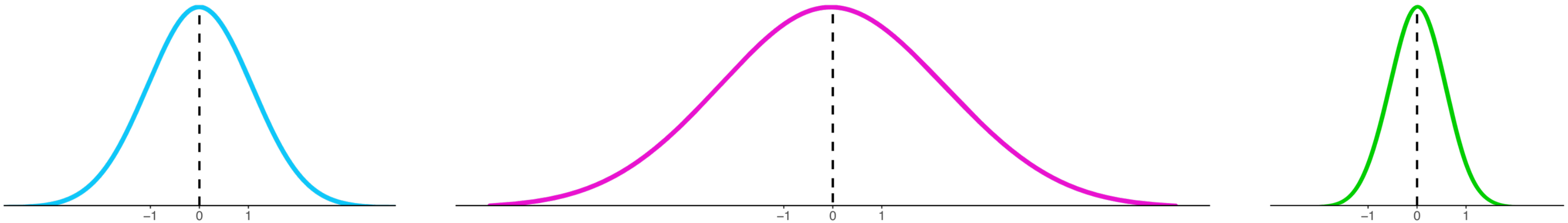
Learning Objectives

- **Describe** three models/measures of *variability*
  - Range
  - Standard Deviation
  - Variance
- **Calculate** variability by hand (& calculator)
- **Interpret** models of variability

Central Tendency, Skew & Variability

- *Central tendency, skew*, and *variability* describe the distribution of observations
  - Variability quantifies how spread out scores are



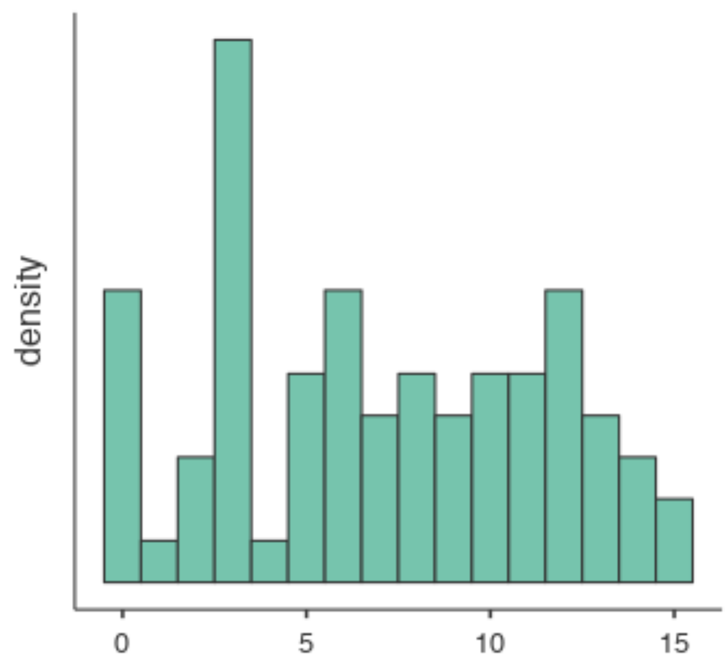
3 Models of Variability

1. Range	Range?
2. Standard Deviation	s, σ, std, s.d.
3. Variance	s^2, σ^2, var

Range

- **<u>Range</u>** is the absolute difference between the most extreme scores
  - Data = Nutritional values from (N=77) cereals

Density Histogram. Grams sugar per 28g of cereal.



Range

Formula:

$$\text{Range} = \text{Max} - \text{Min}$$

$$= X_{\text{Smacks}} - X_{\text{SW}}$$

Cereal	g/Sugar
All Bran	5
Cap'n Crunch	12
Corn Flakes	2
Kix	3
Lucky Charms	12
Shredded Wheat	1
Smacks	15
Special K	3
Trix	12
Wheaties	3

Deviation Score

- Amount an observation deviates from the sample mean

Formula:

$$X_i - \bar{X}$$

What is the deviation score for X_{trix}?

Hint $\bar{X} = \frac{\Sigma X_i}{N}$

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All Bran	5
Cap'n Crunch	12
Corn Flakes	2
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Summed Deviation

Formula:

$$\Sigma(X_{\mathrm{i}} - \bar{X})$$

What is the summed deviation?

Remember $\bar{X}$ = 6.8

Cereal	g/Sugar
All Bran	5
Cap’n Crunch	12
Corn Flakes	2
Kix	3
Lucky Charms	12
Shredded Wheat	1
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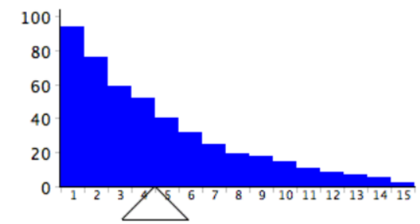
Deviations

<u>Problem</u>**:** Summing or averaging deviation scores will give us 0

– Remember the mean is a fulcrum



<u>Solution</u>: Square each deviation score

– All negative deviations become positive

– ***Then*** sum these squared deviations together for the *sum of squared deviations* (or *SS*)

$$SS = \Sigma(X_i - \bar{X})^2$$

Standard Deviation

- *SS* is the total **sum** of squared deviations
  - Dividing this by *N* gives us ***mean*** squared deviation (aka, *variance*)
  - Taking the *square root* gives us mean deviation or ***standard deviation***
  - But, this needs a slight correction for bias (in samples)*

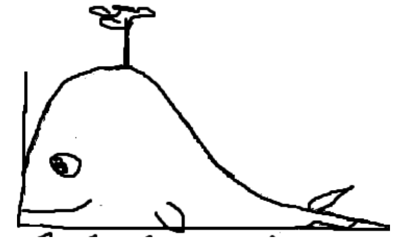
$$s = \sqrt{\frac{\Sigma(X_i - \bar{X})^2}{N - 1}}$$

Sample vs. Population

$$s \;=\; \sigma_{\text{est}} \;=\; \sqrt{\frac{\Sigma(X_i - \bar{X})^2}{N-1}}$$

$$\sigma \;=\; \sigma_{\text{pop}} \;=\; \sqrt{\frac{\Sigma(X_i - \mu)^2}{N}}$$

Statisticians suck



- *"What's the deal with skew?"*
- *"Why no symbol for range?"* ☹
- Regular letters = *Italicized*; Greek = not

'Sigma'	
Σ	σ

Formula Review

$\Sigma(X_i - \bar{X})^2$ = Sum of squares (*SS*)

$$\sqrt{\frac{\Sigma(X_i - \bar{X})^2}{N-1}}$$ = Standard deviation

(sample not pop.)

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$\Sigma(X_i - \bar{X})^2$ = Sum of squares (*SS*)

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(sample not pop.)

= Variance!

Alternative Formulas

$$\sum X^2 - \frac{(\sum X)^2}{N}$$ = Sum of squares (*SS*)

$$\sqrt{\frac{SS}{N-1}}$$ = Standard deviation (*s*)

= Variance (s^2)