R Matrix Commands

R commands

- c(): create a vector
- cbind(): bind vectors together as columns of a matrix
- t(): transpose of a matrix
- %*%: matrix multiplication
- solve(): find the inverse of a matrix
- matrix(): directly create a matrix from specified values; by default this will make a matrix with 1 column

Examples

Create model matrix: X

```
X <- cbind(
  c(1,1,1),
  c(0,1,1)
)
X
```

```
##      [,1] [,2]
## [1,]    1    0
## [2,]    1    1
## [3,]    1    1
```

Matrix multiplication: $\mathbf{X}'\mathbf{X}$

```
t(X)%*%X
```

```
##      [,1] [,2]
## [1,]    3    2
## [2,]    2    2
```

Matrix inversion: $(\mathbf{X}'\mathbf{X})^{-1}$

```
solve(t(X)%*%X)
```

```
##      [,1] [,2]
## [1,]    1 -1.0
## [2,]   -1  1.5
```

Create y

```
# suppose y_1=2, y_2=4, y_3=6
y <- matrix(c(1,2,3))
```

Helpful side note (may be useful in the future)

```
example <- matrix(1:6, nrow=2, ncol=3)
example
```

```
##      [,1] [,2] [,3]
## [1,]    1    3    5
## [2,]    2    4    6
```

$\hat{\beta}$ computed using matrices

```
beta_hat <- solve(t(X)%*%X) %*% t(X) %*% y
```

Compute hat matrix (also called the projection matrix)

```
H <- X %*% solve(t(X)%*%X) %*% t(X)
H
```

```
##              [,1]         [,2]         [,3]
## [1,] 1.000000e+00 1.110223e-16 1.110223e-16
## [2,] 1.110223e-16 5.000000e-01 5.000000e-01
## [3,] 1.110223e-16 5.000000e-01 5.000000e-01
```

Compute $\hat{\mathbf{y}}$

$\hat{\mathbf{y}} = \mathbf{X}\hat{\beta}$

```
y_hat1 <- X %*% beta_hat
y_hat1
```

```
##      [,1]
## [1,]  1.0
## [2,]  2.5
## [3,]  2.5
```

$\hat{\mathbf{y}} = \mathbf{H}\mathbf{y}$

```
y_hat2 <- H %*% y
y_hat2
```

```
##      [,1]
## [1,]  1.0
## [2,]  2.5
## [3,]  2.5
```

Compute residuals

$\hat{\epsilon} = \mathbf{y} - \hat{\mathbf{y}}$

```
resids <- y-y_hat1
resids
```

```
##               [,1]
## [1,] -4.440892e-16
## [2,] -5.000000e-01
## [3,]  5.000000e-01
```

Recall, all of this came from minimizing the residual sum of squares (RSS)!

```
rss <- sum(resids^2)
rss
```

```
## [1] 0.5
```