# Intro to R

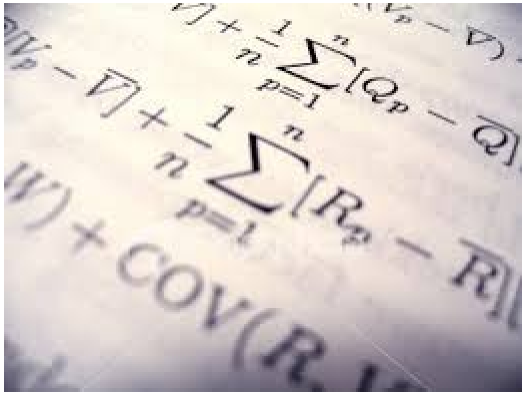
## 3. Descriptive Statistics

# Descriptive Statistics


Explore a dataset:

- What's in the dataset?
- What does it mean?
- What if there's *a lot* of it?

# Basic statistical functions in R



Wanted: measures of the center and the spread of our numeric data.

- mean()
- median()
- range()
- var() and sd()   # variance, standard deviation
- summary()   # combination of measures

# mean()


A measure of the data's “most typical” value.

- Arithmetic mean == average
- Divide sum of values by number of values

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

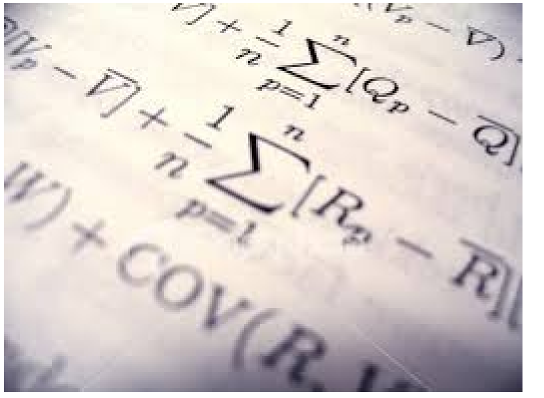
# mean()

A measure of the data's “most typical” value.

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

```
> f <- c(3, 2, 4, 1)
> mean(f)     # == sum(f)/length(f) == (3+2+4+1)/4
[1] 2.5
```

# median()

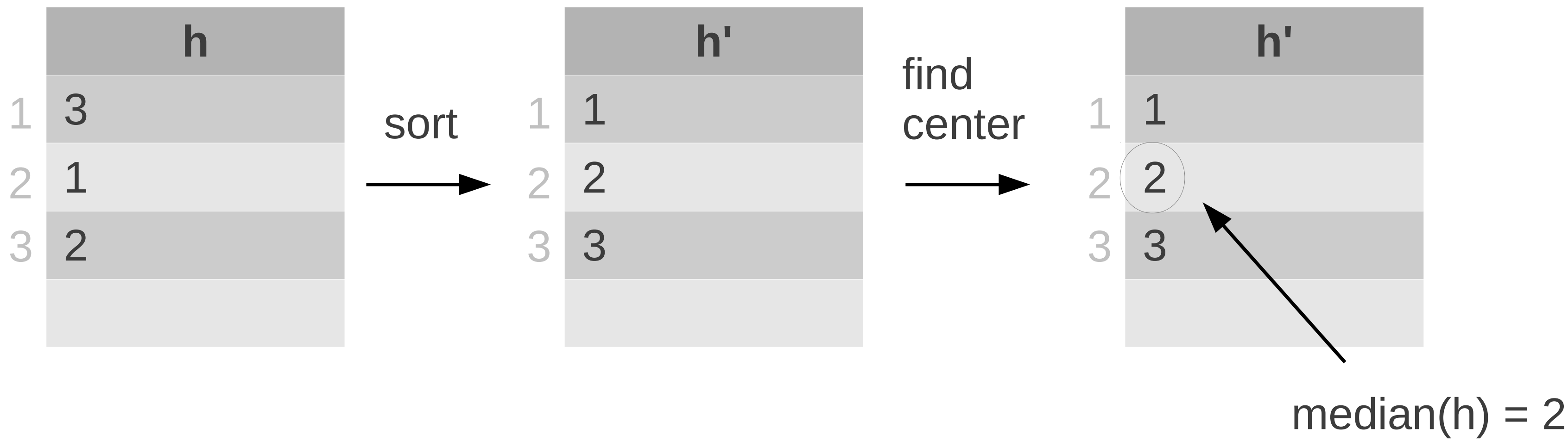


A measure of the data's center value. To find it:

- Sort the contents of the data structure
- Compute the value at the center of the data:
  - For odd number of elements, take the center element's value.
  - For even number of elements, take mean around center.

# median()

## Odd number of values:




> h <- c(3, 1, 2)

> median(h)

[1] 2

# median()

## Even number of values: need to find mean()

| | f |
|---|---|
| 1 | 3 |
| 2 | 2 |
| 3 | 4 |
| 4 | 1 |

sort →

| | f' |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |

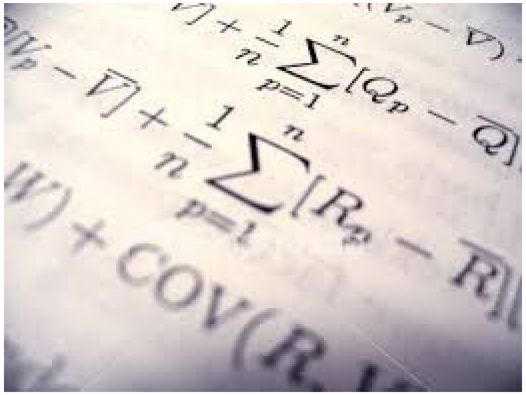
find center →

| | f' |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |

median(f)
= mean(c(2,3))
= 2.5

```
> f <- c(3, 2, 4, 1)
> median(f)
[1] 2.50
```

# range():
# min() and max()



range() reports the minimum and maximum values found in the data structure.

```
> f <- c(3, 2, 4, 1)
> range(f)   # reports min(f) and max(f)
  [1] 1   4
```

# var() and sd()

- *Variance*: a measure of the spread of the values relative to their mean:

$$Var = s_n^2 = \frac{1}{n}\sum_{i=1}^{n}(y_i - \overline{y})^2$$

Sample variance

- *Standard deviation*: square root of the variance

$$s_n = \sqrt{Var}$$

Sample standard deviation

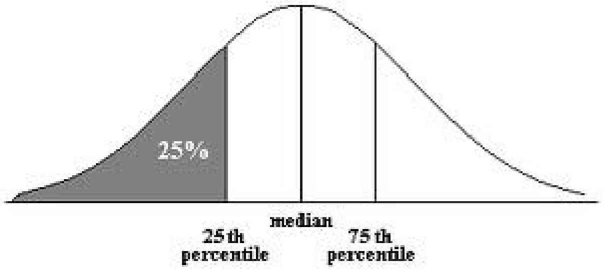
# R's summary() function

Provides several useful descriptive statistics about the data:

```
> g <- c(3, NA, 2, NA, 4, 1)
> summary(g)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   1.00    1.75    2.50    2.50    3.25    4.00       2
```

*Quartiles*: Sort the data set and divide it up into quarters...

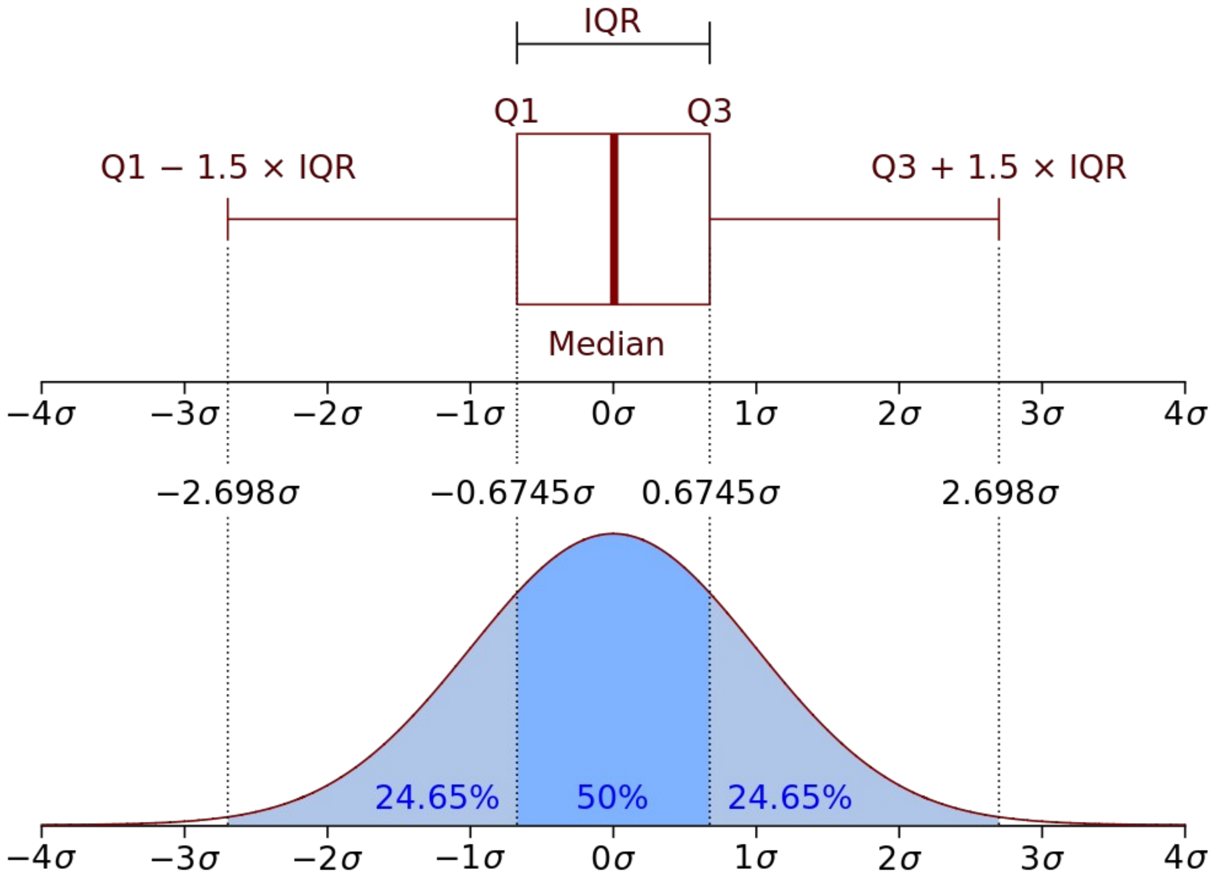
# Quartiles




Quartiles are the *three points* that divide ordered data into four equal-sized groups:

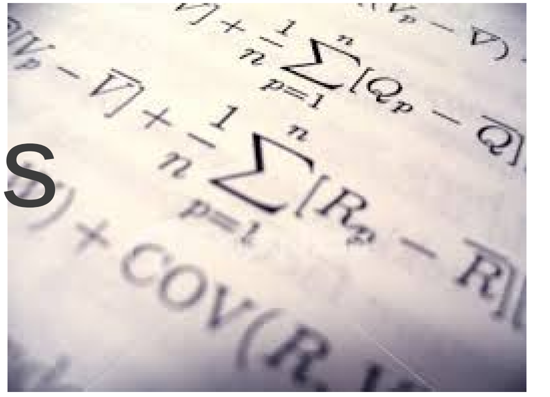
- Q1 marks the boundary just above the lowest 25% of the data
- Q2 (the *median*) cuts the data set in half
- Q3 marks the boundary just below the highest 25% of data

# Quartiles




Boxplot and probability distribution function of Normal N(0,1$\sigma^2$) population

# Summary: basic statistical functions



- Characterize the center and the spread of our numeric data.
- Comparing these measures can give us a good sense of our dataset.

# Statistics and Missing Data

If NAs are present, specify na.rm=TRUE to call:

- mean()
- median()
- range()
- sum()
- ...and some other functions

R disregards NAs, then proceeds with the calculation.

# diamonds data

## 50,000 diamonds, for example:

| | carat | cut | color | clarity | depth | table | price | x | y | z |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.23 | Ideal | E | SI2 | 61.5 | 55 | 326 | 3.95 | 3.98 | 2.43 |
| 2 | 0.21 | Premium | E | SI1 | 59.8 | 61 | 326 | 3.89 | 3.84 | 2.31 |
| 3 | 0.23 | Good | E | VS1 | 56.9 | 65 | 327 | 4.05 | 4.07 | 2.31 |

What can we learn about these data?

# diamonds data summary()

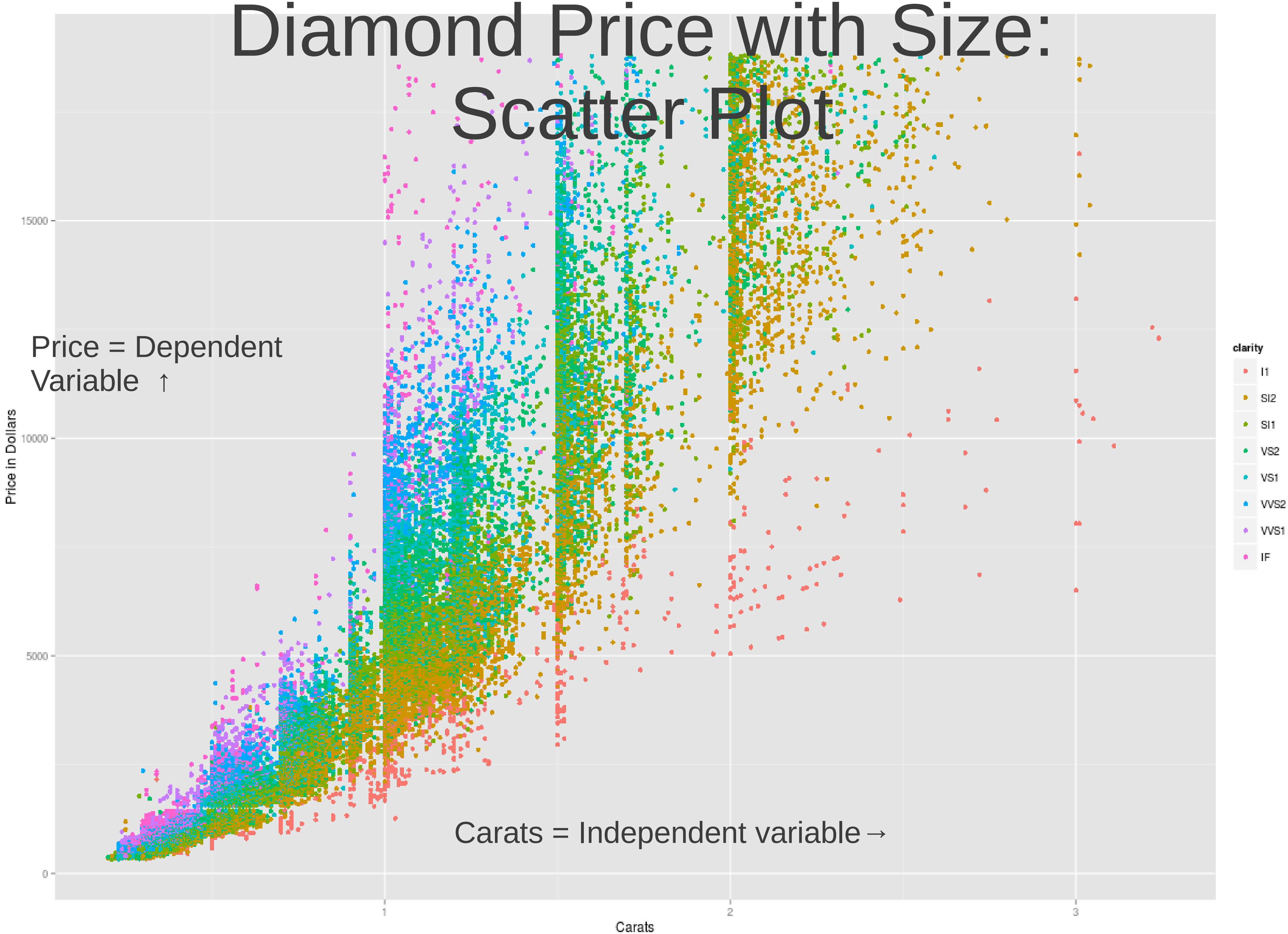
Information provided by summary() depends on the type of data, by column:

```
    carat               cut           color          price
Min.   :0.2000   Fair     : 1610   D: 6775   Min.   :  326
1st Qu.:0.4000   Good     : 4906   E: 9797   1st Qu.:  950
Median :0.7000   Very Good:12082   F: 9542   Median : 2401
Mean   :0.7979   Premium  :13791   G:11292   Mean   : 3933
3rd Qu.:1.0400   Ideal    :21551   H: 8304   3rd Qu.: 5324
Max.   :5.0100                     I: 5422   Max.   :18823
                                   J: 2808
```

numeric data:
statistical summary

categorical (factor) data:
counts

# Diamond Price with Size: Scatter Plot



# table() function

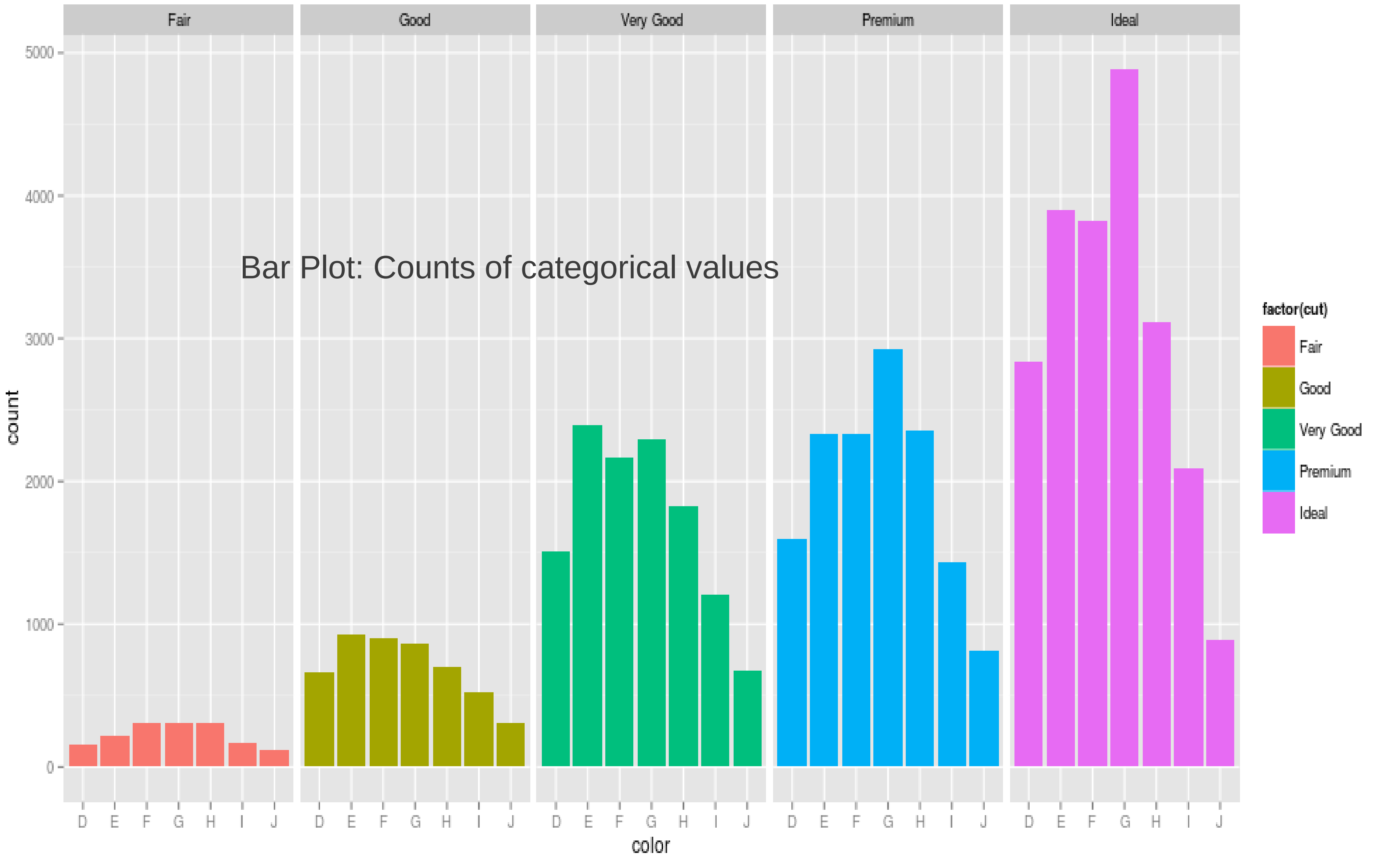
Contingency table: counts of categorical values for selected columns

```
> table(diamonds$cut, diamonds$color)
```

| | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|
| Fair | 163 | 224 | 312 | 314 | 303 | 175 | 119 |
| Good | 662 | 933 | 909 | 871 | 702 | 522 | 307 |
| Very Good | 1513 | 2400 | 2164 | 2299 | 1824 | 1204 | 678 |
| Premium | 1603 | 2337 | 2331 | 2924 | 2360 | 1428 | 808 |
| Ideal | 2834 | 3903 | 3826 | 4884 | 3115 | 2093 | 896 |

# Diamond Color and Cut

Bar Plot: Counts of categorical values



# Correlation

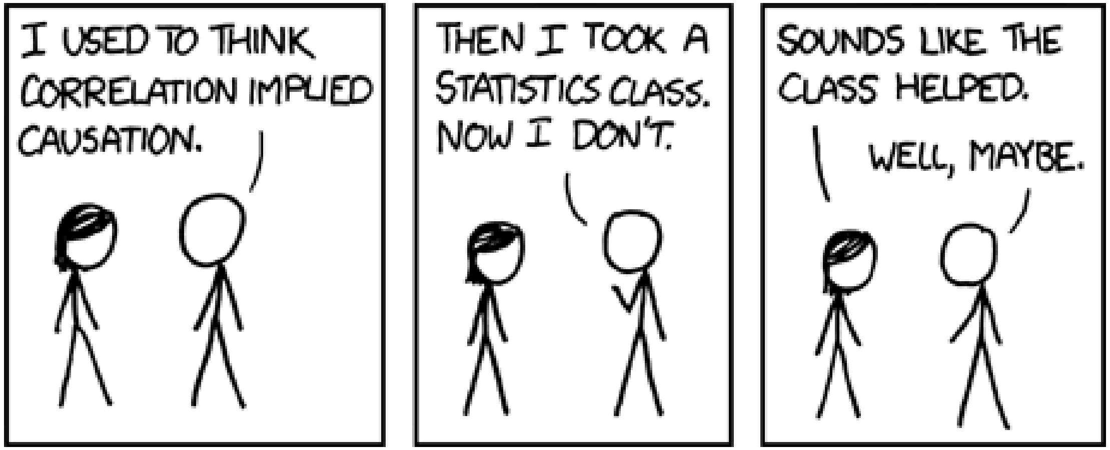
Do the two quantities X and Y vary together?

- Positively: $0 < \rho < 1$
- Or negatively: $-1 < \rho < 0$

$$\rho_{X,Y} = corr(X,Y) = \frac{cov(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$$

A pairwise, *statistical* relationship between quantities

# Correlation




$$\rho_{X,Y} = corr(X,Y) = \frac{cov(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$$

NOTE: Correlation does not imply causation...

# Looking for correlations

## diamonds data frame: 50,000 diamonds

- carat: weight of the diamond (0.2–5.01)
- table: width of top of diamond relative to widest point (43–95)
- price: price in US dollars
- x: length in mm (0–10.74)
- y: width in mm (0–58.9)
- z: depth in mm (0–31.8)

# cor() function

Look at pairwise, *statistical* relationships between numeric data:

```
> cor(diamonds[c(1,6:10)])
```

| | carat | table | price | x | y | z |
|---|---|---|---|---|---|---|
| carat | 1.0000000 | 0.1816175 | 0.9215913 | 0.9750942 | 0.9517222 | 0.9533874 |
| table | 0.1816175 | 1.0000000 | 0.1271339 | 0.1953443 | 0.1837601 | 0.1509287 |
| price | 0.9215913 | 0.1271339 | 1.0000000 | 0.8844352 | 0.8654209 | 0.8612494 |
| x | 0.9750942 | 0.1953443 | 0.8844352 | 1.0000000 | 0.9747015 | 0.9707718 |
| y | 0.9517222 | 0.1837601 | 0.8654209 | 0.9747015 | 1.0000000 | 0.9520057 |
| z | 0.9533874 | 0.1509287 | 0.8612494 | 0.9707718 | 0.9520057 | 1.0000000 |

-1.0: perfectly anticorrelated

↕

0 : uncorrelated

↕

1.0: perfectly correlated

# Interlude

Complete descriptive statistics exercises.

Open in the RStudio source editor:

<workshop>/exercises/exercises-descriptive-statistics.R