Bayesian Statistics

Gowlapalli Rohit

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Contents

```
rm(list = setdiff(ls(), lsf.str()))
setwd("/Users/gowlapallirohit/Documents/IIITH/SEM-6/BRSM/Activities/Bayesian")
load("parenthood.RData")
ls() #returns a list of all the objects you just loaded (and anything else in your environment)
```

```
## [1] "parenthood"
```

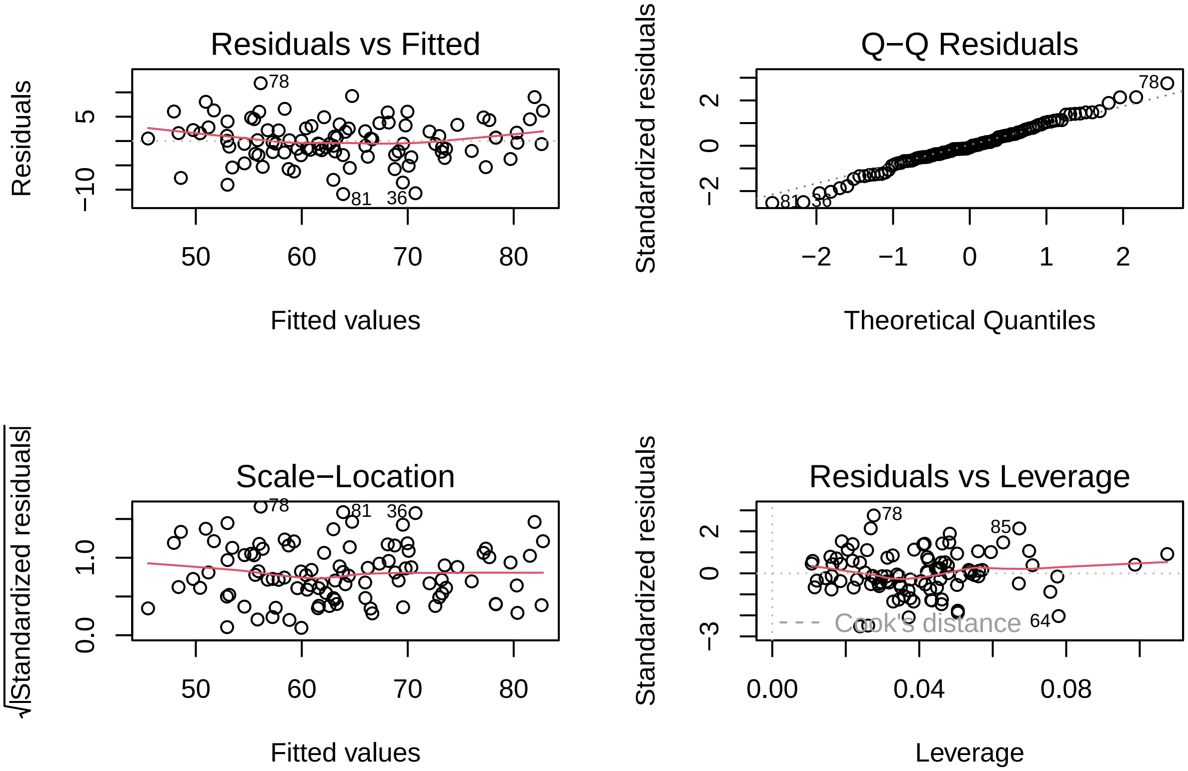
```
write.csv(parenthood,
  file="parenthood.csv")
parenthood
```

```
##     dan.sleep baby.sleep dan.grump day
## 1        7.59      10.18        56   1
## 2        7.91      11.66        60   2
## 3        5.14       7.92        82   3
## 4        7.71       9.61        55   4
## 5        6.68       9.75        67   5
## 6        5.99       5.04        72   6
## 7        8.19      10.45        53   7
## 8        7.19       8.27        60   8
## 9        7.40       6.06        60   9
## 10       6.58       7.09        71  10
## 11       6.49      11.68        72  11
## 12       6.27       6.13        65  12
## 13       5.95       7.83        74  13
## 14       6.65       5.60        67  14
## 15       6.41       6.03        66  15
## 16       6.33       8.19        69  16
## 17       6.30       6.38        73  17
## 18       8.47      11.11        52  18
## 19       7.21       5.51        61  19
## 20       7.53       6.69        53  20
## 21       8.00       9.74        54  21
## 22       7.35       9.02        63  22
## 23       6.86       6.44        74  23
## 24       7.86       9.43        56  24
## 25       4.86       3.46        82  25
## 26       5.87       6.32        72  26
## 27       8.40       7.95        59  27
## 28       6.93       7.69        66  28
## 29       7.21       7.45        60  29
## 30       6.99       7.56        67  30
## 31       8.17       7.95        44  31
## 32       7.85      11.61        53  32
## 33       6.27       4.70        76  33
## 34       8.66       8.52        41  34
## 35       4.98       4.70        86  35
## 36       6.19       8.32        60  36
## 37       6.41       9.38        63  37
## 38       4.84       4.18        89  38
## 39       7.03       5.98        61  39
## 40       7.66       9.29        57  40
## 41       7.51       6.01        59  41
## 42       7.92      10.54        60  42
## 43       8.12      11.78        48  43
## 44       7.47      11.60        53  44
## 45       7.99      11.35        50  45
## 46       5.44       5.63        72  46
## 47       8.16       6.98        57  47
## 48       7.62       6.03        60  48
## 49       5.87       4.66        70  49
## 50       9.00       9.81        46  50
## 51       8.31      12.07        58  51
## 52       6.71       7.57        68  52
## 53       7.43      11.35        58  53
## 54       5.90       5.47        71  54
## 55       8.52       8.29        52  55
## 56       6.03       6.80        74  56
## 57       7.29      10.63        59  57
## 58       7.32       8.59        59  58
## 59       6.88       7.82        67  59
## 60       6.22       7.18        67  60
## 61       6.94       8.29        61  61
## 62       7.01      11.08        64  62
## 63       7.20       6.46        61  63
## 64       6.30       3.25        61  64
## 65       8.72       9.74        54  65
## 66       7.82       8.75        62  66
## 67       8.14      11.75        52  67
## 68       7.27       9.31        64  68
## 69       6.70       7.73        65  69
## 70       7.55       8.68        65  70
## 71       7.38       9.77        57  71
## 72       7.73       9.71        59  72
## 73       5.32       4.17        79  73
## 74       7.86      10.18        53  74
## 75       6.35       9.28        67  75
## 76       7.11       7.23        61  76
## 77       5.45       6.38        82  77
## 78       7.80       9.20        68  78
## 79       7.13       8.20        67  79
## 80       8.35      10.16        54  80
## 81       6.93       8.95        53  81
## 82       7.07       6.80        62  82
## 83       8.66       8.34        50  83
## 84       5.09       6.25        80  84
## 85       4.91       6.75        91  85
## 86       7.03       9.09        62  86
## 87       7.02      10.42        64  87
## 88       7.67       8.89        57  88
## 89       8.15       9.43        54  89
## 90       5.88       6.79        72  90
## 91       5.72       6.91        78  91
## 92       6.66       6.05        63  92
## 93       6.85       6.32        59  93
## 94       5.57       8.62        74  94
## 95       5.16       7.84        76  95
## 96       5.31       5.89        79  96
## 97       7.77       9.77        51  97
## 98       5.38       6.97        82  98
## 99       7.02       6.56        55  99
## 100      6.45       7.93        74 100
```

```r
# frequentist regression
model <- lm( formula = dan.grump ~ dan.sleep + day + baby.sleep, data = parenthood)
summary(model)
```

```
##
## Call:
## lm(formula = dan.grump ~ dan.sleep + day + baby.sleep, data = parenthood)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -10.906  -2.284  -0.295   2.652  11.880
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 126.278707   3.242492  38.945   <2e-16 ***
## dan.sleep    -8.969319   0.560007 -16.016   <2e-16 ***
## day          -0.004403   0.015262  -0.288    0.774
## baby.sleep    0.015747   0.272955   0.058    0.954
## ---
## Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 ’.’ 0.1 ’ ’ 1
##
## Residual standard error: 4.375 on 96 degrees of freedom
## Multiple R-squared:  0.8163, Adjusted R-squared:  0.8105
## F-statistic: 142.2 on 3 and 96 DF,  p-value: < 2.2e-16
```

```r
# model diagnostics
par(mfrow = c(2, 2))
plot(model)
```



```r
# If the model diagnostics look good, then the results above may be valid and we can start to interpret
```

```r
library(BayesFactor)
```

```
## Loading required package: coda
```

```
## Loading required package: Matrix
```

```
## Warning in .recacheSubclasses(def@className, def, env): undefined subclass
## "ndiMatrix" of class "replValueSp"; definition not updated
```

```
## ************
## Welcome to BayesFactor 0.9.12-4.7. If you have questions, please contact Richard Morey (richarddmorey
##
## Type BFManual() to open the manual.
## ************
```

```r
parenthood <- as.data.frame(parenthood)

regressionBF(
  formula = dan.grump ~ dan.sleep + day + baby.sleep, data = parenthood)
```

```
## Bayes factor analysis
## --------------
## [1] dan.sleep                          : 1.622545e+34 ±0.01%
## [2] day                                : 0.2724027    ±0%
## [3] baby.sleep                         : 10018411     ±0%
## [4] dan.sleep + day                    : 1.016576e+33 ±0%
## [5] dan.sleep + baby.sleep             : 9.77022e+32  ±0%
## [6] day + baby.sleep                   : 2340755      ±0%
## [7] dan.sleep + day + baby.sleep       : 7.835625e+31 ±0%
##
## Against denominator:
##   Intercept only
## ---
## Bayes factor type: BFlinearModel, JZS
```

```
# Check and compare BF between models, examine a defined number of models instead of looking at all of
models <- regressionBF(formula = dan.grump ~ dan.sleep + day + baby.sleep, data = parenthood)
head(models, n = 3)
```

```
## Bayes factor analysis
## --------------
## [1] dan.sleep              : 1.622545e+34 ±0.01%
## [2] dan.sleep + day        : 1.016576e+33 ±0%
## [3] dan.sleep + baby.sleep : 9.77022e+32  ±0%
##
## Against denominator:
##   Intercept only
## ---
## Bayes factor type: BFlinearModel, JZS
```

```
# Find the best model by comparing models against the one with the largest Bayes Factor
head(models/max(models), n = 3)
```

```
## Bayes factor analysis
## --------------
## [1] dan.sleep              : 1         ±0%
## [2] dan.sleep + day        : 0.0626532 ±0.01%
## [3] dan.sleep + baby.sleep : 0.0602154 ±0.01%
##
## Against denominator:
##   dan.grump ~ dan.sleep
## ---
## Bayes factor type: BFlinearModel, JZS
```

```
# Display all models
models
```

```
## Bayes factor analysis
## --------------
## [1] dan.sleep                          : 1.622545e+34 ±0.01%
## [2] day                                : 0.2724027    ±0%
## [3] baby.sleep                         : 10018411     ±0%
## [4] dan.sleep + day                    : 1.016576e+33 ±0%
## [5] dan.sleep + baby.sleep       : 9.77022e+32  ±0%
## [6] day + baby.sleep             : 2340755      ±0%
## [7] dan.sleep + day + baby.sleep : 7.835625e+31 ±0%
##
## Against denominator:
##   Intercept only
## ---
## Bayes factor type: BFlinearModel, JZS
```

```
# Compare specific models
models[1] / models[4]
```

```
## Bayes factor analysis
## --------------
## [1] dan.sleep : 15.96088 ±0.01%
##
## Against denominator:
##   dan.grump ~ dan.sleep + day
## ---
## Bayes factor type: BFlinearModel, JZS
```

```
# Use the "top" option to analyze what happens if you drop predictor variables from a certain model
regressionBF(
    formula = dan.grump ~ dan.sleep + baby.sleep,
    data = parenthood,
    whichModels = "top"
)
```

```
## Bayes factor top-down analysis
## --------------
## When effect is omitted from dan.sleep + baby.sleep , BF is...
## [1] Omit baby.sleep : 16.60705     ±0.01%
## [2] Omit dan.sleep  : 1.025403e-26 ±0.01%
##
## Against denominator:
##   dan.grump ~ dan.sleep + baby.sleep
## ---
## Bayes factor type: BFlinearModel, JZS
```