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CHAPTER NOTES

Statistics Class 11 Notes | CBSE Maths Chapter 13

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Statistics Class 11 Notes | CBSE Maths Chapter 13

Statistics is Chapter 13 of CBSE Class 11 Maths — and it is the chapter that finally answers a question you have been asking since school: *how spread out is my data?* Two batsmen can have the same average score, yet one is wildly inconsistent and the other is rock-steady. Measures of dispersion are the tools that tell them apart, and this chapter hands you every one of them.

By the end of these notes you will be able to compute range, mean deviation, variance, and standard deviation for both ungrouped and grouped data, use the lightning-fast shortcut (step-deviation) method, and compare two data sets using the coefficient of variation. This is a scoring chapter carrying roughly 6–8 marks in boards, and it is the direct foundation for Probability and all of Class 12 statistics.

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Key Concepts

1. Measures of Dispersion

A **measure of central tendency** (mean, median, mode) tells you where the centre of the data lies, but it hides how scattered the values are. A **measure of dispersion** tells you how far the observations are spread out from that centre.

The four measures of dispersion you study in this chapter are **range, mean deviation, variance, and standard deviation**. The last three measure scatter *about a central value*, which is why they are far more useful than range alone.

Key idea: Less dispersion means the data is more consistent and the average is more reliable.

2. Range

The **range** is the simplest measure of dispersion — it is just the difference between the largest and the smallest observation.

Range = Maximum value – Minimum value

- The **coefficient of range** = $(\text{Max} - \text{Min})/(\text{Max} + \text{Min})$, a unit-free comparison.
 - It uses only two extreme values, so it ignores how the rest of the data is distributed.
 - It is highly affected by outliers, which is its biggest weakness.
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3. Mean Deviation

Mean deviation is the average of the *absolute* distances of all observations from a central value (the mean or the median). We take absolute values so that positive and negative deviations do not cancel out.

For **ungrouped data** with n observations:

- **About the mean:** $\text{M.D.}(\bar{x}) = (1/n) \sum |x_i - \bar{x}|$
- **About the median:** $\text{M.D.}(M) = (1/n) \sum |x_i - M|$

For **grouped (frequency) data** with total frequency $N = \sum f_i$:

- **About the mean:** $\text{M.D.}(\bar{x}) = (1/N) \sum f_i |x_i - \bar{x}|$
- **About the median:** $\text{M.D.}(M) = (1/N) \sum f_i |x_i - M|$

Important property: Mean deviation is *least* when taken about the median. So if minimising deviation matters, the median is the best central value to use.

4. Variance

The drawback of mean deviation is the awkward modulus sign. **Variance** fixes this by squaring the deviations instead of taking their absolute value — squares are always positive and far easier to handle algebraically.

Variance is the mean of the squared deviations from the mean. It is denoted by σ^2 (sigma squared).

- **Ungrouped data:** $\sigma^2 = (1/n) \sum (x_i - \bar{x})^2$
- **Grouped data:** $\sigma^2 = (1/N) \sum f_i (x_i - \bar{x})^2$

Note: Because deviations are squared, variance has the *square* of the original units (e.g., if data is in cm, variance is in cm^2). That is why we usually take its square root.

5. Standard Deviation

Standard deviation (σ) is the positive square root of the variance. It brings the measure of spread back to the original units of the data, which makes it the most widely used measure of dispersion.

- **Ungrouped data:** $\sigma = \sqrt{[(1/n) \sum (x_i - \bar{x})^2]}$
- **Grouped data:** $\sigma = \sqrt{[(1/N) \sum f_i (x_i - \bar{x})^2]}$

A handy **computational form** that avoids first finding the mean is:

$$\sigma = \sqrt{[(\sum x_i^2)/n - ((\sum x_i)/n)^2]}$$

For grouped data this becomes $\sigma = (1/N) \sqrt{[N \sum f_i x_i^2 - (\sum f_i x_i)^2]}$.

6. Shortcut (Step-Deviation) Method

When the values x_i are large, computing deviations from the mean is tedious. The **shortcut method** shifts the origin to an assumed mean A and scales by the class width h , which keeps the arithmetic small.

Let $d_i = (x_i - A)/h$. Then the standard deviation is:

$$\sigma = h \times \sqrt{[(\sum f_i d_i^2)/N - ((\sum f_i d_i)/N)^2]}$$

- A is the **assumed mean** (usually a middle class mark).
 - h is the **common class width**.
 - The answer is exactly the same as the direct method — only the computation is lighter.
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7. Coefficient of Variation

Standard deviation has units, so you cannot fairly compare the spread of, say, heights (in cm) with weights (in kg). The **coefficient of variation (C.V.)** solves this by expressing standard deviation as a percentage of the mean — a pure, unit-free number.

$$\text{C.V.} = (\sigma / \bar{x}) \times 100 \quad (\bar{x} \neq 0)$$

- It measures **relative variability** or consistency.
 - The series with the **greater** C.V. is *more variable* (less consistent).
 - The series with the **smaller** C.V. is *more consistent* (more stable / uniform).
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8. Comparing Two Frequency Distributions

When two data sets have **the same mean**, you compare them directly by standard deviation — the one with the smaller σ is more consistent.

When the two data sets have **different means**, standard deviation alone is misleading. You must use the **coefficient of variation**, because it accounts for the size of the mean.

Rule of thumb: For consistency or stability questions (most consistent player, most stable share price), always reach for C.V. — smaller C.V. wins.

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	6–8 marks	Mean deviation, standard deviation (grouped), coefficient of variation
JEE Main	1 question	Variance/SD of ungrouped data, effect of change of scale, combined SD
CUET / School tests	2–3 questions	Range, mean deviation about median, C.V. comparison

[TABLE: Question-type split — VSA (1 mark): definitions, range, coefficient of range; SA (2–3 marks): mean deviation about mean/median; LA (5 marks): standard deviation of grouped data by shortcut method, comparing two distributions using C.V.]

Important Definitions

Term	Definition
Dispersion	The extent to which observations are scattered about a central value
Range	Difference between the largest and smallest observation: $\text{Max} - \text{Min}$
Mean deviation	Mean of the absolute deviations from a central value: $(1/N) \sum f_i x_i - a $
Variance	Mean of the squared deviations from the mean: $\sigma^2 = (1/N) \sum f_i (x_i - \bar{x})^2$
Standard deviation	Positive square root of the variance: $\sigma = \sqrt{(\text{variance})}$
Coefficient of range	Relative range: $(\text{Max} - \text{Min})/(\text{Max} + \text{Min})$
Coefficient of variation	Relative variability: $\text{C.V.} = (\sigma/\bar{x}) \times 100$
Consistency	A data set with smaller C.V. is more consistent (less variable)

Solved Examples

Example 1

Find the range and the coefficient of range for the data: 24, 18, 32, 41, 16, 29.

Answer: Max = 41, Min = 16. Range = $41 - 16 = 25$. Coefficient of range = $(41 - 16)/(41 + 16) = 25/57 \approx 0.439$.

Example 2

Find the mean deviation about the mean for: 6, 8, 10, 12, 14.

Answer: $\bar{x} = (6 + 8 + 10 + 12 + 14)/5 = 50/5 = 10$. Absolute deviations: 4, 2, 0, 2, 4; their sum = 12. $M.D.(\bar{x}) = 12/5 = \mathbf{2.4}$.

Example 3

Find the mean deviation about the median for: 3, 9, 5, 3, 12, 10, 18, 4, 7, 19, 21.

Answer: Arrange: 3, 3, 4, 5, 7, 9, 10, 12, 18, 19, 21 ($n = 11$). Median = 6th term = 9. $\sum |x_i - 9| = 6+6+5+4+2+0+1+3+9+10+12 = 58$. $M.D.(M) = 58/11 \approx \mathbf{5.27}$.

Example 4

Find the variance and standard deviation of: 2, 4, 6, 8, 10.

Answer: $\bar{x} = 30/5 = 6$. Squared deviations: 16, 4, 0, 4, 16; sum = 40. $\sigma^2 = 40/5 = \mathbf{8}$. $\sigma = \sqrt{8} = 2\sqrt{2} \approx \mathbf{2.83}$.

Example 5

Using the computational formula, find the standard deviation of: 4, 7, 8, 9, 10, 12, 14 ($n = 7$).

Answer: $\sum x_i = 64$, so $\bar{x} = 64/7$. $\sum x_i^2 = 16+49+64+81+100+144+196 = 650$. $\sigma^2 = 650/7 - (64/7)^2 = 92.857 - 83.592 = 9.265$. $\sigma = \sqrt{9.265} \approx \mathbf{3.04}$.

Example 6

The mean and standard deviation of the runs scored by two batsmen are: Batsman A — mean 50, $\sigma = 5$; Batsman B — mean 40, $\sigma = 5$. Who is more consistent?

Answer: $C.V.(A) = (5/50) \times 100 = \mathbf{10\%}$; $C.V.(B) = (5/40) \times 100 = \mathbf{12.5\%}$. Since A has the smaller C.V., **Batsman A is more consistent** even though both have the same standard deviation.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Define dispersion. Name any two measures of dispersion.
2. Write the formula for the coefficient of range.
3. About which central value is the mean deviation least?
4. What is the relationship between variance and standard deviation?
5. If every observation of a data set is increased by 5, what happens to its standard deviation?

2–3-Mark Questions (SA)

1. Find the mean deviation about the mean for: 38, 70, 48, 40, 42, 55, 63, 46, 54, 44.
2. Find the mean deviation about the median for: 13, 17, 16, 14, 11, 13, 10, 16, 11, 18, 12, 17.
3. Calculate the variance and standard deviation of the first n natural numbers and state the formula.
4. Explain, with an example, why the coefficient of variation is preferred over the standard deviation when comparing two distributions with different means.

5-Mark Questions (LA)

1. Find the mean, variance, and standard deviation of the following grouped data using the shortcut (step-deviation) method, given classes 0–10, 10–20, 20–30, 30–40, 40–50 with frequencies 5, 8, 15, 16, 6.
 2. The means and standard deviations of two distributions of 100 and 150 items are 50, 5 and 40, 6 respectively. Find the standard deviation of the combined distribution of 250 items.
 3. From the prices of shares X and Y given over several days, determine which share is more stable in value using the coefficient of variation.
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Quick Revision Points

- Dispersion = scatter of data about a central value; measures: range, mean deviation, variance, SD
 - Range = Max – Min; coefficient of range = $(\text{Max} - \text{Min})/(\text{Max} + \text{Min})$
 - M.D. about mean = $(1/N) \sum f_i |x_i - \bar{x}|$; about median = $(1/N) \sum f_i |x_i - M|$
 - Mean deviation is least about the median
 - Variance $\sigma^2 = (1/N) \sum f_i (x_i - \bar{x})^2$; units are squared
 - Standard deviation $\sigma = \sqrt{\text{variance}}$; same units as the data
 - Computational form: $\sigma = \sqrt{[(\sum x_i^2)/n - ((\sum x_i)/n)^2]}$
 - Shortcut method: $\sigma = h \sqrt{[(\sum f_i d_i^2)/N - ((\sum f_i d_i)/N)^2]}$, where $d_i = (x_i - A)/h$
 - Coefficient of variation C.V. = $(\sigma/\bar{x}) \times 100$ — unit-free
 - Smaller C.V. $\Rightarrow$ more consistent; greater C.V. $\Rightarrow$ more variable
 - Adding a constant to all data leaves σ unchanged; multiplying by k multiplies σ by $|k|$
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Next Chapter: Chapter 14 — Probability



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