

# Zero, First, Second, Third and Fourth Central and Arbitrary Moments in Statistics

Data Science and A.I. Lecture Series

Bindeshwar Singh Kushwaha

PostNetwork Academy

# Reach PostNetwork Academy

## Website

PostNetwork Academy | [www.postnetwork.co](http://www.postnetwork.co)

## YouTube Channel

[www.youtube.com/@postnetworkacademy](http://www.youtube.com/@postnetworkacademy)

## PostNetwork Academy Facebook Page

[www.facebook.com/postnetworkacademy](http://www.facebook.com/postnetworkacademy)

## LinkedIn Page

[www.linkedin.com/company/postnetworkacademy](http://www.linkedin.com/company/postnetworkacademy)

# Moments About an Arbitrary Point (Ungrouped Data)

**Definition:** The general formula is:

$$\mu'_r = \frac{\sum_{i=1}^n (x_i - A)^r}{n}, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

# Moments About an Arbitrary Point (Ungrouped Data)

**Definition:** The general formula is:

$$\mu'_r = \frac{\sum_{i=1}^n (x_i - A)^r}{n}, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

- **Zero-order moment:**

$$\mu'_0 = \frac{\sum_{i=1}^n (x_i - A)^0}{n} = 1$$

# Moments About an Arbitrary Point (Ungrouped Data)

**Definition:** The general formula is:

$$\mu'_r = \frac{\sum_{i=1}^n (x_i - A)^r}{n}, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

• **Zero-order moment:**

$$\mu'_0 = \frac{\sum_{i=1}^n (x_i - A)^0}{n} = 1$$

• **First-order moment:**

$$\mu'_1 = \frac{\sum_{i=1}^n (x_i - A)}{n}$$

# Moments About an Arbitrary Point (Ungrouped Data)

**Definition:** The general formula is:

$$\mu'_r = \frac{\sum_{i=1}^n (x_i - A)^r}{n}, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

• **Zero-order moment:**

$$\mu'_0 = \frac{\sum_{i=1}^n (x_i - A)^0}{n} = 1$$

• **First-order moment:**

$$\mu'_1 = \frac{\sum_{i=1}^n (x_i - A)}{n}$$

• **Second-order moment:**

$$\mu'_2 = \frac{\sum_{i=1}^n (x_i - A)^2}{n}$$

# Moments About an Arbitrary Point (Ungrouped Data)

**Definition:** The general formula is:

$$\mu'_r = \frac{\sum_{i=1}^n (x_i - A)^r}{n}, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

• **Zero-order moment:**

$$\mu'_0 = \frac{\sum_{i=1}^n (x_i - A)^0}{n} = 1$$

• **First-order moment:**

$$\mu'_1 = \frac{\sum_{i=1}^n (x_i - A)}{n}$$

• **Second-order moment:**

$$\mu'_2 = \frac{\sum_{i=1}^n (x_i - A)^2}{n}$$

• **Third-order moment:**

$$\mu'_3 = \frac{\sum_{i=1}^n (x_i - A)^3}{n}$$

# Moments About an Arbitrary Point (Ungrouped Data)

**Definition:** The general formula is:

$$\mu'_r = \frac{\sum_{i=1}^n (x_i - A)^r}{n}, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

• **Zero-order moment:**

$$\mu'_0 = \frac{\sum_{i=1}^n (x_i - A)^0}{n} = 1$$

• **First-order moment:**

$$\mu'_1 = \frac{\sum_{i=1}^n (x_i - A)}{n}$$

• **Second-order moment:**

$$\mu'_2 = \frac{\sum_{i=1}^n (x_i - A)^2}{n}$$

• **Third-order moment:**

$$\mu'_3 = \frac{\sum_{i=1}^n (x_i - A)^3}{n}$$

• **Fourth-order moment:**

$$\mu'_4 = \frac{\sum_{i=1}^n (x_i - A)^4}{n}$$



# Moments About an Arbitrary Point (Grouped Data)

**Definition:** For grouped data with mid-values  $x_1, x_2, \dots, x_n$  and frequencies  $f_1, f_2, \dots, f_n$ , the moments about an arbitrary point  $A$  are:

$$\mu'_r = \frac{\sum_{i=1}^n f_i(x_i - A)^r}{N}, \quad N = \sum_{i=1}^n f_i, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

# Moments About an Arbitrary Point (Grouped Data)

**Definition:** For grouped data with mid-values  $x_1, x_2, \dots, x_n$  and frequencies  $f_1, f_2, \dots, f_n$ , the moments about an arbitrary point  $A$  are:

$$\mu'_r = \frac{\sum_{i=1}^n f_i (x_i - A)^r}{N}, \quad N = \sum_{i=1}^n f_i, \quad r = 0, 1, 2, 3, 4$$

**Specific Cases:**

- Zero-order moment:

$$\mu'_0 = \frac{\sum_{i=1}^n f_i}{N} = 1$$

# Moments About an Arbitrary Point (Grouped Data)

**Definition:** For grouped data with mid-values  $x_1, x_2, \dots, x_n$  and frequencies  $f_1, f_2, \dots, f_n$ , the moments about an arbitrary point  $A$  are:

$$\mu'_r = \frac{\sum_{i=1}^n f_i (x_i - A)^r}{N}, \quad N = \sum_{i=1}^n f_i, \quad r = 0, 1, 2, 3, 4$$

## Specific Cases:

- Zero-order moment:

$$\mu'_0 = \frac{\sum_{i=1}^n f_i}{N} = 1$$

- First-order moment:

$$\mu'_1 = \frac{\sum_{i=1}^n f_i (x_i - A)}{N}$$

# Moments About an Arbitrary Point (Grouped Data)

**Definition:** For grouped data with mid-values  $x_1, x_2, \dots, x_n$  and frequencies  $f_1, f_2, \dots, f_n$ , the moments about an arbitrary point  $A$  are:

$$\mu'_r = \frac{\sum_{i=1}^n f_i (x_i - A)^r}{N}, \quad N = \sum_{i=1}^n f_i, \quad r = 0, 1, 2, 3, 4$$

## Specific Cases:

- Zero-order moment:

$$\mu'_0 = \frac{\sum_{i=1}^n f_i}{N} = 1$$

- First-order moment:

$$\mu'_1 = \frac{\sum_{i=1}^n f_i (x_i - A)}{N}$$

- Second-order moment:

$$\mu'_2 = \frac{\sum_{i=1}^n f_i (x_i - A)^2}{N}$$

# Moments About an Arbitrary Point (Grouped Data)

**Definition:** For grouped data with mid-values  $x_1, x_2, \dots, x_n$  and frequencies  $f_1, f_2, \dots, f_n$ , the moments about an arbitrary point  $A$  are:

$$\mu'_r = \frac{\sum_{i=1}^n f_i (x_i - A)^r}{N}, \quad N = \sum_{i=1}^n f_i, \quad r = 0, 1, 2, 3, 4$$

## Specific Cases:

- Zero-order moment:

$$\mu'_0 = \frac{\sum_{i=1}^n f_i}{N} = 1$$

- First-order moment:

$$\mu'_1 = \frac{\sum_{i=1}^n f_i (x_i - A)}{N}$$

- Second-order moment:

$$\mu'_2 = \frac{\sum_{i=1}^n f_i (x_i - A)^2}{N}$$

- Third-order moment:

$$\mu'_3 = \frac{\sum_{i=1}^n f_i (x_i - A)^3}{N}$$

# Moments About an Arbitrary Point (Grouped Data)

**Definition:** For grouped data with mid-values  $x_1, x_2, \dots, x_n$  and frequencies  $f_1, f_2, \dots, f_n$ , the moments about an arbitrary point  $A$  are:

$$\mu'_r = \frac{\sum_{i=1}^n f_i (x_i - A)^r}{N}, \quad N = \sum_{i=1}^n f_i, \quad r = 0, 1, 2, 3, 4$$

## Specific Cases:

- Zero-order moment:

$$\mu'_0 = \frac{\sum_{i=1}^n f_i}{N} = 1$$

- First-order moment:

$$\mu'_1 = \frac{\sum_{i=1}^n f_i (x_i - A)}{N}$$

- Second-order moment:

$$\mu'_2 = \frac{\sum_{i=1}^n f_i (x_i - A)^2}{N}$$

- Third-order moment:

$$\mu'_3 = \frac{\sum_{i=1}^n f_i (x_i - A)^3}{N}$$

- Fourth-order moment:

$$\mu'_4 = \frac{\sum_{i=1}^n f_i (x_i - A)^4}{N}$$

# Moments about Origin

**Definition:** Moments about origin measure the  $r^{\text{th}}$ -order summary of data relative to  $A = 0$ .

**For Ungrouped Data:**

$$\mu_r'' = \frac{1}{n} \sum_{i=1}^n (x_i - 0)^r = \frac{1}{n} \sum_{i=1}^n x_i^r$$

# Moments about Origin

**Definition:** Moments about origin measure the  $r^{\text{th}}$ -order summary of data relative to  $A = 0$ .

**For Ungrouped Data:**

$$\mu_r'' = \frac{1}{n} \sum_{i=1}^n (x_i - 0)^r = \frac{1}{n} \sum_{i=1}^n x_i^r$$

- **Zero-order moment:**  $\mu_0'' = \frac{1}{n} \sum_{i=1}^n (x_i)^0 = 1$



# Moments about Origin

**Definition:** Moments about origin measure the  $r^{\text{th}}$ -order summary of data relative to  $A = 0$ .

**For Ungrouped Data:**

$$\mu_r'' = \frac{1}{n} \sum_{i=1}^n (x_i - 0)^r = \frac{1}{n} \sum_{i=1}^n x_i^r$$

- **Zero-order moment:**  $\mu_0'' = \frac{1}{n} \sum_{i=1}^n (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{n} \sum_{i=1}^n x_i$  (Mean)

# Moments about Origin

**Definition:** Moments about origin measure the  $r^{\text{th}}$ -order summary of data relative to  $A = 0$ .

**For Ungrouped Data:**

$$\mu_r'' = \frac{1}{n} \sum_{i=1}^n (x_i - 0)^r = \frac{1}{n} \sum_{i=1}^n x_i^r$$

- **Zero-order moment:**  $\mu_0'' = \frac{1}{n} \sum_{i=1}^n (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{n} \sum_{i=1}^n x_i$  (Mean)
- **Second-order moment:**  $\mu_2'' = \frac{1}{n} \sum_{i=1}^n x_i^2$

# Moments about Origin

**Definition:** Moments about origin measure the  $r^{\text{th}}$ -order summary of data relative to  $A = 0$ .

**For Ungrouped Data:**

$$\mu_r'' = \frac{1}{n} \sum_{i=1}^n (x_i - 0)^r = \frac{1}{n} \sum_{i=1}^n x_i^r$$

- **Zero-order moment:**  $\mu_0'' = \frac{1}{n} \sum_{i=1}^n (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{n} \sum_{i=1}^n x_i$  (Mean)
- **Second-order moment:**  $\mu_2'' = \frac{1}{n} \sum_{i=1}^n x_i^2$
- **Third-order moment:**  $\mu_3'' = \frac{1}{n} \sum_{i=1}^n x_i^3$

# Moments about Origin

**Definition:** Moments about origin measure the  $r^{\text{th}}$ -order summary of data relative to  $A = 0$ .

**For Ungrouped Data:**

$$\mu_r'' = \frac{1}{n} \sum_{i=1}^n (x_i - 0)^r = \frac{1}{n} \sum_{i=1}^n x_i^r$$

- **Zero-order moment:**  $\mu_0'' = \frac{1}{n} \sum_{i=1}^n (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{n} \sum_{i=1}^n x_i$  (Mean)
- **Second-order moment:**  $\mu_2'' = \frac{1}{n} \sum_{i=1}^n x_i^2$
- **Third-order moment:**  $\mu_3'' = \frac{1}{n} \sum_{i=1}^n x_i^3$
- **Fourth-order moment:**  $\mu_4'' = \frac{1}{n} \sum_{i=1}^n x_i^4$

## For Grouped Data:

$$\mu_r'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i - 0)^r = \frac{1}{N} \sum_{i=1}^n f_i x_i^r$$

- $N = \sum_{i=1}^n f_i$  (Total Frequency)

## For Grouped Data:

$$\mu_r'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i - 0)^r = \frac{1}{N} \sum_{i=1}^n f_i x_i^r$$

- $N = \sum_{i=1}^n f_i$  (Total Frequency)
- **Zero-order moment:**  $\mu_0'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i)^0 = 1$

## For Grouped Data:

$$\mu_r'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i - 0)^r = \frac{1}{N} \sum_{i=1}^n f_i x_i^r$$

- $N = \sum_{i=1}^n f_i$  (Total Frequency)
- **Zero-order moment:**  $\mu_0'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{N} \sum_{i=1}^n f_i x_i$

## For Grouped Data:

$$\mu_r'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i - 0)^r = \frac{1}{N} \sum_{i=1}^n f_i x_i^r$$

- $N = \sum_{i=1}^n f_i$  (Total Frequency)
- **Zero-order moment:**  $\mu_0'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{N} \sum_{i=1}^n f_i x_i$
- **Second-order moment:**  $\mu_2'' = \frac{1}{N} \sum_{i=1}^n f_i x_i^2$



## For Grouped Data:

$$\mu_r'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i - 0)^r = \frac{1}{N} \sum_{i=1}^n f_i x_i^r$$

- $N = \sum_{i=1}^n f_i$  (Total Frequency)
- **Zero-order moment:**  $\mu_0'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{N} \sum_{i=1}^n f_i x_i$
- **Second-order moment:**  $\mu_2'' = \frac{1}{N} \sum_{i=1}^n f_i x_i^2$
- **Third-order moment:**  $\mu_3'' = \frac{1}{N} \sum_{i=1}^n f_i x_i^3$

## For Grouped Data:

$$\mu_r'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i - 0)^r = \frac{1}{N} \sum_{i=1}^n f_i x_i^r$$

- $N = \sum_{i=1}^n f_i$  (Total Frequency)
- **Zero-order moment:**  $\mu_0'' = \frac{1}{N} \sum_{i=1}^n f_i (x_i)^0 = 1$
- **First-order moment:**  $\mu_1'' = \frac{1}{N} \sum_{i=1}^n f_i x_i$
- **Second-order moment:**  $\mu_2'' = \frac{1}{N} \sum_{i=1}^n f_i x_i^2$
- **Third-order moment:**  $\mu_3'' = \frac{1}{N} \sum_{i=1}^n f_i x_i^3$
- **Fourth-order moment:**  $\mu_4'' = \frac{1}{N} \sum_{i=1}^n f_i x_i^4$

# Moments About the Mean (Ungrouped Data)

**Formulas: Definition:** Moments about mean measure the  $r^{\text{th}}$ -order summary of data relative to  $A = \bar{x}$ .

# Moments About the Mean (Ungrouped Data)

**Formulas: Definition:** Moments about mean measure the  $r^{\text{th}}$ -order summary of data relative to  $A = \bar{x}$ .

- **Zero Order Moment:**

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^0 = 1$$

# Moments About the Mean (Ungrouped Data)

**Formulas: Definition:** Moments about mean measure the  $r^{\text{th}}$ -order summary of data relative to  $A = \bar{x}$ .

- **Zero Order Moment:**

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^0 = 1$$

- **First Order Moment:**

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x}) = 0$$

# Moments About the Mean (Ungrouped Data)

**Formulas: Definition:** Moments about mean measure the  $r^{\text{th}}$ -order summary of data relative to  $A = \bar{x}$ .

- **Zero Order Moment:**

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^0 = 1$$

- **First Order Moment:**

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x}) = 0$$

- **Second Order Moment: (Variance)**

$$\mu_2 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2$$

# Moments About the Mean (Ungrouped Data)

**Formulas: Definition:** Moments about mean measure the  $r^{\text{th}}$ -order summary of data relative to  $A = \bar{x}$ .

- **Zero Order Moment:**

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^0 = 1$$

- **First Order Moment:**

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x}) = 0$$

- **Second Order Moment: (Variance)**

$$\mu_2 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2$$

- **Third Order Moment::**

$$\mu_r = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^3$$

# Moments About the Mean (Ungrouped Data)

**Formulas: Definition:** Moments about mean measure the  $r^{\text{th}}$ -order summary of data relative to  $A = \bar{x}$ .

- **Zero Order Moment:**

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^0 = 1$$

- **First Order Moment:**

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x}) = 0$$

- **Second Order Moment: (Variance)**

$$\mu_2 = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2$$

- **Third Order Moment::**

$$\mu_r = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^3$$

- **Fourth Order Moment::**

$$\mu_r = \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^4$$



# Moments About the Mean (Grouped Data)

# Moments About the Mean (Grouped Data)

- Zero Order Moment:

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N f_i = 1$$

# Moments About the Mean (Grouped Data)

- Zero Order Moment:

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N f_i = 1$$

- First Order Moment:

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N f_i (x_i - \bar{x}) = 0$$

# Moments About the Mean (Grouped Data)

- Zero Order Moment:

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N f_i = 1$$

- First Order Moment:

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N f_i(x_i - \bar{x}) = 0$$

- Second Order Moment (Variance):

$$\mu_2 = \frac{1}{N} \sum_{i=1}^N f_i(x_i - \bar{x})^2$$

# Moments About the Mean (Grouped Data)

- Zero Order Moment:

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N f_i = 1$$

- First Order Moment:

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N f_i(x_i - \bar{x}) = 0$$

- Second Order Moment (Variance):

$$\mu_2 = \frac{1}{N} \sum_{i=1}^N f_i(x_i - \bar{x})^2$$

- Third Order Moment:

$$\mu_3 = \frac{1}{N} \sum_{i=1}^N f_i(x_i - \bar{x})^3$$

# Moments About the Mean (Grouped Data)

- Zero Order Moment:

$$\mu_0 = \frac{1}{N} \sum_{i=1}^N f_i = 1$$

- First Order Moment:

$$\mu_1 = \frac{1}{N} \sum_{i=1}^N f_i (x_i - \bar{x}) = 0$$

- Second Order Moment (Variance):

$$\mu_2 = \frac{1}{N} \sum_{i=1}^N f_i (x_i - \bar{x})^2$$

- Third Order Moment:

$$\mu_3 = \frac{1}{N} \sum_{i=1}^N f_i (x_i - \bar{x})^3$$

- Fourth Order Moment:

$$\mu_4 = \frac{1}{N} \sum_{i=1}^N f_i (x_i - \bar{x})^4$$