

Covariance: A Numerical Example

Data Science and A.I. Lecture Series

Bindeshwar Singh Kushwaha

PostNetwork Academy

Problem Statement and Table of Deviations

Example: Calculate the covariance between the age of husband and wife of the following seven couples.

Data:

- Age of Husband X : 35, 34, 40, 43, 56, 20, 38
- Age of Wife Y : 32, 30, 31, 32, 53, 20, 33

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Deviations are: $u_i = x_i - 40$ and $v_i = y_i - 32$.

Table of Deviations and Products:

x_i	$u_i = x_i - 40$	y_i	$v_i = y_i - 32$	$u_i v_i$
35	-5	32	0	0
34	-6	30	-2	12
40	0	31	-1	0
43	3	32	0	0
56	16	53	21	336
20	-20	20	-12	240
38	-2	33	1	-2

Covariance Calculation

The formula for covariance is:

$$\text{Cov}(X, Y) = \frac{1}{n} \sum u_i v_i - \left(\frac{1}{n} \sum u_i \right) \left(\frac{1}{n} \sum v_i \right)$$

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Substituting the values:

- $n = 7, \sum u_i v_i = 586, \sum u_i = -14, \sum v_i = 7$

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- Step 1: $\frac{1}{n} \sum u_i v_i = \frac{586}{7}$
- Step 2: $\frac{1}{n} \sum u_i = \frac{-14}{7} = -2$ and $\frac{1}{n} \sum v_i = \frac{7}{7} = 1$

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- Step 1: $\frac{1}{n} \sum u_i v_i = \frac{586}{7}$
- Step 2: $\frac{1}{n} \sum u_i = \frac{-14}{7} = -2$ and $\frac{1}{n} \sum v_i = \frac{7}{7} = 1$
- Step 3: Combine:

$$\text{Cov}(X, Y) = \frac{586}{7} - (-2)(1)$$

- Step 4: Simplify:

$$\text{Cov}(X, Y) = 85.71$$

Result Interpretation

Final Answer: The covariance is 85.71.

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- As the age of the husband increases, the age of the wife also tends to increase.

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Covariance measures the linear association between two variables. A positive value means both variables move in the same direction.

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