FREE NOTES · NCERT + JEE LEVEL

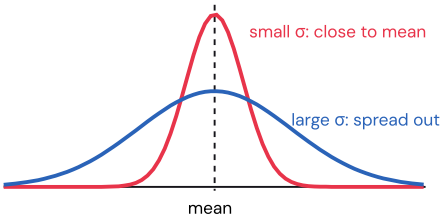
Statistics

Measures of dispersion: range, mean deviation about mean and median, variance and standard deviation for ungrouped, discrete and continuous data, the step-deviation method and comparing variability with the coefficient of variation.

01 Why dispersion?
02 Range
03 Mean deviation
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01 Why dispersion?

Two batsmen can have the same average but one is far more consistent. Mean, median and mode tell the centre; **measures of dispersion** tell how spread out the data is around the centre.



Same mean, different spread

02 Range

Range = maximum − minimum. Quick but uses only two values, so it is affected by extreme values.

03 Mean deviation

Ungrouped: $\text{M.D.}(a) = \Sigma|x_i - a| / n$

Discrete / continuous: $\text{M.D.}(a) = \Sigma f_i|x_i - a| / N,\ N = \Sigma f_i$

a = mean or median. For continuous data use class mid-points as x_i. Median of grouped data: $l + [(N/2 - cf)/f] \times h$. Mean deviation is least about the median.

Limitation: ignoring signs (taking |...|) makes further algebra hard, so we prefer variance.

04 Variance & standard deviation

$$\sigma^2 = \Sigma(x_i - \bar{x})^2 / n$$

$\sigma = \sqrt{(\text{variance})};$ shortcut $\sigma^2 = \Sigma x_i^2/n - (\bar{x})^2$

Standard deviation has the same unit as the data. Adding a constant to all values doesn't change σ; multiplying by k multiplies σ by |k|.

05 Grouped data

$\sigma^2 = \Sigma f_i(x_i - \bar{x})^2 / N$

$\sigma = (1/N)\sqrt{(N\,\Sigma f_i x_i^2 - (\Sigma f_i x_i)^2)}$

06 Shortcut: step-deviation method

$y_i = (x_i - A)/h$ (A = assumed mean, h = class width)

$$\sigma = (h/N)\sqrt{(N\,\Sigma f_i y_i^2 - (\Sigma f_i y_i)^2)}$$

$\bar{x} = A + h\,\Sigma f_i y_i / N$

07 Coefficient of variation

$$C.V. = (\sigma / \bar{x}) \times 100$$

Used to compare variability of two series. **Higher C.V. ⇒ less consistent** (more variable). If means are equal, compare σ directly.

08 JEE Extra + Tricks

JEE LEVEL

- Variance $\sigma^2 = \Sigma x^2/n - (\bar{x})^2$; adding a constant to all data doesn't change σ; multiplying by k multiplies σ by $|k|$.
- Combined variance of two groups: $\sigma^2 = [n_1(\sigma_1^2 + d_1^2) + n_2(\sigma_2^2 + d_2^2)]/(n_1 + n_2)$, $d_i = \bar{x_i} - \bar{x}$
- Mean deviation is least about the median.
- Coefficient of variation CV = $(\sigma/\bar{x}) \times 100$: lower CV ⇒ more consistent.
- For first n natural numbers: mean $(n + 1)/2$, variance $(n^2 - 1)/12$.

09 Solved examples

Q1. Mean deviation about mean of 6, 7, 10, 12, 13, 4, 8, 12.

$\bar{x} = 72/8 = 9$. |dev|: 3, 2, 1, 3, 4, 5, 1, 3 = 22 ⇒ M.D. = 22/8 = **2.75**.

Q2. Variance of 6, 8, 10, 12, 14, 16, 18, 20, 22, 24.

$\bar{x} = 15$; $\Sigma(x - 15)^2 = 81+49+25+9+1+1+9+25+49+81 = 330$ ⇒ σ^2 = **33**.

Q3. Series A: $\bar{x} = 50$, $\sigma = 10$; B: $\bar{x} = 40$, $\sigma = 6$. Which is more consistent?

C.V. A = 20%, B = 15% ⇒ **B** is more consistent.

Q4. The mean and variance of 5 observations are 4.4 and 8.24. Three are 1, 2, 6. Find the other two.

$x + y = 13$, $x^2 + y^2 = 97$ ⇒ x, y = **4 and 9**.

10 Common mistakes

- Forgetting the absolute value in mean deviation.
- Dividing by n − 1 (NCERT uses n).
- Using class limits instead of mid-points.
- Saying higher C.V. means more consistent (it's the opposite).

11 Formula sheet & practice

M.D.	$\Sigma f_i\|x_i - a\|/N$
Variance	$\Sigma f_i(x_i - \bar{x})^2/N = \Sigma fx^2/N - \bar{x}^2$
Step-deviation σ	$(h/N)\sqrt{(N\Sigma fy^2 - (\Sigma fy)^2)}$
C.V.	$\sigma/\bar{x} \times 100$

1. Range of 15, 8, 23, 4, 19?
2. If each value is increased by 5, what happens to σ?
3. If each value is doubled, what happens to variance?
4. Find σ of 2, 4, 6, 8, 10.

ANSWERS

1) 19 · 2) No change · 3) Becomes 4 times · 4) √8 = 2√2

12 Quick revision: 5 minutes before the exam

DISPERSION

- Range = max − min.
- M.D. least about median.

VARIANCE

- $\sigma^2 = \Sigma x^2/n - \bar{x}^2$.
- σ same unit as data.

CHANGES

- +k: σ same.
- ×k: σ × |k|, $\sigma^2 \times k^2$.

COMPARE

- C.V. = $\sigma/\bar{x} \times 100$.
- Lower C.V. = more consistent.

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.