# Example Rmarkdown Notebook

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*September 19, 2018*

## Matrix Algebra and Functions

There are five basic data structures in R: vectors, matrices, arrays, lists, and data.frames. We'll be going through each of these here, but if you want an in depth exploration of these I'd recommend Norman Matloff's *The Art of R Programming: A Tour of Statistical Software Design*.

### Matrix basics

Up to this point, we've primarily *talked* about vectors. We've encountered other data types, but haven't used them. Vectors have length, but no width (they can only represent one variable at a time). Matrices are just collections of vectors (exactly like you learned in math camp). We can combine them by column using `cbind`, or by row, using `rbind`. We then access elements of matrix by `matrix[row, column]`.

```
vap <- voting.age.population <- c(3481823, 496387, 4582842, 2120139,26955438,3617942,26731

total.votes <- tv <- c(NA, 238307, 1553032, 780409,8899059,1586105, 1162391,258053, 122356,

m1 <- cbind(vap, tv) # Combined by column
m2 <- rbind(vap, tv) # combined by row
m2[1,2] # first row, second column
```

```
##    vap
## 496387
```

```
m1[,1] # the ith colum
```

```
##  [1]  3481823   496387  4582842  2120139 26955438  3617942  2673154
##  [8]   652189   472143 14085749  6915512   995937  1073799  9600372
## [15]  4732010  2265860  2068253  3213141  3188765  1033632  4242214
## [22]  4997677  7620982  3908159  2139918  4426278   731365  1321923
## [29]  1870315  1012033  6598368  1452962 14838076  6752018   494923
## [36]  8697456  2697855  2850525  9612380   824854  3303593   594599
## [43]  4636679 17038979  1797941   487900  5841335  4876661  1421717
## [50]  4257230   392344
```

```
m1[1:5,1:2] # a submatrix
```

```
##           vap      tv
## [1,]  3481823      NA
## [2,]   496387  238307
## [3,]  4582842 1553032
## [4,]  2120139  780409
## [5,] 26955438 8899059
```

```
m2[1,1:10]
```

```
##  [1]  3481823   496387  4582842  2120139 26955438  3617942  2673154
##  [8]   652189   472143 14085749
```

```
m2[1:2, 1:10]
```

```
##        [,1]   [,2]    [,3]    [,4]     [,5]    [,6]    [,7]   [,8]   [,9]
## vap 3481823 496387 4582842 2120139 26955438 3617942 2673154 652189 472143
## tv       NA 238307 1553032  780409  8899059 1586105 1162391 258053 122356
##        [,10]
## vap 14085749
## tv   4884544
```

```
m2[, 1:10] # same as previous line since there are only two rows.
```

```
##        [,1]   [,2]    [,3]    [,4]     [,5]    [,6]    [,7]   [,8]   [,9]
## vap 3481823 496387 4582842 2120139 26955438 3617942 2673154 652189 472143
## tv       NA 238307 1553032  780409  8899059 1586105 1162391 258053 122356
##        [,10]
## vap 14085749
## tv   4884544
```

```
class(m2)
```

```
## [1] "matrix"
```