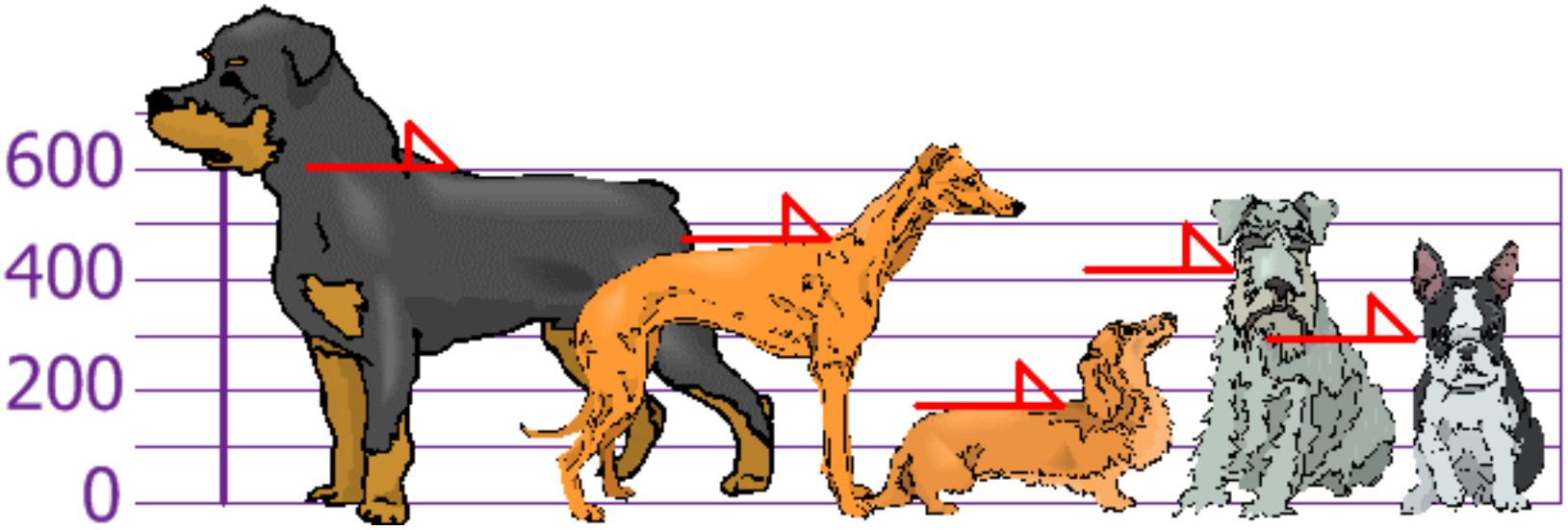
Mean, Median, Mode
Variance
Standard Deviation

Bozeman Biology videos: Statistics for Science
Standard Deviation
Standard Error

Science Practice 2: The student can use mathematics appropriately

Modified from: Mathisfun.com
http://www.mathsisfun.com/data/standard-deviation.html

A sample of dogs was measured



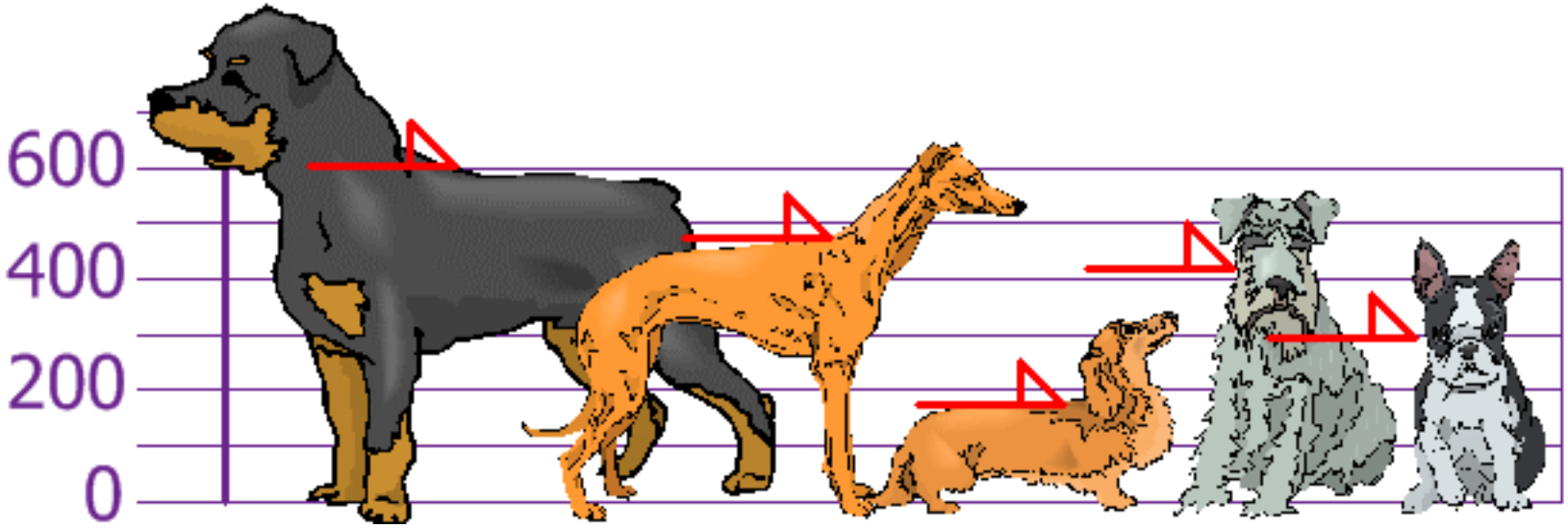
The heights (at the shoulders) are:
600mm, 470mm, 170mm, 430mm and 300mm.

Image from: http://www.mathsisfun.com/data/standard-deviation.html

FIND the RANGE

Smallest number - largest number

170 mm – 600 mm



The heights (at the shoulders) are:
600mm, 470mm, 170mm, 430mm and 300mm.

Image from: http://www.mathsisfun.com/data/standard-deviation.html

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

Find the MEAN

MEAN ($\bar{x}$): average of all data points

$$\text{Mean} = \frac{600 + 470 + 170 + 430 + 300}{5} = \frac{1970}{5} = 394$$

Mean height is 394 mm

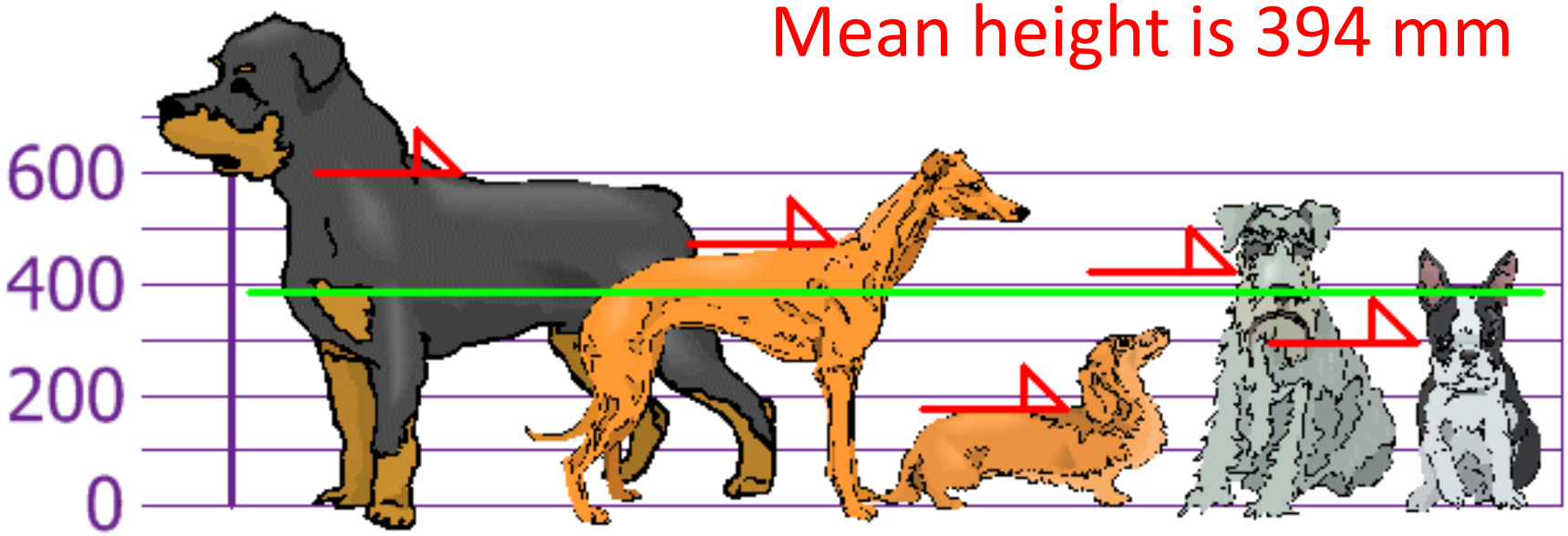
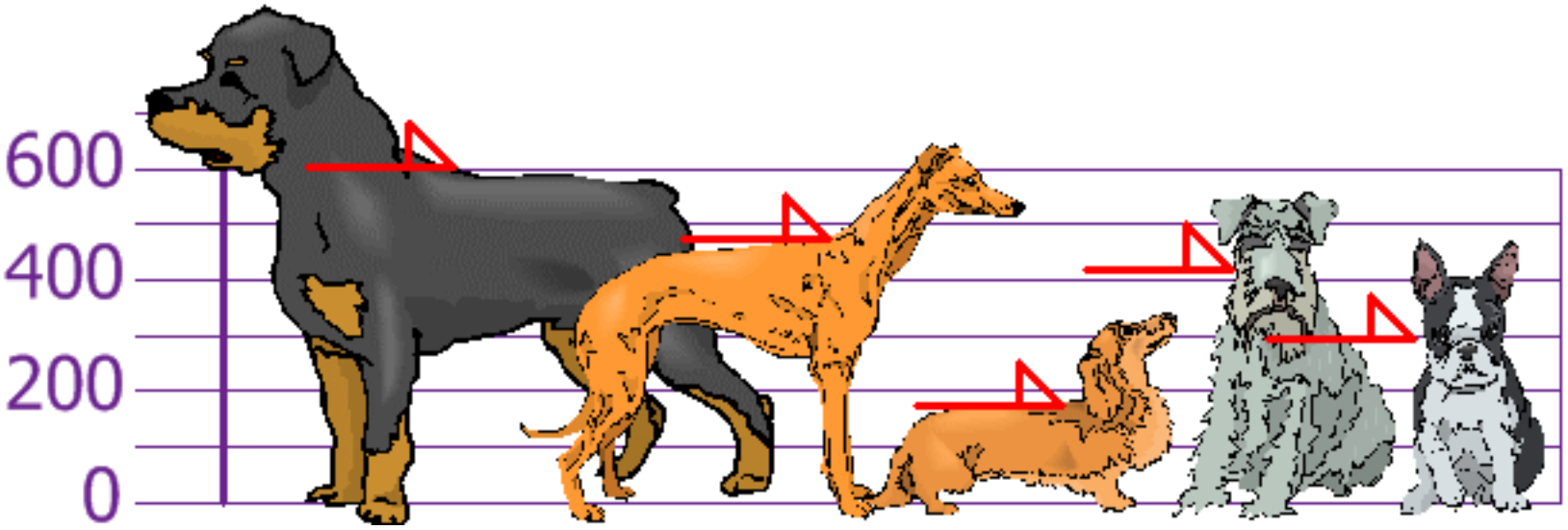


Image from: http://www.mathsisfun.com/data/standard-deviation.html

FIND the MEDIAN



The heights (at the shoulders) are:
600mm, 470mm, 170mm, 430mm and 300mm.

.

Image from: http://www.mathsisfun.com/data/standard-deviation.html

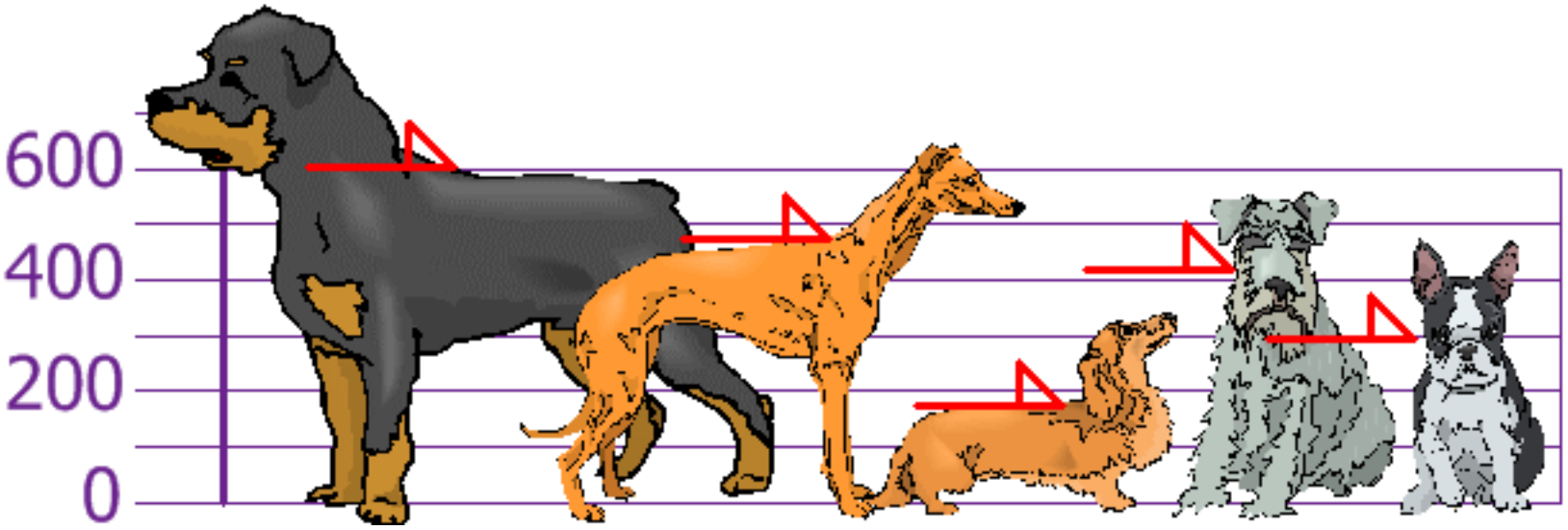
MEDIAN:

Data point that is found in the middle when all the measurements are lined up from in order from high to low

(or an average of middle two values if there is an even number of data points

170mm 300mm 430mm 470 mm 600mm

FIND the MODE



The heights (at the shoulders) are:
600mm, 470mm, 170mm, 430mm and 300mm.

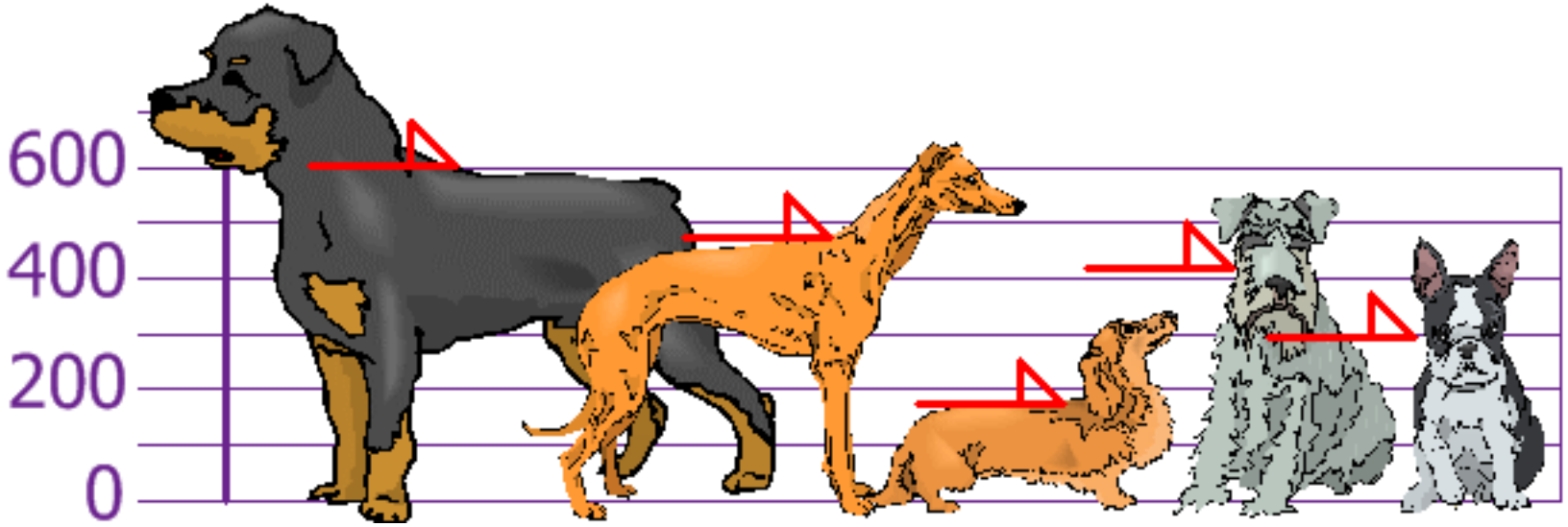
.

Image from: http://www.mathsisfun.com/data/standard-deviation.html

MODE: Most common data point

170mm 300mm 430mm 470 mm 600mm

There is no mode for these data



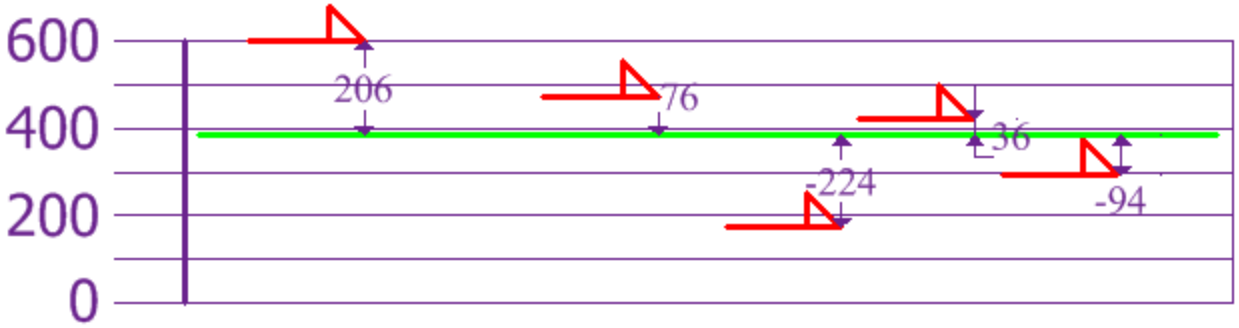
The heights (at the shoulders) are:
600mm, 470mm, 170mm, 430mm and 300mm.

Determine the VARIANCE.
How far is each measurement away from the mean?

Image from: http://www.mathsisfun.com/data/standard-deviation.html

VARIANCE (= s^2)

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



$$s^2 = \frac{(600 - 394)^2 + (470 - 394)^2 + (170 - 394)^2 + (430 - 394)^2 + (470 - 394)^2}{5-1}$$

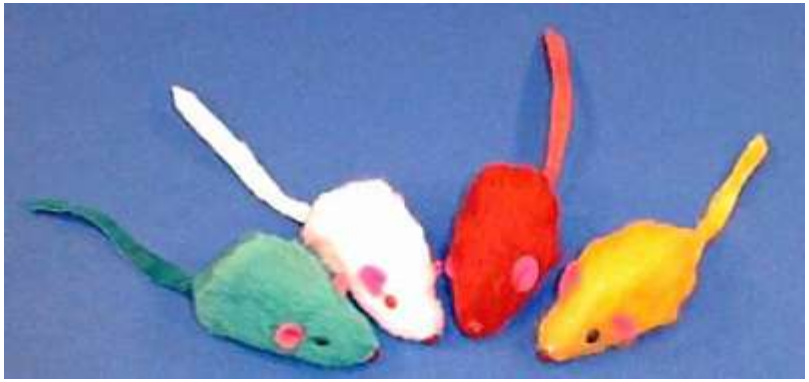
$$s^2 = \frac{206^2 + 76^2 + (-224)^2 + 36^2 + (-94)^2}{4}$$

$$s^2 = 21{,}704$$

http://www.mathsisfun.com/data/standard-deviation.html

Does the mutagen have an impact on mean tail length ($\overline{x}$) in *Mus musculus*?

- A group of mice was fed a diet with a mutagen that was thought to affect tail length in mice added.
- Another group of mice was fed the same diet w/o the mutagen added.
- H_O ?



Mutagen mice idea from Kristen Dotti
Catalyst Learning Curriculum

Image from: http://www.petdiscounters.com/assets/images/product_images/image/d_4491.jpg

MEASURING MICE

- Determine the tail lengths of the mice in the sample provided to your group.

- Determine RANGE, MEAN, MEDIAN, MODE, & VARIANCE for the mice in your sample.
- Post your measurements on class data chart

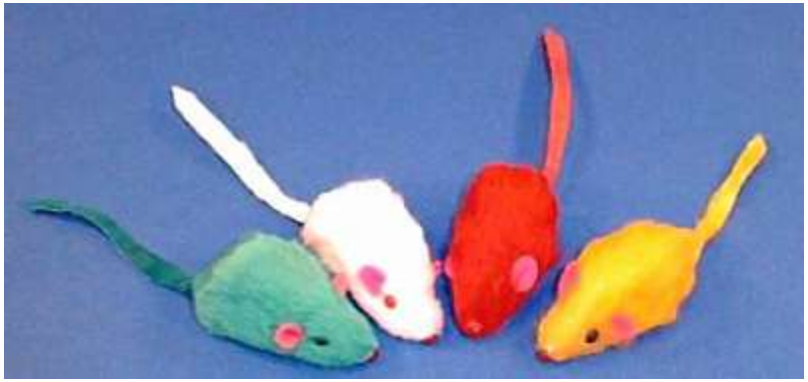


Image from: http://www.petdiscounters.com/assets/images/product_images/image/d_4491.jpg

STANDARD DEVIATION (s)

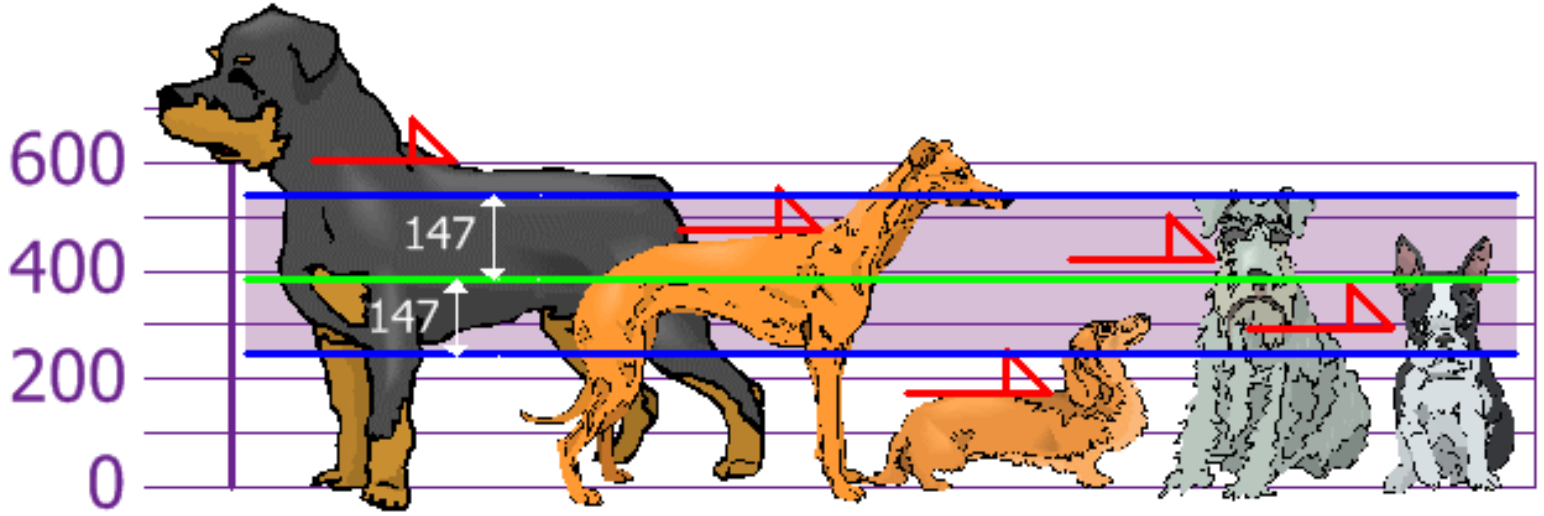
Watch Bozeman Biology video

$$s = \sqrt{s^2}$$

Standard Deviation= square root of Variance

σ = √21,704 = 147.32... = 147mm

Standard Deviation is useful. Now we can show which heights are within one Standard Deviation (147mm) of the Mean:



Rottweilers **are** tall dogs and Dachshunds **are** a bit short

Image from: http://www.mathsisfun.com/data/standard-deviation.html

STANDARD DEVIATION

the **standard deviation** of the sample is the degree to which individuals within the sample differ from the sample mean.

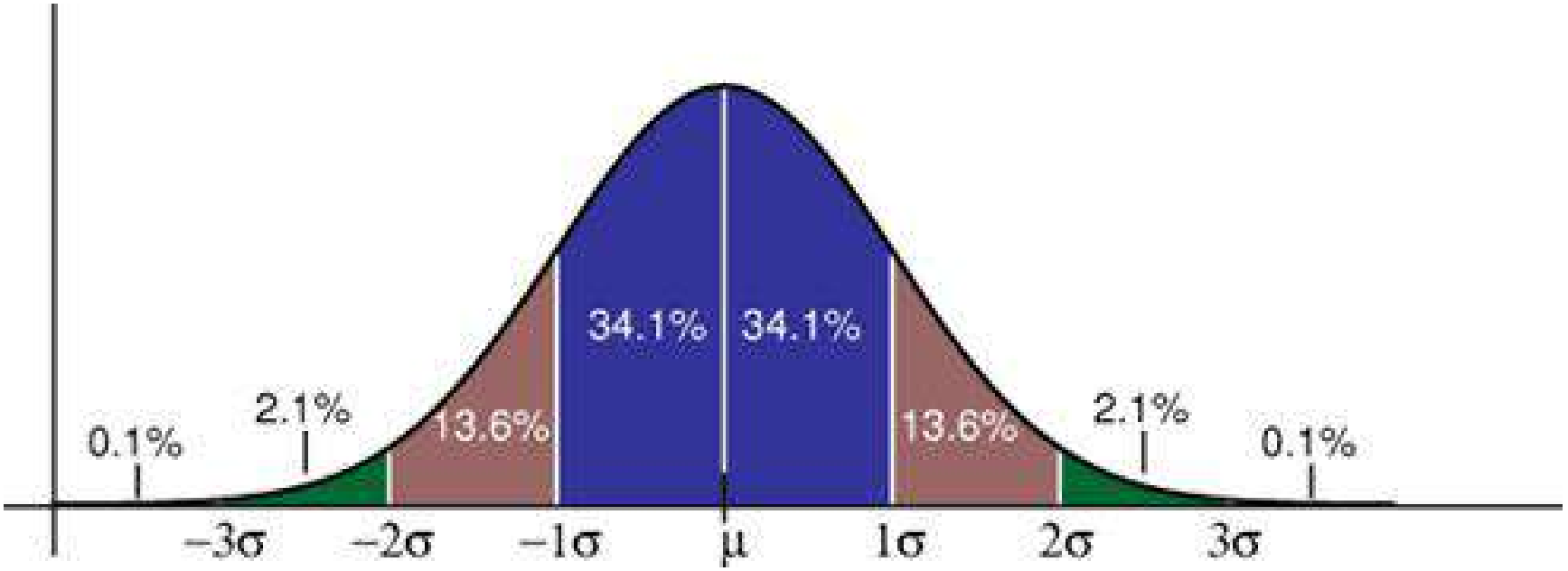
$$s = \sqrt{s^2}$$

STANDARD ERROR OF THE MEAN

the **standard error of the mean** is an estimate of how far the sample mean is likely to be from the population mean

Bozeman Biology Standard Error

$$\mathrm{SE}_{\bar{x}} = \frac{s}{\sqrt{n}}$$



In a normal distribution

68.2% within 1 standard deviation from mean

95.4% within 2 standard deviations from mean

99.7% within 3 standard deviations from mean

http://www.strath.ac.uk/media/faculties/hass/appliededucationalresearch/mod4unit3/curve1.jpg