MA 4710 Homework 8

Benjamin Hendrick

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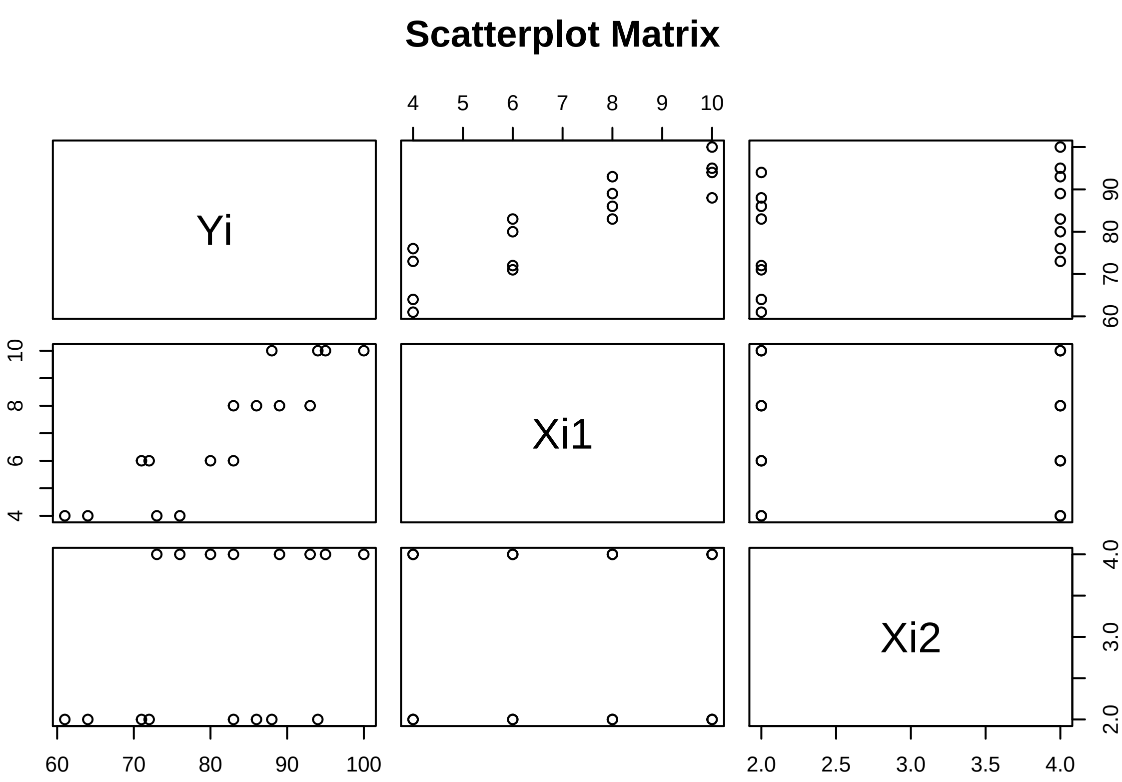
Problem 6.5

```
brand <- read.table("~/GitHub/MA-4710/Homework 8/brand.txt",
                    quote="\"", comment.char="")
names(brand) <- c("Yi","Xi1", "Xi2")
```

Part A

```
pairs(brand, main = "Scatterplot Matrix")
```




```
cor(brand)
```

```
##            Yi       Xi1       Xi2
## Yi  1.0000000 0.8923929 0.3945807
## Xi1 0.8923929 1.0000000 0.0000000
## Xi2 0.3945807 0.0000000 1.0000000
```

According to the correlation matrix, there is no correlation between X_{i1} and X_{i2}.

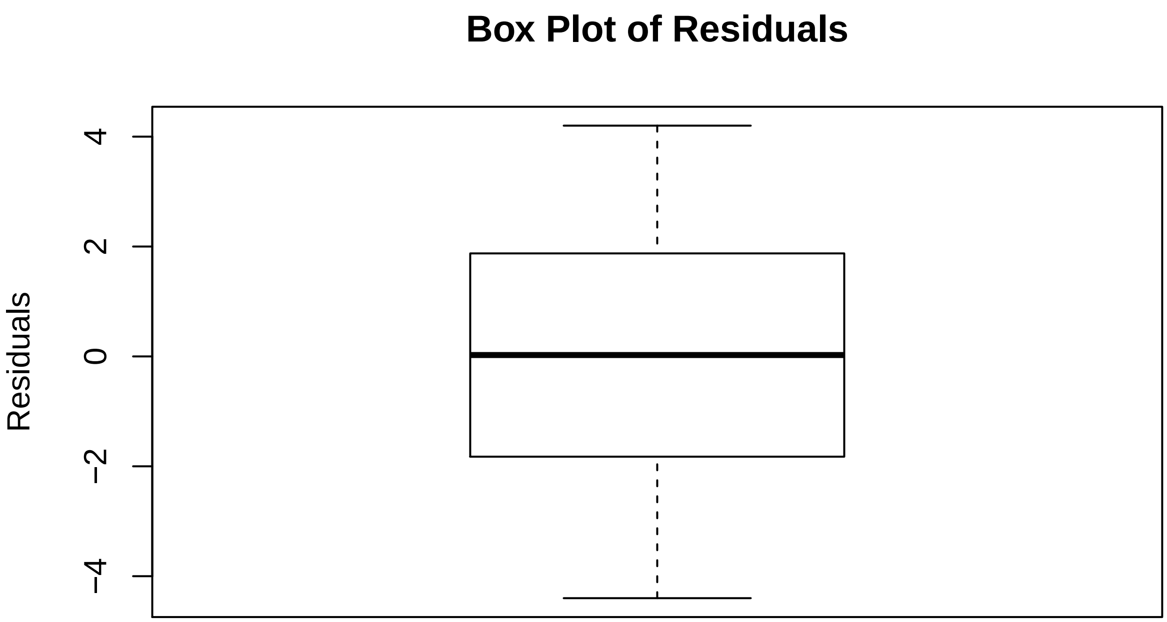
Part B

```
brand.lm <- lm(Yi ~ Xi1 + Xi2, data=brand)
```

The estimated regression function is $\hat{Y}_i = 37.65 + 4.425X_{i1} + 4.375X_{i2}$. b_1 provides the dependency of the moisture content and brand liking. For every increase in brand liking, the moisture content increases by 4.425.

Part C

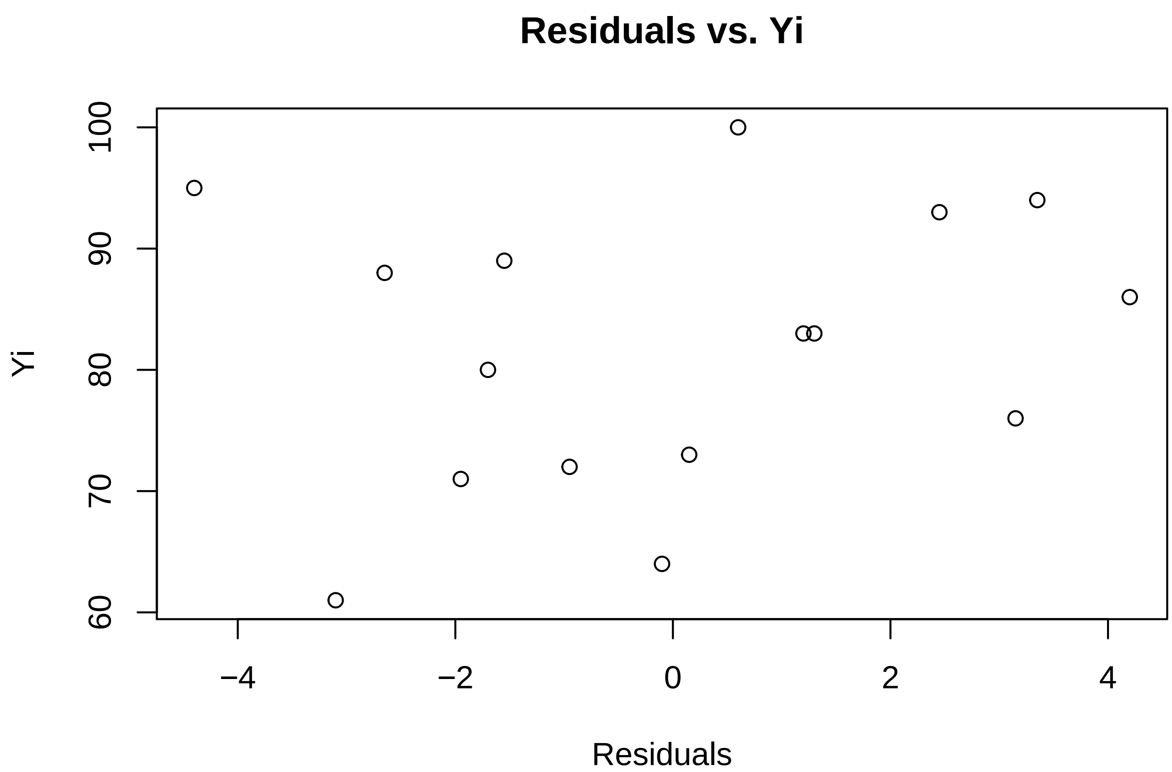
```
brand.lm.resid <-resid(brand.lm)
boxplot(brand.lm.resid, main = "Box Plot of Residuals", ylab= "Residuals")
```



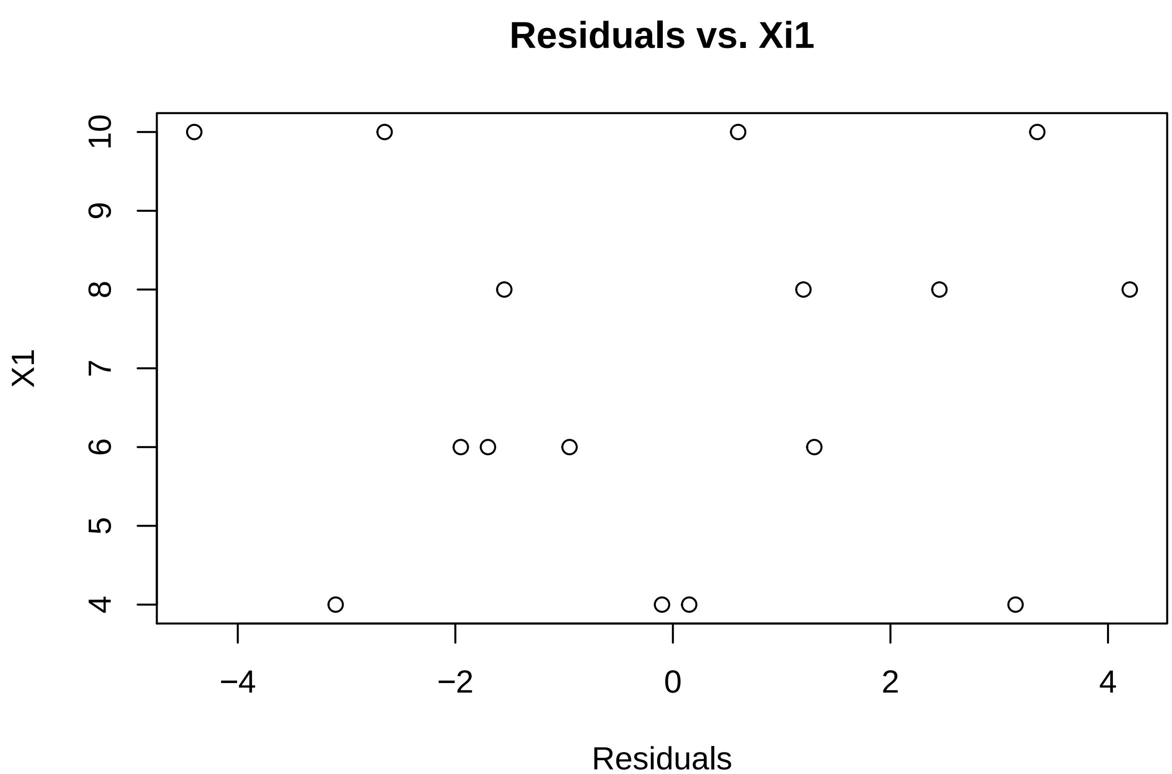
The redisuals appear to be symmetrically distributed around zero and have zero mean.

Part D

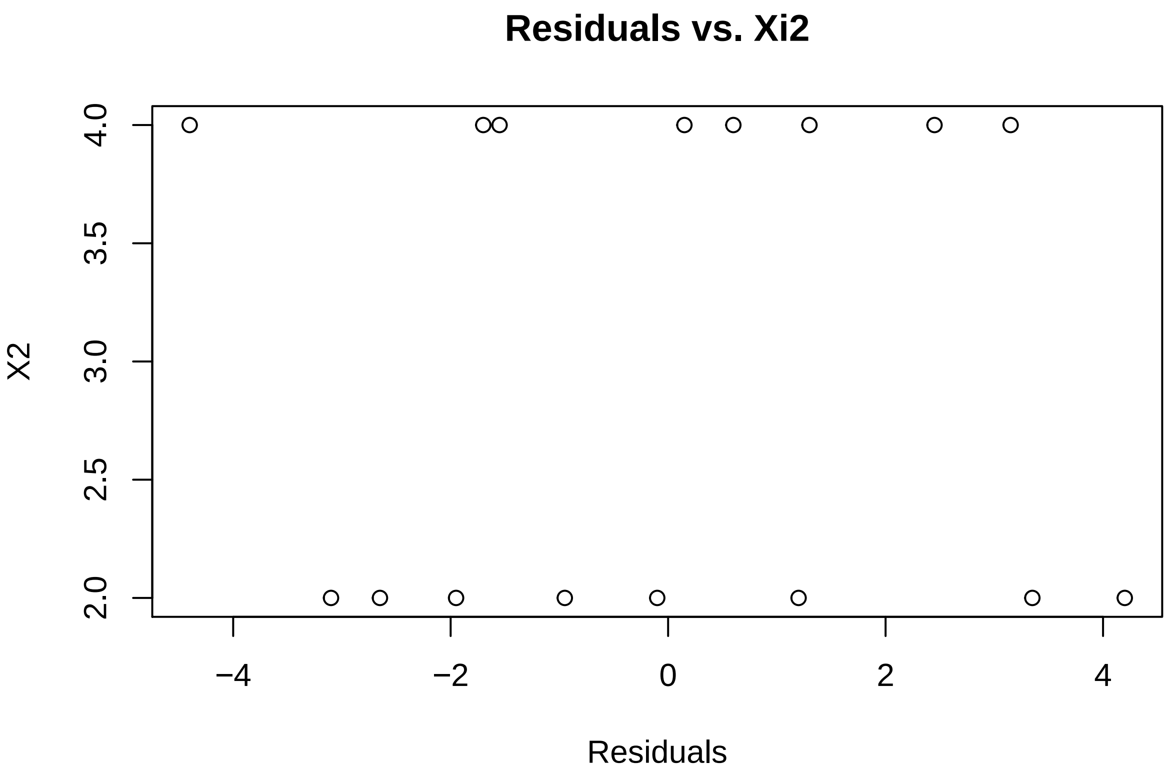
```
# Resid vs Yi
plot(x = brand.lm.resid, y = brand$Yi,
     xlab = "Residuals", ylab = "Yi",
     main = "Residuals vs. Yi")
```



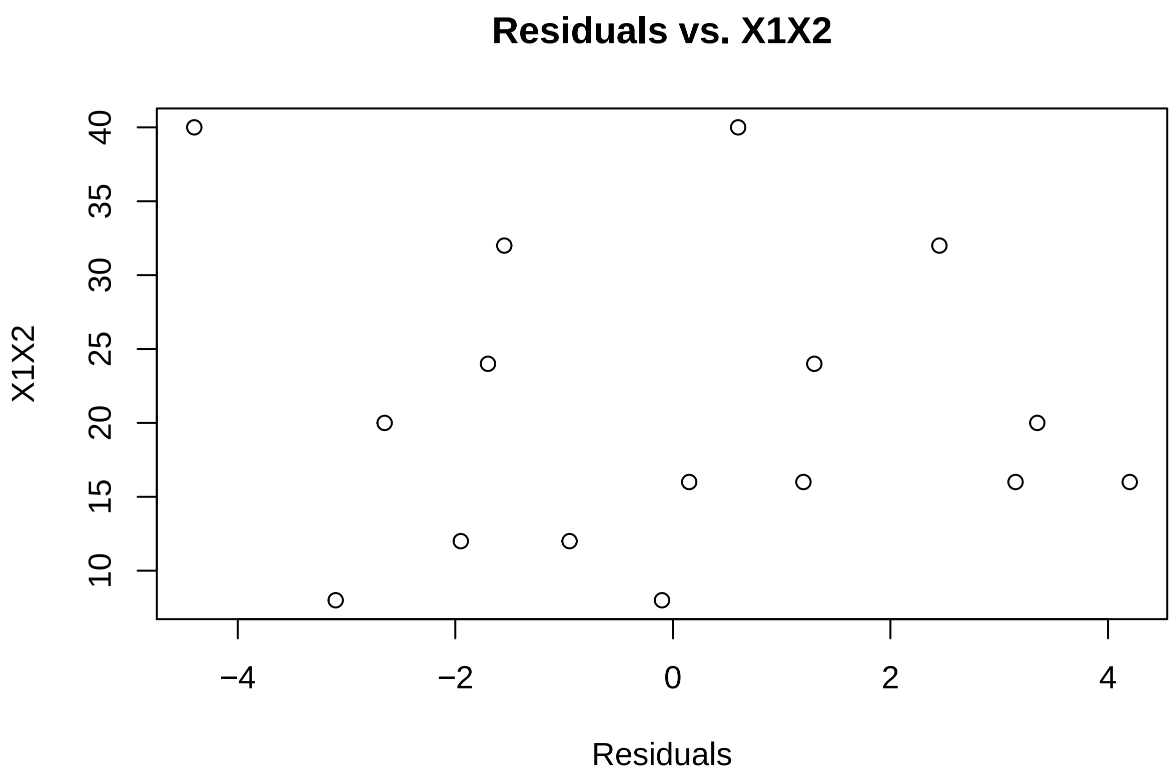

```r
# Resid vs Xi1
plot(x = brand.lm.resid, y = brand$Xi1,
     xlab = "Residuals", ylab = "X1",
     main = "Residuals vs. Xi1")
```



```r
# Resid vs. Xi2
plot(x = brand.lm.resid, y = brand$Xi2,
     xlab = "Residuals", ylab = "X2",
     main = "Residuals vs. Xi2")
```

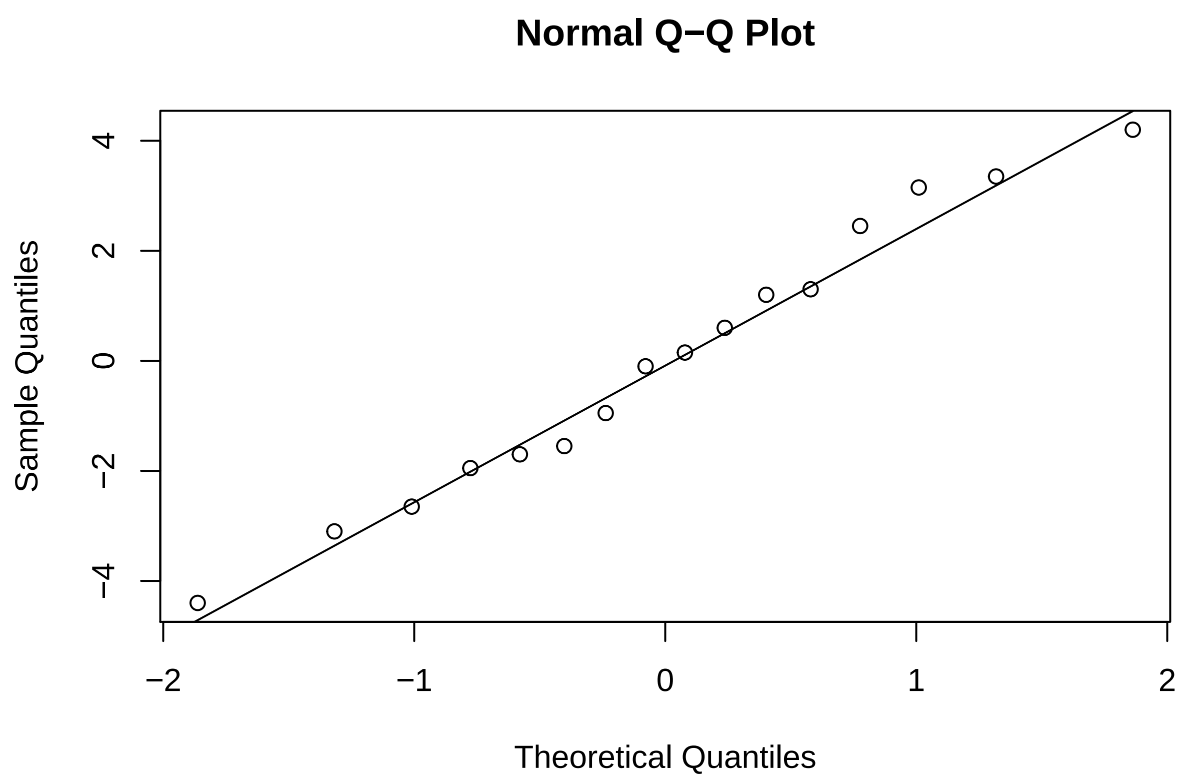



```r
# Resid vs. Xi1 * Xi2
plot(x = brand.lm.resid, y = brand$Xi1 * brand$Xi2,
     xlab = "Residuals", ylab = "X1X2",
     main = "Residuals vs. X1X2")
```



The residual plots have a uniform spread across all veriables.

```
qqnorm(brand.lm.resid)
qqline(brand.lm.resid)
```



The normal probability plot suggests that the residuals are normally distributed.

Part E

```r
library(lmtest)
```

```
## Loading required package: zoo
##
## Attaching package: 'zoo'
##
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```r
bptest(Yi ~ Xi1 + Xi2, data = brand)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  Yi ~ Xi1 + Xi2
## BP = 2.0441, df = 2, p-value = 0.3599
```

$H_0 : \upsilon_1 = 0$ vs. $H_a : \upsilon_1 \neq 0$.

Because the p-value, 0.3598534,is greater than 0.01, we fail to reject H_0, proving that the error variance is constant.

Problem 6.6

Part A

```r
summary(brand.lm)
```

```
##
## Call:
## lm(formula = Yi ~ Xi1 + Xi2, data = brand)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -4.400 -1.762  0.025  1.587  4.200
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  37.6500     2.9961  12.566 1.20e-08 ***
## Xi1           4.4250     0.3011  14.695 1.78e-09 ***
## Xi2           4.3750     0.6733   6.498 2.01e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.693 on 13 degrees of freedom
## Multiple R-squared:  0.9521, Adjusted R-squared:  0.9447
## F-statistic: 129.1 on 2 and 13 DF,  p-value: 2.658e-09
```

$H_0 : \beta_i = 0$ vs. $H_1 : \beta_i \neq= 0$.

From the `summary` function, we find that the p-value for β_1, 1.78×10^{-9}, is less than $\alpha = 0.1$. Therefore we reject H_0 proving that $\beta_1 \neq 0$.

The p-value for β_2, 2.01×10^{-5}, is less than $\alpha = 0.1$. Therefore we reject H_0 proving that $\beta_2 \neq 0$.

Part B

The p-values from of the test in Part A are $1.20 \times 10^{-8}, 1.78 \times 10^{-9}, 2.01 \times 10^{-5}$ for β_0, β_1, and β_2, respectively.

Part C

```
coef <- summary(brand.lm)$coefficients          # Statement Confidence Level
alpha <- 0.01                             # alpha : significance level

B <- qt(1-alpha/(2),brand.lm$df.residual)
BCI <- cbind(coef[,2]-B*coef[,3],coef[,2]+B*coef[,3])
colnames(BCI) <- c("Lower Bound","Upper Bound")
BCI[2:3,]
```

```
##     Lower Bound Upper Bound
## Xi1   -43.96473    44.56697
## Xi2   -18.89928    20.24593
```

The bounds of the Bonferroni procedure for X_{i1} are (-43.9647332, 44.5669726). The bounds of the Bonferroni procedure for X_{i2} are (-18.8992802, 20.2459285).

Problem 6.7

The coefficient of multiple determintaiton R^2 from the `summary` function is 0.952059