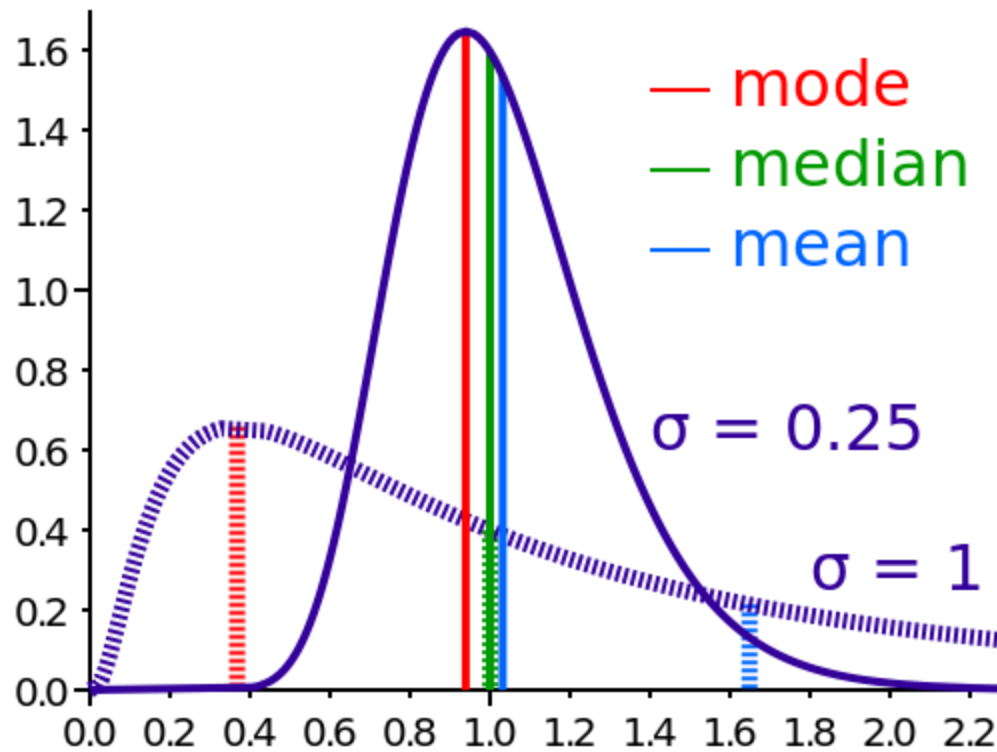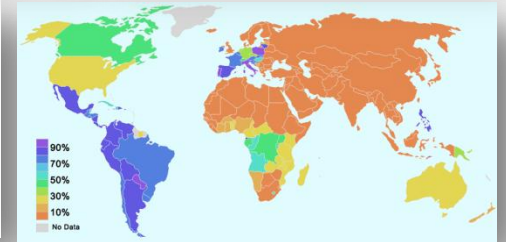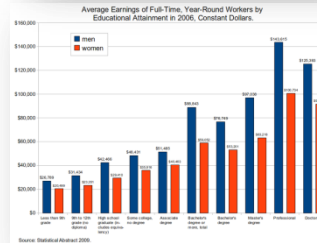# Means, Modes, and Medians

Brainstorming

Where do you find mean, mode and median being used?

What are they used for?

Mean value

- The **mean** of a set of numbers is defined as a sum of these numbers divided by the size of the set of these numbers.

- **Example: What is mean of {6, 11, 7}?**

  - Sum of these numbers is 6+11+7 = 24.
  - The size of the set of these numbers is 3.
  - Sum of these numbers divided by the size of the set is 24/3 = 8.
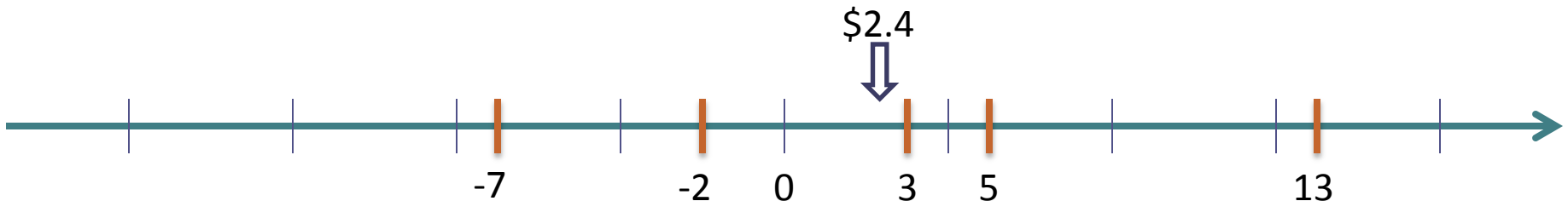 - The mean value is 8.

Example

- **Matt's daily savings during the consecutive five weekdays are $3, $-7, $5, $13, $-2.**

  The sum of the numbers is $3 - 7 + 5 + 13 - 2 = 12$.
  There are 5 numbers.
  The sum divided by the size of the set $12 / 5 = 2.4$.
  The mean saving is $2.4.

$2.4

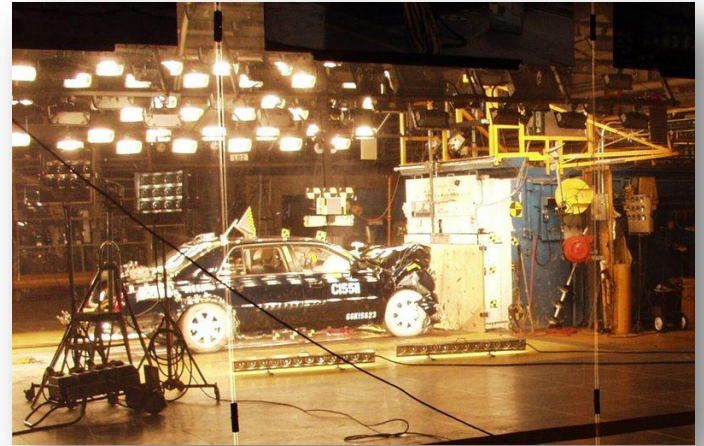-7   -2   0   3   5   13

Mode value

- The **mode** of a set of numbers is defined as the number that occurs the most frequently in the set.

- **Example. What is the mode of the following set?**

  $$\{8, \quad 9, \quad 14, \quad 6, \quad 9, \quad 10\}$$

- Ordering the data from least to greatest, we get: 6, 8, 9, 9, 10, 14.
- The mode is 9.

Example

In a crash test, 8 cars were tested to determine what impact speed was required to obtain minimal bumper damage. Find the mode of the speeds given in miles per hour.

24, 15, 19, 20, 18, 24, 26, 18.

Ordering the data from least to greatest, we get: 15, 18, 18, 19, 20, 24, 24, 26.

Since both 18 and 24 occur three times, the modes are 18 and 24 miles per hour.

This data set is bimodal.

Median value

- The **median** is the *"middle number"* (in a sorted list of numbers).

- To find the median, place the numbers you are given in **value order** and find the **middle number**.

Example: find the Median of {12, 3 and 5}

- Put them in order: 3,5,12.
- The middle number is 5, so the median is 5.

Example

A digital temperature sensor takes measurements in ˚F once an hour. During four consecutive hours it has recorded the following data : 90˚F, 89.5 ˚F, 88 ˚F, 88.2 ˚F. Find the median temperature.

Ordering the data from least to greatest, we get: 88, 88.2, 89.5, 90.

Since the size of data set is an even number (4 total), the median is the average of the two "middle numbers" 88.2 and 89.5.
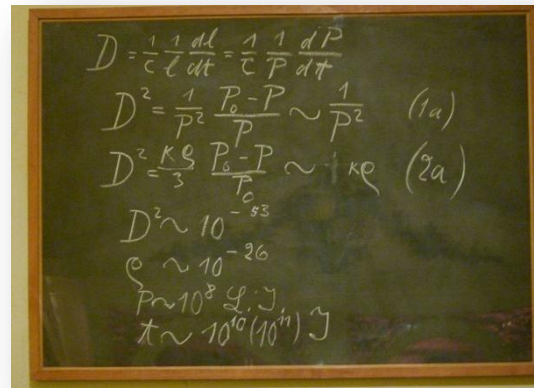
The median temperature measurement is $\frac{88.2+89.5}{2} = 88.85$ ˚F.

Analyzing Change: Percent error

Percent error is a technique for comparing two quantities.

$$\%Error = \left| \frac{Experimental - Theoretical}{Theoretical} \right| \times 100\%$$

This measure is *unit-less* and assumes that one quantity is experimental and another quantity is theoretical.

Theoretical

Experimental

Example

- Example: The average measured length of two bungee cords is 20.4cm, and the factory stated length is equal to 20cm. Find %Error.

$$\%Error = \left|\frac{20.4-20}{20}\right| \text{x}100\% = 2\%$$

There is 2% error between reported length and actual length of bungee cords. Need to keep this in mind during engineering design process.

Analyzing Change: Percent difference

Percent difference is a technique for comparing two quantities. Given two values: x_1 and x_2.

$$\%Difference = \left| \frac{x_1 - x_2}{\frac{(x_1 + x_2)}{2}} \right| \times 100\% = \left| \frac{x_1 - x_2}{Average(x_1, x_2)} \right| \times 100\%$$

This measure is *unit-less* and does not assume either quantity to be incorrect even if a difference between them exists.

Example

The length of the blue colored bungee cord was measured to be 20.4 cm. The length of the purple colored bungee cord was measured to be 20.5cm. Find the percent difference of their lengths.

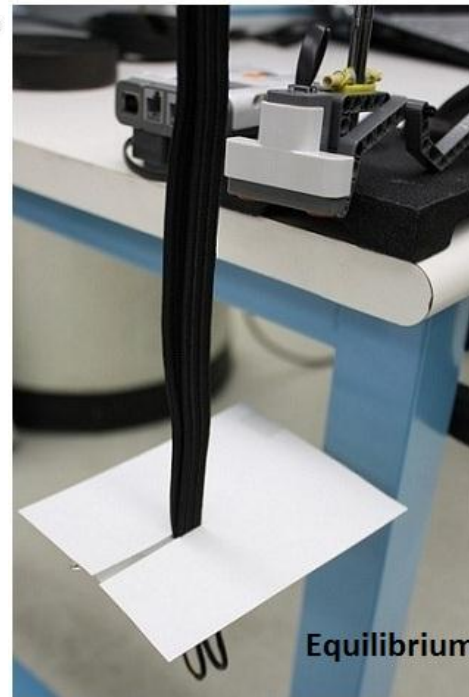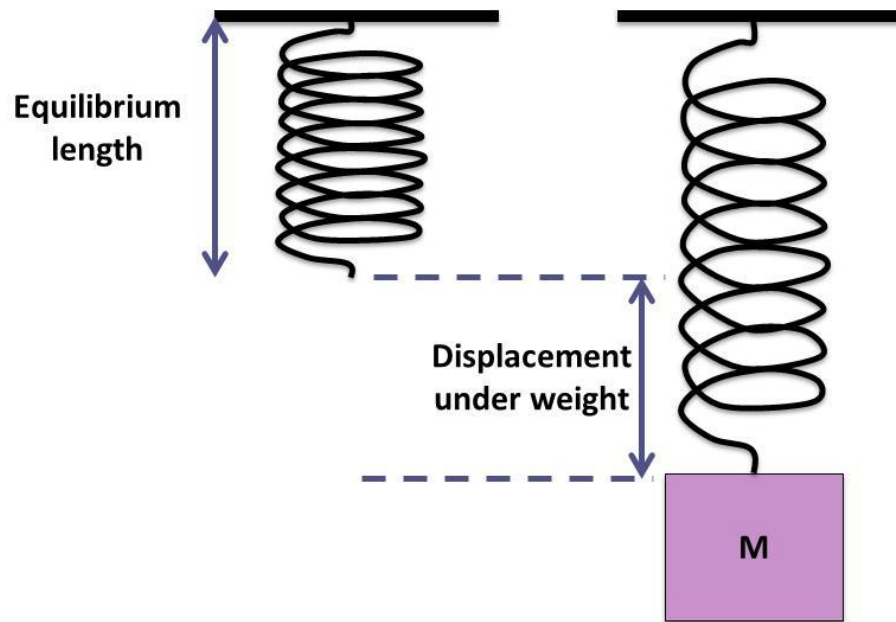$$x_1 = 20.4cm, x_2 = 20.5cm$$

$$\%Difference = \left| \frac{20.4 - 20.5}{\frac{20.4+20.5}{2}} \right| \text{x}100\% = 0.49\%$$

There is 0.49% difference in the lengths of two cords. Note that we do not assume either length to be wrongly measured even if difference between lengths exists.

Bungee jumping

Spring-mass Activity

Equilibrium length

Displacement under weight

M

Equilibrium

Displacement under weight

Formulas and references

The **mean** of a set of numbers is defined as a sum of these numbers divided by the size of the set of these numbers.

The **mode** of a set of numbers is defined as the number that occurs the most frequently in the set.

The **median** is the *"middle number"* (in a sorted list of numbers).

Percent error.

$$\%Error = \left| \frac{Experimental - Theoretical}{Theoretical} \right| \text{x}100\%$$

Percent difference. Given two values: x_1 and x_2.

$$\%Difference = \left| \frac{x_1 - x_2}{\frac{(x_1 + x_2)}{2}} \right| \text{x}100\% = \left| \frac{x_1 - x_2}{Average(x_1, x_2)} \right| \text{x}100\%$$