Standard Deviation and Covariance

Variance is the statistical second moment of a distribution.

The variance S_x^2 is defined as $\{ \sum (x_i - \bar{x})^2 \} / n$

where S_x is the standard deviation and $\bar{x} = (\sum x_i) / n$

So $\{ \sum (x_i - \bar{x})^2 \} / n \quad = \{ \sum x_i^2 - \sum 2 x_i \bar{x} + \sum \bar{x}^2 \} / n$

$$= (\sum x_i^2) / n - 2 \bar{x} (1/n) \sum x_i + \bar{x}^2 \}$$

but as $(1/n) \sum x_i = \bar{x}$ $\quad S_x^2 = (\sum x_i^2) / n - \bar{x}^2$

$$S_x = \sqrt{ \{ (\sum x_i^2) / n - \bar{x}^2 \} }$$

Covariance

In probability theory and statistics, **covariance** is a measure of the joint variability of two random variables. The sign of the covariance, therefore, shows the tendency in the linear relationship between the variables.

The covariance S_{xy} is defined as $\{ \sum (x_i - \bar{x}) (y_i - \bar{y}) \} / n$

Expanding $(x_i - \bar{x}) (y_i - \bar{y})$ gives $S_{xy} = \{ \sum x_i y_i - \bar{x} \sum y_i - \bar{y} \sum x_i + \sum \bar{x} \bar{y} \} / n$

$$= \{ \sum x_i y_i \} / n - \bar{x}\bar{y} - \bar{x}\bar{y} + \bar{x}\bar{y}$$

$$= \{ \sum x_i y_i \} / n - \bar{x}\bar{y}$$

which again is pretty neat.

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$= \{ \sum x_i y_i \} / n - \bar{x} \bar{y} - \bar{x} \bar{y} + \bar{x} \bar{y}$

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