



# MEASURES OF VARIABILITY

## DESCRIPTIVE STATISTICS

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# TOPIC OUTLINE

Measures of Variability

Range and Interquartile Range

Variance and Standard Deviation

Coefficient of Variation



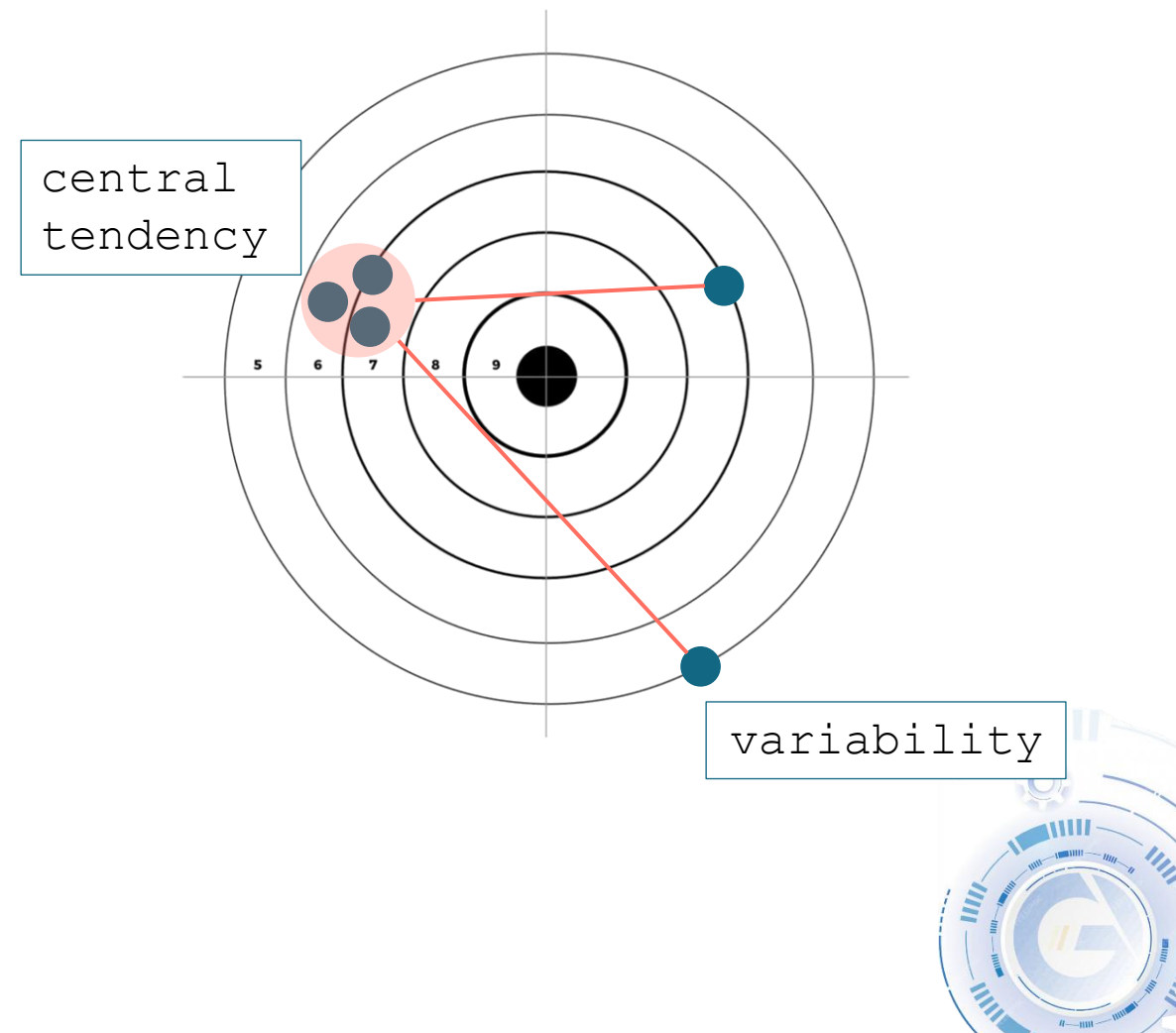
# MEASURES OF VARIABILITY



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Measures of variability (or dispersion) describe how **spread out** or scattered a dataset is. These measures provide insights into the consistency of data points relative to the central tendency (mean, median, or mode).

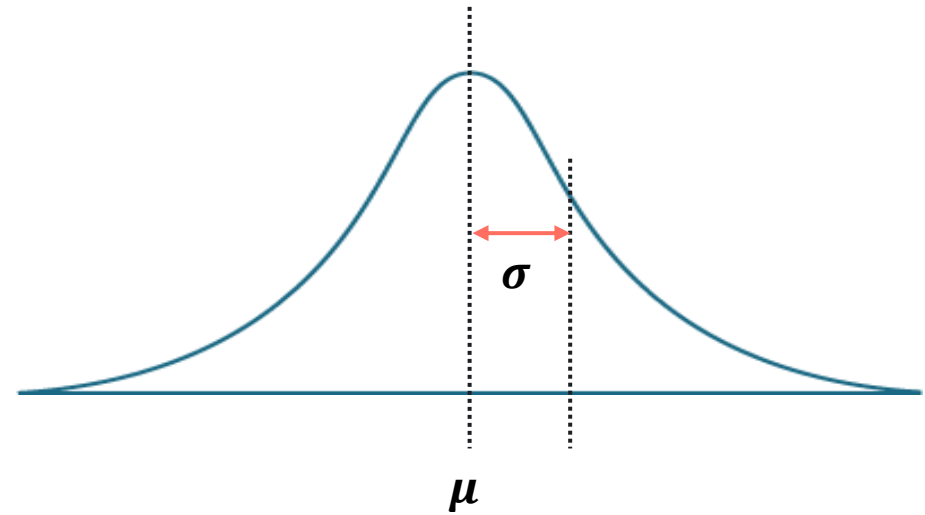
## Dartboard Analogy



# MEASURES OF VARIABILITY

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Normal Distribution



# RANGE AND INTERQUARTILE RANGE



# RANGE

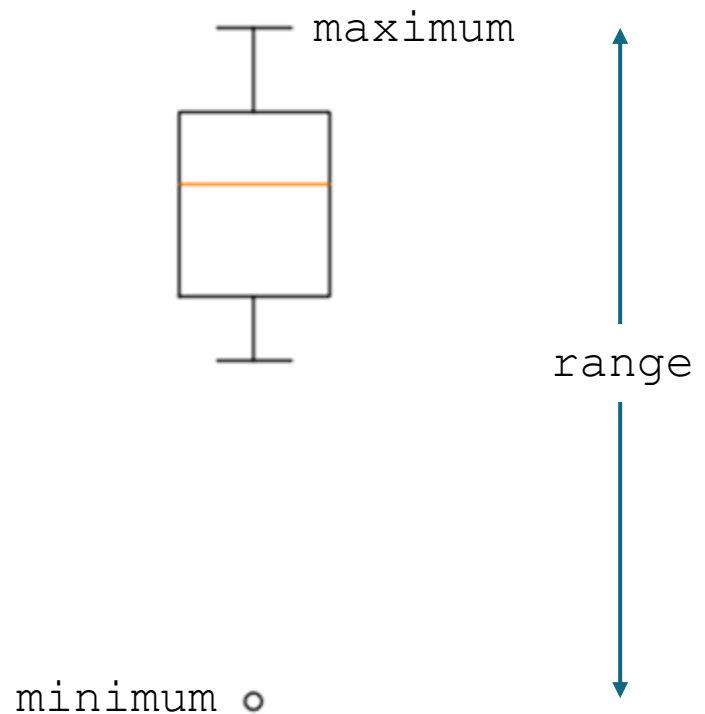
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## Boxplot

The range is the simplest measure of variability and is calculated as the difference between the maximum and minimum values in a dataset.

### Formula

$$\text{range} = \text{maximum value} - \text{minimum value}$$



# INTERQUARTILE RANGE

## Boxplot

The interquartile range (IQR) measures the spread of the middle 50% of the data, reducing the influence of outliers.

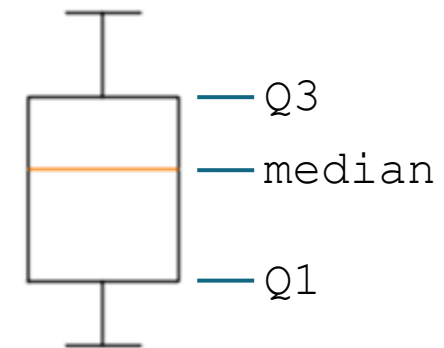
### Formula

$$IQR = Q_3 - Q_1$$

where:

$Q_1$  (first quartile) is the median of the lower half of the data (25%).

$Q_3$  (third quartile) is the median of the upper half of the data (75%).



○ outlier





# EXERCISE

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The dataset provided contains the exam grades of 12 students. Calculate the **range** and **interquartile range** (IQR) to analyze the spread and variability of the grades.

## Solution

Exam Performance	
Student	Grade
1	3.5
2	6.7
3	7
4	7.4
5	7.8
6	8.2
7	8.5
8	8.8
9	9
10	9.1
11	9.4
12	9.8



# VARIANCE AND STANDARD DEVIATION



# VARIANCE

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## Population Variance

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

Variance measures the average squared deviation of each data point from the mean.

## Sample Variance

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



# STANDARD DEVIATION

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## Population Standard Deviation

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

The standard deviation is the square root of variance.

## Sample Standard Deviation

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



# EXERCISE

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The dataset provided contains the sugar content (in grams) per serving for 10 popular breakfast cereals. Calculate the variance and standard deviation to measure the spread or variability in the sugar content across these cereals.

Breakfast Cereal	
Brand	Sugar
A	12
B	9
C	15
D	8
E	10
F	11
G	13
H	7
I	14
J	6



# POOLED STANDARD DEVIATION

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Pooled standard deviation is a weighted average of the standard deviations from two or more groups.

Formula:

$$\bar{\sigma}_{pooled} = \sqrt{\bar{\sigma}^2}$$

where:

$$\bar{\sigma}^2 = \frac{\sum_{i=1}^n \sigma_i^2}{n}$$

Variances add

$$\sigma_{total}^2 = \sigma_1^2 + \sigma_2^2 + \cdots \sigma_n^2$$

Standard deviations do not

$$\sigma_{total} \neq \sigma_1 + \sigma_2 + \cdots \sigma_n$$



# EXERCISE

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The dataset provided contains the battery life (in hours) for smartphones from different models.

Calculate the **pooled standard deviation** to measure the combined variability in battery life across these models.

Battery Life	
Model	Hours
A	12.5
A	12.8
A	12.7
A	13.3
A	12.6
B	13.5
B	14.1
B	13.9
B	14.3
B	13.7
C	11.8
C	11.9
C	12.1
C	12.2
C	11.6



# COEFFICIENT OF VARIATION





# COEFFICIENT OF VARIATION

## Population Coefficient of Variation

$$c_v = \frac{\sigma}{\mu}$$

Coefficient of variation ( $c_v$ ) is a relative measure of variability, expressed as the ratio of the standard deviation to the mean.

## Sample Coefficient of Variation

$$\widehat{c_v} = \frac{s}{\bar{x}}$$



# EXERCISE

The provided dataset includes ice cream prices listed in both USD and PHP. Calculate the **standard deviation** and **coefficient of variation** for each currency to analyze the variability in prices.

Ice Cream Price List

Brand	Price (USD)	Price (PHP)
Brand A	3.5	203
Brand B	4	232
Brand C	3.75	217.5
Brand D	4.25	246.5
Brand E	3.9	226.2
Brand F	4.1	237.8
Brand G	3.6	208.8
Brand H	4.5	261
Brand I	3.8	220.4
Brand J	4.15	240.7



# LABORATORY

