Fahad Purohit

SM assignment

PART-A

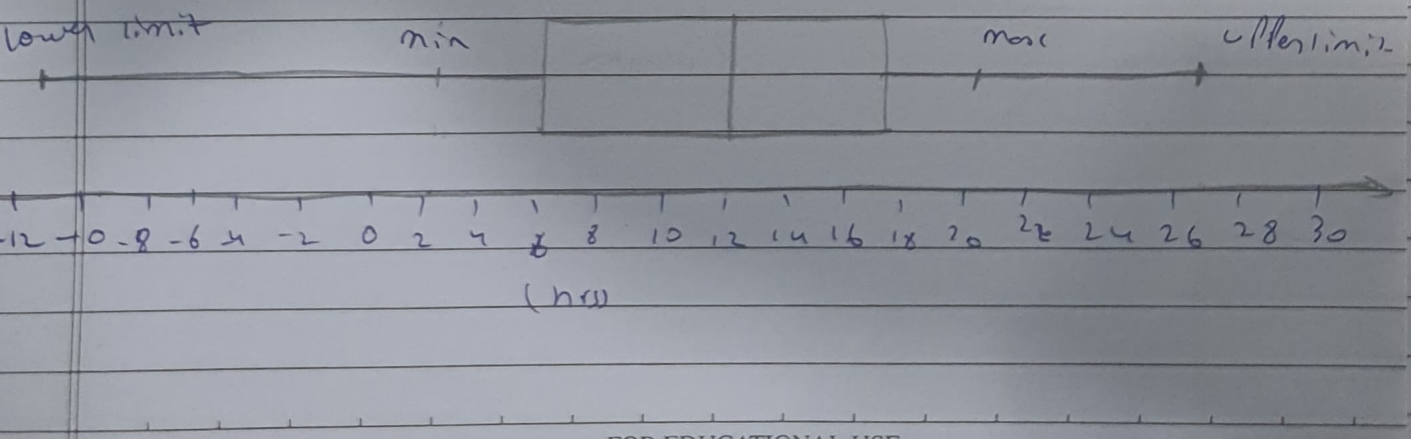
Box - Plot

Q.1] A teacher collects data on the number of hours that her students spend studying per night. The data is as follows →

2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.

→

- Minimum = 2
- Maximum = 20
- Median = $\frac{11+12}{2} = 11.5 \approx 12$ $\left(\frac{N/2^{th} + (N/2+1)^{th}}{2}\right)$
- $Q_1 = \frac{N}{4} = \frac{18^{th}}{4} = 6$
- $Q_3 = \frac{3N}{4} = \frac{54^{th}}{4} \approx 17$
- Inter Quartile Range = 17 - 6 = 11
- Lower whisker = $Q_1 - 1.5 \times IQR = 6 - (1.5 \times 11) = -10.5$
  Higher whisker = $Q_3 + 1.5 \times IQR = 11 + (1.5 \times 11) = 27.5$
- Since max and min are written lower and upper whisker, there are no outliers.



Q.2] The following dataset representing the 8 test scores (out of 100): 85, 78, 92, 88, 95, 89, 76, 90, 84, 88.

→

76, 78, 84, 85, 88, 88, 89, 90, 92, 95

→ minimum = 76

maximum = 95

→ median = 88

→ $Q_1 = \frac{N}{4} = 84$

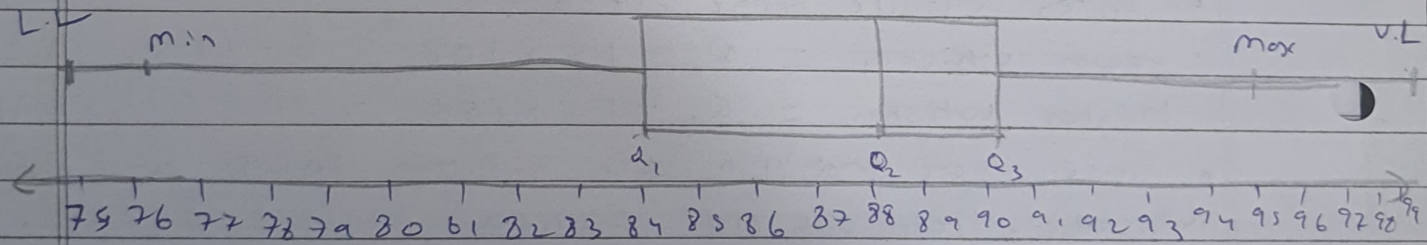
$Q_3 = \frac{3N}{4} = 90$

→ IQR = $Q_3 - Q_1 = 90 - 84 = 6$

→ Lower whisker = $Q_1 - (1.5 \times IQR) = 84 - (1.5 \times 6) = 75$

Upper whisker = $Q_3 + (1.5 \times IQR) = 90 + (1.5 \times 6) = 99$

(Since max and min are whithin the whiskers, there are no outliers)



(marks

Q.3] In a study of how students use mobile Phones, the Phone usage of random sample of 11 student was examined for a Particular week

The total length of calls, 4 mins for 11 students were

17, 23, 35, 36, 51, 53, 54, 55, 60, 72, 110

→ median = 53 → minimum = 17

→ Q_1 = 35 (N/4) → max = 110

→ Q_3 = 60 (3N/4) → IQR = 60 − 35 = 25

→ Lower whisker = $Q_1 - (1.5 \times IQR)$

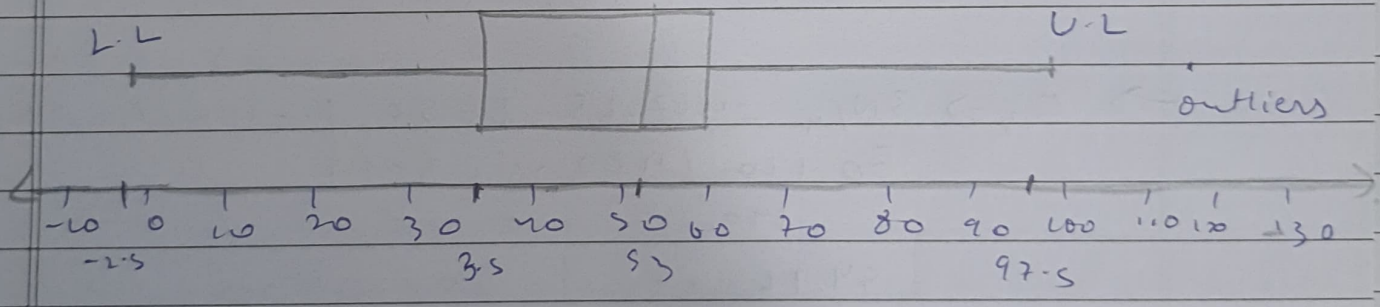
$= 35 - (1.5 \times 25)$

$= -25$

→ upper whisker = $Q_3 + (1.5 \times IQR$

$= 60 + (1.5 \times 25$

$= 97.5$



Qu) There are 543 members in a village, with the following ages:-

Age (yr)	f	cf
10-20	3	3
20-30	61	64
30-40	132	196
40-50	153	349
50-60	140	489
60-70	51	540
70-80	3	543

→ $N = 543$

→ $Q_2 = l + \frac{h}{f}\left(\frac{N}{2} - c\right)$

$= 40 + \frac{10}{153}(271.5 - 196)$

$= 44.93$

→ $Q_3 \Rightarrow 3N/4 = 407.25,\ l = 50,\ f = 140,\ c = 349$

$= 50 + \frac{10}{140}(407.25 - 349)$

$= 54.16$

→ $Q_1 \Rightarrow N/4 = 135.75,\ l = 30,\ f = 132,\ c = 64$

$= 30 + \frac{10}{132}(135.75 - 64)$

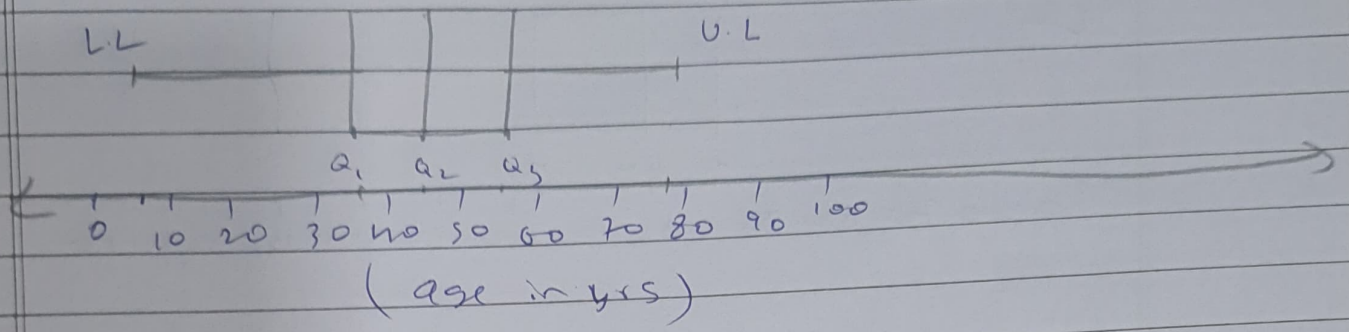
$= 35.43$

→ $IQR = Q_3 - Q_1 = 18.724$

→ $\text{Lower limit} = Q_1 - (1.5 \times IQR) = 7.31$

$\text{Upper limit} = Q_3 + (1.5 \times IQR) = 82.24$

→ No outliers



Q5) A Professor analyses the scores of 2 classes → A & B in maths. Create reflective box Plots and analyze if there are any outliers.

A = 85, 90, 92, 95, 97, 98, 100, 102, 105, 110, 112, 120, 125, 130, 135, 140

B = 75, 78, 80, 82, 85, 88, 92, 95, 96, 98, 100, 105, 108, 112, 115, 150.

→ for class A

• Median = $\left(\frac{\frac{N^{th}}{2} + \frac{N+1}{2}^{th}}{2}\right)$ = $\frac{102+105}{2}$ = 103.5

Q_1 = ~~Q - (1.5 × IQR)~~ $\frac{95+92}{2}$ = 96

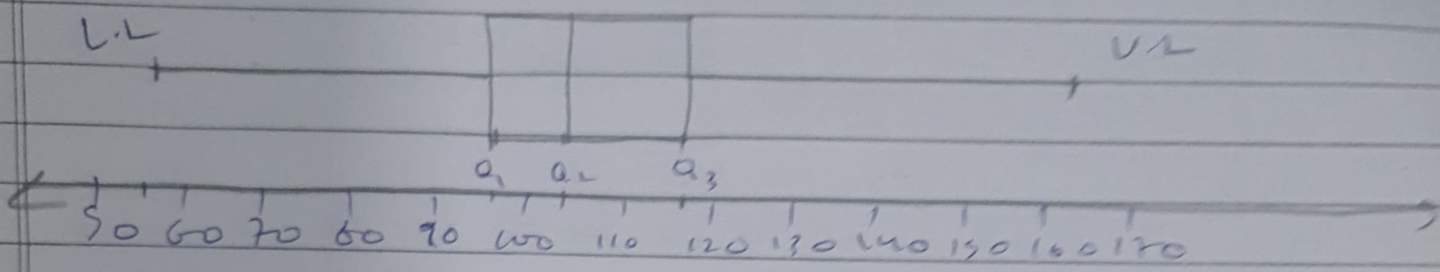
~~56.25~~

Q_2 = $\frac{120+125}{2}$ = 122.5

• IQR = $Q_3 - Q_1$ = 122.5 − 96 = 26.5

• lower limit = Q_1 − (1.5 × IQR)
= 56.25

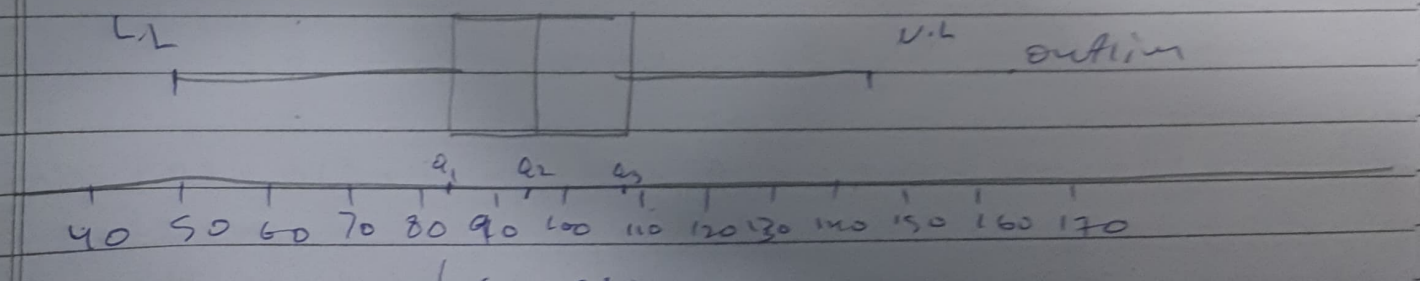
upper limit = Q_3 + (1.5 × 26.5)
= 162.25



There are no outliers in Class A

→ For Class B

- median $= \frac{95+96}{2} = 95.5$
- $Q_1 = \frac{82+85}{2} = 83.5$
- $Q_3 = \frac{105+108}{2} = 106.5$
- IQR $= Q_3 - Q_1 = 106.5 - 83.5 = 23$
- Lower limit $= Q_1 - (1.5 \times IQR) = 83.5 - (1.5 \times 23)$
  $= 47$
- upper limit $= Q_3 + (1.5 \times IQR) = 106.5 + (1.5 \times 23)$
  $= 141$



∴ In Class B, there is 1 outlier = 150

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Assignment - B

Q.1] Check whether a linear regression model is applicable for the following data

x : 60 70 80 85 95 $= 390$

y : 70 65 70 95 85 $= 385$

$\hat{y}$ = 65.41 71.80 70.78 81.5 87.94 $= 384.73$

→

residual $(y - \hat{y})$: 4.59 −6.8 −0.78 13.5 −2.94

$(y - \hat{y})^2$: 21.0681 46.7856 0.5584 182.25 8.6436

$\sum (y - \hat{y})^2 = 327.3057$

xy : 4200 4550 5600 8075 8075 $= 30500$

$$SS_{xy} = 30500 - \frac{390 \times 385}{5}$$

$$= -470$$

$$SS_{xx} = 31500 - 30420$$

$$= 730$$

$$b_1 = \frac{SS_{xy}}{SS_{xx}} = -0.6438$$

$$b_0 = \frac{385}{5} - \frac{(-0.6438)(390)}{5}$$

$$= 127.2164$$

$$y = 127.2164 - 0.6438x$$

$$Se = \sqrt{\frac{327.3057}{5-2-1}} = \sqrt{\frac{327.3057}{2}}$$

$$= 12.7927$$

Q2] The equation of a regression line is, the data is as follows; Solve for the residual and graph a residual plot. Do the data seem to violate any assumptions of regression?

→

x	y	x^2	xy
57	42	3249	2679
11	38	121	418
12	32	144	384
19	24	361	456
25	22	625	550
$\Sigma x = 124$	153	$\Sigma x^2 = 4500$	$\Sigma xy = 4487$
	(Σy)		

→ $n = 5$

→ $SS_{xy} = \Sigma xy - \frac{\Sigma x \Sigma y}{n} = 4487 - \frac{(124 \times 163)}{5}$

$= 444.6$

→ $S_{xx} = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 4500 - \frac{124^2}{5}$

→ $b_1 = \frac{S_{xy}}{S_{xx}} = \frac{444.6}{1424.8}$

$= 0.3120$

→ $b_0 = \frac{\Sigma y}{n} - b \frac{\Sigma x}{n} = \frac{163}{5} - \left(0.3120 \times \frac{124}{5}\right)$

$= 24.8624$

→ $\hat{y} = b_0 + b_1 x$

2 24.8624 + 0.3120x

→

y	$\hat{y}$	$y - \hat{y}$
47	42.6464	4.3536
38	28.2944	9.7056
32	28.6064	3.3936
24	30.7904	−6.7904
22	32.6624	−10.6624
		$\Sigma(y - \hat{y}) = 0$

→ from the graph we infer that the residuals are scattered randomly around the origin
∴ The model is an appropriate linear regression model

→ No, the data doesn't seem to be violating any assumptions of regression, the residuals are randomly distributed as they should be and the sum of residuals comes out to be zero

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Assignment - 3 Case Studies

0.1]

(i) response variable : US ticket Sales

explanatory variables : x_0 = budget

x_1 = stars

x_2 = runtime

(ii) $\hat{y} = -22.989025 + 1.134423 x_0 + 24.972358 x_1 - 0.402295 x_2$

(iii) x_0 : US ticket sales is positively correlated to budget

x_1 : US ticket sales is positively correlated to stars

x_2 : US ticket sales is negatively correlated to run time (minutes)

(iv) $x_0 = \$32$ millions, $x_1 = 3$ stars, $x_2 = 100$ minutes

$\therefore \hat{y} = -22.989025 + 1.134423(32) + 24.972358(3) - 0.402295(100)$

$\therefore \hat{y} = 47.899256$

(v)

F - test	T - test
H_0 : model is not significant P value > LOS	H_0 : x_0 is not significant P-value > LOS
H_1 : model is significant P value < LOS	H_1 : x_0 is significant P-value < LOS

(vi) f-test : P-value = < 0.0001 < 0.05

∴ model is significant

(vii) ∵ t-test : Pvalue of run times > 0.05

i.e $0.113 > 0.05$

∴ we will drop runtime from the model and rerun the model

(viii) $R^2 = 0.4737$

adj $R^2 = 0.4603$

∴ R^2 is more closer to 1 than adj R^2.

Q2)

(i) Response variable = netflix subscribers

Explanatory variables : x_0 = Monthly Price

x_1 = no of movies

x_2 = Price of rival

(ii) $\hat{y} = 2905.9639 + 111.213003 x_0 + 10.087515 x_1$

$- 605.173348 x_2$

(iii) x_0 : monthly Price is positively correlated to netflix subscribers

x_1 = no of movies is positively correlated to netflix subscribers

x_2 = Price of rival is negatively correlated to netflix subscribers

(iv) $x_0 = 0 \quad x_1 = 4250, \quad x_2 = 7$

∴ $\hat{y} = 2905.9639 + (111.213003)(0) + (10.087515)(4250)$

∴ $-605.173348(7) = 42479.84246$

(v) f test	T-test
H_0 : model is not significant P-value > LOS	H_0 : x_0 is not significant P-value > LOS
H_1 : model is significant P value < LOS	H_1 : model is significant P-value < LOS

(vi) f-test : P-value $= 4.30416 \times 10^{-5} < 0.05$

∴ model is significant

(vii) $R^2 = 0.88921293$

adj $R^2 = 0.8855976$

R^2 is more closer to 1 than adj R^2

(viii)

∴ t-test : P-value : $x_0 = 0.9040293 > 0.05$

$x_2 = 0.1997113 > 0.05$

∴ we will drop monthly Prices (x_0)

Q.10)

(i) response variable : y

Explanatory variable : $x_0 = x_1$

$x_1 = x_2$

$x_2 = x_4$

$x_3 = x_7$

(ii) $y = -55.9 + 0.0105 x_1 - 0.107 x_2 + 0.579 x_3 - 0.870 x_4$

(iv) $x_1 = 9, \; x_2 = 11, \; x_3 = 1, \; x_4 = 80$

$\therefore y = -55.9 + 0.0105(9) - 0.107(11) + 0.579(1) - 0.870(80)$

$= -117.0035$

(iii) x_1 is positively correlated to y

x_2 is negatively correlated to y

x_3 is positively correlated to y

x_4 is negatively coveld to y

(iv) F-test	T-test
H_0 : the model is not significa	$H_0 : x_1$ is not significant
P-value > LOS	P-value > los
H_1 : the model is signifi	$H_1 : x_1$ is significant
P-value < LOS	P-value < LOS

(v) $R^2 = 80.2\%$

adj. $R^2 = 70.7\%$

R^2 is more closer to 100% than adj R^2

(vii) f-test : P-value = 0.000 < 0.05

∴ model is Significant

viii) t-test = P value : x_1 = 0.619 > 0.05

∴ we will drop x_1 from the model

Q.ii) Predictors : 2 (x_1 and x_2)

$\hat{y} = 203.3432 + 1.1151 x_1 - 2.2115 x_2$

Strength :

∴ R^2 = 0.663 ; adj R^2 = 0.636

∴ R^2 is more closer to 1 than adj. R^2

∴ model is strong

∴ P-value : x_1 = 0.448 > 0.05

∴ x_1 is not significant

x_2 = 0.0006 < 0.05

∴ x_2 is significant

∴ co-eff : x_1 = 1.1151

x_2 = -2.2115

∴ x_2 has stronger negative correlation than that of the x_1 with comparitively weaker positive correlation

Q.12]

(i) response variable : y
exploratory variable : x_1 = college
x_1 = age - years
x_3 = income - k
x_4 = gender

(ii) $y = 1.94528 0922 + 8.683514224 x_4 + 0.06011530$
$- x_2 + 0.8164345 32 x_3 + 8.683514224 x_4$

(iii) all x_1, x_2, x_3 and x_4 are positively correlated to y
∴ college, age (years), income (k) and gender are positively correlated to the amount of customer purchase.

(iv) $x_1 = 5$, $x_2 = 10$, $x_3 = 12$

∴ $y = 1.94528 0922 + 8.039875895 (5) + 0.0601153 01 (10)$
$+ 0.8164345 39 (12) + 8.6835 4224 x_4$

$= 51.62362794 + 8.683514224 x_4$

(v) F-test	T-test
H_0: model is not significant	H_0: x_i is not significant
p-value > 0.05	p-value > 0.05
H_1: model is significant	H_1: x_i is significant
p-value < 0.05	p-value < 0.05

(vi) $R^2 = 0.974610686$, adj $R^2 = 0.954310036$
R^2 is more closer to 1 than adj R^2

(vii) p-value : model = 0.00352771 < 0.05
∴ model is significant.

(viii) P-value : college = 0.0226144843 > 0.05
age (yrs) = 0.7238696882 > 0.05
income (k) = 0.00032543 < 0.05
gender = 0.0560344432 > 0.05
∴ we will drop college x_1, age (yrs) x_2 and gender (x_4) from the model and rerun the model

Q.3
(i) response variable = concentration of chlorine
explanatory variables = temperature, extraction, CO, Mg, depth, pH, salinity, DO, bicarbonate, Ca, Cl^-, silicate, NH_4, NO_2^-, NO_3, PO_4^{3-}

(ii)
$y = -0.436 + 0.012x_1 - 0.02x_2 - 0.108x_3 - 0.015x_4 +$
$0.003x_5 + 0.013x_6 + 0x_7 + 0x_8 + 0x_9 + 0x_{10} + 0x_{11}$
$- 0.003x_{12} + 0x_{13} + 0x_{14}$

$\therefore y = -0.436 + 0.012x_1 - 0.02x_2 - 0.108x_3 - 0.015x_4$
$+ 0.003x_5 + 0.013x_6 - 0.003x_{12}$

(iv) $x_1 = 9, x_2 = 11, x_3 = 1, x_4 = 20$

$\therefore y = -0.436 + 0.012(9) - 0.02(11) - 0.108 - 0.015(20)$
$+ 0.003x_5 + 0.003x_{12}$
$= -1.156 + 0.003x_5 + 0.013x_6 - 0.003x_{12}$

(x) (v)

F-test	T-test
H_0: model is not significant & P-value > los	H_0: x_4 is not significant P-value > los
H_1: model is significant P-value < los	H_0: x_4 is significant P-value < los

(vi) $R^2 = 0.82327601$; adj $R^2 = 0.54863046$

R^2 is more closer to 1 than adj R^2

(vii) P-value : model $= 0.05139974 > 0.05$

∴ model is slightly insignificant

(viii) P-value : temperature $= 0.2527 > 0.5$

Extinction coef $= 0.303 > 0.5$

DO $= 0.253 > 0.05$

bicarbonate $= 0.34 > 0.05$

ammonium-N $= 0.455 > 0.5$

Nitrate-N $= 0.378 > 0.05$

Phosphate-P $= 0.714 > 0.05$

∴ we will drop temperature, extinction coef, DO, bicarbonate.

0.14) Predictors : 3 (x variable 1, X variable 2, x variable 3)
observations : 1 (4)
$y = 657.053 + 9.5710 x_1 - 0.4169 x_2 - 3.7252 x_3$

Strength : Model

- $R^2 = 0.710$; adj $R^2 = 0.630$
R^2 is more closer to 1 than adj R^2
∴ model is strong.

Model : P-value = 0.007 < 0.05
∴ model is strong

Significant : Predictors

x_1 : P-value = 0.0037 < 0.05
x_2 : P-value = 0.2122 > 0.05
x_3 : P-value = 0.0349 < 0.05
∴ x_1 and x_3 are significant

0.15) Strength : Model

- Model : P-value = 0.021 < 0.05
∴ Model is strong and significant

∴ $R^2 = 51.5\%$: adj $R^2 = 40.4\%$
R^2 is closer to 1 than adj
∴ Model is moderately sig..

Sleigh : Predictors

- x_1 : P-value = 0.05 < 0.05
- x_2 : P-value = 0.805 > 0.05
- x_3 : P-value = 0.230 > 0.05

∴ x_1 is the only significant Predictor

The model doesn't appear to be fit the data well.

Recommend: Drop x_2 and x_3 from the model and re run the model

Q.16) Predictors = 2(x_1 and x_{1*1})

$y = 203.3232$

Note: Some data and repetitive questions from Q.14 from PDF and Q.11 from this sheet

Q.17)

Note: Some data and repetitive questions from Q.8 of QB pdf and Q15 from next sheet.