**Activity 1.3.1 Linear and Nonlinear Growth**

One of the most important ways to study functions is to look at how they grow. Suppose you have a table of values from a function where the inputs are always increasing by 1. There are three types of function growth we will study in this Activity:

* If the **difference** between successive outputs is constant, the function has **linear growth**.
* If the **ratio** between successive outputs is constant, the function has **exponential growth**.
* If the **difference between the successive differences** in outputs (the “second differences”) is constant, the function has **quadratic growth**.

Follow these steps to complete the tables in this Activity.

* Fill-in the output column.
* In the “difference between outputs” column, find the difference between successive outputs when the inputs increase by 1. If the differences in this column are constant, the function has **linear** growth.
* If not, then in the “ratio of outputs” column, find the ratios between successive outputs when the inputs increase by 1. If the ratios in this column are constant, the function has **exponential** growth.
* If not, then in the “differences in differences” column, find the difference in successive differences between outputs. If the differences in this column are constant, the function has **quadratic** growth.
* If none of these characteristics are found, write **other** for the type of growth in the function.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** |
| 1 | 1 |  |  |  |
| 2 | 4 | 4 – 1 = 3 | 4/1 = 4 |  |
| 3 | 9 | 9 – 4 = 5 | 9/4 = 2.25 | 5 – 3 = 2 |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |

1. What type of function growth does have? Explain why.
2. Sketch a graph of on the axes below.



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** | | 1 | 3 |  |  |  | | 2 | 1 | 1 – 3 = -2 | 1/3 = 0.33 |  | | 3 |  |  |  |  | | 4 |  |  |  |  | | 5 |  |  |  |  | | 6 |  |  |  |  | |  |

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** | | 1 |  |  |  |  | | 2 |  |  |  |  | | 3 |  |  |  |  | | 4 |  |  |  |  | | 5 |  |  |  |  | | 6 |  |  |  |  | |  |

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** | | 1 |  |  |  |  | | 2 |  |  |  |  | | 3 |  |  |  |  | | 4 |  |  |  |  | | 5 |  |  |  |  | | 6 |  |  |  |  | |  |

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** | | 1 |  |  |  |  | | 2 |  |  |  |  | | 3 |  |  |  |  | | 4 |  |  |  |  | | 5 |  |  |  |  | | 6 |  |  |  |  | |  |

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** | | 1 |  |  |  |  | | 2 |  |  |  |  | | 3 |  |  |  |  | | 4 |  |  |  |  | | 5 |  |  |  |  | | 6 |  |  |  |  | |  |

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Input**  ***x*** | **Output**  ***f (x)*** | **Difference between outputs** | **Ratio of outputs** | **Difference in differences** | | 1 |  |  |  |  | | 2 |  |  |  |  | | 3 |  |  |  |  | | 4 |  |  |  |  | | 5 |  |  |  |  | | 6 |  |  |  |  | |  |

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