

Calculate a Sigmoid Function in Excel

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This comprehensive tutorial offers a detailed methodology for calculating the value of the [Sigmoid function](#) directly within Microsoft [Excel](#). Mastery of this specific function is exceptionally vital in quantitative fields such as statistics, modern [machine learning](#), and the architecture of [neural networks](#), where it frequently operates as a fundamental [activation function](#).

Understanding the Sigmoid Function and its Properties

Mathematically, the Sigmoid function is defined by its characteristic graphical output: a smooth, continuous curve that is distinctly "S" shaped. These functions possess crucial properties that make them invaluable for modeling transitional phenomena: they are monotonically increasing (always moving upward) and, most importantly, they map any conceivable input value (often denoted as x) to a tightly constrained output value that falls strictly between 0 and 1. This bounding characteristic makes the Sigmoid ideal for modeling processes that require gradual transitions between two distinct extremes.

The form that is most frequently implemented and widely known is the [logistic sigmoid function](#), often simplified to the logistic function. Its primary purpose in data science is to normalize raw, unbounded scores, transforming them into probabilities or likelihoods. This conversion is absolutely essential for tasks related to binary classification, where the goal is to determine the likelihood of an input belonging to one of two possible categories.

In practical machine learning scenarios, the resulting output of the sigmoid function is generally interpreted as the probability that the given input belongs to the positive class (represented by the value 1). Conversely, the remaining probability (calculated as 1 minus the sigmoid output) represents the probability of the input belonging to the negative class (represented by the value 0). This clear probabilistic interpretation is a cornerstone of many predictive models.

Deconstructing the Logistic Sigmoid Formula

The standard formula for the logistic sigmoid function, commonly expressed as $F(x)$, is elegantly derived using the exponential function. Despite its profound utility, the mathematical expression is remarkably concise, incorporating the fundamental constant e , known as [Euler's number](#), which serves as the base of the natural logarithm system.

The function calculates the sigmoid value based on the input variable x using the following expression:

$$F(x) = 1 / (1 + e^{-x})$$

This specific mathematical construction rigorously guarantees that regardless of the input value x --whether it is a massive positive number, a deeply negative number, or precisely zero--the resulting

output $F(x)$ will always be confined to the open interval (0, 1). This critical property of constraining the output range is precisely why the sigmoid function is so exceptionally valuable when results must be interpreted rigorously as probabilities or normalized likelihoods.

Implementing the Sigmoid Formula Using Excel Syntax

To successfully calculate this complex exponential expression within the computational environment of [Excel](#), we must rely on the software's dedicated set of built-in functions. The mathematical term e raised to the power of $-x$ cannot be entered directly using superscript notation; instead, we must employ the specialized **EXP** function. The [EXP](#) function is specifically designed to compute the value of Euler's number (e) raised to any specified numerical power.

Assuming, for the purpose of this instruction, that the input value x (the raw score for which we intend to calculate the sigmoid output) is conveniently located in cell **A1** of your spreadsheet, the precise [Excel](#) formula that accurately replicates the logistic sigmoid function is structured as follows:

=1/(1+EXP(-A1))

This formula perfectly mirrors the mathematical definition: it computes the reciprocal of the quantity (1 plus the exponential of the negative input value). When constructing this expression, it is absolutely essential to ensure that the parentheses are correctly nested. This nesting enforces the necessary order of operations, thereby ensuring that the entire denominator calculation is fully completed before the final division operation is executed, guaranteeing computational accuracy.

A Practical Step-by-Step Calculation Example

To solidify your understanding, let us walk through a concrete, practical example demonstrating how to efficiently apply this formula across an entire range of input data within a standard spreadsheet environment. Imagine you have a preparatory dataset consisting of various raw input scores, which are systematically listed in Column A of your worksheet, beginning in cell A2.

We begin the example with the following dataset of x values, structured in [Excel](#). The inputs deliberately span both negative and positive ranges to allow us to fully observe the characteristic extent of the sigmoid curve:

	A	B	C	D	E	F
1	x					
2	-5					
3	-4.5					
4	-4					
5	-3.5					
6	-3					
7	-2.5					
8	-2					
9	-1.5					
10	-1					
11	-0.5					
12	0					
13	0.5					
14	1					
15	1.5					
16	2					
17	2.5					
18	3					
19	3.5					
20	4					
21	4.5					
22	5					
23						
24						

To determine the corresponding normalized sigmoid output for the first input value (which is located in cell **A2**), you must carefully input the adapted formula into the adjacent cell, **B2**. This specific calculation is meticulously targeted at the input value found in **A2**:

$$=1/(1+EXP(-A2))$$

Once the formula has been correctly entered into cell **B2**, you can leverage [Excel's](#) highly efficient autofill feature. By clicking and dragging the formula's handle down to cover all the remaining cells in Column B, Excel automatically and intelligently adjusts the underlying cell reference (for example, A2 automatically increments to A3, then A4, and so on). This process calculates the precise sigmoid value for every corresponding x input across the entire dataset, producing a rapid and accurate transformation of the data.

The resulting completed table will clearly display the normalized sigmoid values in Column B. Notice how every single output value is correctly constrained between 0 and 1, precisely as expected from the function's definition, illustrated below:

B2		=1/(1+EXP(-A2))						
	A	B	C	D	E	F	G	H
1	x	F(x)						
2	-5	0.006693						
3	-4.5	0.010987						
4	-4	0.017986						
5	-3.5	0.029312						
6	-3	0.047426						
7	-2.5	0.075858						
8	-2	0.119203						
9	-1.5	0.182426						
10	-1	0.268941						
11	-0.5	0.377541						
12	0	0.5						
13	0.5	0.622459						
14	1	0.731059						
15	1.5	0.817574						
16	2	0.880797						
17	2.5	0.924142						
18	3	0.952574						
19	3.5	0.970688						
20	4	0.982014						
21	4.5	0.989013						
22	5	0.993307						
23								
24								

Visualizing the Sigmoid Curve: Confirming the S-Shape

While the numerical calculation of the values is essential, visualizing the resulting data is a crucial step that helps confirm the characteristic non-linear behavior of the function. By generating a **line plot**, we can clearly and immediately illustrate the distinctive "S" shaped curve that fundamentally defines the Sigmoid function.

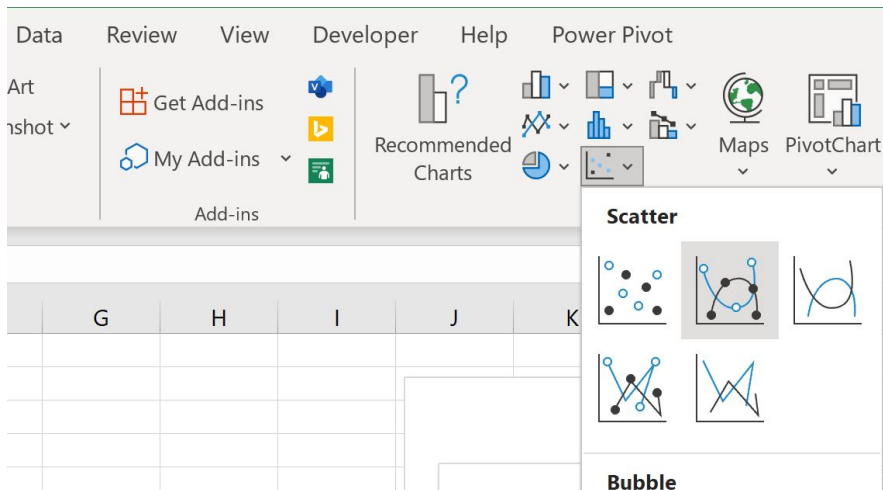
Follow these precise steps to generate the visualization using [Excel's](#) charting tools:

Begin by highlighting the entire dataset. This selection must include both the input x values (Column A) and the corresponding calculated sigmoid values (Column B). Selecting both columns is vital to instruct [Excel](#) to use the raw input values for the horizontal x -axis and the computed output values for the vertical y -axis.

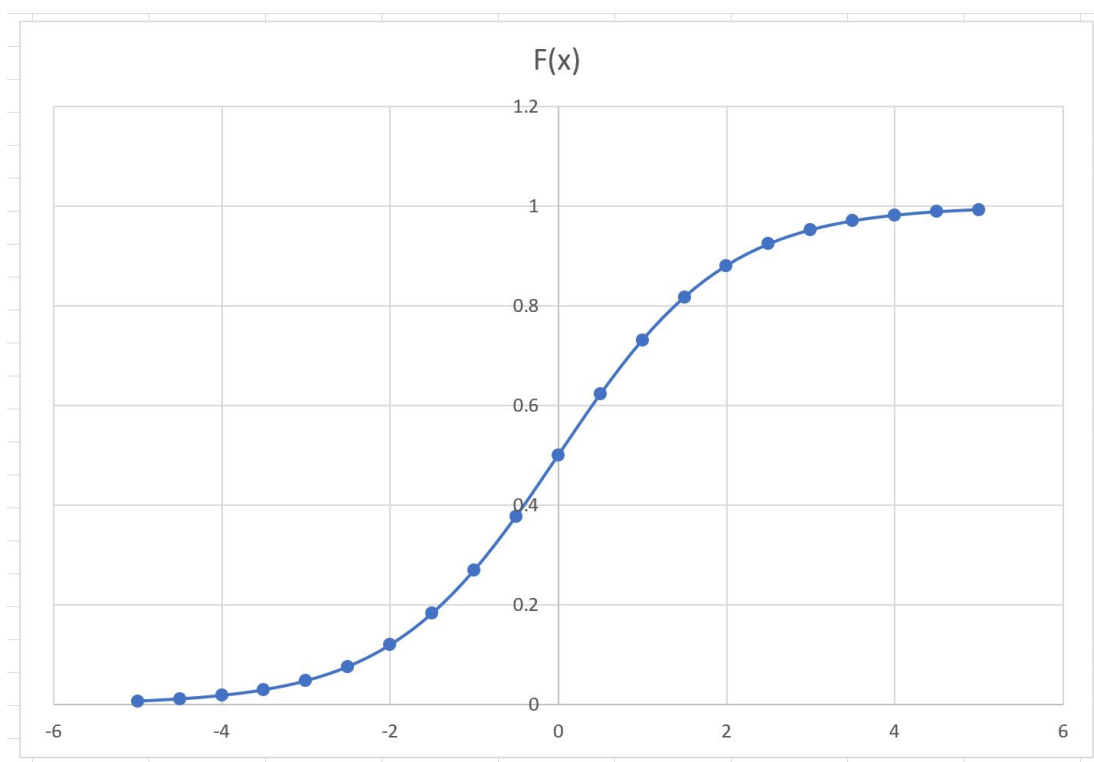
	A	B	C	D	E	F	G
1	x	F(x)					
2	-5	0.006693					
3	-4.5	0.010987					
4	-4	0.017986					
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24							

Once the data is highlighted, navigate to the "Insert" tab located on the primary [Excel](#) ribbon interface.

Locate the "Charts" group and specifically select the option for an [X Y \(Scatter\)](#) chart. Within the sub-options, choose the type that connects the resulting data points with smooth, continuous lines. This specific chart type is universally recognized as the best choice for accurately visualizing mathematical functions and their continuous relationships.



Upon clicking the appropriate chart style, the line chart will immediately be rendered, providing a vivid visual display of the smooth, non-linear relationship between the original raw input scores and the newly normalized output probabilities:



Carefully examine the resulting graphic: the horizontal x-axis represents the raw data inputs, spanning from large negatives to large positives. The vertical y-axis represents the calculated sigmoid output, strictly limited between 0 and 1. The visual outcome confirms the distinctive, smooth, non-linear **S-shaped curve**, clearly demonstrating that the function successfully maps

large negative inputs asymptotically toward zero and large positive inputs asymptotically toward one.

Advanced Applications of the Sigmoid Function

Although calculating the sigmoid curve within the structured environment of [Excel](#) serves as an excellent foundational exercise in mathematical modeling, the function itself carries profound significance in advanced analytical fields. Its unique capability to introduce non-linearity into linear systems and compress an infinite range of input values into a small, defined output window makes it an absolutely indispensable component in complex statistical and algorithmic models.

One of the function's most critical real-world uses is within [logistic regression](#), a staple statistical model utilized extensively for solving binary classification problems. In this context, the sigmoid function takes the result of a linear combination of input features and instantly converts that raw score into a probability--specifically, the likelihood that a particular observation belongs to a specific positive class (e.g., predicting "yes" or "success").

Furthermore, in the specialized field of [deep learning](#), the sigmoid function played a historically prominent role as a primary [activation function](#) within artificial neural networks. While more recent network architectures often favor alternatives like ReLU (Rectified Linear Unit) to alleviate computational challenges such as the vanishing gradient problem, the sigmoid function remains foundational for learning and understanding how early, critical neural architectures processed and propagated information across their internal layers.

Expanding Your Excel Functionality and Knowledge

Mastering the application of the **EXP** function and successfully implementing complex mathematical logic within [Excel](#) is the gateway to undertaking numerous other sophisticated statistical and analytical operations. If you are keen on expanding your practical knowledge of mathematical and data modeling using spreadsheet software, we highly recommend exploring additional tutorials focused on related computational topics.

The following resources explain how to perform several other common and powerful operations in [Excel](#):

A comprehensive tutorial on accurately calculating standard deviation in Excel.

An essential guide to effectively using the IF function for implementing conditional logic and controlling calculation flow.

Instructions on how to plot other complex non-linear equations using scatter charts for visualization.

Engaging with these resources will significantly enhance your proficiency in transforming raw data into meaningful and actionable insights using the advanced features of Microsoft **Excel**.