Regression Models: Assignment 1

Daniel Alonso

November 24th, 2020

Importing libraries

```
library(dplyr)
library(MuMIn)
```

Exercise 1

Simulation

```
sim = list()
for (j in 1:1000) {
    vals = c()
    for (i in 1:100) {
        run = 3 + 3*cos(i/10 + 50) + rnorm(1, mean=0, sd=1)
        vals = c(vals, run)
    }
    sim[[j]] = vals
}
sim
```

Exercise 2

Importing the data

```
d <- data.frame(read.table('../data/index.txt', header=TRUE))
```

```
X = d$PovPct
Y = d$Brth15to17
beta1 = cov(X, Y)/var(X)
beta0 = mean(Y) - beta1*mean(X)
beta1
```

```
## [1] 1.373345
```

```
beta0
```

```
## [1] 4.267293
```

Exercise 3

First we have the log-likelihood function for β and σ^2

$l(\sigma^2|X) = \sum_{i=1}^{n} log(\frac{1}{\sqrt{2\pi\sigma^2}} - \frac{(Y_i-(\beta_0+\beta_1 x_{ik}+\cdots+\beta_k x_{ik}))^2}{2\sigma^2})$

Exercise 4

Exercise 5

```
bodyfat <- data.frame(read.table('../data/bodyfat.txt', header=TRUE))
modall <- lm(hwfat ~., data = bodyfat)
summary(modall)
```

```
##
## Call:
## lm(formula = hwfat ~ ., data = bodyfat)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -6.162 -1.858 -0.464  2.502  8.177
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 13.29370    9.63027   1.380   0.1718
## age         -0.32893    0.32158  -1.023   0.3098
## ht          -0.06731    0.16051  -0.419   0.6762
## wt          -0.01365    0.02591  -0.527   0.5999
## abs          0.37142    0.08837   4.203 7.55e-05 ***
## triceps      0.38743    0.13761   2.815   0.0063 **
## subscap      0.11405    0.14193   0.804   0.4243
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.028 on 71 degrees of freedom
## Multiple R-squared:  0.8918, Adjusted R-squared:  0.8827
## F-statistic: 97.54 on 6 and 71 DF,  p-value: < 2.2e-16
```

The sum of residuals is zero:

```
residuals <- sum(resid(modall))
```

The sum of the observed data is equal to the sum of the fitted values

```
Y_hat <- predict(modall, bodyfat[1:length(names(bodyfat))-1])
sum(bodyfat$hwfat) - sum(Y_hat)
```

```
## [1] 4.547474e-13
```

The residuals are orthogonal to the predictors

```
sum(residuals*bodyfat[1:length(names(bodyfat))-1])
```

```
## [1] -3.077268e-10
```

The residuals are orthogonal to the fitted values

```
sum(residuals*Y_hat)
```

```
## [1] -1.568657e-11
```

Exercise 6

```
# rsq <- function(x,y) cor(x,y)^2
# cols <- names(bodyfat)[1:length(names(bodyfat))-1]
# r_2 <- c()
# names(r_2) <- cols
# for (i in 1:length(cols)) {
#     modall <- lm(hwfat ~ cols[i], bodyfat)
#     r_2 <- rsq(predict(hwfat))
# }
# r2
```

```
options(na.action = "na.fail")
modall <- lm(hwfat ~., data = bodyfat)
combs <- dredge(modall)
```

```
## Fixed term is "(Intercept)"
```

```
combs
```

```
## Global model call: lm(formula = hwfat ~ ., data = bodyfat)
## ---
## Model selection table
##    (Intrc)    abs     age       ht   sbscp  trcps        wt df   logLik  AICc
## 20 10.6200 0.3564 -0.5331                  0.4656           5 -194.268 399.4
## 50  5.1120 0.4235                          0.4918 -0.028140  5 -194.664 400.2
## 22 13.6200 0.3674         -0.17460        0.4733           5 -194.986 400.8
## 24 15.6100 0.3702 -0.4237 -0.10200        0.4554           6 -193.854 400.9
## 52  9.9400 0.3997 -0.3838                  0.4694 -0.015850  6 -193.866 400.9
## 18  2.0590 0.3371                          0.5043           4 -196.412 401.4
## 58  5.5980 0.3980                  0.14100 0.3972 -0.032400  6 -194.113 401.4
## 28 10.6000 0.3393 -0.5312          0.06218 0.4249           6 -194.153 401.5
## 54  8.7750 0.4124         -0.06753        0.4831 -0.020710  6 -194.569 402.3
## 30 15.0200 0.3379         -0.19550 0.12100 0.3900           6 -194.574 402.3
## 60  9.6920 0.3826 -0.3335          0.11180 0.3974 -0.020840  7 -193.527 402.7
## 32 16.6200 0.3462 -0.3979 -0.12330 0.09771 0.3893           7 -193.583 402.8
## 56 13.2800 0.3897 -0.3805 -0.06232        0.4616 -0.009103  7 -193.784 403.2
## 26  2.0700 0.3189                  0.06632 0.4607           5 -196.288 403.4
## 62  9.5590 0.3856         -0.07290 0.14300 0.3865 -0.024440  7 -194.001 403.6
## 64 13.2900 0.3714 -0.3289 -0.06731 0.11410 0.3874 -0.013650  8 -193.430 404.9
## 42  7.4660 0.4762                  0.42120        -0.043120  5 -198.493 407.8
## 14 21.4300 0.3960         -0.28230 0.38890                   5 -198.642 408.1
## 16 23.0300 0.4042 -0.4012 -0.20930 0.36490                   6 -197.735 408.7
## 44 11.5500 0.4608 -0.3326          0.39220        -0.031600  6 -197.973 409.1
## 46 15.5400 0.4463         -0.15050 0.40980        -0.026090  6 -198.053 409.3
## 12 13.1700 0.4014 -0.6434          0.34470                   5 -199.292 409.4
## 48 19.2200 0.4325 -0.3228 -0.14520 0.38200        -0.015510  7 -197.558 410.7
## 10  2.9280 0.3826                  0.37920                   4 -202.064 412.7
## 4  15.8000 0.6277 -0.7675                                    4 -204.471 417.5
## 8  23.5900 0.6402 -0.5846 -0.16290                           5 -203.642 418.1
## 25  1.7770                         0.35830 0.6036           4 -204.923 418.4
## 27  7.6410        -0.3661          0.36830 0.5852           5 -204.109 419.1
## 6  21.2400 0.6511         -0.26800                           4 -205.331 419.2
## 36 15.3200 0.6623 -0.6555                          -0.012050  5 -204.292 419.4
## 29 10.1000                -0.12580 0.40470 0.5636           5 -204.352 419.5
```

```
## 63 23.5200        -0.5416 -0.27070 0.26730 0.5295  0.045310  7 -202.096 419.8
## 61 17.8800                -0.29330 0.32620 0.5370  0.030900  6 -203.355 419.9
## 59  8.9530        -0.5902          0.27760 0.5924  0.021350  6 -203.449 420.1
## 40 26.0400 0.6147 -0.6296 -0.20570                 0.010020  6 -203.573 420.3
## 57  1.4210                         0.34310 0.6065  0.003343  5 -204.900 420.6
## 55 24.7500        -0.6974 -0.28320         0.7331  0.064000  6 -203.733 420.6
## 34  7.2360 0.7265                                 -0.033440  4 -206.112 420.8
## 31 11.1600        -0.2855 -0.07273 0.39290 0.5661            6 -203.955 421.1
## 51  9.5250        -0.7546                  0.8072  0.039630  5 -205.154 421.1
## 38 19.3700 0.6714         -0.22600                -0.008267  5 -205.280 421.4
## 2   3.6540 0.6325                                            3 -207.960 422.2
## 53 17.3600                -0.31810         0.8051  0.049850  5 -205.846 422.5
## 17  1.5790                                 0.9765            3 -208.638 423.6
## 49 -0.5971                                 0.8959  0.020900  4 -207.554 423.7
## 19  6.6240        -0.3154                  0.9696            4 -208.089 424.7
## 21  2.4020                -0.01249         0.9773            4 -208.633 425.8
## 23  4.1000        -0.3768  0.05320         0.9648            5 -208.005 426.8
## 47 34.5900        -0.5836 -0.43270 0.69370          0.056720  6 -208.474 430.1
## 45 28.6700                -0.45950 0.76370          0.041360  5 -209.717 430.3
## 13 18.8100                -0.24280 0.89990                    4 -211.248 431.0
## 11 10.6500        -0.4874          0.86910                    4 -211.939 432.4
## 9   2.8940                         0.87680                    3 -213.126 432.6
## 15 19.8100        -0.2609 -0.19480 0.89120                    5 -210.970 432.8
## 43 11.7800        -0.6758          0.79840          0.017830  5 -211.563 434.0
## 41  3.2050                         0.88800         -0.002960  4 -213.111 434.8
## 39 71.3700        -1.7370 -0.93490                  0.211500  5 -227.610 466.1
## 37 63.1800                -1.22300                  0.212600  4 -235.343 479.2
## 35 26.1600        -2.4350                           0.170900  4 -237.409 483.4
## 33 -9.2640                                          0.152500  3 -250.046 506.4
## 7  -0.6592        -1.8330  0.65440                            4 -276.779 562.1
## 3  31.9500        -1.1270                                     3 -279.011 564.3
## 1  14.2400                                                    2 -280.162 564.5
## 5  -9.6720                 0.35800                            3 -279.391 565.1
##     delta weight
## 20   0.00  0.181
## 50   0.79  0.122
## 22   1.43  0.088
## 24   1.52  0.085
## 52   1.54  0.084
## 18   2.00  0.066
## 58   2.04  0.065
## 28   2.12  0.063
## 54   2.95  0.041
## 30   2.96  0.041
## 60   3.28  0.035
## 32   3.40  0.033
## 56   3.80  0.027
## 26   4.04  0.024
## 62   4.23  0.022
## 64   5.58  0.011
## 42   8.45  0.003
## 14   8.75  0.002
## 16   9.28  0.002
## 44   9.76  0.001
```

```
## 46   9.92  0.001
## 12  10.05  0.001
## 48  11.35  0.001
## 10  13.31  0.000
## 4   18.12  0.000
## 8   18.75  0.000
## 25  19.02  0.000
## 27  19.68  0.000
## 6   19.84  0.000
## 36  20.05  0.000
## 29  20.17  0.000
## 63  20.42  0.000
## 61  20.52  0.000
## 59  20.71  0.000
## 40  20.96  0.000
## 57  21.26  0.000
## 55  21.28  0.000
## 34  21.40  0.000
## 31  21.72  0.000
## 51  21.77  0.000
## 38  22.02  0.000
## 2   22.87  0.000
## 53  23.15  0.000
## 17  24.23  0.000
## 49  24.29  0.000
## 19  25.36  0.000
## 21  26.44  0.000
## 23  27.47  0.000
## 47  30.76  0.000
## 45  30.90  0.000
## 13  31.67  0.000
## 11  33.05  0.000
## 9   33.21  0.000
## 15  33.40  0.000
## 43  34.59  0.000
## 41  35.40  0.000
## 39  66.68  0.000
## 37  79.86  0.000
## 35  84.00  0.000
## 33 107.05  0.000
## 7  162.74  0.000
## 3  164.98  0.000
## 1  165.11  0.000
## 5  165.74  0.000
## Models ranked by AICc(x)
```