Solving for Beta

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The results below are generated from an R script.

```
library(matlib) # for inv() function
library(matrixcalc) # for LU decomposition
library(microbenchmark) # for comparing the two methods

###
### Inversion Method
###

invertFun <- function(X, y, W){
  beta <- inv(t(X)%*%W%*%X)%*%t(X)%*%W%*%y
  return(beta)
}

###
### Using LU Decomposition
###

solveFun <- function(X, y, W){

  ## Pseudo-code step 1
  decomp <- lu.decomposition(t(X)%*%W%*%X)
  L <- decomp$L
  U <- decomp$U

  ## Pseudo-code step 2
  y <- forwardsolve(L, t(X)%*%W%*%y)

  ## Pseudo-code step 3
  beta <- backsolve(U, y)
  return(beta)
}

###
### Simulate Data and Implement
###

N <- c(800)
P <- c(200)
```

*This report is automatically generated with the R package **knitr** (version 1.37).

```
for(i in 1:length(N)){

  ## Initialize variables
  n <- N[i]
  p <- P[i]
  W <- diag(n) # identity matrix for W for
  X <- matrix(rnorm(n*p), n, p) # design matrix
  y <- rnorm(n, 0.3*X[,1]+0.5*X[,2], 1)

  ## Implementation
  assign(paste0("benchmark",i),microbenchmark(invertFun(X, y, W), solveFun(X, y, W), times=10)) # save b
}

###
### Print Results
###

for(i in 1:length(N)){
  print(paste0("Benchmark when N=",N[i]," and P=",P[i]))
  print(get(paste0("benchmark",i)))
}

## [1] "Benchmark when N=800 and P=200"
## Unit: milliseconds
##                expr        min         lq       mean     median         uq        max
##  invertFun(X, y, W) 30428.7280 31680.0271 31664.8722 31772.3117 31918.7712 32158.4157
##   solveFun(X, y, W)   793.4299   797.2425   800.1262   800.1762   803.7212   805.5329
##  neval
##     10
##     10
```

The R session information (including the OS info, R version and all packages used):

```
sessionInfo()

## R version 4.1.2 (2021-11-01)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04.3 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.9.0
## LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.9.0
##
## locale:
##  [1] LC_CTYPE=en_US.UTF-8       LC_NUMERIC=C               LC_TIME=en_US.UTF-8
##  [4] LC_COLLATE=en_US.UTF-8     LC_MONETARY=en_US.UTF-8    LC_MESSAGES=en_US.UTF-8
##  [7] LC_PAPER=en_US.UTF-8       LC_NAME=C                  LC_ADDRESS=C
## [10] LC_TELEPHONE=C             LC_MEASUREMENT=en_US.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] microbenchmark_1.4.9 matrixcalc_1.0-5     matlib_0.9.5
```

```
##
## loaded via a namespace (and not attached):
##  [1] rgl_0.108.3       digest_0.6.29     MASS_7.3-55       R6_2.5.1
##  [5] xtable_1.8-4      jsonlite_1.7.3    magrittr_2.0.1    evaluate_0.14
##  [9] highr_0.9         stringi_1.7.6     rlang_0.4.12      carData_3.0-5
## [13] car_3.0-12        tools_4.1.2       stringr_1.4.0     htmlwidgets_1.5.4
## [17] xfun_0.29         abind_1.4-5       fastmap_1.1.0     compiler_4.1.2
## [21] htmltools_0.5.2   knitr_1.37
```

```
Sys.time()
```

```
## [1] "2022-01-27 18:14:39 CST"
```