RPS
Analiza podatkov

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Vprašanja

Nekaj vprašanj, na katere bi radi odgovorili je:

- Ali so fantje večji od deklet?
- Ali so fantje težji od deklet?
- Ali sta razpon rok in višina približno enaka?
- Ali drži Galtonovo opažanje glede višine otrok in staršev?
- ...

Zbrali smo nekaj podatkov o študentih, s katerimi si bomo lahko poskusili odgovoriti.

Podatki

Podaki so o študentih 3. letnika biologije v letu 2012/13 so v datoteki lfn in na http://bit.ly/16oBVpR

```
fpath <- "http://bit.ly/16oBVpR"
data <- read.table(fpath, header = TRUE, sep = "\t")
names(data)
```

```
 [1] "starost" "mesec"   "spol"    "masa"    "visina" 
 [6] "roke"    "cevelj"  "lasje"   "oci"     "mati"   
[11] "oce"     "majica" 
```

Opisna statistika

```
summary(data[, 1:6])
```

```
   starost          mesec        spol        masa
Min.   :20.00   Min.   : 0.000   F:33   Min.   :50.00
1st Qu.:21.00   1st Qu.: 5.000   M:10   1st Qu.:55.50
Median :21.00   Median : 7.000          Median :61.00
Mean   :22.07   Mean   : 6.814          Mean   :63.42
3rd Qu.:22.00   3rd Qu.: 9.500          3rd Qu.:70.00
Max.   :59.00   Max.   :11.000          Max.   :91.00

    visina            roke
Min.   :156.0   Min.   :154.0
1st Qu.:164.0   1st Qu.:163.2
Median :170.0   Median :167.8
Mean   :169.9   Mean   :169.3
3rd Qu.:173.5   3rd Qu.:172.5
Max.   :189.0   Max.   :193.0
                NA's   :5
```

Ali pri podatkih kaj opazite?

Nenavadni podatki

Kaj storiti s tistim, ki je napisal, da je rojen v mesecu 0?
Eden pa je star 59 let??

Popravljanje podatkov

Ohranimo *ta mlade*

```
data <- data[data$starost < 30, ]
```

Podatke o mesecu 0 spremenimo v `NA`

```
data[data$mesec == 0, "mesec"] <- NA
table(data$mesec)
```

```
 1  2  3  4  5  6  7  8  9 10 11
 1  3  2  3  4  3  7  5  2  5  6
```

Nadaljevanje opisa

```r
summary(data[, 7:dim(data)[2]])
```

```
    cevelj      lasje  oci         mati
Min.   :36.00   S:19   S:23   Min.   :157.0
1st Qu.:38.00   T:23   T:19   1st Qu.:160.0
Median :39.00                 Median :165.0
Mean   :39.93                 Mean   :165.6
3rd Qu.:41.00                 3rd Qu.:168.0
Max.   :48.00                 Max.   :180.0
                              NA's   :5
     oce         majica
Min.   :170.0   L : 4
1st Qu.:174.0   M :19
Median :179.0   S :16
Mean   :179.1   XL: 1
3rd Qu.:182.0   XS: 2
Max.   :190.0
NA's   :5
```

Višina po spolu

Povzetek višin glede na spol

```
  summary(data$mati)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  157.0   160.0   165.0   165.6   168.0   180.0       5
```

```
  by(data$visina, data$spol, summary)
```

```
data$spol: F
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  156.0   163.0   168.0   166.8   170.0   178.0
---------------------------------------------
data$spol: M
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  171.0   180.0   180.0   180.2   183.0   189.0
```

```
  summary(data$oce)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  170.0   174.0   179.0   179.1   182.0   190.0       5
```

Doseg spremenljivk v objektu `data.frame`

Poglejte kakšne so vrednosti spremenljivke `visina`!
Ali je v delovnem prostoru (workspace)?
Do spremenljivk lahko pridem posredno na več načinov

- `data$visina`
- `data[, 'visina']`
- `data[,5]`

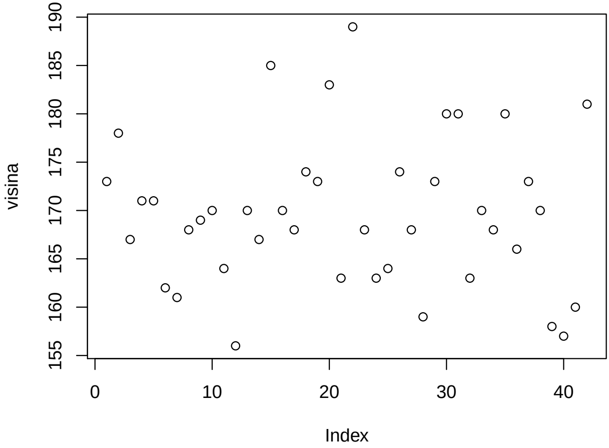
Neposreden dostop

Neposreden dostop do spremenljivk omogoči

```
  attach(data)
  length(visina)

[1] 42

  visina[1:5]

[1] 173 178 167 171 171
```

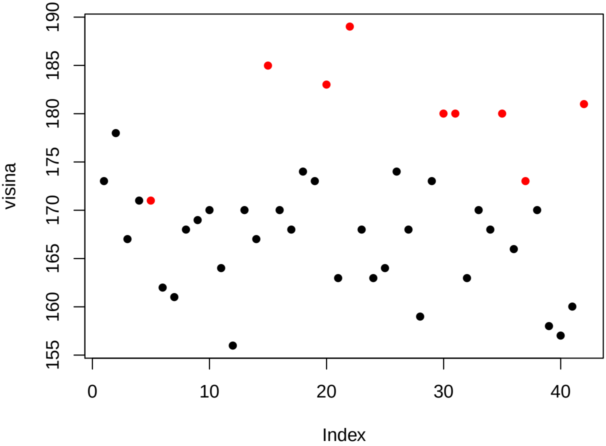
Grafični prikaz podatkov

```
plot(visina)
```



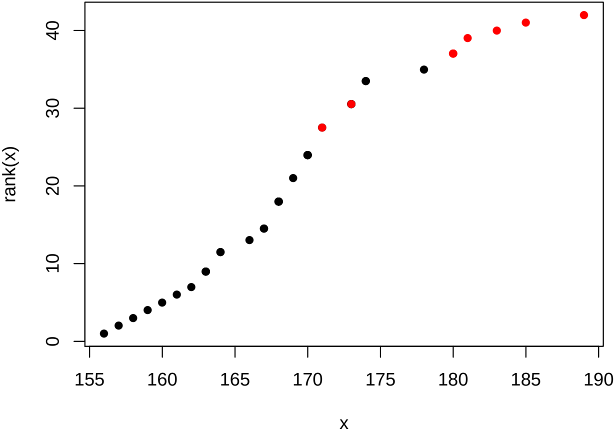
Grafični prikaz podatkov

```
plot(visina, pch = 16, col = spol)
```



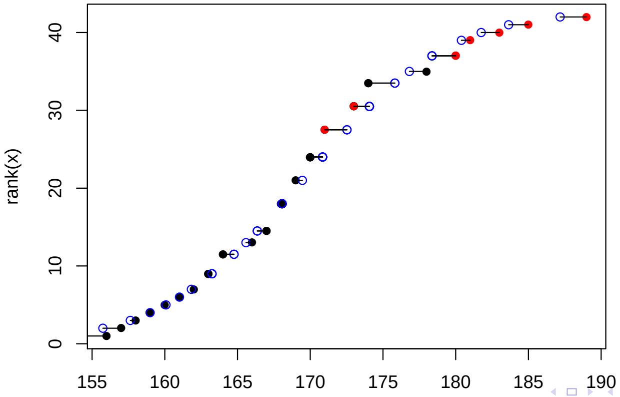
Kumulativa

```
x <- visina
plot(x, rank(x), pch = 16, col = spol)
```



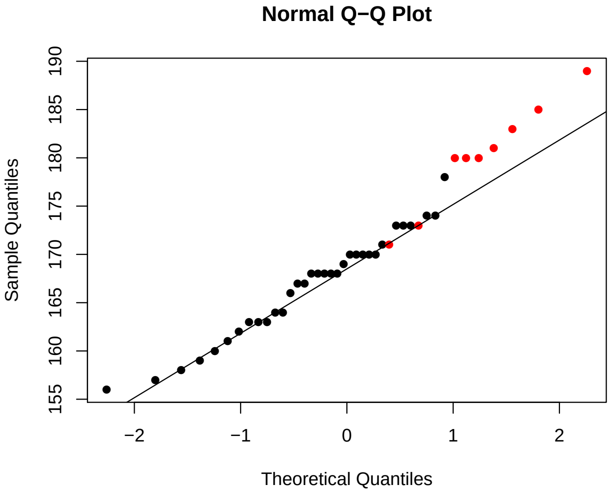
Kumulativa in normalna aproksimacija

```
 x <- visina
 plot(x, rank(x), pch = 16, col = spol)
 q <- qnorm((rank(x) - 0.5)/length(x), mean(x),
+  sd(x))
 points(q, rank(x), col = 4)
 segments(x, rank(x), q, rank(x))
```



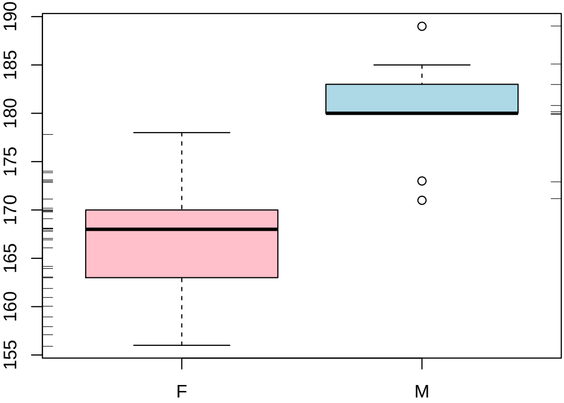
Slika kvantilov

```
qqnorm(visina, col = spol, pch = 16)
qqline(visina)
```



Boxplot

```
boxplot(visina ~ spol, col = c("pink", "lightblue"))
rug(jitter(visina[spol == "F"]), side = 2)
rug(jitter(visina[spol == "M"]), side = 4)
```



Dorišite točke za mediane. Pomagajte si s `str()`, `locator()`.

Student t-test

```
  t.test(visina ~ spol)
```

```
Welch Two Sample t-test

data:  visina by spol
t = -6.4643, df = 12.502, p-value = 2.55e-05
alternative hypothesis: true difference in means is not
95 percent confidence interval:
 -17.901862  -8.906219
sample estimates:
mean in group F mean in group M
       166.8182        180.2222
```

Lahko tudi tako:

```
  t.test(visina[spol == "F"], visina[spol == "M"])
```

Oglejte si, kaj vrne funkcija `t.test()`. Dorišite točki povprečij.

Teža in spol

Izberite si nekaj prejšnjih prikazov in

- Raziščite kako je s težo pri dekletih in fantih.
- Izračunajte novo spremenljivko $BMI = masa/visina^2$
- Kaj pa velja za BMI?

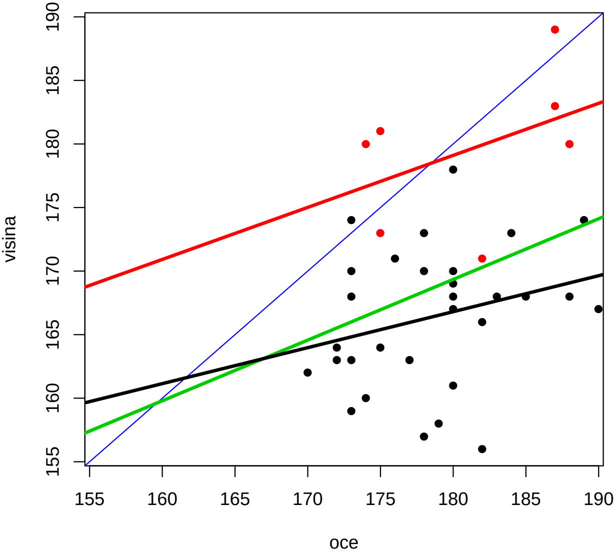
Velikost staršev in potomcev

Galton je ugotavljal korelacijo med velikostjo staršev in potomcev. Uvedel je pojem regresija, ki izvira iz ugotovitve, da so velikost staršev in potomcev v posebnem razmerju, ki zagotavlja 'regesijo' k povprečju.

Fantje

```
  with(data, plot(oce, visina, col = spol, pch = 16,
+     xlim = range(visina)))
  abline(c(0, 1), col = "blue")
  abline(lm(visina ~ oce, data = data), col = 3,
+     lwd = 3)
  abline(lm(visina ~ oce, data = data[data$spol ==
+     "M", ]), col = "red", lwd = 3)
  abline(lm(visina ~ oce, data = data[data$spol ==
+     "F", ]), lwd = 3)
```

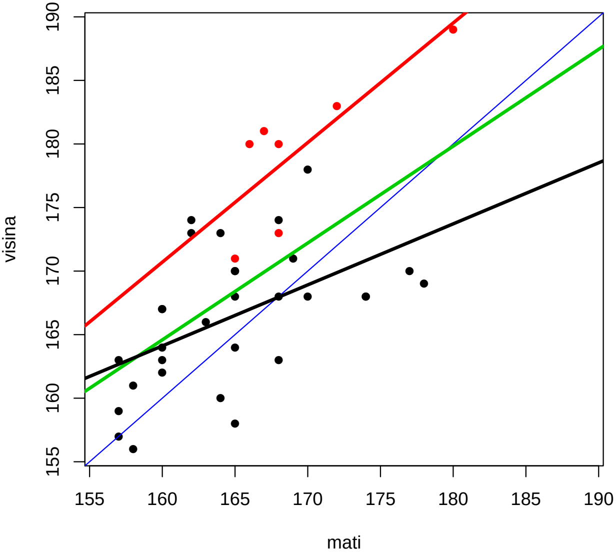
Fantje


190
185
180
175
170
165
160
155
visina
155
160
165
170
175
180
185
190
oce

Dekleta

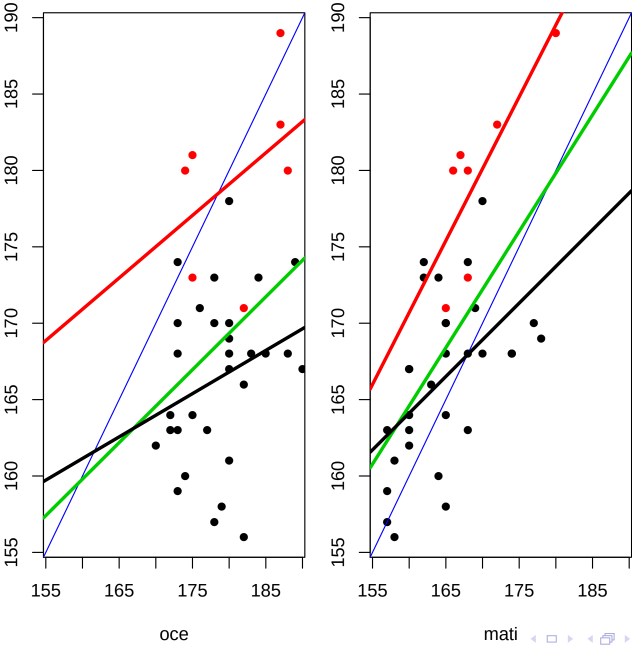
```
  with(data, plot(mati, visina, col = spol, pch = 16,
+     xlim = range(visina)))
  abline(c(0, 1), col = "blue")
  abline(lm(visina ~ mati, data = data), col = 3,
+     lwd = 3)
  abline(lm(visina ~ mati, data = data[data$spol ==
+     "M", ]), col = "red", lwd = 3)
  abline(lm(visina ~ mati, data = data[data$spol ==
+     "F", ]), lwd = 3)
```

Dekleta



visina
155
160
165
170
175
180
185
190
mati
155
160
165
170
175
180
185
190

Fantje in dekleta

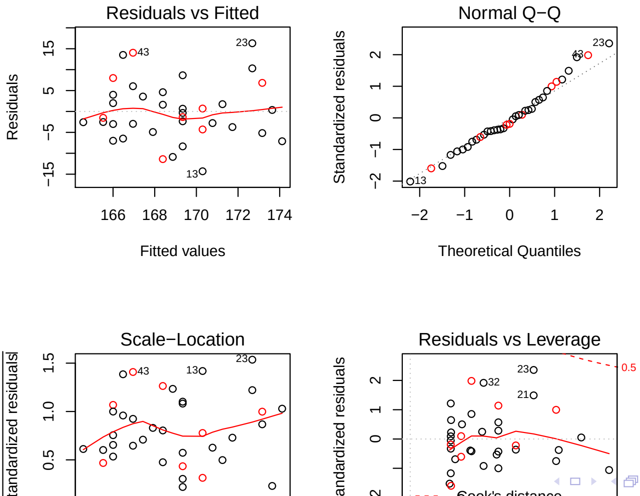


Koeficienti

```
  fit <- lm(visina ~ oce, data = data)
  summary(fit)
Call:
lm(formula = visina ~ oce, data = data)

Residuals:
    Min      1Q  Median      3Q     Max 
-14.298  -4.298  -1.343   3.998  16.315 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)  
(Intercept)  83.4128    39.1670   2.130   0.0403 *
oce           0.4774     0.2186   2.183   0.0358 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Residual standard error: 7.231 on 35 degrees of freedom
  (5 observations deleted due to missingness)
Multiple R-squared: 0.1199, Adjusted R-squared: 0.09474
```

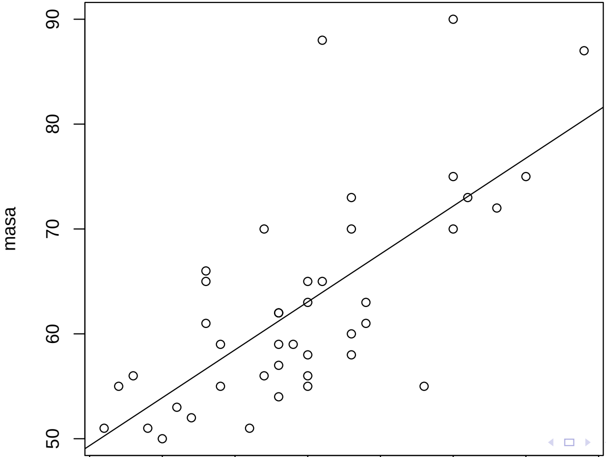
Grafična analiza

```
par(mfrow = c(2, 2))
plot(fit, col = spol)
```



Regresija

```
plot(visina, masa)
abline(lm(masa ~ visina))
```



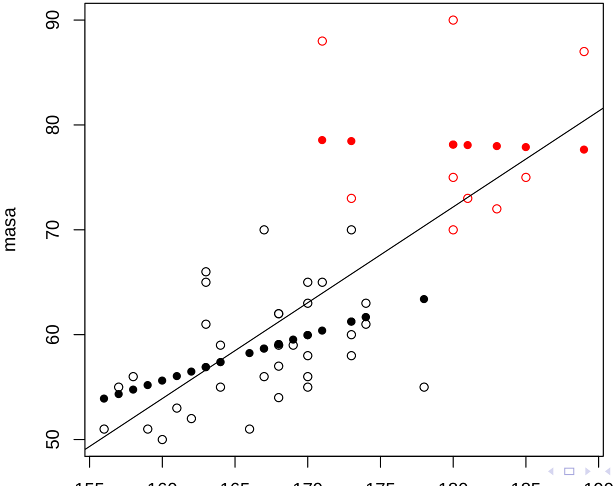
Regresija

```
  cor(masa, visina)
[1] 0.7049331
  fit <- lm(masa ~ visina)
  summary(fit)
Call:
lm(formula = masa ~ visina)

Residuals:
    Min      1Q  Median      3Q     Max
-15.354  -4.140  -1.786   3.579  24.042

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -92.2700    24.6887  -3.737 0.000581 ***
visina        0.9136     0.1453   6.286 1.87e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Residual standard error: 7.202 on 40 degrees of freedom
```

Regresija

```
  fit <- lm(masa ~ visina * spol)
  summary(fit)
Call:
lm(formula = masa ~ visina * spol)

Residuals:
   Min     1Q Median     3Q    Max
-8.381 -4.148 -1.588  3.022 11.878

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -13.1070    31.2526  -0.419   0.6773
visina        0.4297     0.1872   2.295   0.0274 *
spolM       100.1884    73.0398   1.372   0.1782
visina:spolM  -0.4795     0.4113  -1.166   0.2509
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Residual standard error: 5.738 on 38 degrees of freedom
```

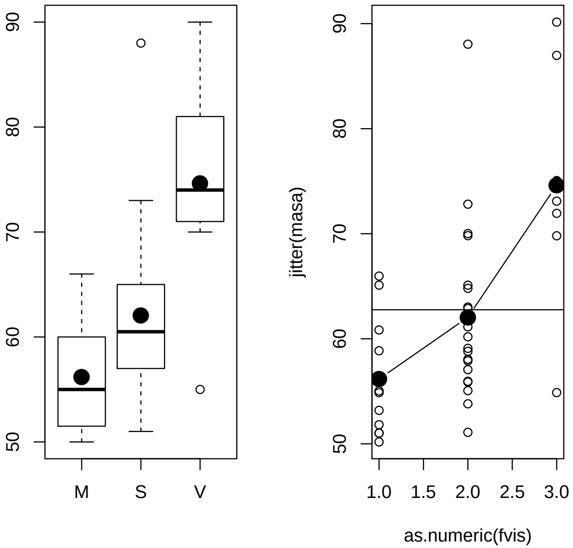
```
plot(visina, masa, col = spol)
abline(lm(masa ~ visina))
points(visina, predict(fit), pch = 16, col = spol)
```



Analiza variance

```
  fvis <- cut(visina, breaks = c(155, 165, 175,
+     200), labels = c("M", "S", "V"))
  table(fvis)

fvis
 M  S  V
12 22  8

  (m <- by(masa, fvis, mean))

fvis: M
[1] 56.16667
---------------------------------------------
fvis: S
[1] 62.04545
---------------------------------------------
fvis: V
[1] 74.625
```

AOV



50
60
70
80
90
M
S
V
jitter(masa)
50
60
70
80
90
1.0
1.5
2.0
2.5
3.0
as.numeric(fvis)

AOV - ukazi za sliko

```
par(mfrow = c(1, 2))
plot(fvis, masa)
points(1:3, m, pch = 16, cex = 2)
plot(as.numeric(fvis), jitter(masa))
points(1:3, m, pch = 16, cex = 2, type = "b")
abline(h = mean(masa))
```

Linearni model

```r
fit <- lm(masa ~ 0 + fvis)
summary(fit)
```

```
Call:
lm(formula = masa ~ 0 + fvis)

Residuals:
    Min      1Q  Median      3Q     Max 
-19.625  -4.510  -1.167   2.924  25.954 

Coefficients:
      Estimate Std. Error t value Pr(>|t|)    
fvisM   56.167      2.295   24.48   <2e-16 ***
fvisS   62.045      1.695   36.61   <2e-16 ***
fvisV   74.625      2.811   26.55   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Residual standard error: 7.949 on 39 degrees of freedom
Multiple R-squared: 0.9855, Adjusted R-squared: 0.9843
```

Linearni model - odkloni od povprečja

```
fit <- lm(I(masa - mean(masa)) ~ 0 + fvis)
summary(fit)
```

```
Call:
lm(formula = I(masa - mean(masa)) ~ 0 + fvis)

Residuals:
    Min      1Q  Median      3Q     Max 
-19.625  -4.510  -1.167   2.924  25.954 

Coefficients:
      Estimate Std. Error t value Pr(>|t|)    
fvisM  -6.5952     2.2948  -2.874 0.006529 ** 
fvisS  -0.7165     1.6948  -0.423 0.674812    
fvisV  11.8631     2.8105   4.221 0.000141 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Residual standard error: 7.949 on 39 degrees of freedom
Multiple R-squared: 0.4023, Adjusted R-squared: 0.3564
```