BA_ASSIGNMENT-3

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```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.3     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.3     v tibble    3.2.1
## v lubridate 1.9.2     v tidyr     1.3.0
## v purrr     1.0.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(mlbench)
```

```
## Warning: package 'mlbench' was built under R version 4.3.2
```

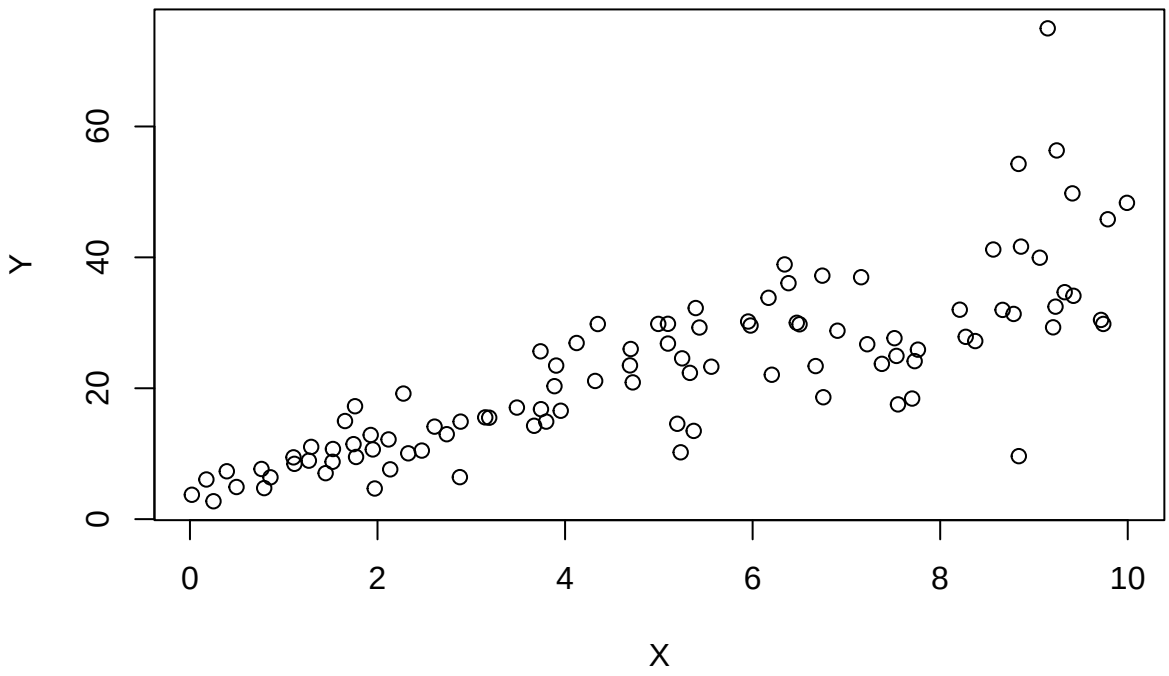
```
library(tinytex)
```

#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
```

#1a)Plot Y against X

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



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

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

#1b)Construct a simple linear model of Y based on X

```
Linear_Model=lm(Y ~X)
summary(Linear_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 to summary, accuracy of model can be derived from R-squared value. R-squared value of above summary is 0.6517. Hence, the accuracy of model is 65.17%.

#Write the equation that explains Y based on X?

#Y=3.6108*X+4.4655

#1c)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
```

#2a) 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
```

#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 that according to James assumption the model shows accuracy of 43.39% and according to Chris assumption the model shows accuracy of 60.24%. So, we can conclude that Chris assumption of comparing Horse power to mpg is better when compared to James assumption.

#2b) 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

```
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 0.524 ...
##  $ 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 ...
```

#3a) Build a model to estimate the median value of owner-occupied homes (medv) based on the following 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.

#3b(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.

#3b(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. Hence, Pupil-teacher ratio for 15 is expensive by 4.48101 when compared to pupil-teacher ratio of 18.

#3c)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.