

Covariance Matrices :

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<https://www.youtube.com/watch?v=0GzMcUy7ZIO>

Handwritten notes on a black background showing the formula for covariance, a data table for variables X, Y, and Z, and the resulting covariance matrix.

$$\text{cov}(X, Y) = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})$$

	X	Y	Z
1	1	1	1
2	1	2	1
3	1	3	2
4	1	4	3

Below the table, the mean values are calculated:

$$\bar{x} = 1.0, \bar{y} = 2.5, \bar{z} = 1.75$$

The covariance matrix is then calculated:

$$\begin{bmatrix} \text{cov}(X, X) & \text{cov}(X, Y) & \text{cov}(X, Z) \\ \text{cov}(Y, X) & \text{cov}(Y, Y) & \text{cov}(Y, Z) \\ \text{cov}(Z, X) & \text{cov}(Z, Y) & \text{cov}(Z, Z) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1.667 & 1.167 \\ 0 & 1.167 & 0.917 \end{bmatrix}$$

Individual covariance calculations are shown below:

$$\begin{aligned} \text{cov}(X, Y) &= 0 & \text{cov}(Y, X) &= 0 \\ \text{cov}(X, Z) &= 0 & \text{cov}(X, X) &= 0 \\ \text{cov}(Y, Z) &= 1.167 \end{aligned}$$

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<https://www.youtube.com/watch?v=locZabK4Als>

# COVARIANCE MATRIX

	$x_1$	$x_2$	$x_3$	$x_4$
$x_1$	$Var(x_1)$	$Cov(x_1, x_2)$	$Cov(x_1, x_3)$	$Cov(x_1, x_4)$
$x_2$		$Var(x_2)$	$Cov(x_2, x_3)$	$Cov(x_2, x_4)$
$x_3$			$Var(x_3)$	$Cov(x_3, x_4)$
$x_4$				$Var(x_4)$

The diagonal of a covariance matrix provides the variance of each individual variable.

The off-diagonal entries in the matrix provide the covariance between each variable pair.

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<https://www.youtube.com/watch?v=152tSYtiQbw>

Correlation :

- Varies between -1 and 1

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[https://www.youtube.com/watch?v=0FuK\\_mrcW98](https://www.youtube.com/watch?v=0FuK_mrcW98)

$$\text{Correlation}(X,Y) = \text{Covariance}(X,Y) / ( \text{Sqrt}(\text{variance}(X)) \times \text{Sqrt}(\text{variance}(Y)) )$$

Or

$$\text{Correlation}(X,Y) = \text{Covariance}(X,Y) / ( \text{StdDev}(X) \times \text{StdDev}(Y) )$$

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[https://www.youtube.com/watch?v=5HNR\\_j6LmPc](https://www.youtube.com/watch?v=5HNR_j6LmPc)

Covariance Matrix :

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- It is a square matrix
- The Eigen Values and Eigen Vectors can be calculated on this matrix
- The Eigen Vectors gives the direction of the data spread and the Eigen Vector gives the strength of those data points.

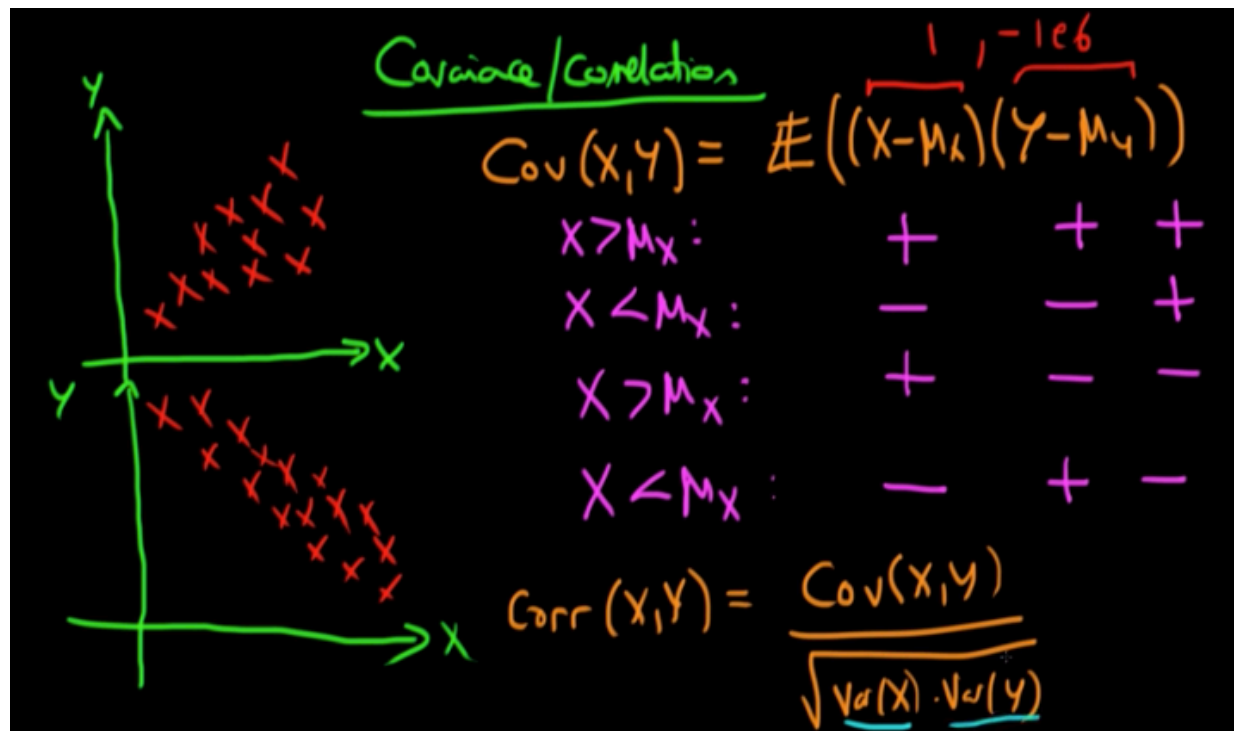
PCA :

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- PCA is a technique for linear transformation of data
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