

## 1 | First order difference

$\frac{\Delta y}{\Delta x}$  (Average slope of the function between two points)

When the first order difference  $> 0$  — as  $x$  increases,  $f(x)$  *increases*

When first order difference  $< 0$  — as  $x$  increases,  $f(x)$  *decreases*

## 2 | Second order differences

$\frac{\Delta^2 y}{\Delta x^2}$  (The "acceleration" of the function)

*This is related to the concavity of the graph!!*

When the second order difference  $> 0$  — the graph should be concave up

"As soon as the yoyo is rolled, it is accelerating upwards. First, the acceleration works to slow the downwards velocity. Then, it actually flips the velocity up."

When first order difference  $< 0$  — as  $x$  increases,  $f(x)$  *decreases*

"As soon as the ball is tossed, it is accelerating downwards. First, the acceleration works to slow the upwards velocity. Then, it actually flips the velocity down."

## 3 | Linear Functions

- No change in slope
- And hence, 0 second order difference
- and so there is no concavity

## 4 | Log Functions

They are inverse to exponential functions.

Recall that, for the base graph  $y = \log(x)$ :

1. Domain should be  $(0, \infty)$
2. Range is  $(-\infty, \infty)$
3. As  $x \rightarrow 0^+$ ,  $y \rightarrow -\infty$
4. x-int at  $y = 0$ .

These, of course, are flipped for its sister, inverse function  $y = 10^x$

1. Range should be  $(0, \infty)$
2. Domain is  $(-\infty, \infty)$
3. As  $x \rightarrow -\infty$ ,  $y \rightarrow 0$
4. y-int at  $x = 0$ .