

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

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

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

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

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

Statistical summarization

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

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

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

```
## 60%
```

```
## 3.44
```

Statistical summarization

```
t.test(mtcars$wt)
```

```
##  
## One Sample t-test  
##  
## data:  mtcars$wt  
## t = 18.6, df = 31, p-value < 2.2e-16  
## alternative hypothesis: true mean is not equal to 0  
## 95 percent confidence interval:  
##  2.864478 3.570022  
## sample estimates:  
## mean of x  
##  3.21725
```

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/summerR_2016/data/Charm_City_Circulator_Ridership.csv

```
circ = read.csv("http://www.aejaffe.com/summerR_2016/data/Charm_City_Circulator_Ridership.csv",  
               header=TRUE,as.is=TRUE)
```

Subsetting to specific columns

Let's just take columns that represent average ridership:

```
library(dplyr, quietly = TRUE)
```

```
##
```

```
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
```

```
##
```

```
##      filter, lag
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      intersect, setdiff, setequal, union
```

```
circ2 = select(circ, date, day, ends_with("Average"))
```

column and row means

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

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

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

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

Summary

```
summary(circ2)
```

```
##           date                day           orangeAverage  pu
## Length:1146           Length:1146           Min.      :    0  M
## 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

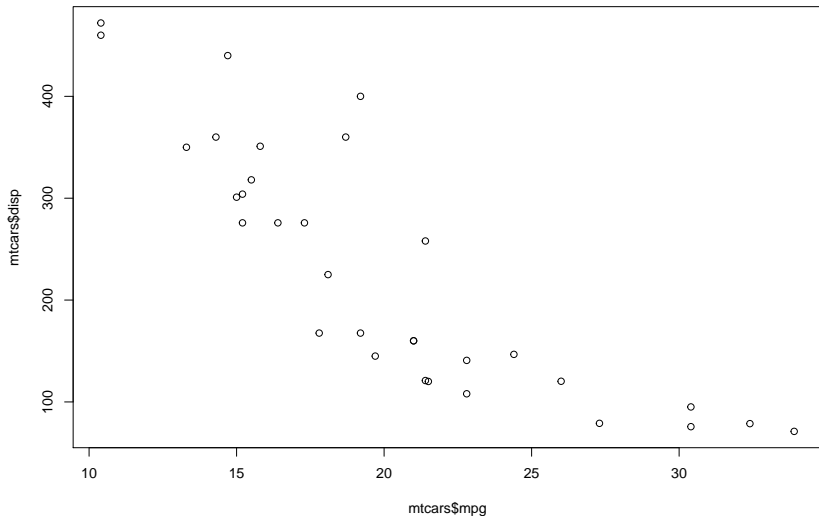
- ▶ Basic summarization plots
 - ▶ `plot(x,y)`: scatterplot of x and y
 - ▶ `boxplot(y~x)`: boxplot of y against levels of x
 - ▶ `hist(x)`: histogram of x
 - ▶ `density(x)`: kernel density plot of x

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.

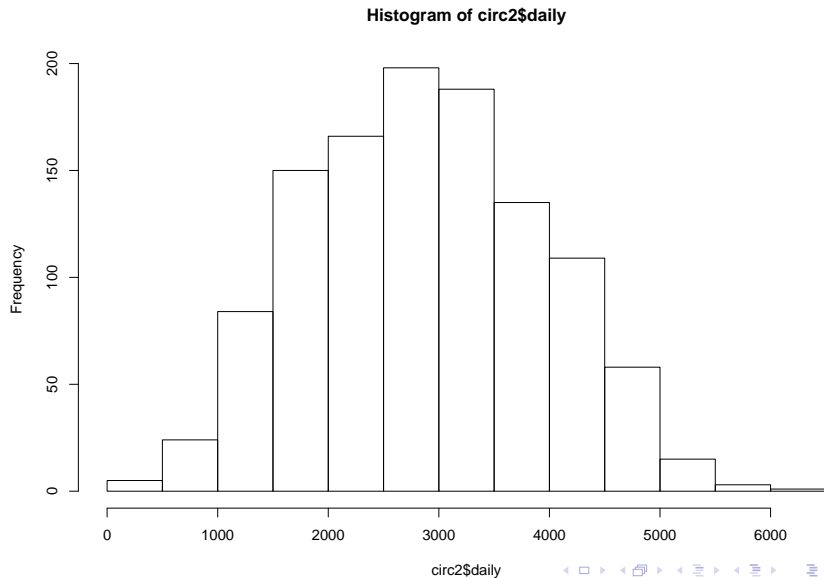
Scatterplot

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



Histograms

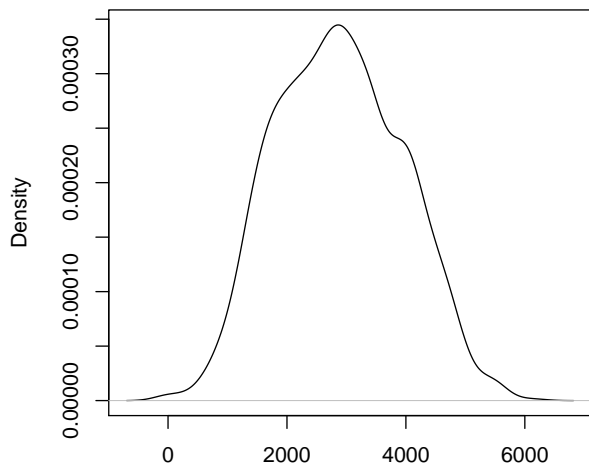
```
hist(circ2$daily)
```



Density

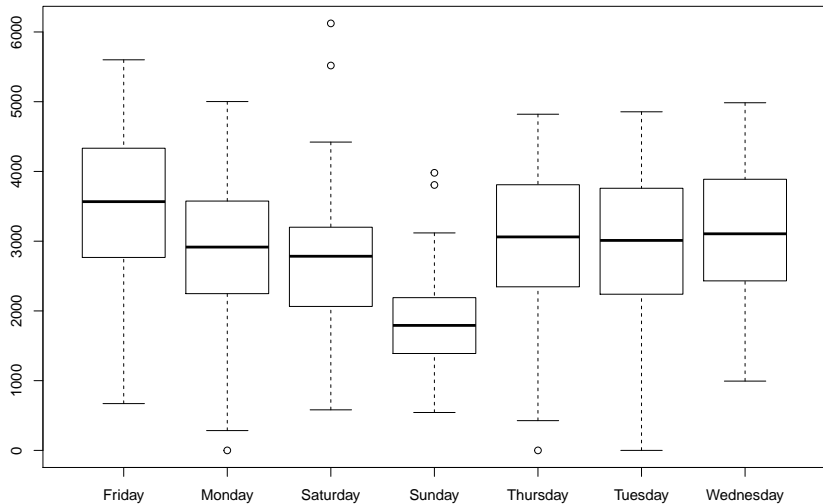
```
## plot(density(circ2$daily))  
plot(density(circ2$daily, na.rm=TRUE))
```

density.default(x = circ2\$daily, na.rm = TRUE)



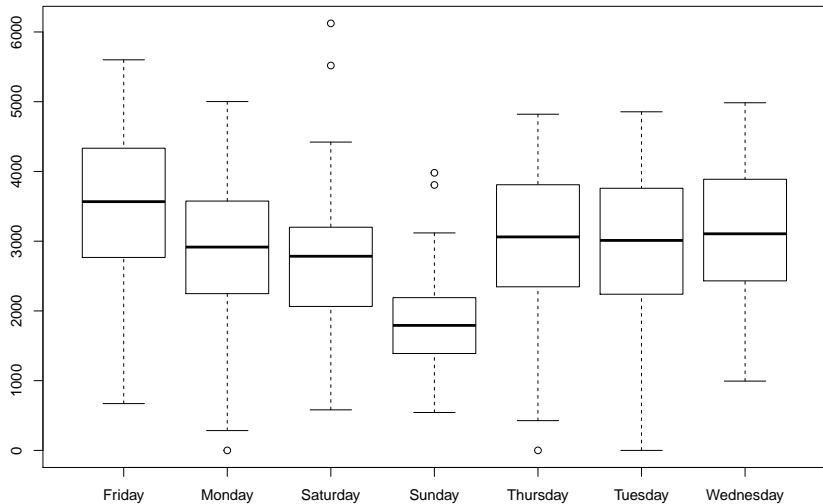
Boxplots

```
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

```
matplot(avgs)
```

