

# What is the process for reading a covariance matrix?

Authored by  
**stats writer**

June 23, 2024

## RECOMMENDED CITATION

stats writer (2024). *What is the process for reading a covariance matrix?*.

PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=148298>

The process for reading a covariance matrix involves understanding the relationships between variables in a data set. The matrix is a square table that displays the covariance values between each pair of variables. The values in the matrix indicate how much two variables vary together, with positive values indicating a direct relationship and negative values indicating an inverse relationship. To read the matrix, one must first identify the variables on the x and y axis and then locate the corresponding value at the intersection of those variables. This value can then be interpreted to understand the strength and direction of the relationship between the two variables. The process of reading a covariance matrix is essential for analyzing the level of association between variables in a data set and can provide valuable insights for further statistical analysis.

## Read a Covariance Matrix

**Covariance is a measure of how changes in one variable are associated with changes in a second variable. Specifically, it's a measure of the degree to which two variables are linearly associated.**

**A covariance matrix is a square matrix that shows the covariance between many different variables. This can be a useful way to understand how different variables are related in a dataset.**

**The following example shows how to read a covariance matrix in practice.**

### How to Read a Covariance Matrix

**Suppose we have the following covariance matrix that contains information about exam scores for three**

## different subjects for college students:

|         |       |       |       |
|---------|-------|-------|-------|
| Math    | 64.9  | 33.2  | -24.4 |
| Science | 33.2  | 56.4  | -24.1 |
| History | -24.4 | -24.1 | 75.6  |

Math Science History

The values along the diagonals of the matrix represent the variances of each subject.

|         |       |       |       |
|---------|-------|-------|-------|
| Math    | 64.9  | 33.2  | -24.4 |
| Science | 33.2  | 56.4  | -24.1 |
| History | -24.4 | -24.1 | 75.6  |

Math Science History

For example:

The variance of the math scores is 64.9. The variance of the science scores is 56.4. The variance of the history scores is 75.6.

The other values in the matrix represent the covariances between the various subjects.

|         |       |       |       |
|---------|-------|-------|-------|
| Math    | 64.9  | 33.2  | -24.4 |
| Science | 33.2  | 56.4  | -24.1 |
| History | -24.4 | -24.1 | 75.6  |

Math Science History

**For example:**

The covariance between the math and science scores is 33.2. The covariance between the math and history scores is -24.4. The covariance between the science and history scores is -24.1.

A positive number for covariance indicates that two variables tend to increase or decrease in tandem.

For example, math and science have a positive covariance (33.2), which indicates that students who score high on math also tend to score high on science.

Conversely, students who score low on math also tend to score low on science.

A negative number for covariance indicates that as one

**variable increases, a second variable tends to decrease.**

**For example, math and history have a negative covariance (-24.44), which indicates that students who score high on math tend to score low on history.**

**Conversely, students who score low on math tend to score high on history.**

#### **A Note on the Symmetry of a Covariance Matrix**

**It's worth noting that a covariance matrix is perfectly symmetrical.**

**For example, the top right cell shows the exact same value as the bottom left cell:**

|         |       |       |       |
|---------|-------|-------|-------|
| Math    | 64.9  | 33.2  | -24.4 |
| Science | 33.2  | 56.4  | -24.1 |
| History | -24.4 | -24.1 | 75.6  |

Math Science History

**This is because both cells are measuring the covariance between History and Math.**

**Because a covariance matrix is symmetrical, half of the covariance values shown in the matrix are redundant and unnecessary.**

**Thus, sometimes only half of the covariance matrix will be displayed:**

|         |       |         |         |
|---------|-------|---------|---------|
| Math    | 64.9  |         |         |
| Science | 33.2  | 56.4    |         |
| History | -24.4 | -24.1   | 75.6    |
|         | Math  | Science | History |

### **When to Use a Covariance Matrix**

**In practice, you will often need to create and interpret a more often than a covariance matrix.**

**However, covariance matrices are often used "under the hood" for different machine learning algorithms and models.**

**For example, the covariance matrix is used when performing , which helps us understand underlying patterns in a dataset that contains a large number of**

**variables.**

**The following tutorials explain how to create a covariance matrix using different statistical software:**

ARABPSYCHOLOGY.COM