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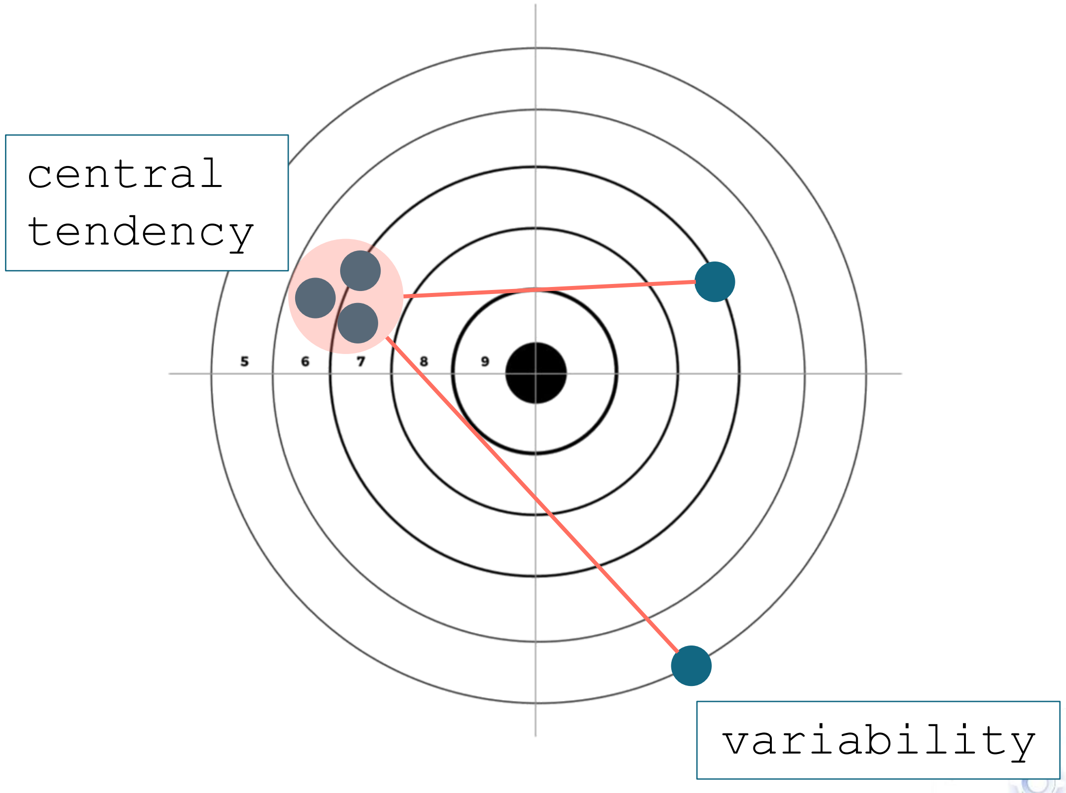
Measures of variability (or dispersion) describe how **spread out** or scattered a dataset is. These measures provide insights into the consistency of data points relative to the central tendency (mean, median, or mode).

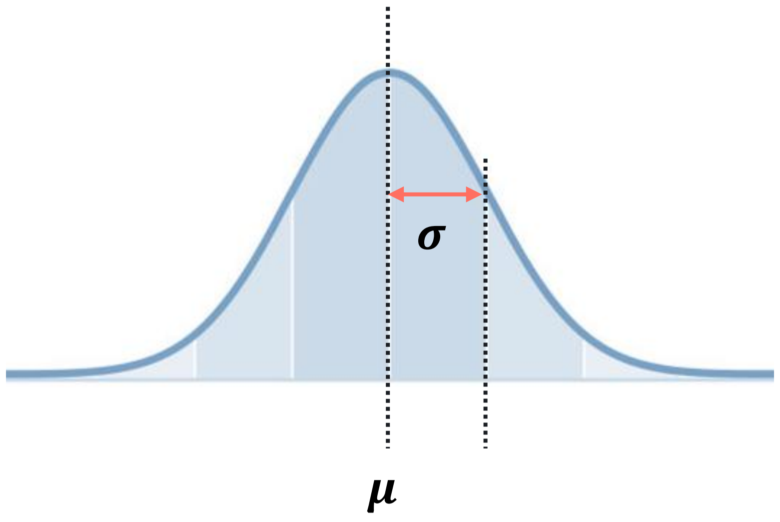
Dartboard Analogy:



MEASURES OF VARIABILITY

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).

Normal Distribution:



RANGE AND INTERQUARTILE RANGE

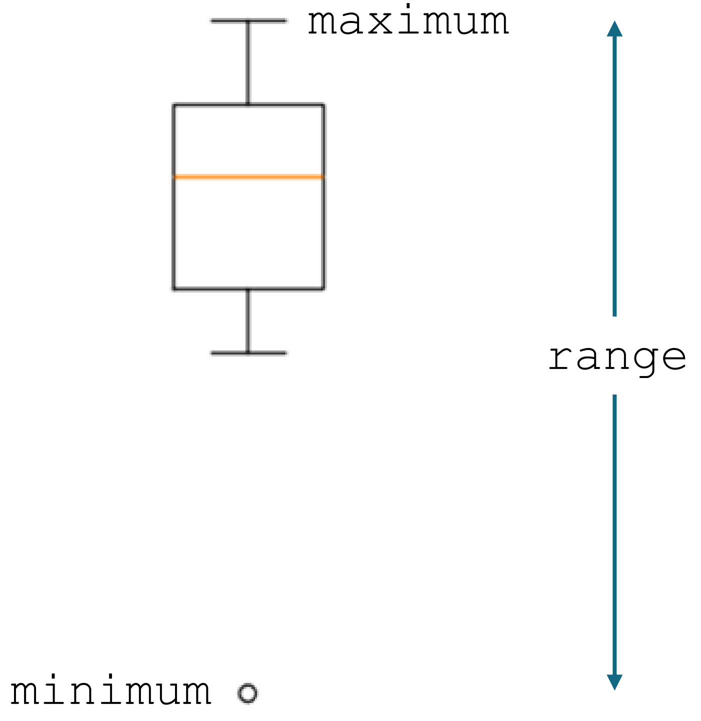
RANGE

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

Formula:

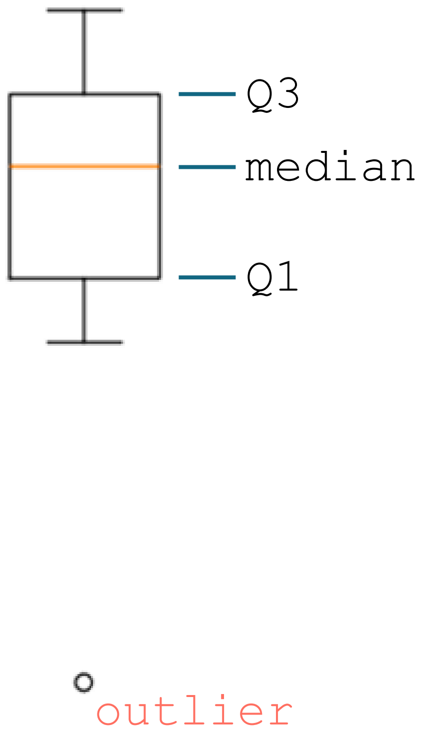
$$\boldsymbol{range = maximum\ value - minimum\ value}$$

Boxplot:



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%).

EXERCISE

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.

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

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

The **standard deviation** is the **square root** of variance.

Population Variance:

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

Sample Variance:

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

EXERCISE

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

Variances add:

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

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

Standard deviations do not:

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

Formula:

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

where:

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

EXERCISE

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

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

Population Coefficient of Variation:

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

Sample Coefficient of Variation:

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

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

Ice Cream	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

LABORATORY

The given dataset consists of test results from two machines, the Jaguar and Panther models, which produce 10 Ω resistors with ±5% tolerance. Determine which machine performs better based on its **measures of variability** for resistance values.

Resistance Test

Test No.	Jaguar	Panther
1	10.6	10.1
2	9.1	11
3	9.3	9.1
4	9.8	20
5	10.5	9.2
6	10.4	10.8
7	9.5	9.9
8	11	9.2
9	10.4	9.1
10	3	9.1
11	9.8	