Assignment 2

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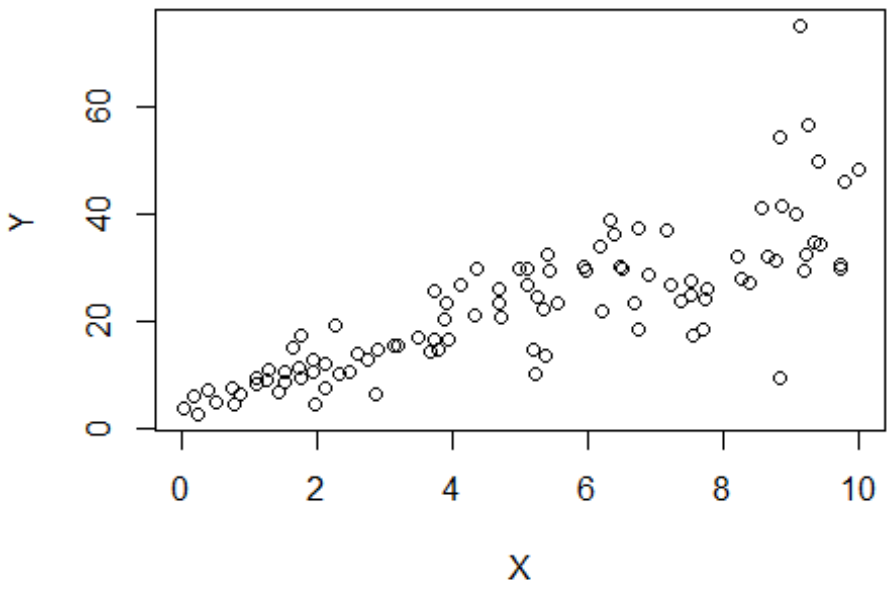
11/15/2021

##1.Run the following code in R-studio to 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
```

##A)Plot Y against X. Include a screenshot of the plot in your submission. Using the File menu you can save the graph as a picture on your computer. Based on the plot do you think we can fit a linear model to explain Y based on X?

```
plot(X,Y)
```




```
#yes, based on the data we can fit a model to explain Y based on X.
```

##B)Construct a simple linear model of Y based on X.Write the equation that explains Y based on X. What is the accuracy of this model?

```
Model_XY= lm(Y~X)
summary(Model_XY)

##
## 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

Model_XY$coefficients

## (Intercept)           X
##    4.465490    3.610759
```

The following equation explains Y based on X is

Y = (3.610759*X)+ 4.465490

The accuracy of the model is 0.6517 i.e., pretty good.

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

R2 is just the squared value of the coorelation cofficient between x and y as the regression is just based on one variable.

```
cor(X,Y)^2

## [1] 0.6517187
```

By above we notice that it's exact the same value of R-squared 0.6517

##2.We will use the 'mtcars' dataset for this question. The dataset is already included in your R distribution. The dataset shows some of the characteristics of different cars.The following shows few samples (i.e. the first 6 rows) ofthe dataset.

##A)James wants to buy a car.He and his friend, Chris, have different opinions about the Horse Power(hp) of cars. James think the weight of a car (wt) can be used to estimate the Horse Power of the car while Chris thinks the fuel consumption expressed in Mile Per

Gallon (mpg), is a better estimator of the (hp). Who do you think is right? Construct simple linear models using mtcars data to answer the question.

```
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
```

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

```
##
## Call:
## lm(formula = mtcars$hp ~ mtcars$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
## mtcars$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
```

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

```
##
## Call:
## lm(formula = mtcars$hp ~ mtcars$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 ***
## mtcars$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
```

As per the linear model of mtcars dataset Chris is right.

Accuracy of Chris model is 0.6024 which is very high than that of James i.e.,0.4339.

##B)Build a model that uses the number of cylinders (cyl) and the mile per gallon (mpg) values of a car to predict the car HorsePower (hp).Using this model, what is the estimated Horse Power of a car with 4 calendar and mpg of 22?

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

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

```
Model_HP$coefficients
```

```
## (Intercept)  mtcars$mpg  mtcars$cyl
##   54.066600   -2.774769   23.978626
```

```
predict_hp<-
(Model_HP$coefficients[2]*22)+(Model_HP$coefficients[3]*4)+Model_HP$coefficie
nts[1]
print(paste('The estimated Horse Power of a car with 4 calendar and mpg of 22
is ',predict_hp))
```

```
## [1] "The estimated Horse Power of a car with 4 calendar and mpg of 22 is
88.9361796789223"
```

##3.For this question, we are going to use BostonHousing dataset. The dataset is in 'mlbench' package, so we first need to instal the package, call the library and the load the dataset using the following commandsinstall.packages('mlbench')library(mlbench)data(BostonHousing)You should have a dataframe with the name of BostonHousing in your Global environment now.The dataset contains information about houses in different parts of Boston. Details of the dataset is explained here. Note the dataset is old, hence low houseprices!

##A)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). Isthis an accurate model?

```
library(mlbench)
data(BostonHousing)

Model_Boston<-lm(formula = BostonHousing$medv ~
BostonHousing$crim+BostonHousing$zn+BostonHousing$ptratio+BostonHousing$chas,
data = BostonHousing)
summary(Model_Boston)

##
## Call:
## lm(formula = BostonHousing$medv ~ BostonHousing$crim + BostonHousing$zn +
##     BostonHousing$ptratio + BostonHousing$chas, data = BostonHousing)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -18.282  -4.505  -0.986   2.650  32.656
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)           49.91868    3.23497  15.431  < 2e-16 ***
## BostonHousing$crim    -0.26018    0.04015  -6.480 2.20e-10 ***
## BostonHousing$zn       0.07073    0.01548   4.570 6.14e-06 ***
## BostonHousing$ptratio -1.49367    0.17144  -8.712  < 2e-16 ***
## BostonHousing$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
```

The Model is not very accurate because the value of the R-square is 0.3599 i.e., very low.

##B)Use the estimated coefficient to answer these questions?

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

```
summary(Model_Boston)
```

```
##
## Call:
## lm(formula = BostonHousing$medv ~ BostonHousing$crim + BostonHousing$zn +
##     BostonHousing$ptratio + BostonHousing$chas, data = BostonHousing)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -18.282  -4.505  -0.986   2.650  32.656
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)           49.91868    3.23497  15.431  < 2e-16 ***
## BostonHousing$crim    -0.26018    0.04015  -6.480 2.20e-10 ***
## BostonHousing$zn       0.07073    0.01548   4.570 6.14e-06 ***
## BostonHousing$ptratio -1.49367    0.17144  -8.712  < 2e-16 ***
## BostonHousing$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
```

##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?

```
x<- 1494*3
x
```

```
## [1] 4482
```

##C)Which of the variables are statistically important (i.e. related to the house price)? Hint: use the p-values of the coefficients to answer.

```
summary(Model_Boston)
```

```
##
## Call:
## lm(formula = BostonHousing$medv ~ BostonHousing$crim + BostonHousing$zn +
##     BostonHousing$ptratio + BostonHousing$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 ***
```

```
## BostonHousing$crim    -0.26018    0.04015  -6.480 2.20e-10 ***
## BostonHousing$zn       0.07073    0.01548   4.570 6.14e-06 ***
## BostonHousing$ptratio -1.49367    0.17144  -8.712  < 2e-16 ***
## BostonHousing$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
```

Since the P-value for the model is <0.05 we can conclude that none of the variables are statistically important.

##D)Use the anovaanalysis and determine the order of importance of these four variables.

```
anova(Model_Boston)
```

```
## Analysis of Variance Table
##
## Response: BostonHousing$medv
##                         Df  Sum Sq Mean Sq F value    Pr(>F)
## BostonHousing$crim       1  6440.8  6440.8 118.007 < 2.2e-16 ***
## BostonHousing$zn         1  3554.3  3554.3  65.122 5.253e-15 ***
## BostonHousing$ptratio    1  4709.5  4709.5  86.287 < 2.2e-16 ***
## BostonHousing$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
```

According to the model, the following order is as given below in Desc order

1.crim

2.ptratio

3.zn

4.chas