Deviation Soup: SD, SE, and s

The SD has two definitions. One for a list of numbers, and one for a random variable.

$$SD(population) = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

$$SD(sample) = \sqrt{\frac{1}{n}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

$$SD(Random\ Variable) = \sqrt{E(Y^2 - E(Y))^2} = \sqrt{E(Y^2) - (E(Y))^2}$$

What about σ. We use σ to represent either the population SD or the random variable standard deviation so we need to be careful when we refer to σ, which one we mean.

Typically we refer to the sample SD as $\hat{\sigma}$ because it is thought to be an estimate of σ. Then there is s

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

Which is another estimate of σ. Sometimes this quantity is referred to as the sample SD.

When the random variable is an estimator of an unknown prameter (such as μ) we often call it an SE, standard error, rather than an SD.

$$SE(\bar{x}) = \sqrt{E(\bar{x}^2 - \mu)^2}$$

We put hats on the estimates of these standard errors when we are trying to estimatoe them.

$$\hat{S}E(\bar{x}) =$$