

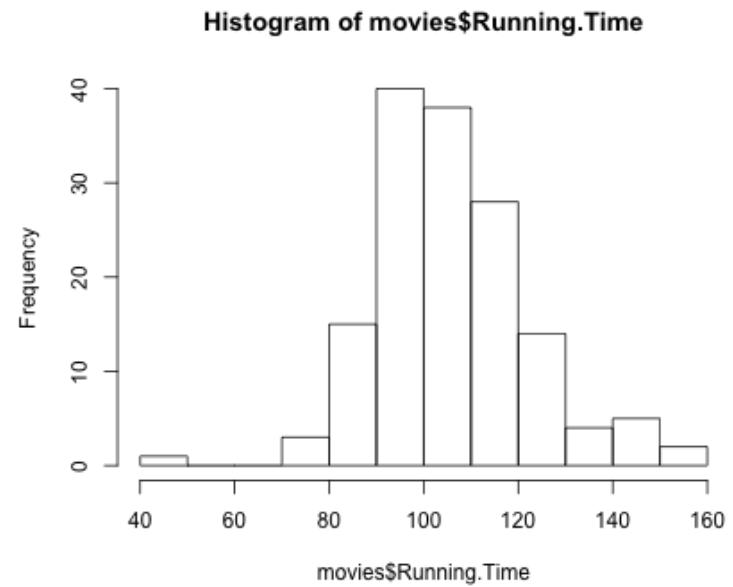
# Displaying Quantitative Data

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# Histograms

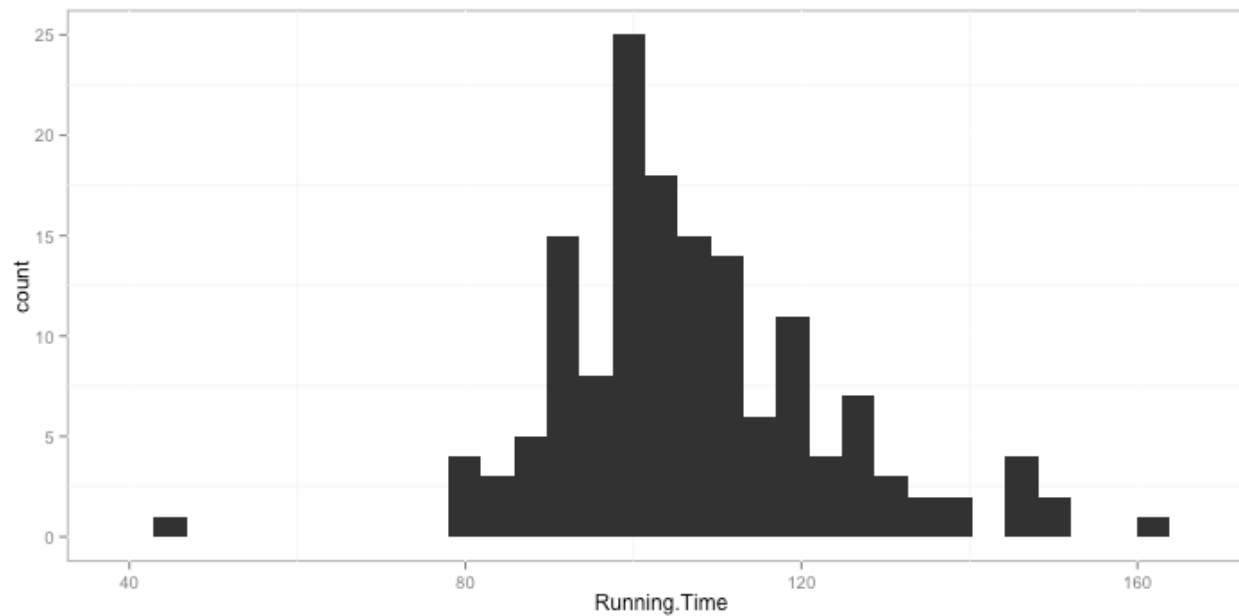
```
hist(movies$Running.Time)
```



# Histograms (with ggplot2)

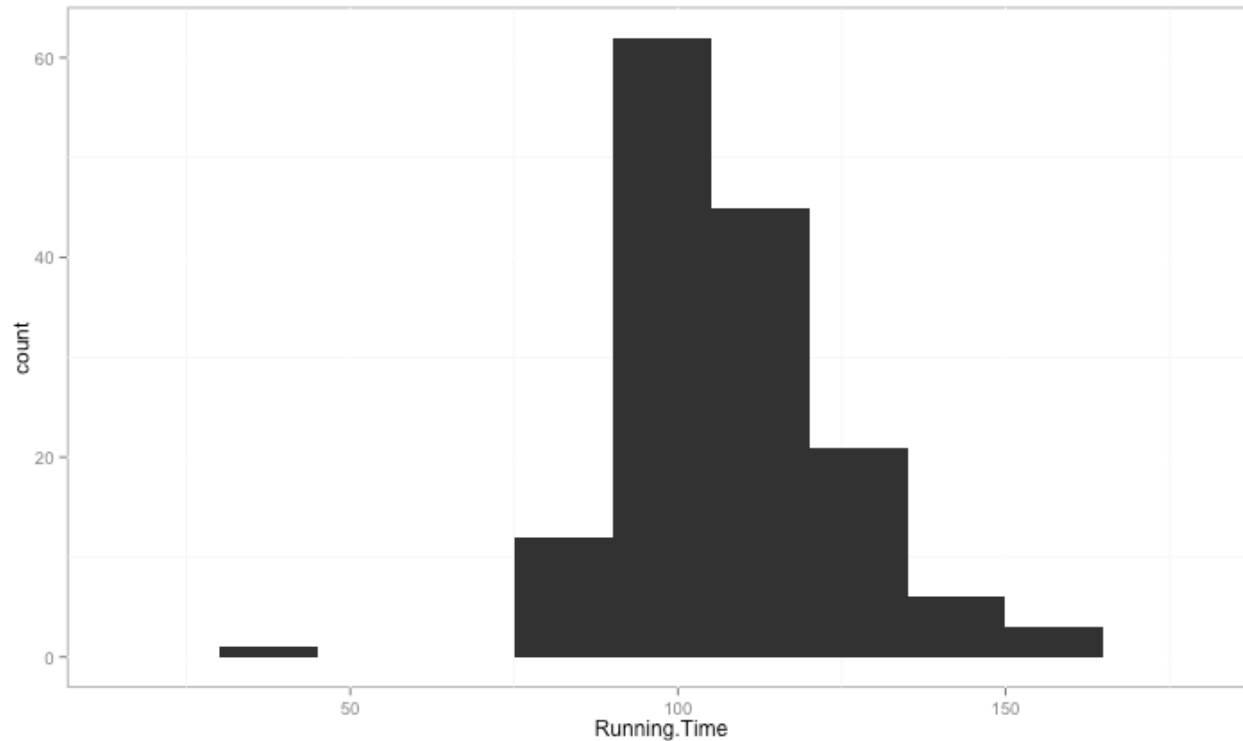
```
ggplot(movies, aes(x = Running.Time)) + geom_histogram()
```

stat\_bin: binwidth defaulted to range/30. Use 'binwidth = x' to adjust this.



# Histograms (with ggplot2): Binwidths

```
ggplot(movies, aes(x = Running.Time)) + geom_histogram(binwidth = 15)
```



# Outliers

```
movies[movies$Running.Time < 50, ]
```

	Title	Running.Time
97	Hubble 3D	43

# Stem and Leaf Plot

```
stem(movies$Running.Time)
```

The decimal point is 1 digit(s) to the right of the |

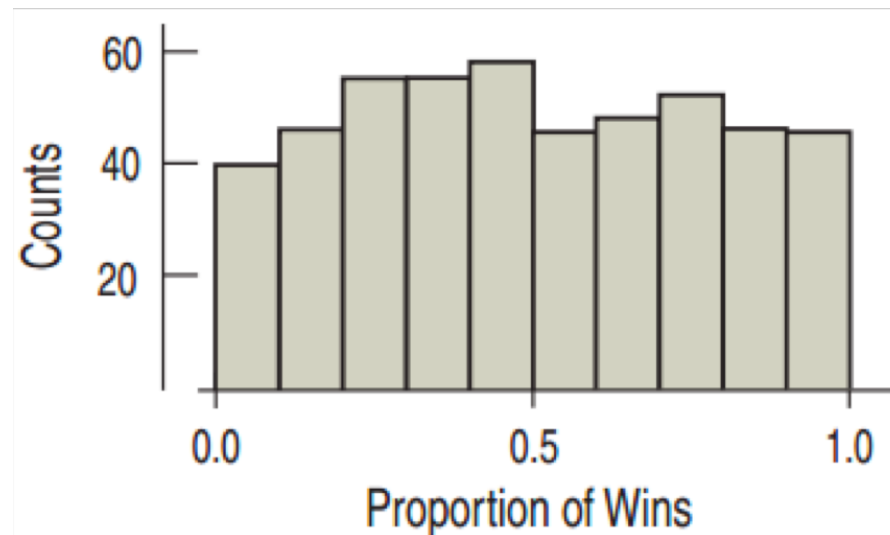
```
4 | 3
5 |
6 |
7 | 9
8 | 00122578889
9 | 00000011122223345556777888888899
10 | 0000000000000001122222333333444555566677777888999
11 | 00011112222233455566777888
12 | 000001234557778899
13 | 0338
14 | 07888
15 | 02
16 | 0
```

## Modes

A Mode of a histogram is a hump or high-frequency bin.

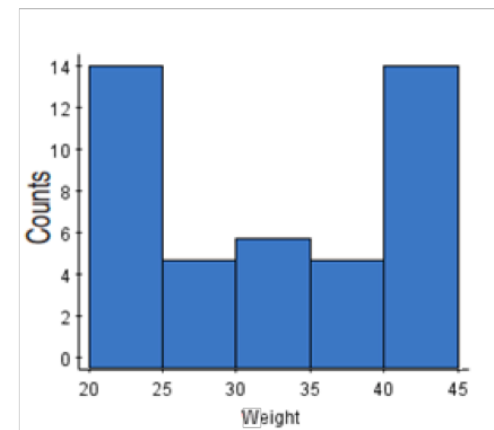
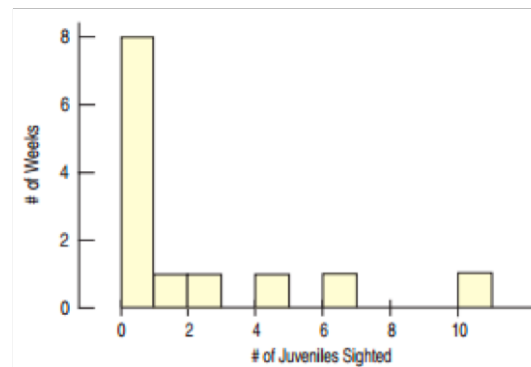
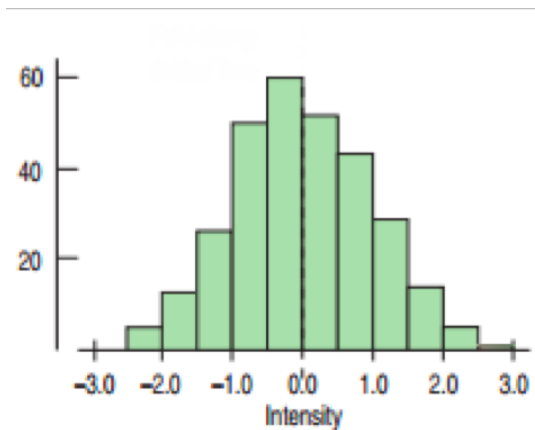
# Uniform Distributions

- Uniform Distribution: All the bins have the same frequency, or at least close to the same frequency.
- The histogram for a uniform distribution will be flat.



# Symmetry

The histogram for a symmetric distribution will look the same on the left and the right of its center.

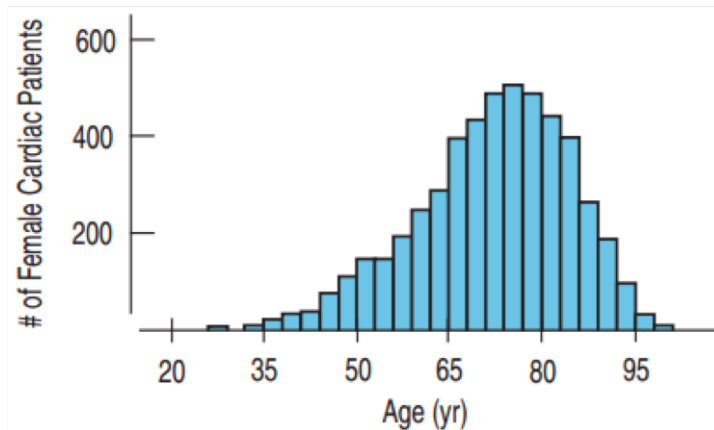




# Skewness

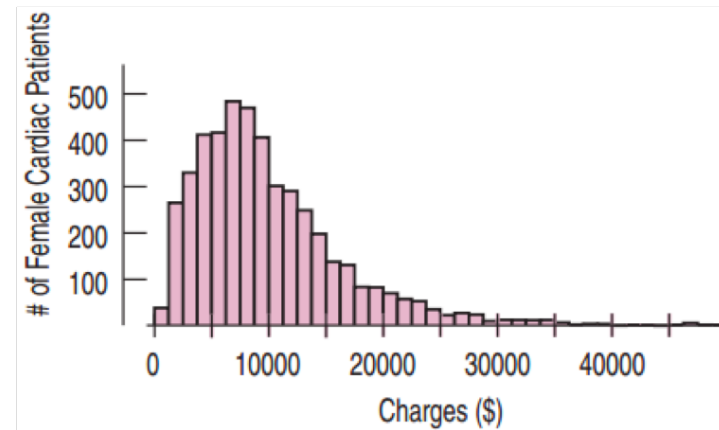
A histogram is skewed left if the longer tail is on the left side of the mode.

Negatively Skewed



A histogram is skewed right if the longer tail is on the right side of the mode.

Positively Skewed



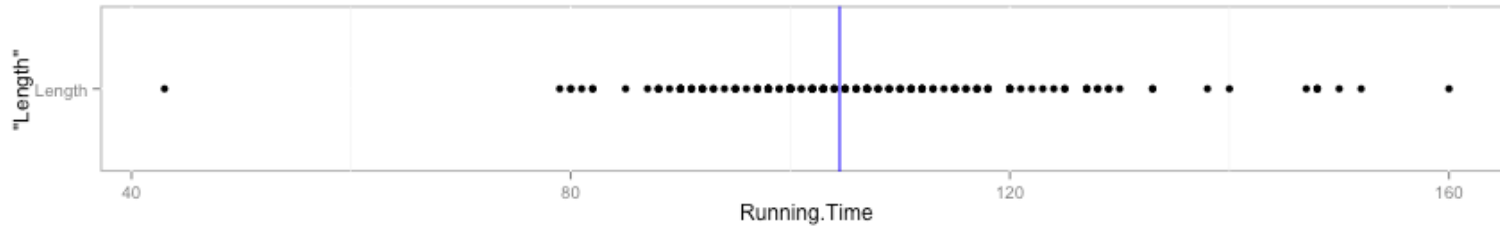
# Center: Median

- Median: The center of the data values
- Half of the data values are to the left of the median and half are to the right of the median.

```
(mediantime <- median(movies$Running.Time))
```

```
[1] 104.5
```

```
ggplot(movies, aes(x=Running.Time, y='Length')) + geom_point() +  
  geom_vline(xintercept=mediantime, color='blue')
```



# Center: Mean

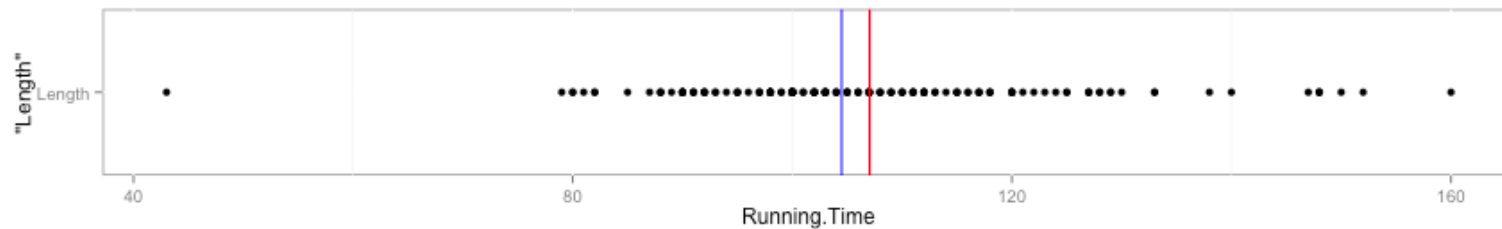
- The Mean is what most people think of as the average.

$$\bar{y} = \frac{\sum y}{n}$$

```
(meantime <- mean(movies$Running.Time))
```

```
[1] 107.1
```

```
ggplot(movies, aes(x=Running.Time, y='Length')) + geom_point() +  
  geom_vline(xintercept=mediantime, color='blue') + geom_vline(xintercept=meantime, color='red')
```



# Median vs. Mean

- For symmetric distributions, the mean and the median are equal.
- The balancing point is at the center.
- The tail "pulls" the mean towards it more than it does to the median.
- The mean is more sensitive to outliers than the median.
- The mean is larger than the median since it is "pulled" to the right by the outlier
- The median is a better measure of the center for data that is skewed.

## Why Use the Mean?

- Although the median is a better measure of the center, the mean weighs in large and small values better.
- The mean is easier to work with.
- For symmetric data, statisticians would rather use the mean.
- It is always ok to report both the mean and the median.

# Spread

- Locating the center is only part of the story
- Are the data all near the center or are they spread out?
- Is the highest value much higher than the lowest value?
- To describe data, we must discuss both the center and the spread.

# Range

- The range is the difference between the maximum and minimum values.  $\text{Range} = \text{Maximum} - \text{Minimum}$
- The range is sensitive to outliers. A single high or low value will affect the range significantly.

# Percentiles and Quartiles

- Percentiles divide the data in one hundred groups.
- The **nth percentile** is the data value such that n percent of the data lies below that value.
- For large data sets, the median is the 50th percentile.
- The median of the lower half of the data is the **25th percentile** and is called the **first quartile (Q1)**.
- The median of the upper half of the data is the **75th percentile** and is called the **third quartile (Q3)**.
- The **Interquartile Range (IQR)** is the difference between the upper quartile and the lower quartile:  
$$\text{IQR} = Q3 - Q1$$

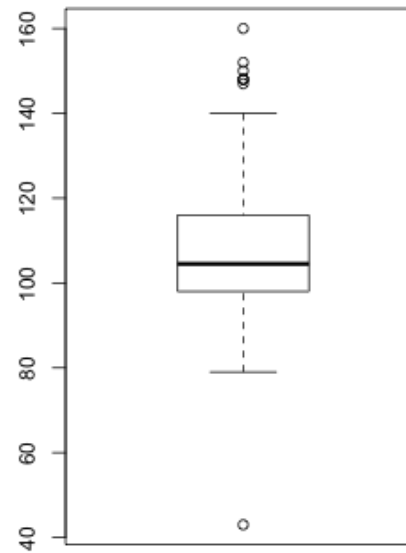
```
summary(movies$Running.Time)
```

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
43	98	104	107	116	160

# Boxplots

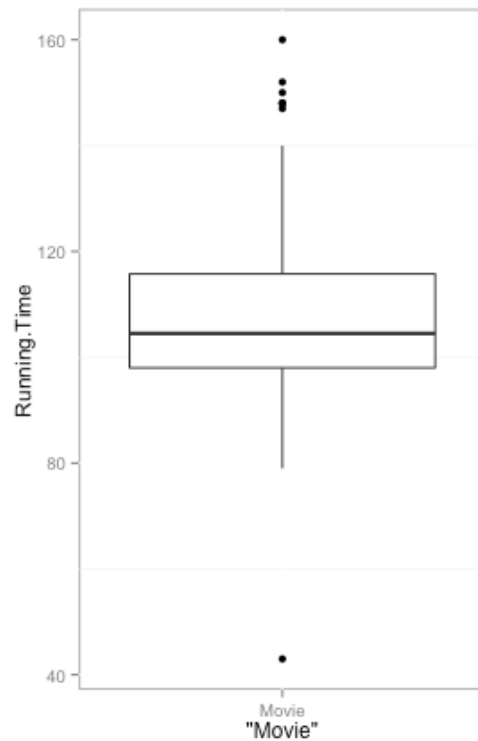
- A Boxplot is a chart that displays the 5-Point Summary and the outliers.
- The Box shows the Interquartile Range.
- The dashed lines are called fences, outside the fences lie the outliers.
- Above and below the box are the whiskers that display the most extreme data values within the fences.
- The line inside the box shows the median.

```
boxplot(movies$Running.Time)
```



# Boxplots

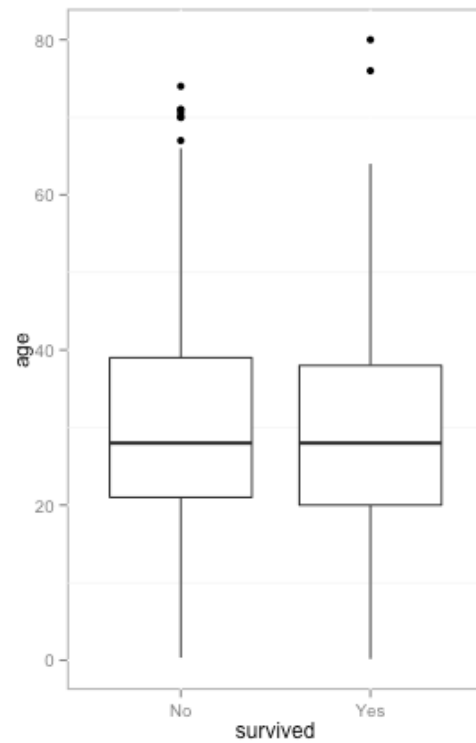
```
ggplot(movies, aes(x = "Movie", y = Running.Time)) + geom_boxplot()
```





# Boxplots

```
ggplot(titanic, aes(x = survived, y = age)) + geom_boxplot()
```



# Variance

$$s^2 = \frac{\sum (y - \bar{y})^2}{n - 1}$$

- The variance is a measure of how far the data is spread out from the mean.
- The difference from the mean is:  $y - \bar{y}$
- To make it positive, square it.
- Then find the average of all of these distances, except instead of dividing by  $n$ , divide by  $n - 1$ .
- Use  $s^2$  to represent the variance.
- The variance will mostly be used to find the standard deviation  $s$  which is the square root of the variance.

# Standard Deviation

$$s^2 = \sqrt{\frac{\sum (y - \bar{y})^2}{n - 1}}$$

- The variance's units are the square of the original units.
- Taking the square root of the variance gives the standard deviation, which will have the same units as y.
- The standard deviation is a number that is close to the average distances that the y values are from the mean.
- If data values are close to the mean (less spread out), then the standard deviation will be small.
- If data values are far from the mean (more spread out), then the standard deviation will be large.