## Precision: The Population Standard Deviation

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

## Precision: The Sample Standard Deviation

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

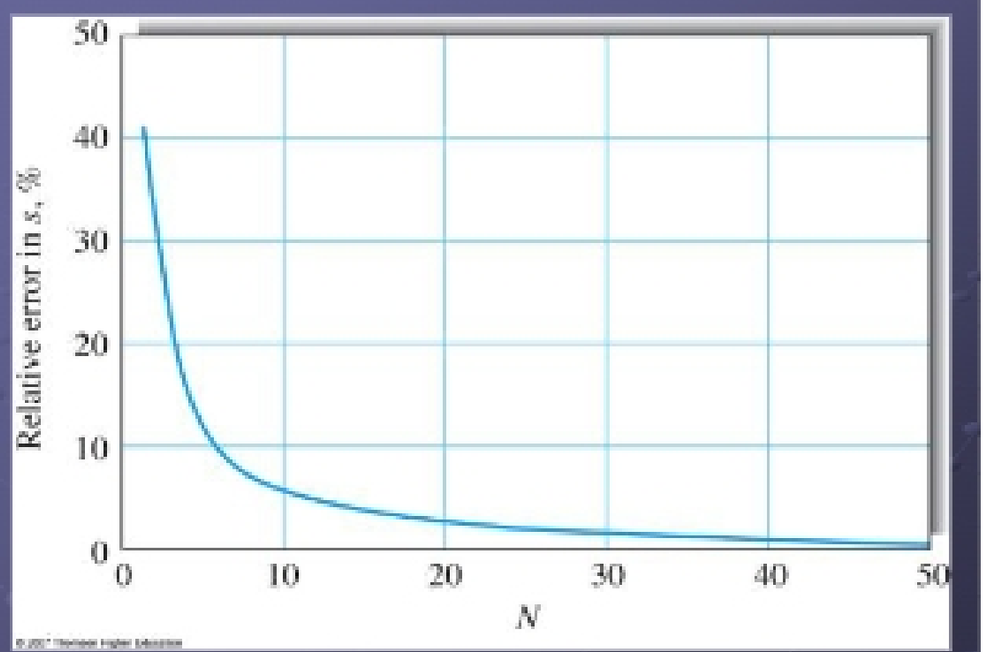
## Side by side

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

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

## $N$ -1 = Degrees of Freedom

- By calculating the mean, we use up a degree of freedom.
- Thus, only $N$ -1 remain.
- As $N \rightarrow \infty$, $N - 1 \rightarrow N$




## The $z$ - statistic

$$z = \frac{x_i - \mu}{\sigma} \text{ or } z = \frac{x_i - \bar{x}}{s}$$

The deviation from the mean given as multiples of the standard deviation.

**TABLE a1-3** Confidence Levels for Various Values of $z$

| Confidence Level, % | $z$ |
|---|---|
| 50 | 0.67 |
| 68 | 1.00 |
| 80 | 1.28 |
| 90 | 1.64 |
| 95 | 1.96 |
| 95.4 | 2.00 |
| 99 | 2.58 |
| 99.7 | 3.00 |
| 99.9 | 3.29 |



## Watch those calculators!

- $\sigma_{xn-1}$ sample
- $\sigma_{xn}$ population

## Watch Excel!

- =STDEV(cells) (sample)
- =STDEVP(cells) (population)
- Let's play some more.
  - Example 6-1, page 126
  - Do it with Excel.