

# Covariance

# Variance

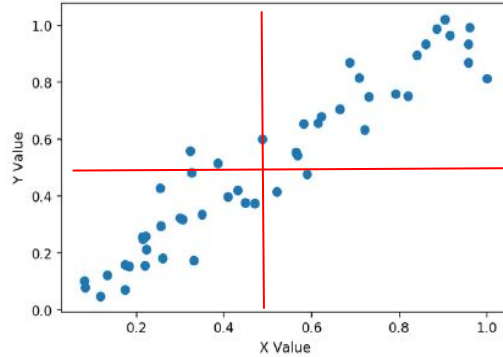
- Variance is the average squared difference of the values from the mean.
- Standard Deviation is the square root of Variance.

The diagram illustrates the formula for standard deviation ( $\sigma$ ) with four numbered annotations:

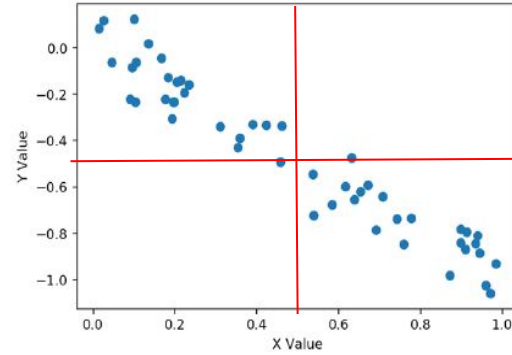
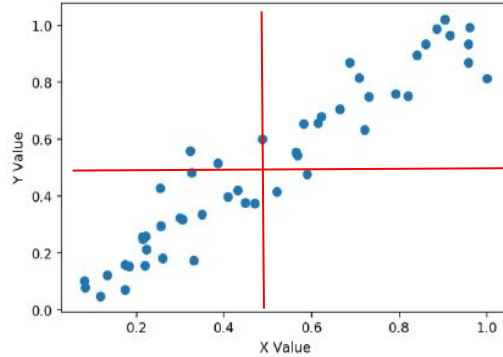
- 1. the mean: Points to the  $\bar{x}$  term in the formula.
- 2. squared distances from mean: Points to the squared term  $(x_i - \bar{x})^2$ .
- 3. variance ( $\sigma^2$ ): Points to the entire expression inside the square root, representing the variance.
- 4. standard deviation ( $\sigma$ ): Points to the square root symbol, indicating that the standard deviation is the square root of the variance.

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}}$$

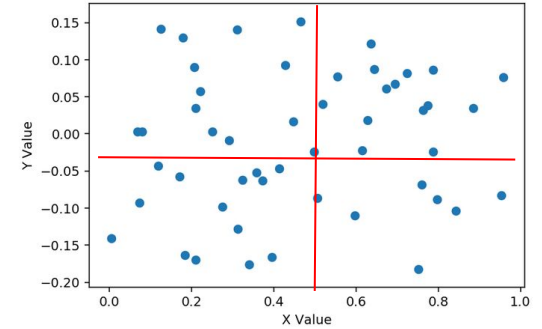
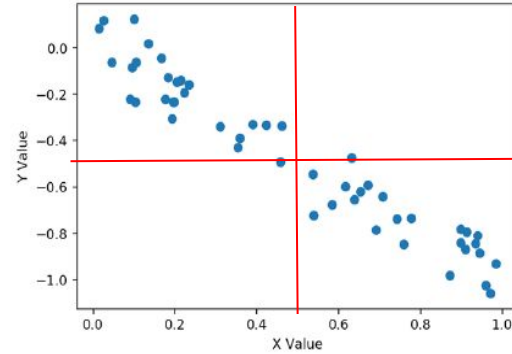
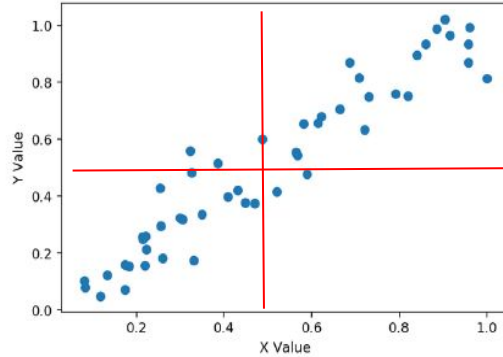
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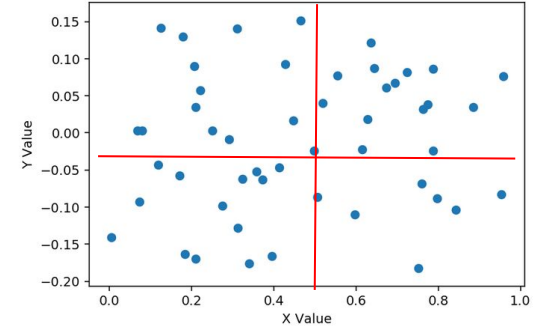
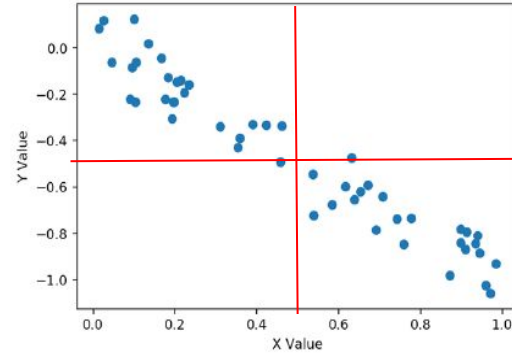
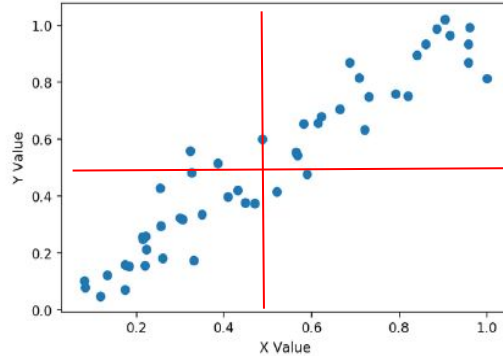
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# Variance



- Variance cannot be used for more than 1 variable
- Covariance is used for high dimension

# Covariance

$$\text{Cov}(X,Y)=\frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{N}$$

# Covariance

$$\text{Cov}(X,Y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N}$$

Ex : Whether Economic Growth and Nifty Returns have a positive relationship or inverse relationship ?



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Economic Growth (in %)	Nifty Returns (in %)
5.1	8
5.5	12
7	14
6.6	10

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$$\begin{aligned}\bar{x} &= (5.1 + 5.5 + 7 + 6.8) / 4 \\ &= 24.4 / 4 \\ &= 6.1\end{aligned}$$

$$\begin{aligned}\bar{y} &= (8 + 12 + 14 + 10) / 4 \\ &= 44 / 4 \\ &= 11\end{aligned}$$

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$x_i$	$y_i$	$x_i - \bar{x}$	$y_i - \bar{y}$
5.1	8	-1	-3
5.5	12	-0.6	1
7	14	0.9	3
6.6	10	0.5	-1

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$$\text{Cov}(x,y) =$$

$$(-1)(-3) + (-0.6)1 + (0.9)3 + (0.5)(-1)/4$$

$$= (3 - 0.6 + 2.7 - 0.5)/4$$

$$= 4.6/4$$

$$= 1.15$$

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$$\text{Cov}(X,Y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N}$$

The diagram illustrates the formula for variance,  $\sigma^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}$ , with three annotations:

- 1. the mean**: A purple line points to the  $\bar{x}$  term in the numerator.
- 2. squared distances from mean**: A blue line points to the  $(x_i - \bar{x})^2$  term in the numerator.
- 3. variance ( $\sigma^2$ )**: A green line points to the entire fraction.

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Linear Relationship between two variables

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Linear Relationship between two variables

It can take any value



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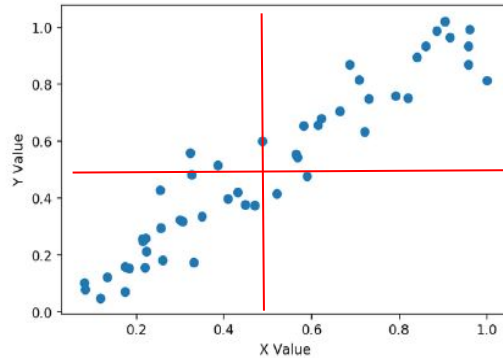
Linear Relationship between two variables

It can take any value

Positive, Negative or Zero Covariance

# Covariance

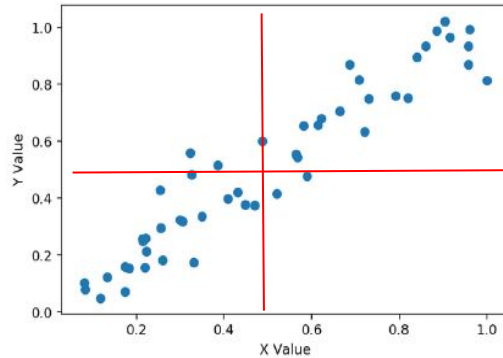
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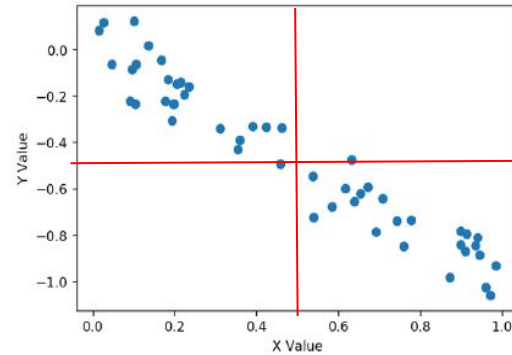
Positive Covariance

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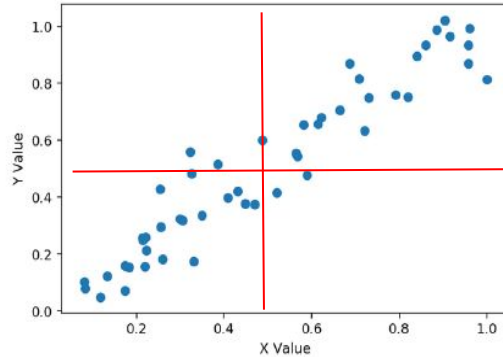
Positive Covariance



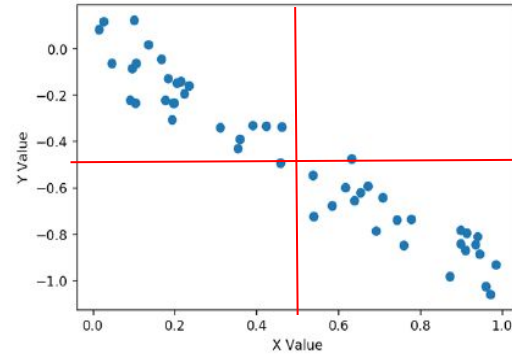
Negative Covariance

# Covariance

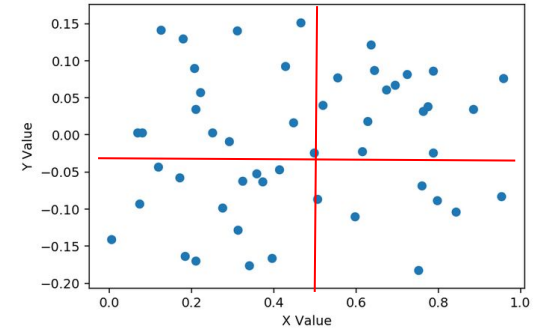
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Positive Covariance



Negative Covariance



Zero Covariance

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Covariance can be 0.000045 or 30 million

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Linear Relationship between two variables

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Correlation

Thank You!