


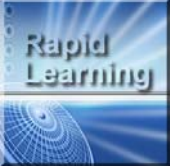
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 **Measures of Central Tendency**

Statistics Rapid Learning Series

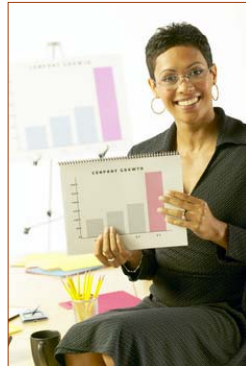
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Learning Objectives

By completing this topic, you will learn to:

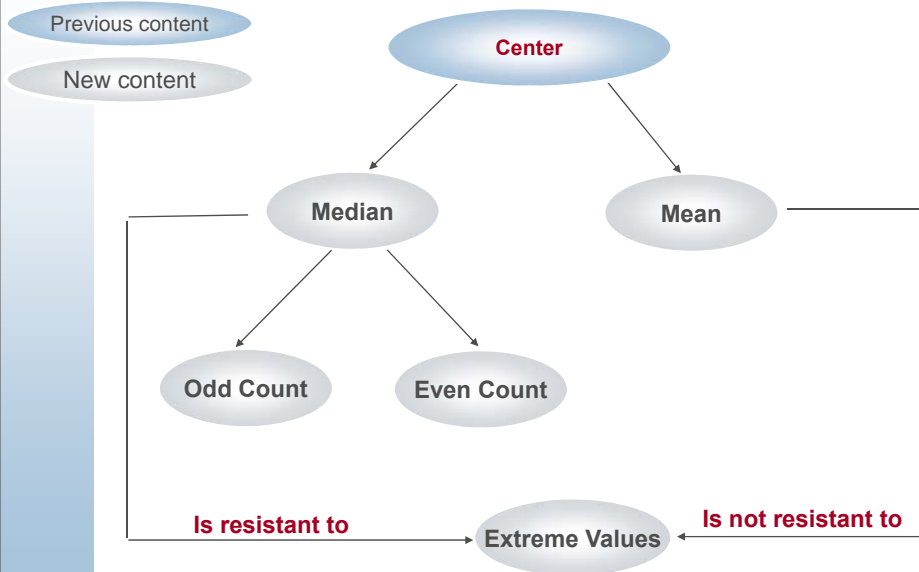


- Find the center of a distribution.
- Compute the mean and median of a set of data.
- Understand how extreme values affect the median and mean.
- Determine when to use mean and when to use the median.
- Determine the shape of a distribution from the mean and median values.
- Calculate the median and mean using a graphing calculator

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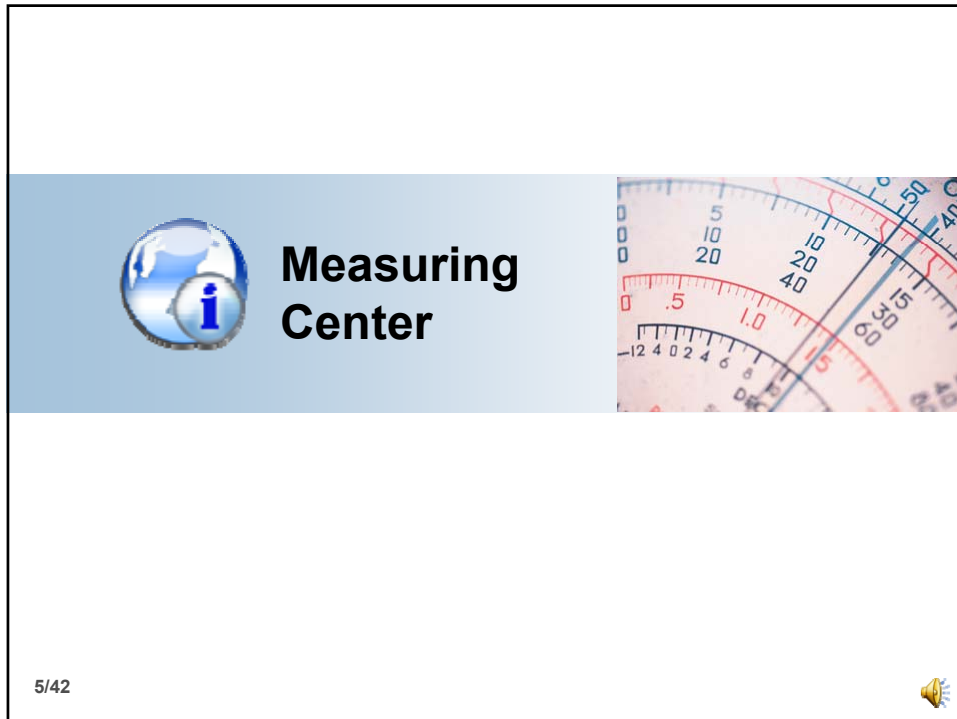


Concept Map



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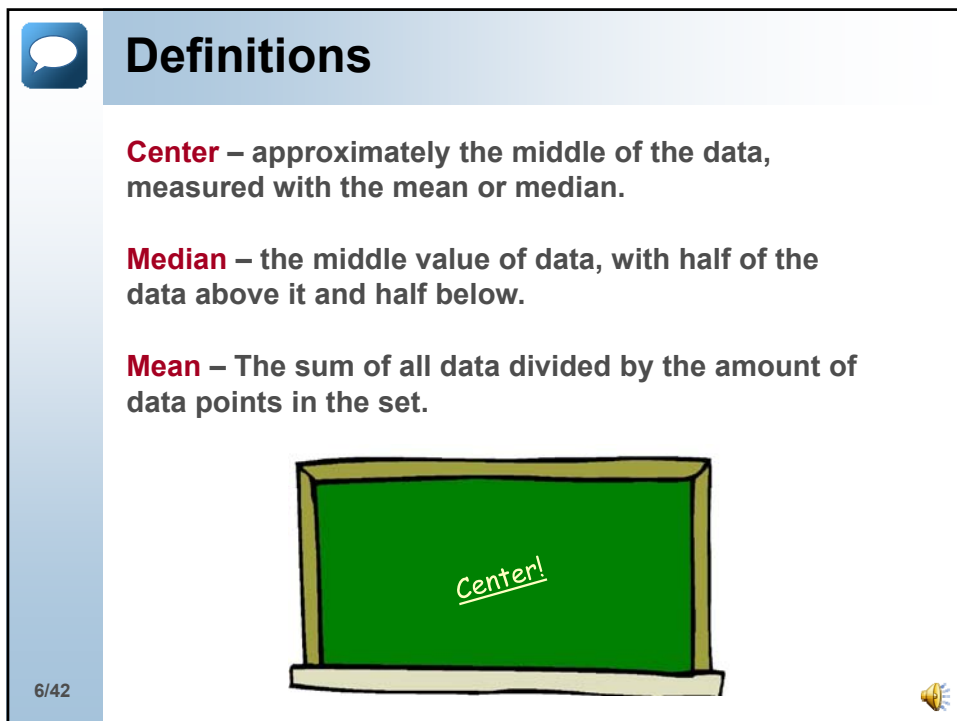




A slide titled "Measuring Center" featuring a blue header with a globe icon containing an 'i' and a background image of a measuring scale. The slide includes a page number "5/42" and a lightbulb icon.

Measuring Center

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A slide titled "Definitions" with a blue header and a speech bubble icon. It lists definitions for Center, Median, and Mean. Below the text is a green chalkboard with "Center!" written on it. The slide includes a page number "6/42" and a lightbulb icon.

Definitions

Center – approximately the middle of the data, measured with the mean or median.

Median – the middle value of data, with half of the data above it and half below.

Mean – The sum of all data divided by the amount of data points in the set.

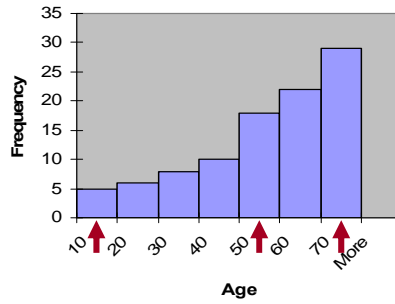
Center!

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About Center: Stop-and-think

Where do you think the **center** of distribution is?



Around 15?

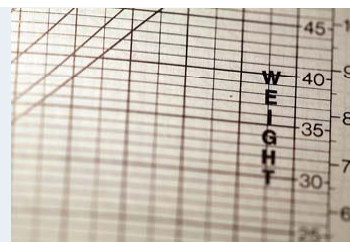
How about 75?

Around 55 is probably a **better guess.**

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Calculating the Median



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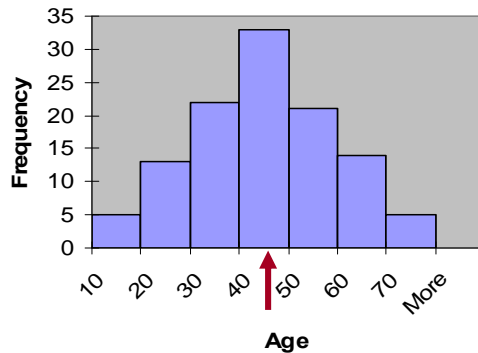




Median: Symmetric Distributions

The **median** is a number that divides the data in half.

50% of the data lie **below** the median and 50% of the data lie **above** the median.



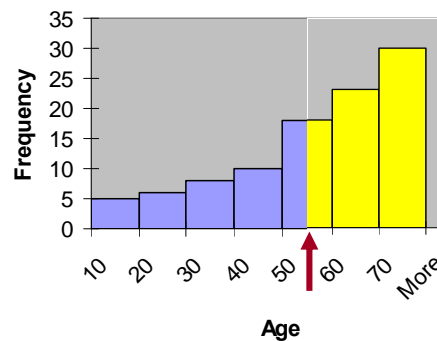
For a **symmetric** distribution, the median lies in the **center** of the histogram.

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Median: Skewed Distributions

For **skewed** distributions, the median may be further to the left or the right.

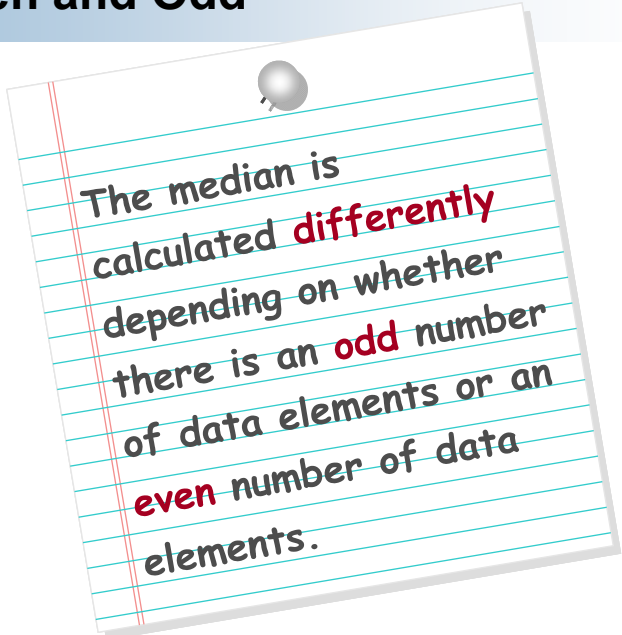


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Even and Odd




The median is calculated **differently** depending on whether there is an **odd** number of data elements or an **even** number of data elements.


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Calculating Median: Odd Count

The steps for calculating the median when there are an odd number of data elements are: 

- 1 Order the data:** order all of the data points from least to greatest or from greatest to least. While ordering, calculate n .
- 2 Find the position of the middle value:** Use the formula $(n + 1)/2$.
- 3 Determine the value represented by the middle position:** count the data from the beginning (or end) of your ordered list to find the value associated with the middle position.

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Example: Calculating Median

Example: Find the median of 62, 44, 21, 31, 41, 50, 30, 55, 43

Solution: We first **order** the data:

21, 30, 31, 41, 43, 44, 50, 55, 62

Since there are 9 data points, we use the formula $(n + 1)/2$ to get $(9 + 1)/2 = 10/2 = 5$

The median is the element in the **5th position**.

21, 30, 31, 41, **43**, 44, 50, 55, 62



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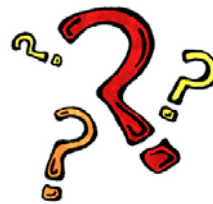


Question: Median with Odd n

What is the median value of the following data set:


26, 18, 31, 30, 47, 42, 28, 58, 42

- 26
- 31
- 18
- 42
- 58

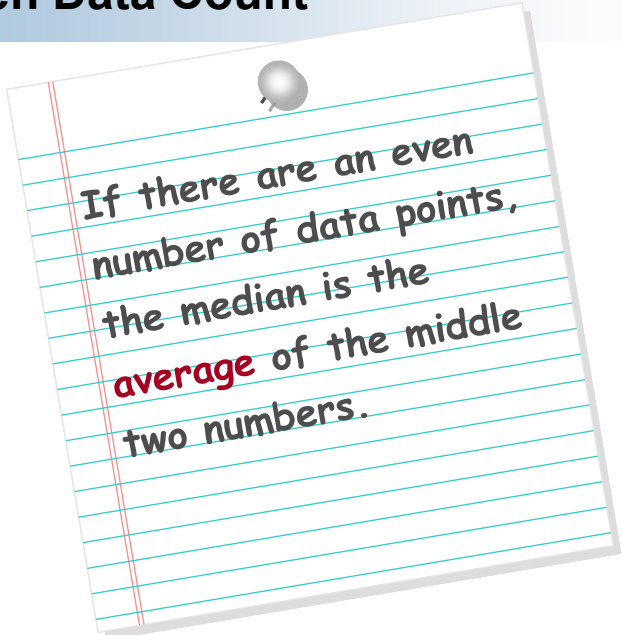


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Even Data Count





If there are an even number of data points, the median is the **average** of the middle two numbers.

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Calculating Median: Even Count

The steps for calculating the median when there are an even number of data elements are: 

- 1 **Order the data:** order all of the data points from least to greatest or from greatest to least. While ordering, calculate n .
- 2 **Find the position of the two middle values:** by using two formulas $n/2$ and $n/2 + 1$.
- 3 **Determine the values represented by the two middle positions:** count the data from the beginning (or end) of your ordered list to find the values associated with the two middle positions.
- 4 **Get an average:** average the two middle values to get the median. 

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Example: Calculating Median

Example: Find the median of 46, 62, 44, 21, 31, 41, 50, 30, 55, 43

Solution: We first **order** the data:

21, 30, 31, 41, 43, 44, 46, 50, 55, 62

Since there are 10 data points, we use the formula $n/2$ to get 5. The two middle values are in the **5th** and **6th** positions.

These values are 43 and 44.

The **median** is the average of 43 and 44 which yields 43.5.



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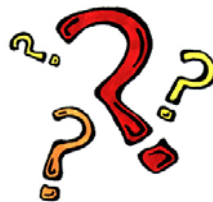


Question: Median with Even n

What is the median value of the following data set:

26, 18, 31, 30, 47, 42, 28, 58, 42, 35

- 30
- 33
- 18
- 42
- 44.5



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Note on Median and Resistance

The median is **resistant** to extreme values which means that if extreme values are in the data, the median will remain **unaffected**.

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Example - Resistance

Example: Consider the two data sets given below.


<u>Data Set 1:</u>	<u>Data Set 2:</u>
2 1	2 1
3 0 1	3 0 1
4 1 3 4	4 1 3 4
5 0 5	5 0 5
6	6 2
7	
8 3	

The **median** for both data sets is easily found to be 43.

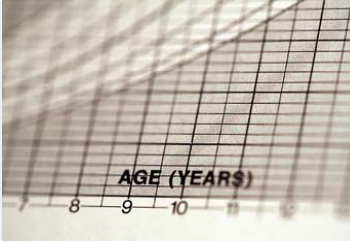
However, the first data set contains the **extreme value** of 83.

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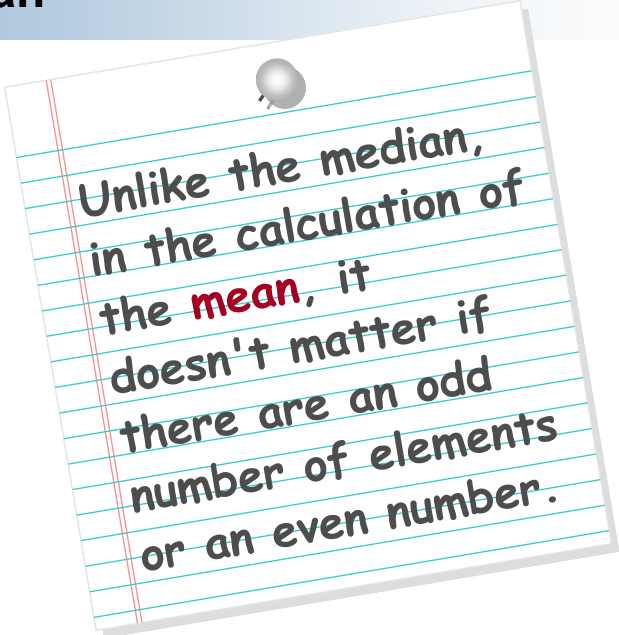
Calculating The Mean




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Mean



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Calculating Mean

The steps for calculating the mean are:



- 1 **Find the sum** of all of the data points or observations.
- 2 **Divide the sum** by the count to obtain the mean.



The mean is denoted by \bar{x} .

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Example: Calculating Mean

Example: Find the mean of 63, 44, 21, 31, 41, 50, 30, 55, 43.

Solution: We first calculate the **sum** of the data:

$$\begin{aligned}\sum x &= 63 + 44 + 21 + 31 + 41 + 50 + 30 + 55 + 43 \\ &= 378\end{aligned}$$

The **mean** is the sum of the data divided by the count:

$$\bar{x} = \frac{\sum x}{n} = \frac{378}{9} = 42$$



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Question: Mean

What is the mean value of the following data set:

29, 18, 31, 30, 47, 42, 28, 58, 42, 35

- 30
- 31.5
- 18
- 36
- 44.5



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Note on Mean and Resistance

The mean is **not resistant** to extreme values which means that if extreme values are present in the data, the mean will be affected.

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Example – Resistance

Example: Consider the data set given below

21, 30, 31, 41, 43, 44, 50, 55, 56

The mean is calculated as

$$\bar{x} = \frac{\sum x}{n} = \frac{21 + 30 + 31 + 41 + 43 + 44 + 50 + 55 + 56}{9} = 41.2$$

Now, suppose that the last data value is **changed** from 56 to 200. The mean then becomes

$$\bar{x} = \frac{\sum x}{n} = \frac{21 + 30 + 31 + 41 + 43 + 44 + 50 + 55 + 200}{9} = 57.2$$

Since the mean changed dramatically, we see that the mean is **not resistant** to extreme values.



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Mode


Another measure of central tendency is the **mode**. The mode is the data value that appears the **most often** in the data set. A data set may have multiple modes.

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Using Technology

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Using a Graphing Calculator - 1

The graphing calculator has the ability to calculate the mean and median for a data set. The steps are:

- Enter the data:** Data are entered into the calculator by pressing **STAT** and then **1:Edit...**

```

EDIT CALC TESTS
1:Edit...
2:SortA(
3:SortD(
4:ClrList
5:SetUpEditor
            
```

L1	L2	L3	1
28			
30			
31			
41			
43			
44			
50			
L1(n)=23			

- Find the 1-variable stats:** The one-variable statistics are found by pressing **STAT**, **→**, **1-Var Stats**, and then **ENTER**.

```


EDIT CALC TESTS
1:Edit...
2:SortA(
3:SortD(
4:ClrList
5:SetUpEditor
            
```

```

EDIT CALC TESTS
1:1-Var Stats
2:2-Var Stats
3:Med-Med
4:LinReg(ax+b)
5:QuadReg
6:CubicReg
7:QuartReg
            
```

```

1-Var Stats
x=44.44444444
x̄=400
Σx²=20270
Sx=17.63014951
σx=16.64072054
n=9
            
```

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Using a Graphing Calculator - 2

The **mean** is given by \bar{x}

```

1-Var Stats
x̄=44.44444444
Σx=400
Σx²=20270
Sx=17.65014951
σx=16.64072054
↓n=9
  
```

and by scrolling down, you can see that the **median** is also given.

```

1-Var Stats
↑n=9
minX=23
Q1=30.5
Med=43
Q3=52.5
maxX=83
  
```



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Determining Shape



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Name that Shape

There are three cases that we use to determine the shape of a distribution from its mean and median.

- 1 **Mean = Median:** when the mean and median values are approximately equal to each other, the shape of the distribution is symmetric.
- 2 **Mean < Median:** when the mean is less than the median, the shape of the distribution is generally left-skewed.
- 3 **Mean > Median:** when the mean is greater than the median, the shape of the distribution is generally right-skewed.



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Symmetric Distribution

Consider the following **symmetric distribution**. We expect the median and the mean to be approximately equal.



2	9
3	0 2
4	1 3 4
5	1 5
6	2

The **median** is in the 5th position and is found to be **43**.

The **mean** is

$$\bar{x} = \frac{\sum x}{n} = \frac{29 + 30 + 32 + 41 + 43 + 44 + 51 + 55 + 62}{9} = 43$$

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Skewed Distribution

Consider the following **skewed distribution**.

1	0
2	1
3	2
4	14
5	03
6	1248
7	13579
8	0

The **median** is in the 9th position and is found to be **62**.

The **mean** is $\bar{x} = \frac{\sum x}{n} = 56.5$

Since the mean is **less** than the median, we see that the distribution is **skewed to the left**.



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Question: Determining Shape

A distribution has a median of 75 and a mean of 100.


Which choice represents the shape of the graph:




- Symmetric
- Left skewed
- Right skewed

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Mean vs. Median & Changing Units



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Choosing the Mean or Median



Because the **mean** is not resistant to extreme values, it is best used when extreme values are **not present** in the data.

When extreme values are **present**, the **median** may be a better measure of the center.

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Changing Units

Sometimes the units of data are changed (seconds to minutes, meters to feet, etc...). The mean and median are both affected in the following ways:

Adding a Constant:

If a constant is added to each data value, the mean and median will be increased by the same constant value.

Multiplying by a Constant:

If each data value is multiplied by a constant, the mean and median will be multiplied by the same constant.



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Learning Summary

Find the **mean** by taking the sum of all of the observations and dividing by the count.

Center is measured with the median or the mean.

Adding or **multiplying** each data value by a constant changes the value of the mean and median.

The **median** is calculated for an odd count or an even count.

The median is resistant to **extreme values**; the mean is not.

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🎀 Congratulations 🎀

You have successfully completed
the tutorial

**Measures of Central
Tendency**

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What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)

→ Step 2: Practice – Interactive Problem Drill

Step 3: Recap – Super Review Cheat Sheet

Go for it!



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