Standard Deviation

Understanding Standard Deviation

Variance and standard deviation measure **how spread out** data values are from the mean.

Measure	Meaning	Best used when
Variance	Measures the average squared distance from the mean	Comparing how spread out data sets are
Standard deviation	Measures how far values are spread from the mean	Comparing consistency and variation in numerical data

Variance Formula

$$\textbf{Variance} = \frac{\sum(x-\bar{x})^2}{n}$$

Where:

x = each data value

$\bar{x}$ = mean

n = number of values

Standard Deviation

There are **two types of standard deviation**:

- Population Standard Deviation – used for the whole population
- Sample Standard Deviation – used for a sample of the population

Population Standard Deviation Formula

$$\sigma = \sqrt{\frac{\sum(x-\bar{\mu})^2}{N}}$$

Where:

σ = population standard deviation

x = each data value

$\bar{\mu}$ = population mean

N = population size

Sample Standard Deviation Formula

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

Where:

s = sample standard deviation

x = each data value

$\bar{x}$ = sample mean

n = sample size

Using $n-1$ gives a better estimate of the population spread.

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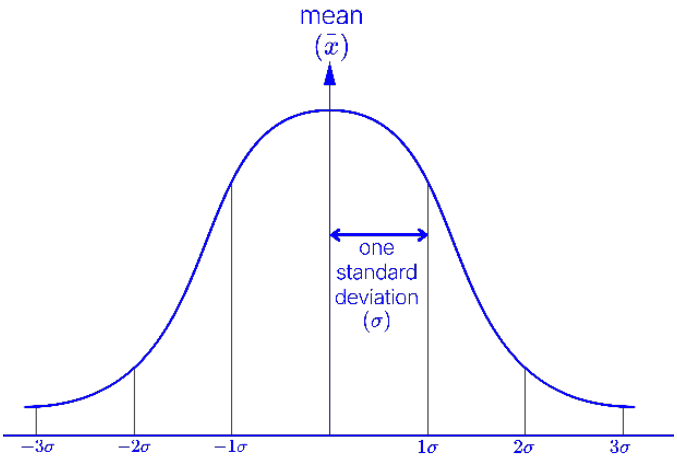
How to calculate variance and standard deviation

Steps	Example
1. Find the mean (x)	Data: 2, 4, 6, 8, 10 $= \frac{2+4+6+8+10}{5}$ = 6
2. Subtract the mean from each value $(x - \bar{x})$	2 – 6 = -4 6 – 6 = 0 10 – 6 = 4 4 – 6 = -2 8 – 6 = 2
3. Square each answer $(x - \bar{x})^2$	$-4^2 = 16$ $0^2 = 0$ $4^2 = 16$ $-2^2 = 4$ $2^2 = 4$
4. Add the squared values	16 + 4 + 0 + 4 + 16 = 40
5. Divide by: • N for a population variance • $n - 1$ for a sample variance	$N = 5$ $n - 1 = 4$ $= \frac{40}{5}$ $= \frac{40}{4}$ $\sigma^2 = 8$ $s^2 = 10$
6. Find the square root for standard deviation	$\sqrt{\sigma^2} = \sqrt{8}$ $\sqrt{s^2} = \sqrt{10}$ $\sigma \approx 2.83$ $\sigma \approx 3.16$

Comparing Data Sets

When comparing data:

- Smaller variance or standard deviation = more consistency
- Larger variance or standard deviation = more spread



Related Helpsheets

- Measures of Spread
- Measures of Centre

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