Definition Of Linear Function In Math

Linear Function Definition in Math: A Straightforward Guide A linear function in math is a function that represents a straight line on a graph. It has a constant rate of change and can be expressed in the form f(x) = mx + b, where 'm' is the slope and 'b' is the y-intercept. Understanding this fundamental concept is crucial for various mathematical applications. linearfunction math algebra function slope yintercept A linear function is a fundamental concept in mathematics, forming the bedrock for understanding more complex algebraic and analytic concepts. Its defining characteristic is its constant rate of change, meaning that for every unit increase in the independent variable (typically 'x'), the dependent variable (typically 'y') changes by a constant amount. This constant rate of change is represented by the slope of the line. The general equation of a linear function is expressed as: **f(x) = mx + b** Where: • f(x) represents the dependent variable (often 'y') – the output of the function. • **x** represents the independent variable – the input of the function. • m represents the slope of the line – the constant rate of change. A positive slope indicates an upward trend, a negative slope indicates a downward trend, and a slope of zero represents a horizontal line. • **b** represents the y-intercept – the point where the line intersects the y-axis (the value of f(x) when x = 0). **Visualizing a Linear Function:**

Let's illustrate this with a simple example. Consider the linear function f(x) = 2x + 1. | x | f(x) | ||| | -2 | -3 | | -1 | -1 | | 0 | 1 | | 1 | 3 | | 2 | 5 | [Insert a graph here showing the points (-2,-3), (-1,-1), (0,1), (1,3), (2,5) plotted and connected to form a straight line. Label the axes clearly and indicate the y-intercept (1) and the slope (2).] In this example, the slope (m) is 2, indicating that for every one-unit increase in x, f(x) increases by two units. The y-intercept (b) is 1, meaning the line crosses the y-axis at the point (0, 1). Advantages of Understanding Linear Functions: • **Predictability:** The constant rate of change allows for accurate predictions of future values based on past data. This is crucial in fields like forecasting sales trends or predicting population growth. • **Simplicity:** Linear functions are relatively easy to understand and work with compared to more complex functions. This makes them a valuable tool for introductory mathematics and various applications. • **Wide Applicability:** Linear functions are used extensively in diverse fields, including physics (describing motion), economics (modeling supply and demand), and computer science (linear algebra). • **Foundation for Advanced Concepts:** Mastering linear functions is a prerequisite for understanding more advanced mathematical topics such as calculus, linear algebra, and differential equations.

Non-Linear Functions

While this focuses on linear functions, it's important to understand that not all functions are linear. Non-linear functions exhibit a changing rate of change. Their graphs are curved rather than straight. Examples include quadratic

functions (e.g., $f(x) = x^2$), exponential functions (e.g., $f(x) = 2^x$), and logarithmic functions (e.g., $f(x) = \ln(x)$). [Insert a graph here comparing a linear function (e.g., $f(x) = x$) and a non-linear function (e.g., $f(x) = x^2$) on the same axes to visually highlight the differences.]

Applications of Linear Functions

Linear functions have far-reaching applications in various fields. Here are a few examples: • **Physics:** Describing uniform motion (constant velocity). The distance traveled is a linear function of time. • **Economics:** Modeling supply and demand. Price often has a linear relationship with quantity supplied or demanded (within certain limits). • Finance: Calculating simple interest. Interest earned is a linear function of the principal amount and time. • Computer science: Representing and manipulating data in linear algebra.

Determining if a Function is Linear

Several methods can determine if a given function is linear. A key indicator is a constant rate of change. If we examine several points from the function, the ratio of the difference in y values to the difference in x values (rise over run) should always be the same. This ratio represents the slope (m). Additionally, plotting the points on a graph should result in a straight line.

Conclusion

Linear functions represent a cornerstone of mathematical understanding. Their simple yet powerful nature allows for solving a wide range of problems across multiple disciplines. Mastering the concept of linear functions is crucial for progressing to more advanced mathematical concepts and for effectively applying mathematical principles in practical settings. Understanding the equation, slope, and y-intercept allows one to visualize and manipulate linear functions effectively. **Advanced FAQs:** 1. **How do I find the equation of a linear function given two points?** Use the slope-intercept form ($y = mx + b$). Calculate the slope (m) using the two points, then substitute one point and the slope into the equation to solve for the y-intercept (b). 2. **What is the difference between a linear function and a linear equation?** A linear equation is a statement that two linear expressions are equal, while a linear function is a rule that assigns a single output to each input. A function implies a relationship where the output values are dependent on the input values. 3. **How are linear functions related to matrices and vectors in linear algebra?** Linear functions are fundamental to linear algebra. Matrices and vectors provide a concise way to represent and manipulate linear transformations (functions that map vectors in one space linear to vectors in another). 4. *Can a linear function have a vertical line as its graph?* No. A vertical line does not represent a function because it violates the vertical line test, where a vertical line should only intersect the graph at one point. The slope would also be undefined. 5. How are piecewise linear functions handled? Piecewise linear functions

are defined by multiple linear functions over different intervals of their domains. To analyze them, each linear segment must be treated separately, and the analysis will focus on the individual linear sections that form the function.

Unraveling the Definition of a Linear Function in Math

Ever stared at a graph that looks like a perfectly straight line and wondered what makes it so special? That straightness isn't just a visual quirk; it's the hallmark of a **linear function in math**. These functions are foundational to algebra, calculus, and so many other areas of mathematics and science. They're the building blocks for understanding more complex relationships, and once you grasp their definition, a whole new world of mathematical understanding opens up. But what exactly *is* a linear function? It sounds simple, and in essence, it is. However, like many simple concepts in math, the true beauty lies in its nuances and its wide-ranging applications. Let's dive deep into the definition of a linear function, explore its characteristics, and see how it manifests in different forms.

What Makes a Function "Linear"? The Core Definition

At its heart, a linear function is a function whose graph is a **straight line**. This might seem obvious, but it's the most crucial characteristic. Mathematically, this translates to a

specific relationship between the input (independent variable, usually denoted by 'x') and the output (dependent variable, usually denoted by 'y' or 'f(x)'). The defining feature of a linear function is that for every **constant change in the input value**, there is a **constant and proportional change in the output value**. Imagine walking at a steady pace. For every minute you walk, you cover the same distance. That consistent rate of change is the essence of linearity. This constant rate of change is mathematically represented by the **slope** of the line. The slope tells us how steep the line is and in which direction it's going. A positive slope means the line rises as you move from left to right, indicating that as 'x' increases, 'y' also increases. A negative slope means the line falls as you move from left to right, showing that as 'x' increases, 'y' decreases. A slope of zero means the line is horizontal.

The Algebraic Representation: Unveiling the Standard Form

While the graphical representation is intuitive, the algebraic definition is what allows us to work with and manipulate linear functions. The most common and recognizable form is the **slope-intercept form**.

y = mx + b

Let's break this down: * **y**: This represents the output or dependent variable. It's what your function "produces." * **x**: This represents the input or independent variable. It's what you feed into your function. * **m**: This is the **slope**

of the linear function. As we discussed, it quantifies the rate of change. It's often described as "rise over run" – the change in 'y' divided by the corresponding change in 'x'. * **b**: This is the **y-intercept**. It's the value of 'y' when 'x' is zero. Graphically, it's the point where the straight line crosses the y-axis. This equation beautifully encapsulates the definition: for any change in 'x', the change in 'y' is 'm' times that change in 'x', plus the constant offset 'b'. This 'b' value simply shifts the entire line up or down without affecting its steepness. Another important form is the **standard form of a linear equation**:

Ax + By = C

Here, 'A', 'B', and 'C' are constants, and 'A' and 'B' are not both zero. While this form might not immediately reveal the slope and y-intercept, it's incredibly useful for solving systems of linear equations and for expressing relationships in various contexts. You can always rearrange the standard form into the slope-intercept form to find 'm' and 'b'. A third, often overlooked but equally valid, form is the **point-slope form**:

$y - y_1 = m(x - x_1)$

This form is particularly useful when you know the slope ('m') of a line and the coordinates of one point ('x_1', 'y_1') that the line passes through. It directly uses the definition of slope as the ratio of change.

Key Characteristics of Linear

Functions

Beyond the definition and algebraic forms, several characteristics define linear functions:

Constant Rate of Change (Slope)

This is the cornerstone. As mentioned, the rate at which the 'y' value changes for a unit change in the 'x' value is always the same. This is what makes the graph a straight line, not a curve. If the rate of change varied, you'd see bending or curvature in the graph.

The Domain and Range are All Real Numbers

Unless the function is restricted (which is sometimes the case in practical applications), the **domain** (all possible input values for 'x') and the **range** (all possible output values for 'y') of a linear function are the set of all real numbers. This means you can plug in any real number for 'x' and get a real number as 'y', and any real number can be an output for some input.

Two-Variable Relationship

Linear functions typically involve two variables, one independent and one dependent. This is inherent in the `y = mx + b` structure. We're looking at how one quantity changes *in relation to* another.

Predictability and Simplicity

One of the most significant advantages of linear functions is

their predictability. Because the rate of change is constant, you can easily predict future values if you know the current value and the slope. This simplicity makes them incredibly powerful for modeling real-world phenomena.

Linear Functions in the Wild: Real-World Examples

The beauty of linear functions is that they are not confined to textbooks. They pop up everywhere! Understanding the definition helps us recognize these patterns in the real world.

Distance, Speed, and Time

If you're traveling at a constant speed, the distance you cover is a linear function of time. * **Independent Variable:** Time (t) * **Dependent Variable:** Distance (d) * **Slope (m):** Speed * **Y-intercept (b):** The initial distance from your starting point (if you start at 0, b=0). The formula would be `d = (speed) * t + initial_distance`.

Cost Calculations

Many pricing structures are linear. For instance, a taxi fare might have a fixed starting fee plus a per-mile charge. * **Independent Variable:** Miles driven (m) * **Dependent Variable:** Total Cost (C) * **Slope (m):** Cost per mile * **Y-intercept (b):** The initial fixed fee. The formula would be `C = (cost_per_mile) * m + initial_fee`.

Conversions

Converting between units often involves a linear relationship. For example, converting Celsius to Fahrenheit. * **Independent Variable:** Temperature in Celsius (°C) * **Dependent Variable:** Temperature in Fahrenheit (°F) * **Slope (m):** 9/5 (or 1.8) * **Y-intercept (b):** 32 The formula is `°F = (9/5) * °C + 32`. These are just a few examples. Think about simple phone plans with a monthly fee and a per-minute charge, or the amount of paint needed for a wall based on its area.

Understanding Non-Linear Functions: The Contrast

To truly appreciate linear functions, it's helpful to understand what they are *not*. **Non-linear functions** are functions whose graphs are not straight lines. Their rate of change is not constant. Examples of non-linear functions include: * **Quadratic functions:** Their graphs are parabolas (e.g., `y = x²`). The rate of change increases or decreases as 'x' changes. * **Exponential functions:** Their graphs show rapid growth or decay (e.g., `y = 2^x`). * **Trigonometric functions:** Their graphs are periodic waves (e.g., `y = sin(x)`). The constant rate of change is the key differentiator. If you see a curve, it's likely a non-linear function.

Why is the Definition of a Linear

Function So Important?

The definition of a linear function is more than just an academic exercise. It's fundamental for several reasons: * **Foundation for Higher Mathematics:** Linear functions are the gateway to understanding more complex mathematical concepts. Concepts like linear algebra, which deals with systems of linear equations and vectors, are built upon this foundation. * **Modeling the Real World:** As we've seen, many real-world scenarios can be approximated or perfectly modeled by linear functions. This allows us to make predictions, analyze trends, and solve practical problems. * **Problem-Solving Skills:** Working with linear functions hones your logical thinking, pattern recognition, and algebraic manipulation skills – all crucial for problem-solving in any field. * **Understanding Rates of Change:** The concept of a constant rate of change is a precursor to understanding calculus, where we study *varying* rates of change.

In Conclusion: The Power of Straight Lines

So, what is the definition of a linear function in math? It's a function whose graph is a straight line, characterized by a constant rate of change between its input and output variables. This constant rate of change is quantified by the slope, and the graph's position on the y-axis is determined by the y-intercept. Whether expressed as `y = mx + b`, `Ax + By = C`, or in its point-slope form, the core idea remains: a

predictable, proportional relationship between two variables. These seemingly simple functions are incredibly powerful tools for understanding and describing the world around us, making them an indispensable part of mathematical literacy. The next time you see a straight line, remember the fundamental mathematical definition that brings it to life!

The Definition and Core Concept of Linear Functions in Mathematics

A linear function is a fundamental mathematical concept that describes a relationship between two variables where the change in the output is proportional to the change in the input. At its core, a linear function takes the form of $y = mx + b$, where m represents the slope—the rate at which y changes with respect to x—and b denotes the y-intercept, the point where the line crosses the vertical axis. This simple yet powerful equation captures a straight-line relationship, reflecting constant rate of change, a defining trait that distinguishes linear functions from nonlinear ones.

Understanding the Structure and Key Components

In a linear function, the coefficient m determines the steepness and direction of the line: a positive slope means as x increases, y also increases, while a negative slope indicates

a decrease. The constant b shifts the line up or down, altering where it intersects the y-axis without affecting its slope. Unlike quadratic or exponential functions, which curve or grow rapidly, linear functions maintain a steady pace, making them predictable and easy to analyze. This consistency allows mathematicians and scientists to model real-world phenomena with reliable precision.

Real-World Applications and Practical Uses

Linear functions are everywhere in daily life and professional fields. In economics, they model supply and demand curves, helping predict how price and quantity interact. Engineers use them to describe voltage, current, and resistance relationships in electrical circuits. In finance, linear functions estimate interest accumulation over time under simple interest models. Education relies on linear functions to track progress, such as calculating final grades based on test scores or attendance. These applications underscore the function’s role as a versatile tool for understanding and forecasting behavior in structured systems.

Benefits of Linear Functions in Problem Solving

One of the primary advantages of linear functions is their simplicity and clarity. Because of their predictable nature, they enable quick calculations and straightforward modeling without complex computations. This ease of interpretation

supports decision-making in fields ranging from business planning to public policy. Additionally, linear relationships are highly compatible with algebraic techniques—solving for unknowns, graphing, and analyzing trends become intuitive tasks. Their ability to represent real-world patterns efficiently makes them indispensable in both theoretical mathematics and practical applications.

The Future Outlook and Expanding Role of Linear Functions

As technology advances, the relevance of linear functions continues to grow, especially in data science, machine learning, and artificial intelligence. Linear regression, a foundational method in predictive modeling, depends heavily on linear functions to identify correlations and make forecasts. In optimization problems, linear programming uses these functions to maximize efficiency or minimize cost within defined constraints. With increasing reliance on quantitative analysis across industries, the ability to model linear relationships remains a critical skill. Moreover, ongoing research into more complex systems often begins with linear approximations, highlighting how deeply rooted linear functions are in the evolving landscape of mathematical and computational sciences. Linear functions, though elementary in appearance, embody a powerful and enduring principle: that change can be understood, measured, and predicted when relationships remain consistent. Their enduring utility

across disciplines confirms their place not only as a cornerstone of algebra but as a vital tool shaping how we interpret and interact with the world.

Unpacking the Definition of a Linear Function in Math: A Comprehensive Guide

In the vast landscape of mathematics, certain concepts serve as foundational pillars, underpinning more complex theories and applications. Among these essential building blocks, the **linear function** stands out. Its simplicity belies its profound importance, appearing in everything from basic algebra to advanced calculus, physics, economics, and computer science. Understanding the **definition of a linear function in math** is therefore crucial for anyone embarking on a mathematical journey or seeking to grasp the underlying principles of many scientific disciplines.

But what exactly constitutes a linear function? At its core, it's a mathematical relationship where the rate of change is constant. This means that for every unit increase in the input variable (often denoted as x), the output variable (often denoted as y or $f(x)$) changes by a fixed amount. This predictable and consistent growth or decay is what gives linear functions their characteristic straight-line graph. This article will delve deeply into the **definition of a linear function**, exploring its algebraic representation, graphical interpretation, key characteristics, and real-world

applications.

The Algebraic Definition: More Than Just a Straight Line

Formally, a **linear function** is a function that can be represented in the form:

$f(x) = mx + b$

or equivalently, in terms of two variables, say x and y:

$y = mx + b$

Let's break down the components of this fundamental equation:

The Slope (m): The Engine of Change

The letter 'm' represents the **slope** of the linear function. The slope is arguably the most critical component, as it quantifies the rate of change of the function. It tells us how much the output variable (y) changes for every one-unit increase in the input variable (x).

1. **Positive Slope (m > 0):** When m is positive, the function is increasing. As x increases, y also increases. This is often referred to as an **increasing linear function**.
2. **Negative Slope (m < 0):** When m is negative, the function is decreasing. As x increases, y decreases. This is known as a **decreasing linear function**.
3. **Zero Slope (m = 0):** When m is zero, the function is neither increasing nor decreasing. The output variable y

remains constant regardless of the input x. This results in a **horizontal line**. For example, $f(x) = 5$ is a linear function with a slope of 0.

4. **Undefined Slope:** While not strictly part of the $y = mx + b$ form, a vertical line has an undefined slope. This is because the change in y for a zero change in x is infinite. Vertical lines are represented by equations of the form $x = c$, where c is a constant, and they do not represent functions in the traditional sense (as they fail the vertical line test).

The slope can be calculated using two points on the line, $(x1, y1)$ and $(x2, y2)$, with the formula:

$m = (y2 - y1) / (x2 - x1)$

This formula highlights the concept of "rise over run" – the change in the vertical direction (rise) divided by the change in the horizontal direction (run).

The Y-Intercept (b): Where the Line Crosses the Vertical Axis

The letter 'b' represents the **y-intercept**. This is the value of the function when the input variable x is zero, i.e., $f(0) = b$. Graphically, it's the point where the line crosses the y-axis. The coordinates of the y-intercept are always $(0, b)$.

The y-intercept provides a starting point for the function. For instance, if you're modeling the cost of a service that has a fixed fee plus an hourly rate, the fixed fee would be represented by b, and the hourly rate by m.

The Variables (x and y): Input and Output

Finally, 'x' is the **independent variable** (the input), and 'y' (or $f(x)$) is the **dependent variable** (the output). The value of y is determined by the value of x according to the linear relationship defined by m and b.

The Graphical Representation: A Straight Path

The most intuitive way to understand a **linear function** is through its graph. As mentioned, the graph of a linear function is always a **straight line**. This visual representation directly reflects the constant rate of change defined by the slope.

Consider the process of plotting a linear function:

1. **Identify the y-intercept (b):** This is your starting point on the y-axis.
2. **Use the slope (m) to find another point:** From the y-intercept, move m units up (if positive) or down (if negative) for every 1 unit you move to the right. Alternatively, you can think of the slope as a ratio: if $m = p/q$, move p units up/down and q units right.
3. **Draw a line through these two points:** Extend this line indefinitely in both directions.

The visual characteristic of a straight line is the key takeaway when thinking about **linear functions in graphing**. Any

deviation from a straight line indicates a non-linear relationship.

Key Characteristics of Linear Functions

Beyond the algebraic definition and graphical representation, linear functions possess several defining characteristics:

1. **Constant Rate of Change:** This is the hallmark of linearity. The slope m is constant throughout the function.
2. **Domain and Range:** For most linear functions (where $m \neq 0$), the domain (all possible x values) and the range (all possible y values) are all real numbers (represented as $(-\infty, \infty)$).
3. **Formality:** Linear functions are a subset of polynomial functions, specifically those of degree one (or zero if $m = 0$).
4. **Predictability:** Due to their constant rate of change, linear functions are highly predictable. Knowing two points is sufficient to determine the entire line and predict any value.

Examples of Linear Functions

To solidify your understanding, let's look at some concrete examples:

1. **Example 1:** $f(x) = 2x + 3$
    1. Slope (m) = 2 (The output increases by 2 for every unit increase in x).

    2. Y-intercept (b) = 3 (The function crosses the y-axis at y = 3).
    3. If x = 0, f(0) = 2(0) + 3 = 3.
    4. If x = 1, f(1) = 2(1) + 3 = 5.
    5. If x = 2, f(2) = 2(2) + 3 = 7.
2. **Example 2:** *y = -x + 1*
    1. Slope (m) = -1 (The output decreases by 1 for every unit increase in x).
    2. Y-intercept (b) = 1 (The function crosses the y-axis at y = 1).
3. **Example 3:** *g(x) = 4*
    1. Slope (m) = 0 (The output is always 4, regardless of x).
    2. Y-intercept (b) = 4.
    3. This represents a horizontal line.

Why is the Definition of a Linear Function Important?

The significance of the **definition of a linear function** extends far beyond the classroom. They are fundamental to:

Modeling Real-World Scenarios

Many real-world phenomena can be approximated by linear functions, at least within a certain range. Examples include:

1. **Distance, Speed, and Time:** If an object moves at a constant speed, the distance it travels is a linear function of time (distance = speed × time + initial distance).
2. **Cost Analysis:** The total cost of producing a certain number of items might be linear, consisting of a fixed cost

(overhead) and a variable cost per item.
3. **Simple Interest:** The amount of interest earned over time with simple interest is a linear function of time.
4. **Temperature Conversions:** Converting between Celsius and Fahrenheit involves a linear relationship.

Foundation for More Advanced Mathematics

Understanding linear functions is a prerequisite for tackling more complex mathematical concepts such as:

1. **Systems of Linear Equations:** Solving for unknowns in multiple linear relationships.
2. **Linear Algebra:** The study of vectors, vector spaces, and linear transformations, which are pervasive in data science and engineering.
3. **Calculus:** While calculus deals with rates of change that are not always constant, the concept of a derivative at a point is essentially the slope of the tangent line, which is a linear approximation.

Problem-Solving and Decision Making

By recognizing linear relationships, individuals and organizations can make more informed decisions. For instance, a business can use linear models to forecast sales, manage inventory, or determine pricing strategies.

Distinguishing Linear from Non-Linear Functions

It's crucial to be able to differentiate between linear and non-

linear functions. A function is non-linear if its graph is not a straight line or if its algebraic representation deviates from the $y = mx + b$ form. Common examples of non-linear functions include:

1. **Quadratic functions:** $f(x) = ax^2 + bx + c$ (parabolic graphs).
2. **Exponential functions:** $f(x) = a^x$ (graphs that curve upwards or downwards rapidly).
3. **Trigonometric functions:** $f(x) = sin(x)$, $f(x) = cos(x)$ (periodic, wave-like graphs).

The key distinction lies in the constant rate of change. In non-linear functions, the rate of change itself varies, leading to curves in their graphical representations.

Conclusion: The Enduring Power of Linearity

In summary, the **definition of a linear function in math** revolves around a constant rate of change, elegantly expressed by the algebraic form $f(x) = mx + b$. The slope (m) dictates this rate, while the y-intercept (b) provides the starting point. Graphically, this translates to a straight line, a visual hallmark of predictability and simplicity.

From its foundational role in algebra to its widespread application in modeling and problem-solving across various disciplines, the linear function remains a cornerstone of mathematical understanding. Mastering its definition is not merely about memorizing an equation; it's about grasping a fundamental principle that governs relationships and changes

in the world around us. As you delve deeper into mathematics, you will continually encounter and build upon the elegant simplicity and enduring power of the linear function.

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Questions & Answers About definition of linear function in math

No	Question	Answer
1	What's the simplest way to define a linear function in math?	A linear function is a function whose graph is a straight line. This means its rate of change is constant, making it predictable and easy to work with.

2	What's the general form or equation of a linear function?	The most common form is y = mx + b. Here, 'y' and 'x' are the variables, 'm' represents the constant rate of change (slope), and 'b' is the y-intercept (where the line crosses the y-axis).
3	Why is the 'slope' so important in a linear function?	The slope ('m') tells you how steep the line is and in which direction it's going. A positive slope means the line goes up from left to right, while a negative slope means it goes down.
4	Can you give an example of a real-world situation that can be modeled by a linear function?	Absolutely! Think about a taxi fare. The fare might have a fixed starting fee (the y-intercept, 'b') plus a charge per mile driven (the slope, 'm'). The total fare is a linear function of the distance traveled.
5	How can you tell if a relationship between two things is linear just by looking at data?	If the data points, when plotted on a graph, tend to form a straight line, the relationship is likely linear. This means for every equal increase in one variable, there's a corresponding equal increase or decrease in the other.
6	What's the difference between a linear function and a linear equation?	A linear equation (like 2x + 3y = 6) describes a relationship between variables that results in a straight line when graphed. A linear function (like f(x) = 2x + 3) is a specific type of linear equation that defines a unique output ('y' or 'f(x)') for every input ('x').

7	Are there any special cases of linear functions?	Yes! A horizontal line is a linear function where the slope (m) is 0 (e.g., y = 5). A vertical line is *not* a function because it fails the vertical line test (multiple y-values for one x-value).

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