TG ACADEMIC RESOURCE SERIES

STATISTICS

Measures of Dispersion
Range, Quartile Deviation, Mean Deviation & Standard Deviation

SUBJECT	Statistics / Business Statistics / Quantitative Methods
LEVEL	BBA / MBA / MSc / BSc / Undergraduate & Postgraduate
RESOURCE TYPE	Sample learning note
PUBLICATION ID	STAT-001 | Version 1.0

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This sample explains how dispersion measures describe the spread of observations around a central value. One grouped-frequency dataset is used throughout so that each measure can be compared consistently.

A focused introduction - not a complete Statistics or Business Analytics module.

1. Learning Objectives

After studying this note, you should be able to:
• Explain why measures of dispersion are needed alongside averages.
• Calculate range and quartile deviation.
• Calculate mean deviation and standard deviation from grouped data.
• Interpret the coefficient of variation as a relative measure of spread.
• Distinguish population and sample standard deviation.

2. What Is Dispersion?

A measure of dispersion describes how widely observations are spread around a central value. Two datasets may have the same mean but very different variability. Therefore, an average alone may give an incomplete picture.

3. Worked Dataset

A business analyst groups the monthly order-processing time (in minutes) for 30 transactions as follows. We will use class midpoints for calculations involving grouped data.

Time (minutes)	Frequency (f)	Midpoint (x)	Cumulative f
0 - 10	2	5	2
10 - 20	5	15	7
20 - 30	9	25	16
30 - 40	8	35	24
40 - 50	4	45	28
50 - 60	2	55	30
Total	30	-	-

For this dataset: N = 30 and the grouped-data mean, calculated from class midpoints, is 29.33 minutes. These are grouped-data estimates; calculations from original transaction-level observations may differ.

4. Absolute and Relative Measures

Absolute measures express spread in the original units, such as minutes: range, quartile deviation, mean deviation and standard deviation.
Relative measures express spread without units, making comparison across datasets or scales easier. The coefficient of variation is one such measure.

5. Range

Range is the difference between the largest and smallest observations. For grouped data with open-ended uncertainty absent, a rough estimate can be made from the outer class boundaries.

$$\text{Estimated Range} = 60 - 0 = 60 \text{ minutes}$$

Because only class intervals are available, 60 minutes is an estimate based on the lowest and highest class boundaries. The exact raw-data range cannot be recovered from this table alone.

6. Quartiles and Quartile Deviation

Quartiles divide an ordered dataset into four parts. For a grouped continuous distribution, the quartile values are estimated by locating the relevant quartile class and interpolating within it.

$$Q_1 = L + \left[\frac{N/4 - cf}{f}\right] \times h$$
$$Q_3 = L + \left[\frac{3N/4 - cf}{f}\right] \times h$$

First quartile (Q1)

$N/4 = 30/4 = 7.5$. The first cumulative frequency at least 7.5 is 16, so the Q1 class is 20 - 30.
$L = 20$, $cf = 7$, $f = 9$, $h = 10$.

$$Q_1 = 20 + \left[\frac{7.5 - 7}{9}\right] \times 10 = 20.56 \text{ minutes}$$

Third quartile (Q3)

$3N/4 = 22.5$. The first cumulative frequency at least 22.5 is 24, so the Q3 class is 30 - 40.
$L = 30$, $cf = 16$, $f = 8$, $h = 10$.

$$Q_3 = 30 + \left[\frac{22.5 - 16}{8}\right] \times 10 = 38.125 \text{ minutes}$$

Interquartile range = Q3 - Q1 = 38.125 - 20.56 = 17.57 minutes (approximately).
Quartile Deviation = (Q3 - Q1) / 2 = 8.78 minutes (approximately).

Coefficient of Quartile Deviation = (Q3 - Q1) / (Q3 + Q1) ≈ 0.30.

7. Mean Deviation About the Mean

Mean deviation about the mean is the average of the absolute deviations of observations from the mean. For grouped data, class midpoints are used as representative observations.

MD about mean = Sum[f x |x - Mean|] / N

Using Mean = 29.33 minutes:

Midpoint (x)	f	|x - Mean|	f x |x - Mean|
5	2	24.33	48.67
15	5	14.33	71.67
25	9	4.33	39.00
35	8	5.67	45.33
45	4	15.67	62.67
55	2	25.67	51.33
Total	30	-	318.67

MD about mean = 318.67 / 30 = 10.62 minutes (approximately).

8. Standard Deviation

Standard deviation measures the typical spread around the mean, using squared deviations. For a frequency distribution treated as the full population:

Population variance (σ^2) = Sum[f(x - Mean)²] / N
Population standard deviation (σ) = square root of σ^2

Midpoint (x)	f	f(x - Mean)²
5	2	1,184.22
15	5	1,027.22
25	9	169.00
35	8	256.89
45	4	981.78
55	2	1,317.56
Total	30	4,936.67

σ^2 = 4,936.67 / 30 = 164.56 minutes²
σ = $\sqrt{164.56}$ = 12.83 minutes (approximately).

9. Coefficient of Variation (CV)

The coefficient of variation expresses standard deviation relative to the mean. It is useful when comparing variability across datasets with different means, provided the data have a meaningful ratio-scale zero and the mean is positive.

CV = (Standard Deviation / Mean) x 100
CV = (12.83 / 29.33) x 100 ≈ 43.73%

For this dataset, the standard deviation is about 43.73% of the mean.

10. Population vs. Sample Standard Deviation

The calculation above treats the 30 transactions as the complete population of interest and divides by N = 30. If these transactions are a sample used to estimate a wider process population, the sample variance uses N - 1 in the denominator (with the grouped-data approximation), and the sample standard deviation is approximately 13.05 minutes.

11. Compare the Measures

Measure	Approximate result	Interpretation
Range	60.00 min	Overall span estimated from outer class boundaries
Quartile Deviation	8.78 min	Half of the interquartile range
Mean Deviation	10.62 min	Average absolute distance from mean
Standard Deviation	12.83 min	Root-mean-square spread around mean
Coefficient of Variation	43.73%	Relative standard deviation

12. Check Your Understanding

Q1. Why is dispersion needed in addition to the mean?
Q2. If Q1 = 18 and Q3 = 42, calculate the quartile deviation.
Q3. Which is more sensitive to extreme values: range or quartile deviation?
Q4. A dataset has mean 50 and standard deviation 5. Calculate its coefficient of variation.

Suggested Answers: A1. The mean alone does not show how widely values vary. A2. (42 - 18)/2 = 12. A3. Range. A4. (5/50) x 100 = 10%.

Where to Go Next

A fuller Statistics sequence can continue with variance, coefficient comparisons, skewness, kurtosis, correlation, regression and probability distributions. These topics require their own worked numerical examples and interpretation.

In guided classes: students can practise choosing an appropriate dispersion measure, completing frequency tables, handling grouped-data formulas and interpreting business variability.

About this resource
TG Academic Resource Series | STAT-001 | Version 1.0
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