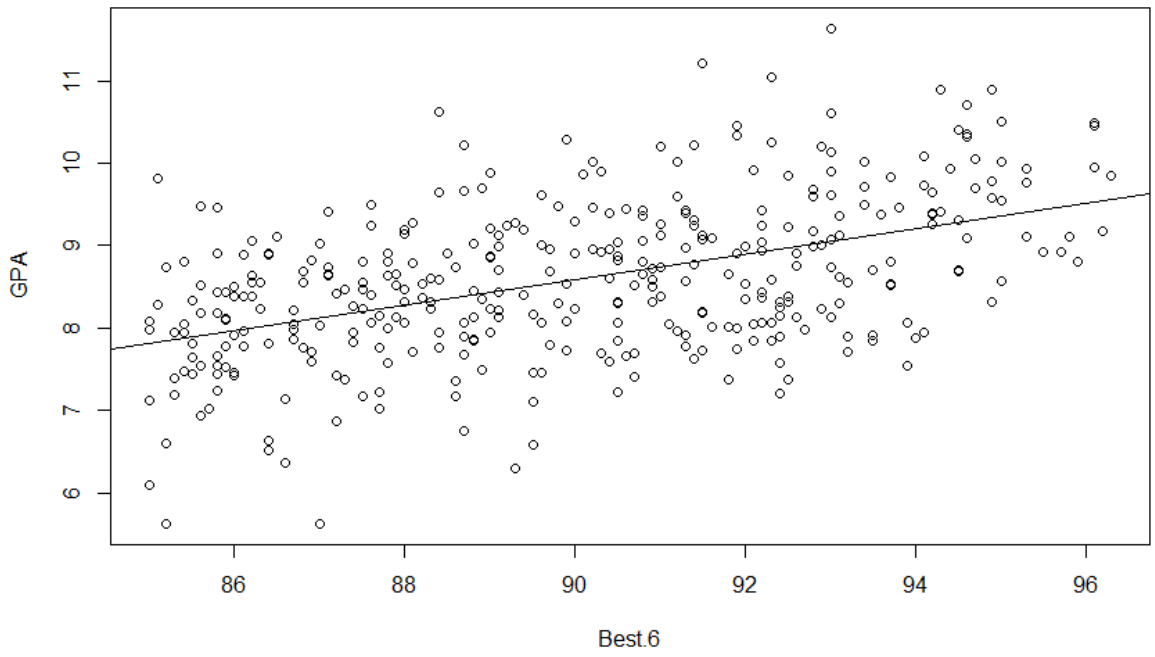
1.

(a) Is there a relationship between university grades and high school average using the best six OACs?



Residuals:

Min	1Q	Median	3Q	Max
-2.49671	-0.56908	0.02352	0.53000	2.58352

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-5.35498	1.31289	-4.079	5.57e-05	***
Best.6	0.15496	0.01458	10.632	< 2e-16	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

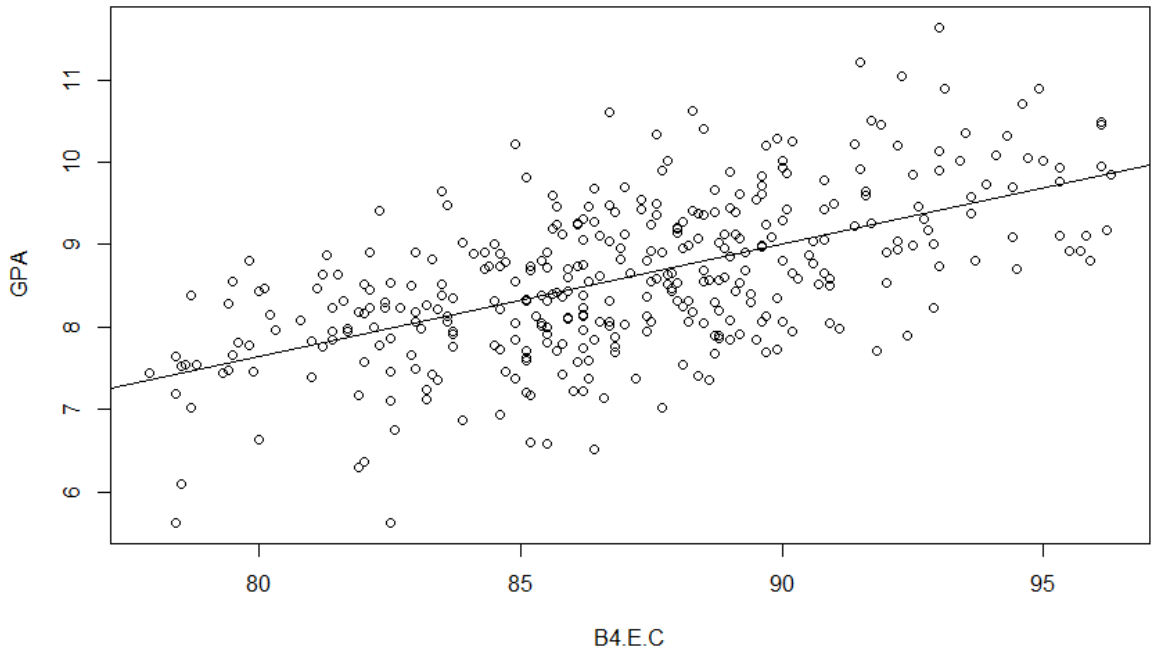
Residual standard error: 0.8295 on 361 degrees of freedom

Multiple R-squared: 0.2385, Adjusted R-squared: 0.2363

F-statistic: 113 on 1 and 361 DF, p-value: < 2.2e-16

藉由繪製散布圖以及 Simple Linear Regression 可以看得出來 GPA 與 Best.6 有線性關係。

(b)Is there a relationship between university grades and high school average using the best four OACs?



Residuals:

Min	1Q	Median	3Q	Max
-2.35057	-0.52668	0.02093	0.52157	2.22092

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-3.321975	0.854028	-3.89	0.000119	***
B4.E.C	0.137001	0.009807	13.97	< 2e-16	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7658 on 361 degrees of freedom

Multiple R-squared: 0.3509, Adjusted R-squared: 0.3491

F-statistic: 195.2 on 1 and 361 DF, p-value: < 2.2e-16

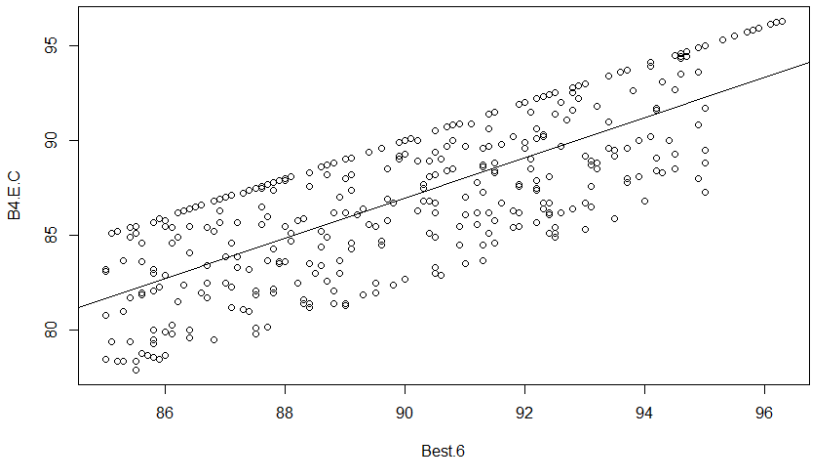
藉由繪製散布圖以及 Simple Linear Regression 可以看得出來 GPA 與 Best.E.C 有線性關係。

(c) Write a comment to the university's academic vice president describing your statistical analysis and your recommendations.

由上述可以發現 B6 與 B4.E.C 與 GPA 的關係十分相似，也可以從下圖發現 B6 與 B4.E.C 存在著線性關係。單以 B6 作為 dependent variable，以 B4.E.C，R squared 可以高達 0.5948。因此，即使採取最高分的六個成績 B6 之中不包含 English 跟 Calculus，還是可以多少代表著 B4.E.C，藉由下面的模型預測出 B4.E.C。

B4.E.C = -8.27950 + 1.05824* B6

Call:



lm(formula = B4.E.C ~ Best.6, data = OACs)

Residuals:

Min	1Q	Median	3Q	Max
-4.9532	-2.4154	0.2506	2.7235	3.3233

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-8.27950	4.14097	-1.999	0.0463	*
Best.6	1.05824	0.04597	23.020	<2e-16	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

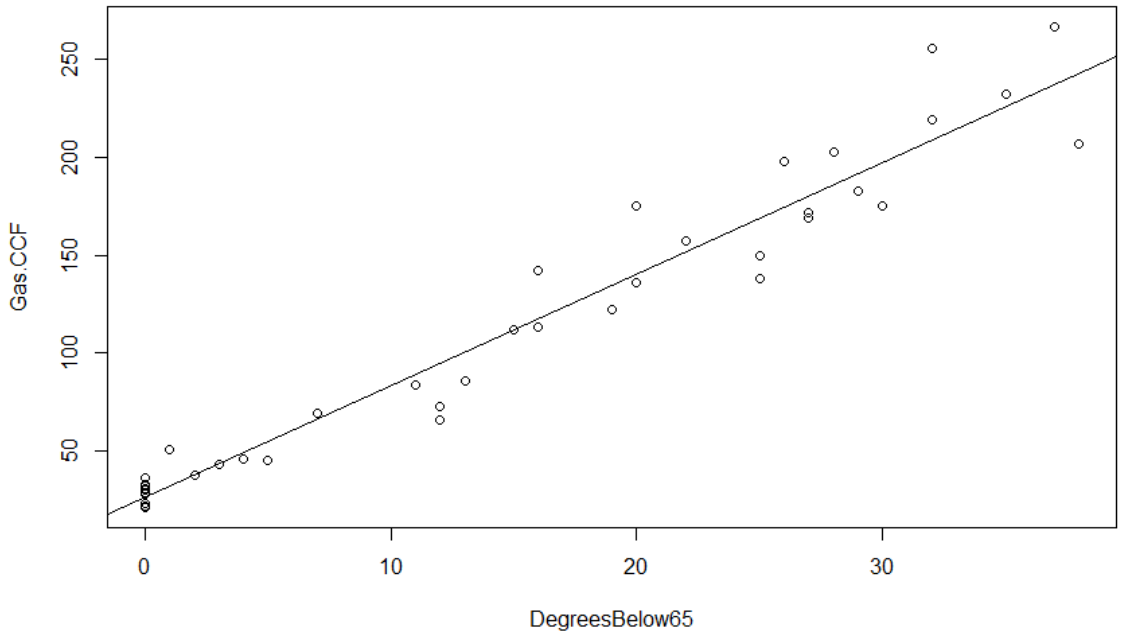
Residual standard error: 2.616 on 361 degrees of freedom

Multiple R-squared: 0.5948, Adjusted R-squared: 0.5937

F-statistic: 529.9 on 1 and 361 DF, p-value: < 2.2e-16

2.

(a) Use R to fit a simple linear model with the date “gas_consumption.txt”. Do the analysis, make the plot, and summarize the results.



Residuals:

Min	1Q	Median	3Q	Max
-36.056	-6.404	0.580	5.460	47.102

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	26.7274	3.2199	8.301	1.07e-10	***
DegreesBelow65	5.6928	0.1818	31.316	< 2e-16	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 16.09 on 46 degrees of freedom

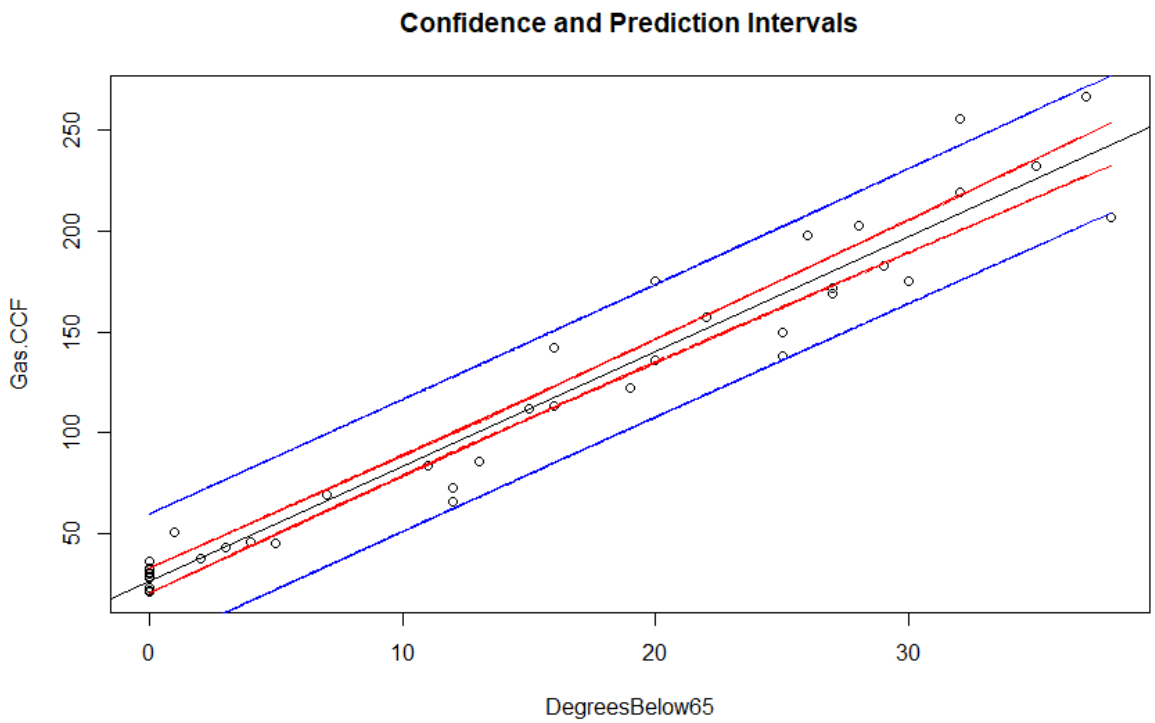
Multiple R-squared: 0.9552, Adjusted R-squared: 0.9542

F-statistic: 980.7 on 1 and 46 DF, p-value: < 2.2e-16

(Intercept)與 DegreeBelow65 的 p-value 都十分小，代表此截距與係數可信。而 R-squared 高達 0.9552，幾乎所有 dependent variable 的變異都被解釋到了。

在 DegreeBelow=0 時，預測 Gas.CCF=26.72，而 DegreeBelow65 每上升 1 單位，Gas.CCF 就會上升 5.69

(b) Modify the script provided for this lecture to create the “Confidence and Prediction Intervals” plot shown on lecture note p. 2-32 and re-printed below.



Code:

```
xy <- data.frame(X=DegreesBelow65)


yhat <- predict(fit, newdata=xy, interval="confidence")
ci <- data.frame(lower=yhat[,"lwr"], upper=yhat[,"upr"])

yhat.pi <- predict(fit, newdata=xy, interval="prediction")
pi <- data.frame(lower=yhat.pi[,"lwr"], upper=yhat.pi[,"upr"])
plot(DegreesBelow65,Gas.CCF, main ="Confidence and Prediction Intervals",
      ylab = "Gas.CCF",
      xlab = "DegreesBelow65")
abline(fit)
lines(xy$X, ci$lower, lty=2, col="red")
lines(xy$X, ci$upper, lty=2, col="red")
lines(xy$X, pi$lower, lty=2, col="blue")
lines(xy$X, pi$upper, lty=2, col="blue")
```

3. Find a linear model that appropriately reveals the relationship among these variables. Clearly state your model building process and interpret the results of your final model.

我先將 Cars 跟 Speed 分別對 Accidents 做 SLD 後，發現 Cars 這項的 p-value 與 R-squared 表現比較好，繼續加入 Speed 後，發現兩個 independent variables 的 p-value 都下降，且 R-squared 與 Adjusted R-squared 都上升，因此選定這項為 final model。

其中 Cars 與 Speed 這兩項變數的 p-value 都>0.05，因此不能否定 H0: Coefficient of Cars = 0 跟 H0: Coefficient of Speed = 0，其中可以利用這兩個變數解釋的變異只有約 5.55%，而在 Global model test 中的 F-statistic: 1.674, p-value: 0.1965，代表我們不行拒絕 H0: Coefficient of Cars = Coefficient of Speed = 0

Call:
lm(formula = Accidents ~ Cars + Speed)

Residuals:

Min	1Q	Median	3Q	Max
-7.8859	-0.8428	-0.0385	1.4427	4.2786

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-12.8719	13.7901	-0.933	0.355
Cars	0.3733	0.2587	1.443	0.155
Speed	0.2699	0.2232	1.209	0.232

Residual standard error: 2.408 on 57 degrees of freedom
Multiple R-squared: 0.05548, Adjusted R-squared: 0.02234
F-statistic: 1.674 on 2 and 57 DF, p-value: 0.1965