7.18 7 7.15 ...
##  $ age    : num  65.2 78.9 61.1 45.8 54.2 58.7 66.6 96.1 100 85.9 ...
##  $ dis    : num  4.09 4.97 4.97 6.06 6.06 ...
##  $ rad    : num  1 2 2 3 3 3 5 5 5 5 ...
##  $ tax    : num  296 242 242 222 222 222 311 311 311 311 ...
##  $ ptratio: num  15.3 17.8 17.8 18.7 18.7 18.7 15.2 15.2 15.2 15.2 ...
##  $ b      : num  397 397 393 395 397 ...
##  $ lstat  : num  4.98 9.14 4.03 2.94 5.33 ...
##  $ medv   : num  24 21.6 34.7 33.4 36.2 28.7 22.9 27.1 16.5 18.9 ...
```

#3.a) Build a model to estimate the median value of owner-occupied homes (medv)based on thefollowing variables: crime crate (crim), proportion of residential land zoned for lots over 25,000 sq.ft (zn), the local pupil-teacher ratio (ptratio) and weather the whether the tract bounds Chas River(chas).

```
boston_model<- lm(medv~crim+zn+ptratio+chas, data = BostonHousing)
summary(boston_model)

##
## Call:
## lm(formula = medv ~ crim + zn + ptratio + chas, data = BostonHousing)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -18.282  -4.505  -0.986   2.650  32.656
##
```

```
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 49.91868    3.23497  15.431  < 2e-16 ***
## crim        -0.26018    0.04015  -6.480 2.20e-10 ***
## zn           0.07073    0.01548   4.570 6.14e-06 ***
## ptratio     -1.49367    0.17144  -8.712  < 2e-16 ***
## chas1        4.58393    1.31108   3.496 0.000514 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.388 on 501 degrees of freedom
## Multiple R-squared:  0.3599, Adjusted R-squared:  0.3547
## F-statistic: 70.41 on 4 and 501 DF,  p-value: < 2.2e-16
```

#Is this an accurate model? - Based on R-squared which is 0.3599 i.e., The accuracy of model is 35%. The model is not accurate enough.

#3.b).i)Imagine two houses that are identical in all aspects but one bounds the Chas Riverand the other does not. Which one is more expensive and by how much?

#->Factors of Chas is in factors of 1 and 0. Identical houses is 1 and who dont have identical houses have 0. And Estimate Std. of chas1 in relation to medv is 4.58393.

#Medv = 49.91868 + (-0.26018) + 0.07073 + (-1.49367) + 4.58393(1) = 52.81949.

#Medv = 49.91868 + (-0.26018) + 0.07073 + (-1.49367) + 4.58393(0) = 48.23556.

#Comparing from above, Identical houses for chas River for which factor is 1, the value as per estimated std 52.81949. When factor is 0 the value as per estimated std. is 48.23556. By comparison of factors 1 and 0, chas River is expensive by 4.58393 for factor 1 in $1000.

#3.b.ii)Imagine two houses that are identical in all aspects but in the neighborhood of one of them the pupil-teacher ratio is 15 and in the other one is 18. Which one is more expensive and by how much?

#Medv = 49.91868 + (-0.26018) + 0.07073 + (-1.49367)(15) + 4.58393= 31.9081.

#Medv = 49.91868 + (-0.26018) + 0.07073 + (-1.49367)(18) + 4.58393= 27.4271.

#Difference between Pupil-teacher ratio for 15 and 18 is 4.48101.Therefore, Pupil-teacher ratio for 15 is expensive by 4.48101 when compared to pupil-teacher ratio of 18.

#3.c)Which of the variables are statistically important? #when comparing dependent and independent variables to show statistical importance, we would like to see p values being as small as possible.From above, p values of crim, zn, ptratio,chas when compared to medv are lowest. We can conclude that all the values are statistically significant.

#3.d)Anova analysis and determine the order of importance of these four variables.?

```
anova_model <- anova(boston_model)
anova_model
```

```
## Analysis of Variance Table
##
## Response: medv
##            Df  Sum Sq Mean Sq F value    Pr(>F)
## crim        1  6440.8  6440.8 118.007 < 2.2e-16 ***
## zn          1  3554.3  3554.3  65.122 5.253e-15 ***
## ptratio     1  4709.5  4709.5  86.287 < 2.2e-16 ***
## chas        1   667.2   667.2  12.224 0.0005137 ***
## Residuals 501 27344.5    54.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

#In Annova analysis, the importance of variables is defined by the sum squared values. From above the values of sum squared, in order of importance are as follows: crim,zn,ptratio,chas.