# Data Summarization

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## Data Summarization

- Basic statistical summarization
  - `mean(x)`: takes the mean of x
  - `sd(x)`: takes the standard deviation of x
  - `median(x)`: takes the median of x
  - `quantile(x)`: displays sample quantities of x. Default is min, IQR, max
  - `range(x)`: displays the range. Same as c(min(x), max(x))

## Some examples

We can use the mtcars and Charm City Circulator datasets to explore different ways of summarizing data.

```
head(mtcars)
```

```
##                    mpg cyl disp  hp drat    wt  qsec vs
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1
```

## Statistical summarization

```r
mean(mtcars$hp)
```

```
## [1] 146.6875
```

```r
quantile(mtcars$hp)
```

```
##    0%   25%   50%   75%  100%
##  52.0  96.5 123.0 180.0 335.0
```

## Statistical summarization

```r
median(mtcars$wt)
```

```
## [1] 3.325
```

```r
quantile(mtcars$wt, probs = 0.6)
```

```
##  60%
## 3.44
```

## Statistical summarization

Note that many of these functions have additional inputs regarding missing data, typically requiring the `na.rm` argument.

```
x = c(1,5,7,NA,4,2, 8,10,45,42)
mean(x)
```

```
## [1] NA
```

```
mean(x,na.rm=TRUE)
```

```
## [1] 13.77778
```

```
quantile(x,na.rm=TRUE)
```

```
##    0%   25%   50%   75%  100%
##     1     4     7    10    45
```

## Data Summarization on matrices/data frames

- Basic statistical summarization
  - `rowMeans(x)`: takes the means of each row of x
  - `colMeans(x)`: takes the means of each column of x
  - `rowSums(x)`: takes the sum of each row of x
  - `colSums(x)`: takes the sum of each column of x
  - `summary(x)`: for data frames, displays the quantile information

## Charm City Circulator data

Please download the Charm City Circulator data:

`http://www.aejaffe.com/winterR_2016/data/Charm_City_Circulator_Ridership.csv`

```
circ = read.csv("http://www.aejaffe.com/winterR_2016/data/C
                header=TRUE,as.is=TRUE)
```

## Subsetting to specific columns

Let's just take columns that represent average ridership:

```
library(dplyr,quietly = TRUE)
circ2 = select(circ, date, day, ends_with("Average"))
```

## column and row means

```r
avgs = select(circ2, ends_with("Average"))
colMeans(avgs,na.rm=TRUE)
```

```
## orangeAverage purpleAverage  greenAverage bannerAverage
##     3033.1611     4016.9345     1957.7814      827.2685
```

```r
circ2$daily = rowMeans(avgs,na.rm=TRUE)
head(circ2$daily)
```

```
## [1]  952.0  796.0 1211.5 1213.5 1644.0 1490.5
```

## Summary

```r
summary(circ2)
```

```
##      date               day            orangeAverage  pu
##  Length:1146        Length:1146        Min.   :   0   Mi
##  Class  :character  Class  :character  1st Qu.:2001   1s
##  Mode   :character  Mode   :character  Median :2968   Me
##                                        Mean   :3033   Me
##                                        3rd Qu.:4020   3r
##                                        Max.   :6926   Ma
##                                        NA's   :10     NA
##   greenAverage   bannerAverage        daily
##  Min.   :   0   Min.   :   0.0   Min.   :   0
##  1st Qu.:1491   1st Qu.: 632.5   1st Qu.:2097
##  Median :2079   Median : 763.0   Median :2846
##  Mean   :1958   Mean   : 827.3   Mean   :2878
##  3rd Qu.:2340   3rd Qu.: 945.9   3rd Qu.:3646
##  Max.   :5094   Max.   :4617.0   Max.   :6123
##  NA's   :661    NA's   :876      NA's   :10
```

## Apply statements

You can apply more general functions to the rows or columns of a matrix or data frame, beyond the mean and sum.

```
apply(X, MARGIN, FUN, ...)
```

*X : an array, including a matrix.*
*MARGIN : a vector giving the subscripts which the function will be applied over. E.g., for a matrix 1 indicates rows, 2 indicates columns, c(1, 2) indicates rows and columns. Where X has named dimnames, it can be a character vector selecting dimension names.*
*FUN : the function to be applied: see 'Details'.*
*. . . : optional arguments to FUN.*

## Apply statements

```
apply(avgs,2,mean,na.rm=TRUE) # column means
```

```
## orangeAverage purpleAverage  greenAverage bannerAverage
##     3033.1611     4016.9345     1957.7814      827.2685
```

```
apply(avgs,2,sd,na.rm=TRUE) # columns sds
```

```
## orangeAverage purpleAverage  greenAverage bannerAverage
##     1227.5779     1406.6544      592.8969      436.0487
```

```
apply(avgs,2,max,na.rm=TRUE) # column maxs
```

```
## orangeAverage purpleAverage  greenAverage bannerAverage
##        6926.5        8089.5        5094.0        4617.0
```

## Other Apply Statements

- `tapply()`: ‘table’ apply
- `lapply()`: ‘list’ apply [tomorrow]
- `sapply()`: ‘simple’ apply [tomorrow]
- Other less used ones. . .

See more details here: `http://nsaunders.wordpress.com/2010/08/20/a-brief-introduction-to-apply-in-r/`

## `tapply()`

From the help file: “Apply a function to each cell of a ragged array, that is to each (non-empty) group of values given by a unique combination of the levels of certain factors.”

```
tapply(X, INDEX, FUN = NULL, ..., simplify = TRUE)
```

Simply put, you can apply function `FUN` to `X` within each categorical level of `INDEX`. It is very useful for assessing properties of continuous data by levels of categorical data.

## tapply()

For example, we can estimate the highest average daily ridership for each day of the week in 1 line in the Circulator dataset.

```
tapply(circ2$daily, circ2$day, max, na.rm=TRUE)
```

```
##     Friday     Monday   Saturday     Sunday   Thursday     Tues
##    5600.75    5002.25    6123.00    3980.25    4820.50     4855
```

## Data Summarization

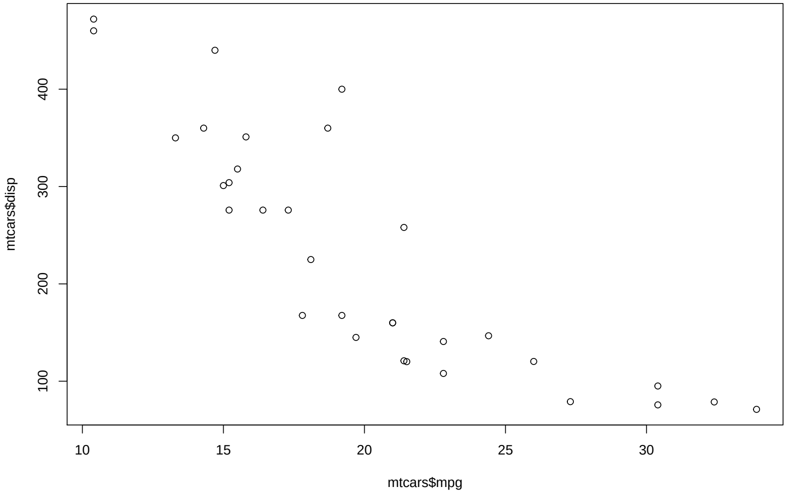
- Basic summarization plots
  - `plot(x,y)`: scatterplot of x and y
  - `boxplot(y~x)`: boxplot of y against levels of x
  - `hist(x)`: histogram of x
  - `density(X)`: kernel density plot of x

## Basic Plots

Plotting is an important component of exploratory data analysis. We will review some of the more useful and informative plots here. We will go over formatting and making plots look nicer in additional lectures.

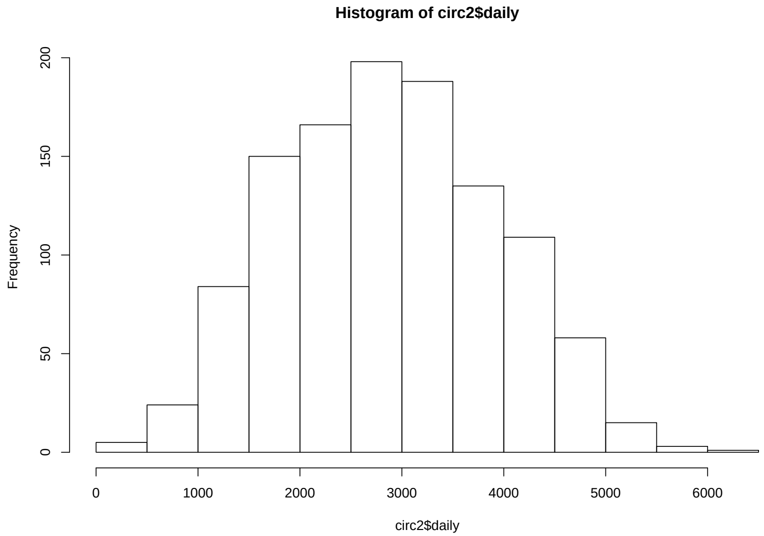
## Scatterplot

```
plot(mtcars$mpg, mtcars$disp)
```



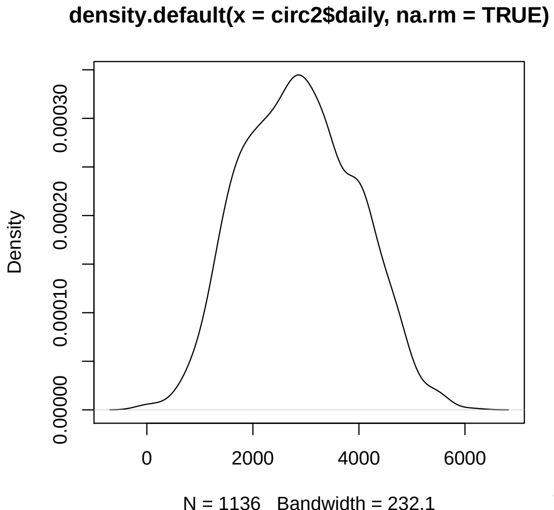
## Histograms

```r
hist(circ2$daily)
```



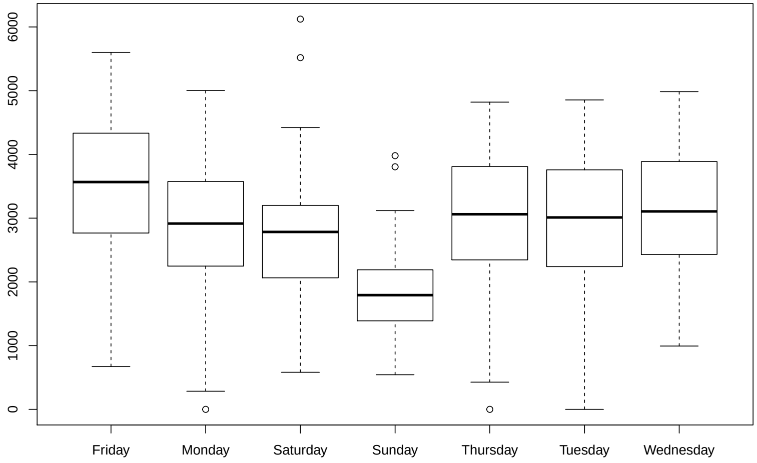
## Density

```r
## plot(density(circ2$daily))
plot(density(circ2$daily,na.rm=TRUE))
```



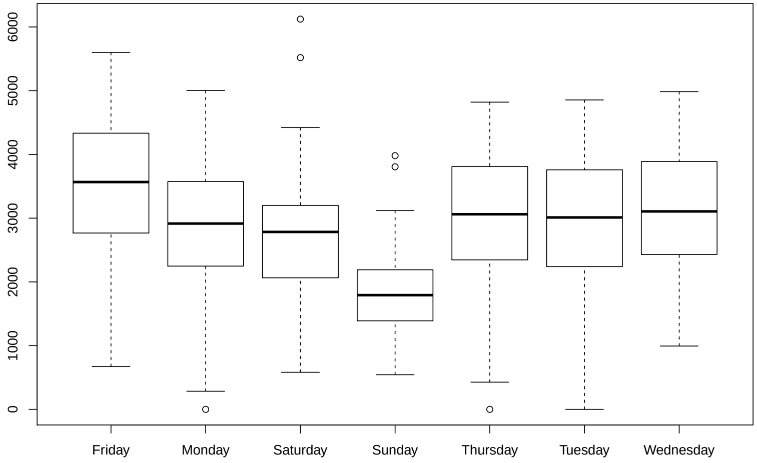
## Boxplots

```r
boxplot(circ2$daily ~ circ2$day)
```



## Boxplots

```
boxplot(daily ~ day, data=circ2)
```

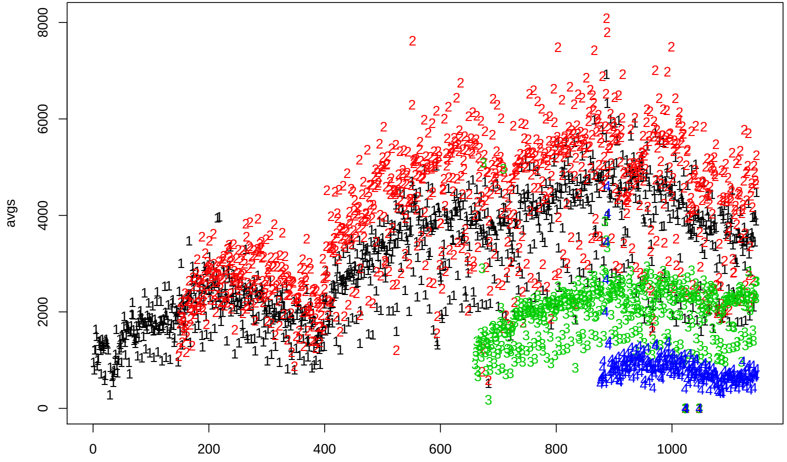


## Data Summarization for data.frames

- Basic summarization plots
  - `matplot(x,y)`: scatterplot of two matrices, x and y
  - `pairs(x,y)`: plots pairwise scatter plots of matrices x and y, column by column

## Matrix plot

```r
matplot(avgs)
```


avgs