What is a Monotonic Relationship? (Definition + Examples)

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A monotonic relationship refers to a consistent pattern or trend between two variables, where one variable either increases or decreases as the other variable changes. This relationship can be either positive or negative, meaning that the variables move in the same or opposite direction, respectively. In a monotonic relationship, the rate or magnitude of change may vary, but the overall direction remains the same. For example, as the amount of exercise increases, the weight loss also increases, showing a positive monotonic relationship. On the other hand, as the temperature decreases, the number of ice cream sales also decreases, illustrating a negative monotonic relationship. Monotonic relationships are commonly used in data analysis and can help identify trends and make predictions.

What is a Monotonic Relationship? (Definition + Examples)

In statistics, a monotonic relationship between two variables refers to a scenario where a change in one variable is generally associated with a change in a specific direction in another variable.

There are two types of monotonic relationships:

Positive Monotonic: When the value of one variable increases, the value of the other variable tends to increase as well.

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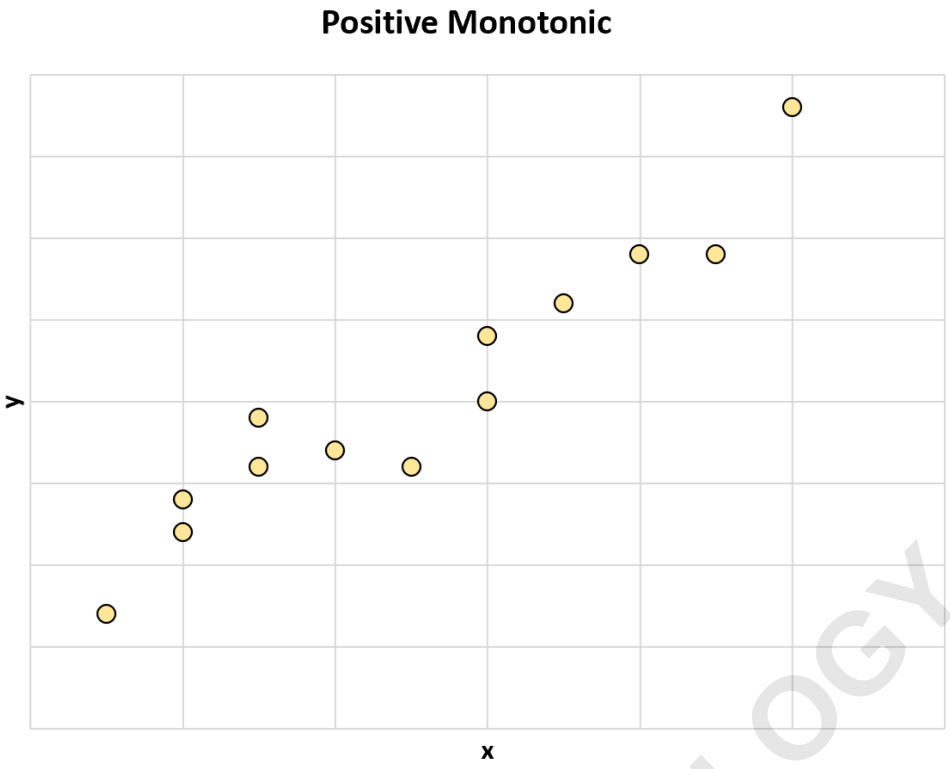

Negative Monotonic: When the value of one variable increases, the value of the other variable tends to decrease.

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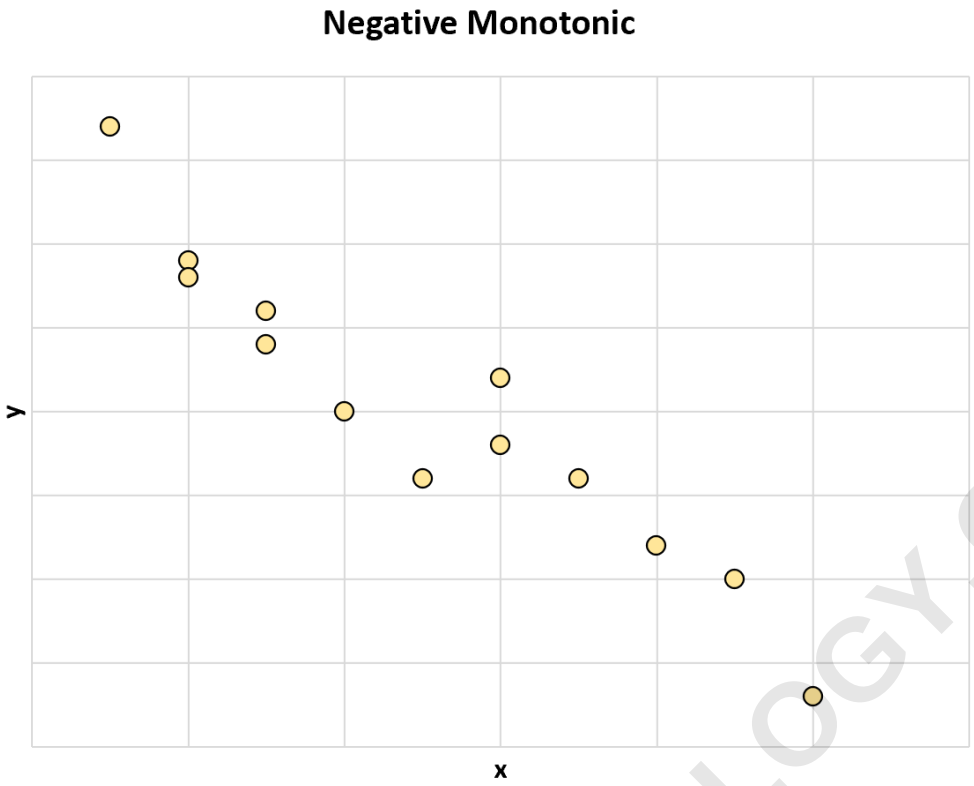

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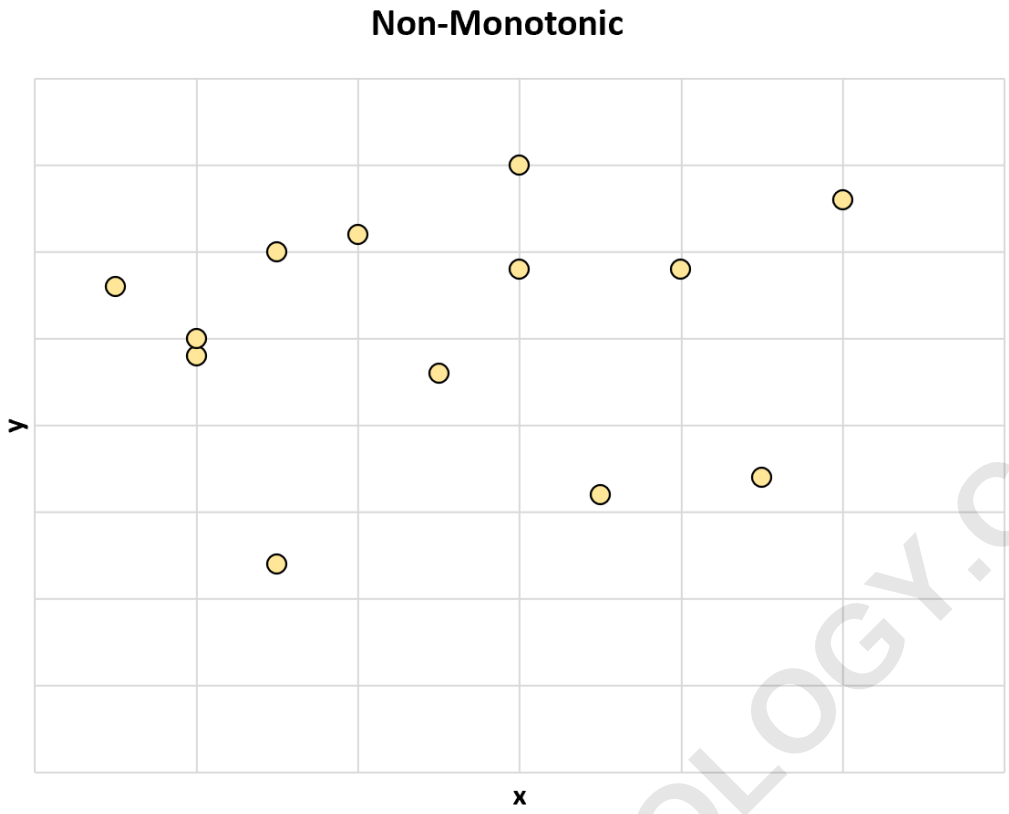
If two variables don't generally change in the same direction , then they are said to have a non-monotonic relationship.

Here's one example of a non-monotonic relationship between two variables:



And here's another example of a non-monotonic relationship between two variables:

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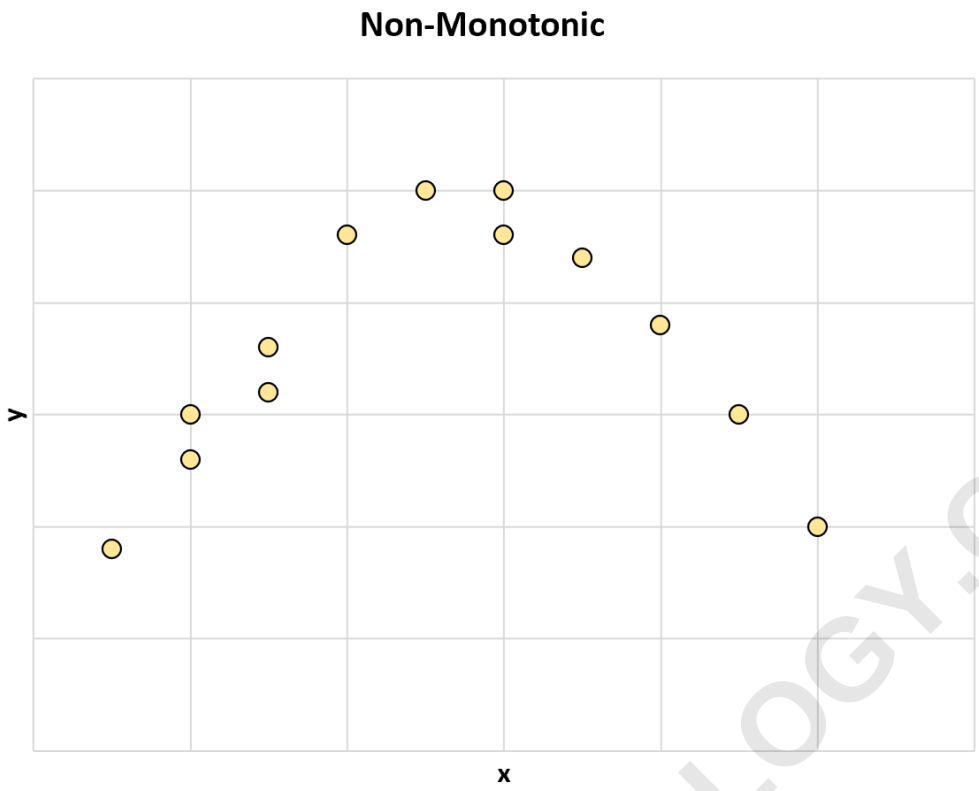

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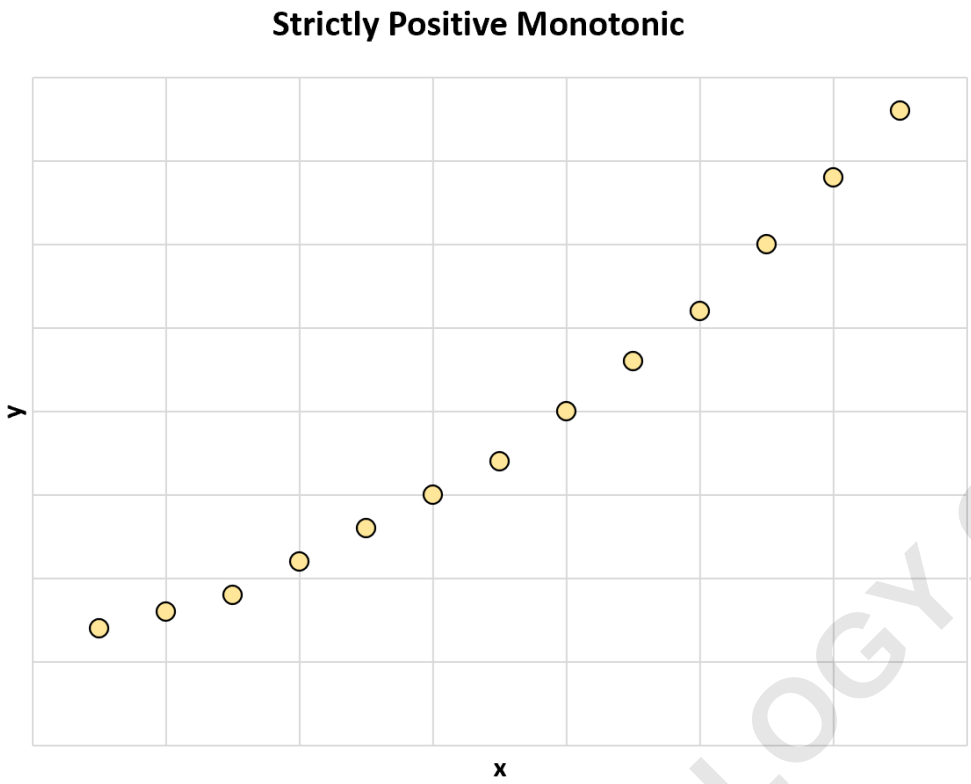
As the value of x increases, the value of y *sometimes* increases, but sometimes the value of y *decreases*.

Strictly Monotonic vs. Non-Strictly Monotonic

Two variables are said to have a strictly monotonic relationship if changes in one variable are *always* associated with a change in the same direction in another variable.

For example, the following chart illustrates a strictly positive monotonic relationship between two variables:



When the value of x increases, the value of y *always* increases.

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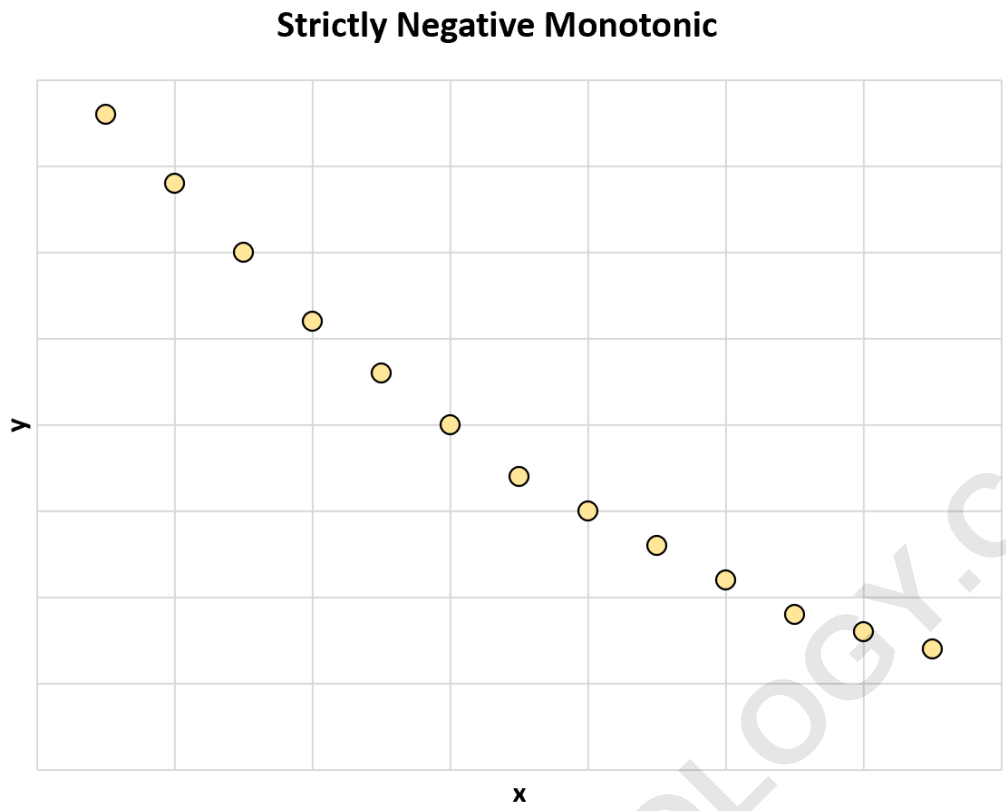

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When the value of x increases, the value of y *always* decreases.

How to Quantify Monotonic Relationships

The most common way to quantify the relationship between two variables is to use the , which measures the linear association between two variables.

This coefficient always takes on a value between -1 and 1 where:

-1 indicates a perfectly negative linear correlation

between two variables0 indicates no linear correlation between two variables1 indicates a perfectly positive linear correlation between two variables

The closer the coefficient is to 1, the stronger the positive relationship between two variables. Conversely, the closer the coefficient is to -1, the stronger the negative relationship between two variables.

However, if the relationship between two variables is monotonic but non-linear (like an exponential relationship) then it's a good idea to use the , which was designed to handle monotonic relationships well.

No matter which type of correlation coefficient you calculate, it's always a good idea to create a scatterplot to visualize the relationship between the variables as well.

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