Calculus

Hochschule Bonn-Rhein-Seig

SS24

Created by Michal & Musharraf, will be presented by Kishan

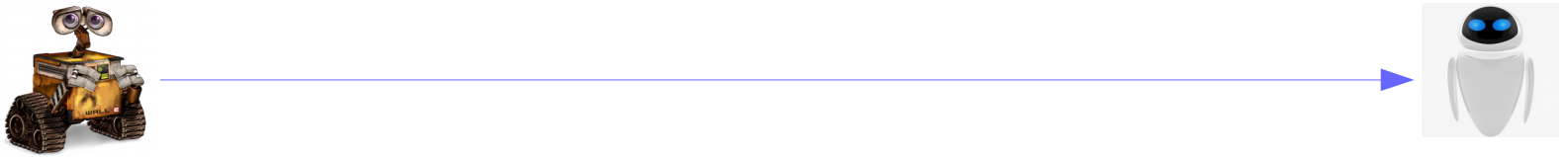
Where is Calculus applied?

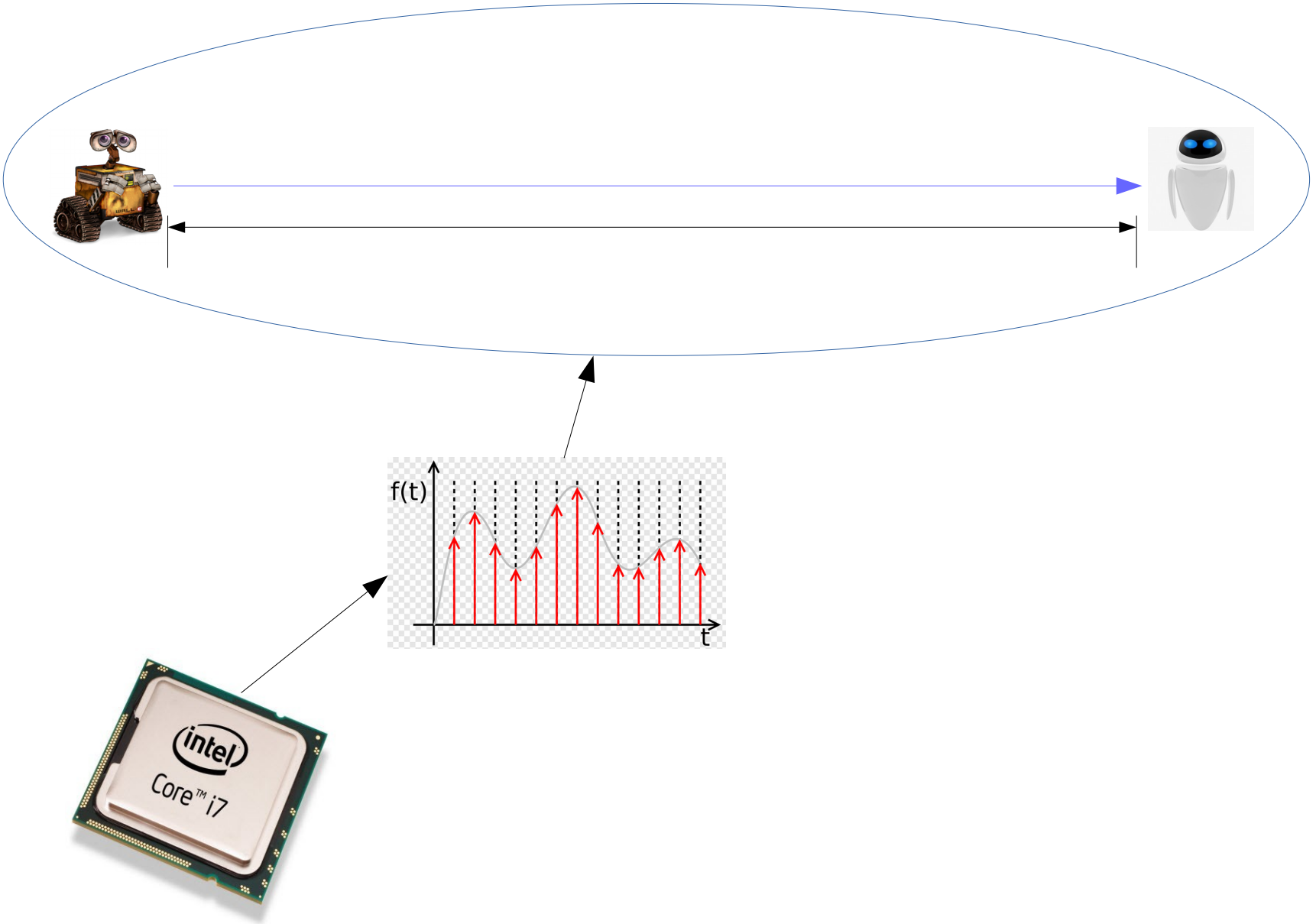
- Robotics (Kinematics)
- Neural Networks
- Dynamic System Modeling (Control System)

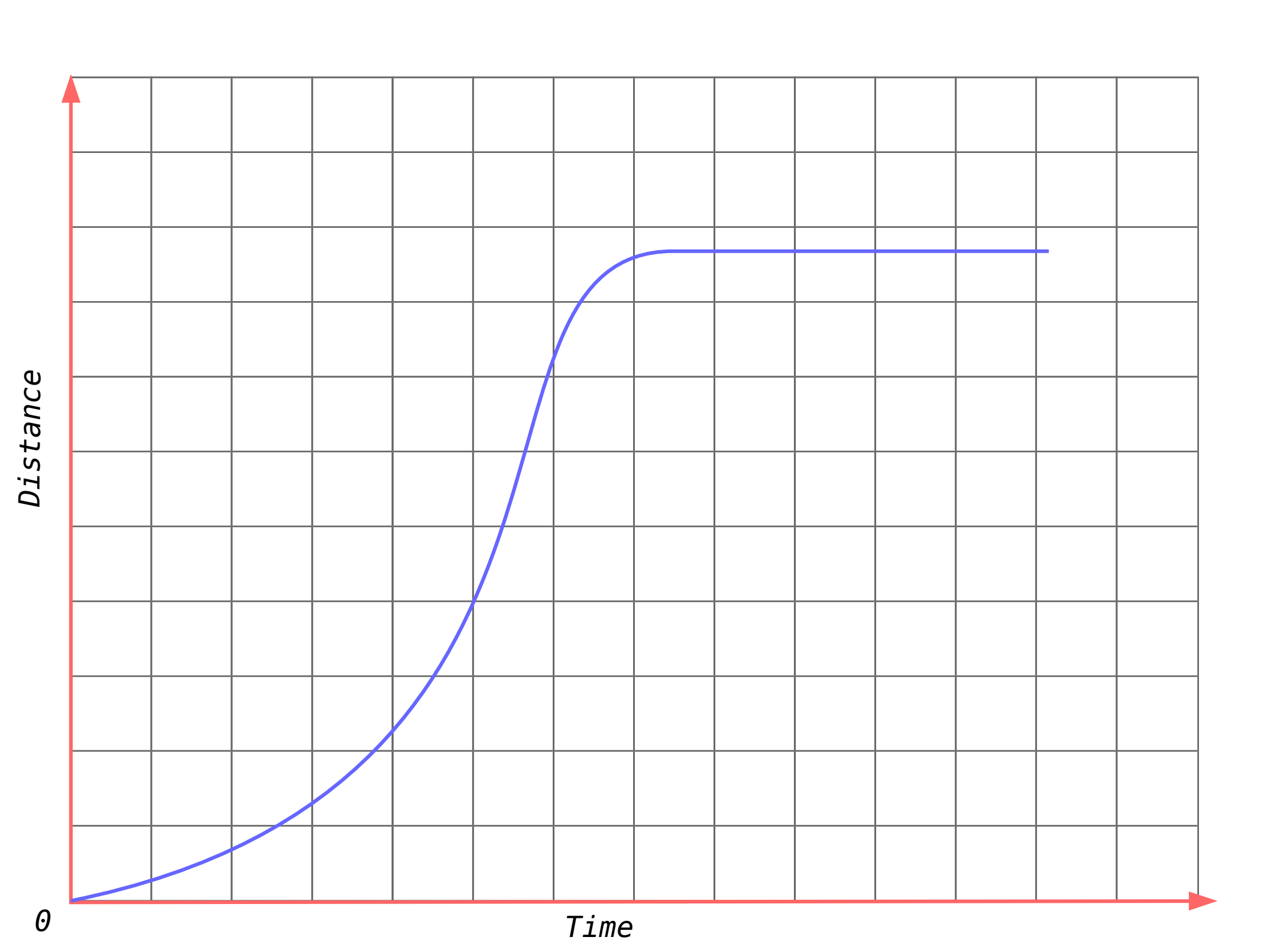
Derivatives

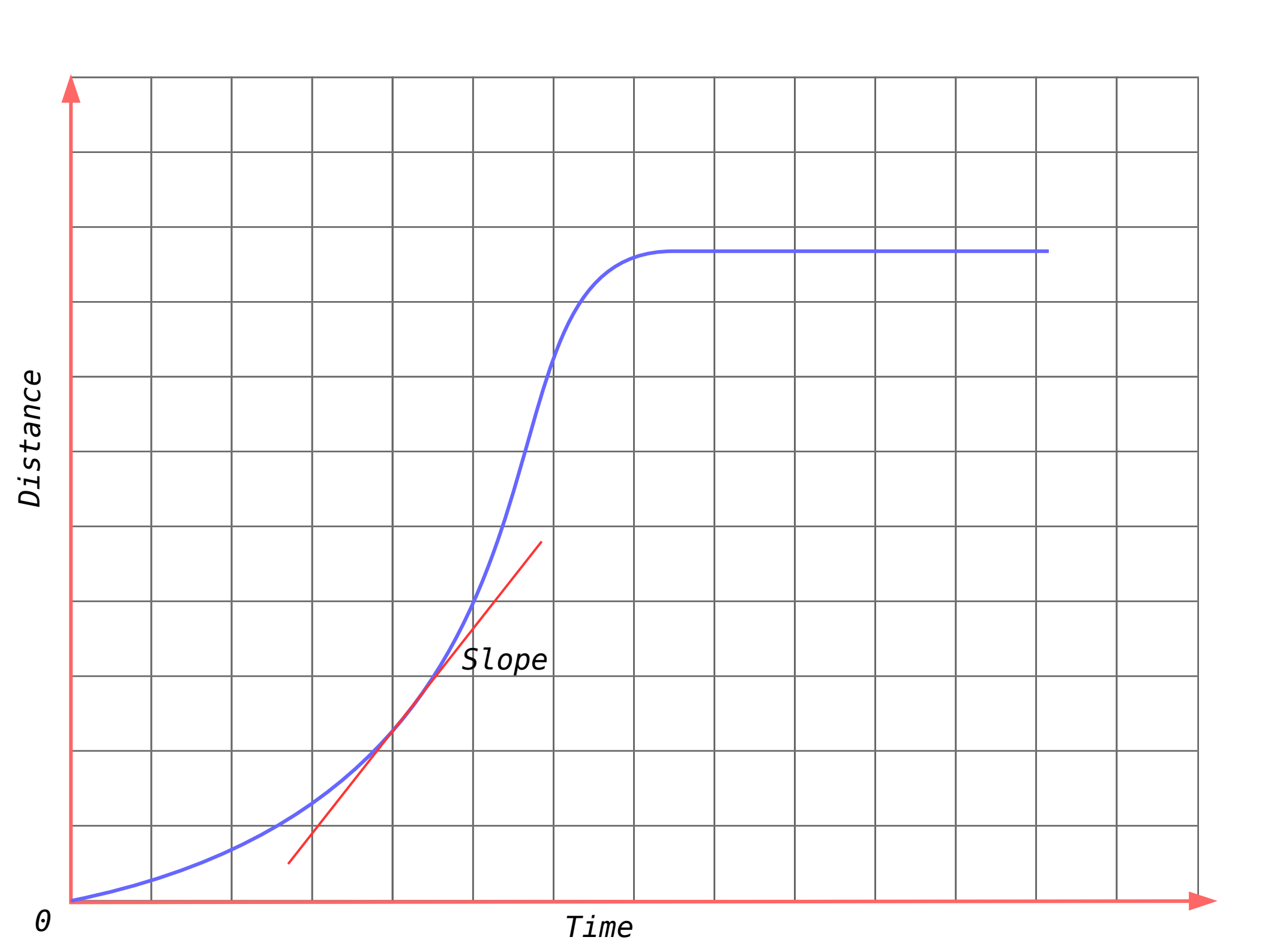
Analog

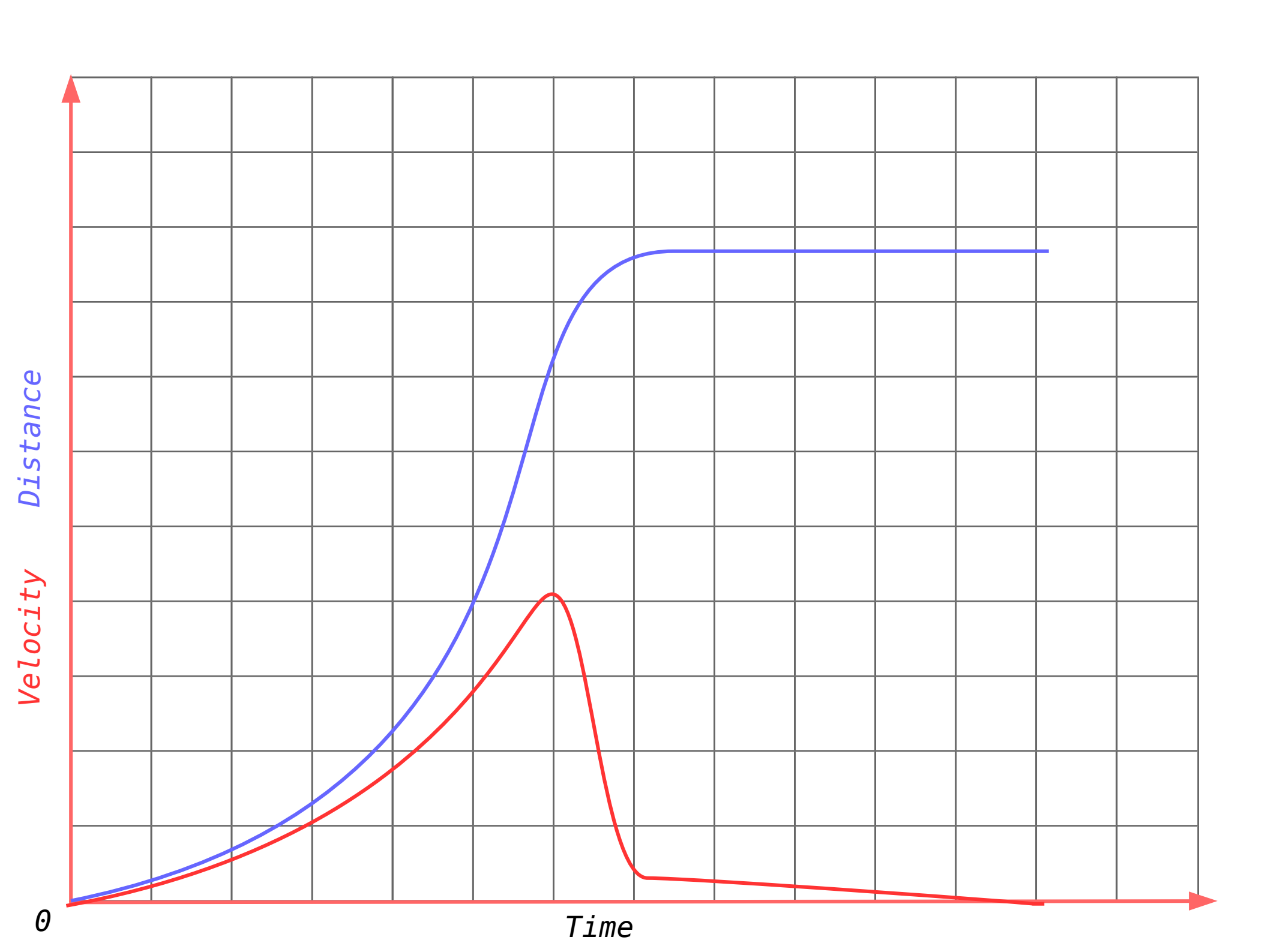
Digital

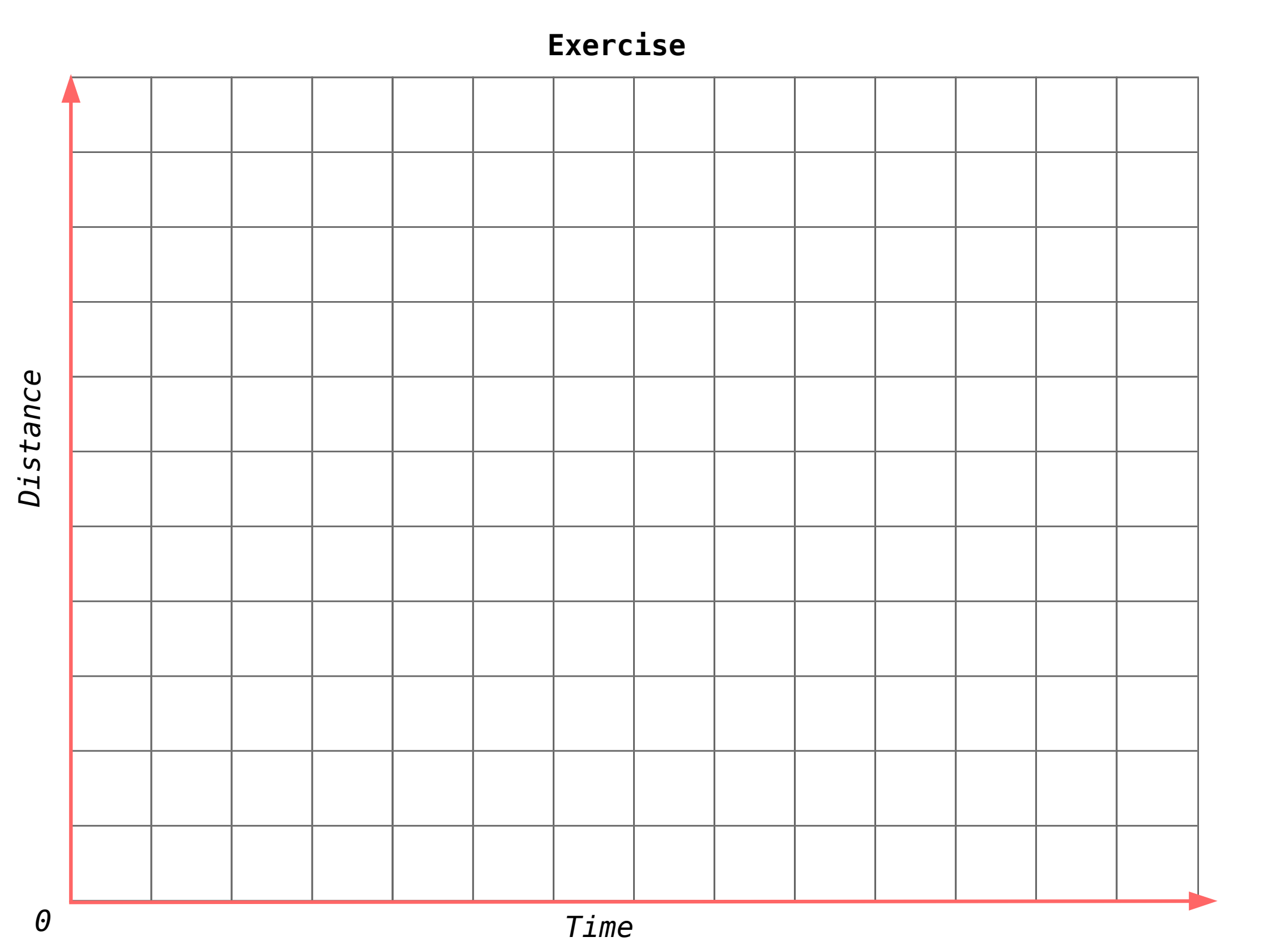


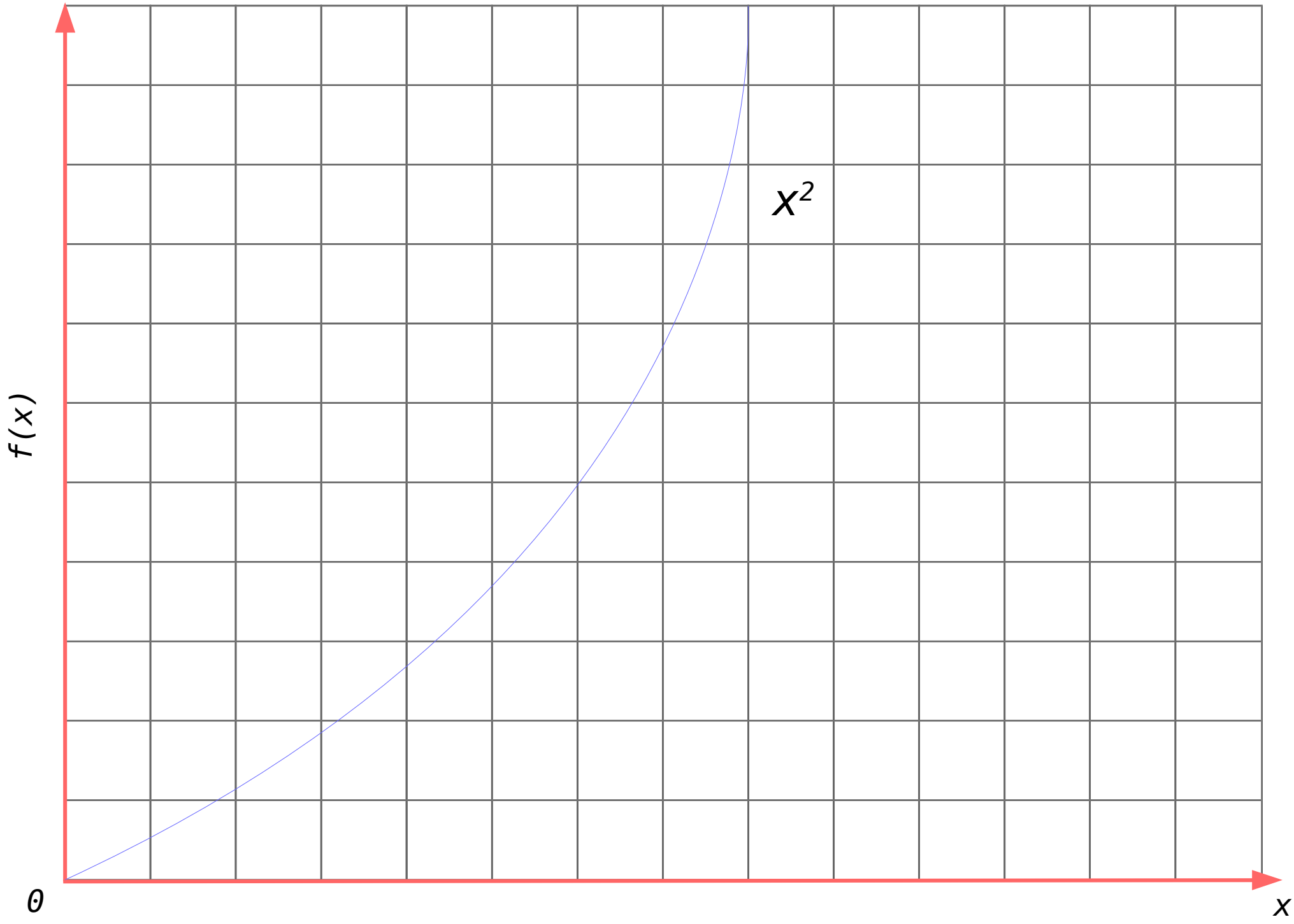

f(t)
t
intel
Core™ i7


Distance
0
Time


Distance
Slope
0
Time


Distance
Velocity
0
Time

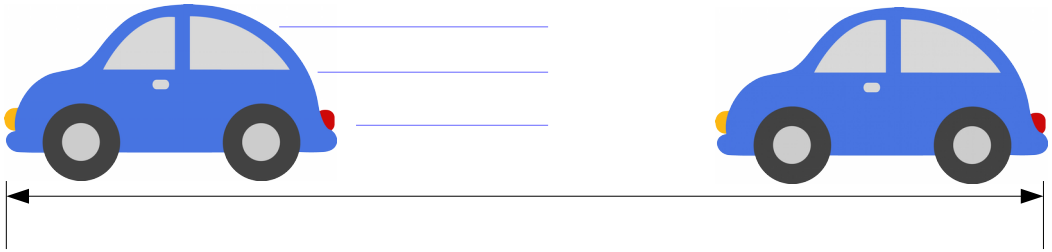

Exercise
Distance
0
Time

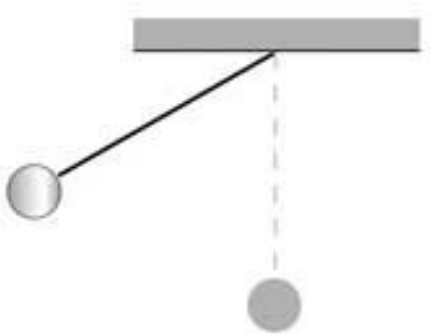

x^2
f(x)
0
x

Functions

- $f(x) = 2x^2 - x^3$
- $f(x) = sin(x)$
- $f(x) = e^x$

Application

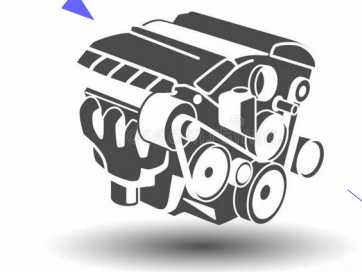




Chain Rule

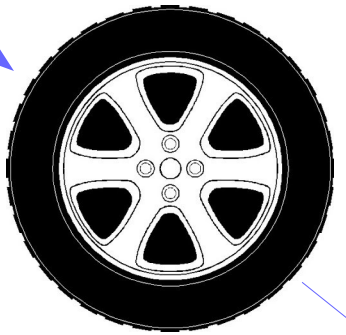
Dependent Systems

$u = f(x)$



$v = g(u)$

$w = h(v)$



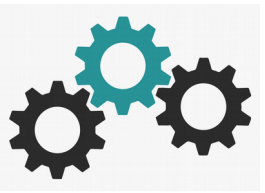
$y = j(w)$

$z = k(y)$

Dependent Systems

$u = f(x)$

$v = g(u)$



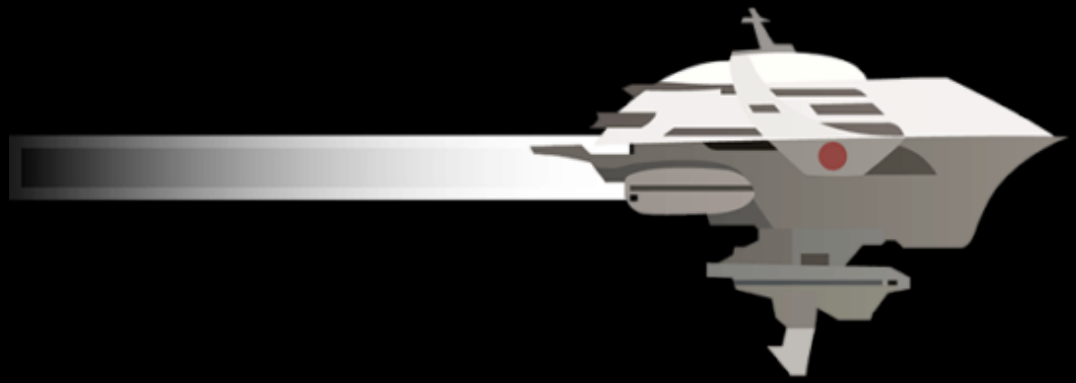
$w = h(v)$

$y = j(w)$

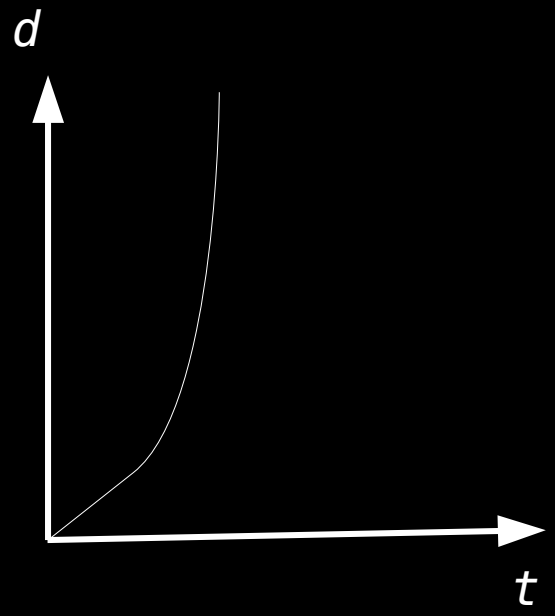
$z = k(y)$

$$\frac{dz}{dx} = \frac{dz}{dy} * \frac{dy}{dw} * \frac{dw}{dv} * \frac{dv}{du} * \frac{du}{dx}$$

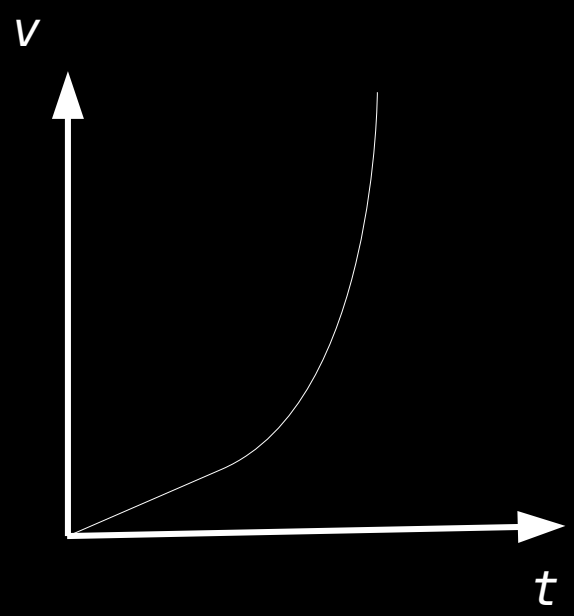
Higher Order Derivatives



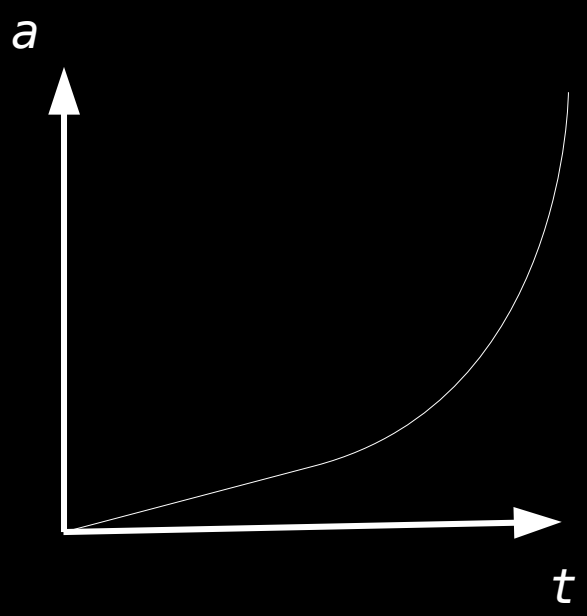
Warp Drive



$d = t^4$



$v = 4t^3$



$a = 12t^2$

What about derivative of the discrete function?

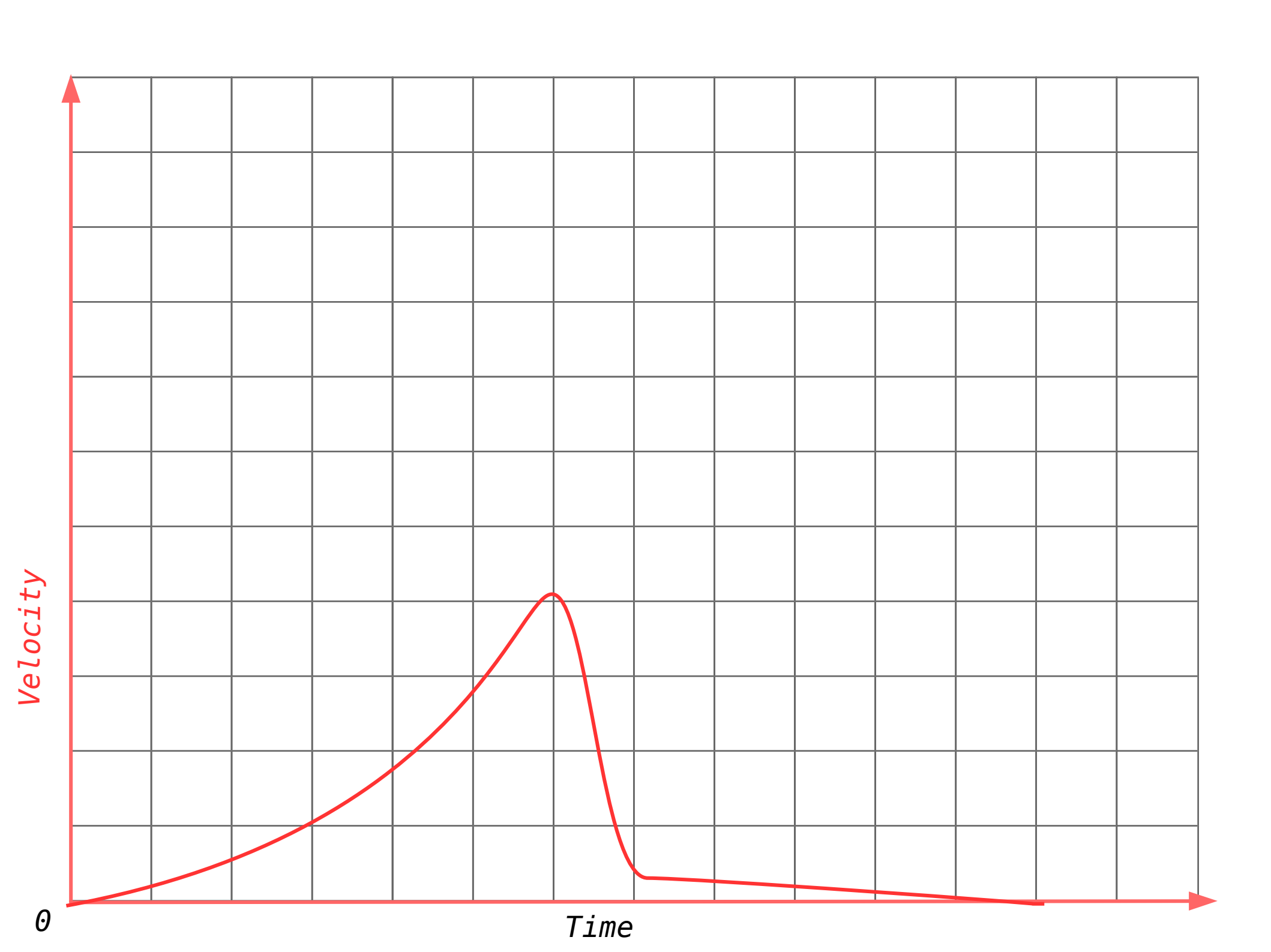
Approximate!

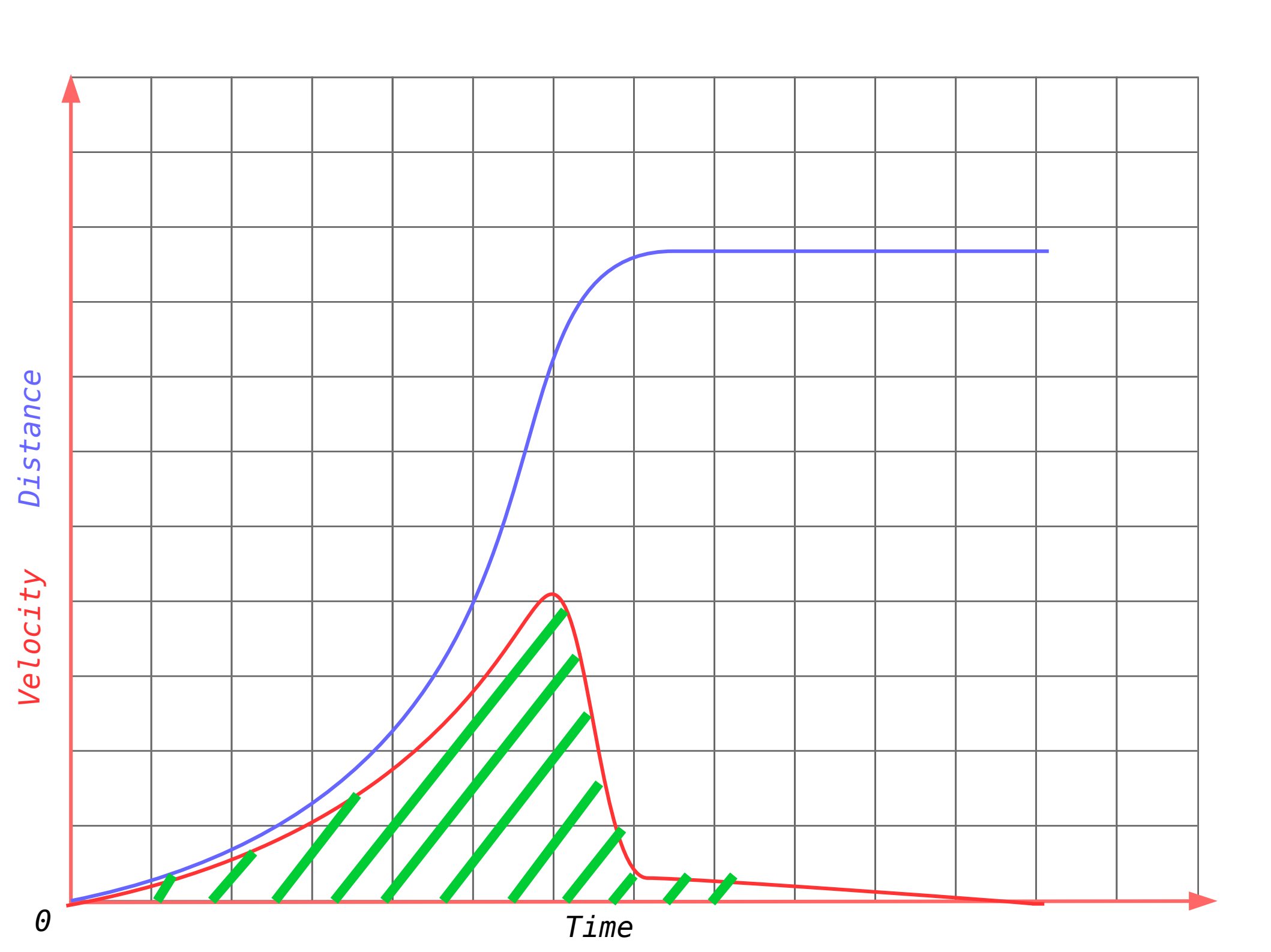
$$f'(x) = \lim_{\epsilon \to 0} \frac{f(x+\epsilon) - f(x)}{\epsilon}$$

$$f'(x) \approx \frac{f(x+h) - f(x)}{h}$$

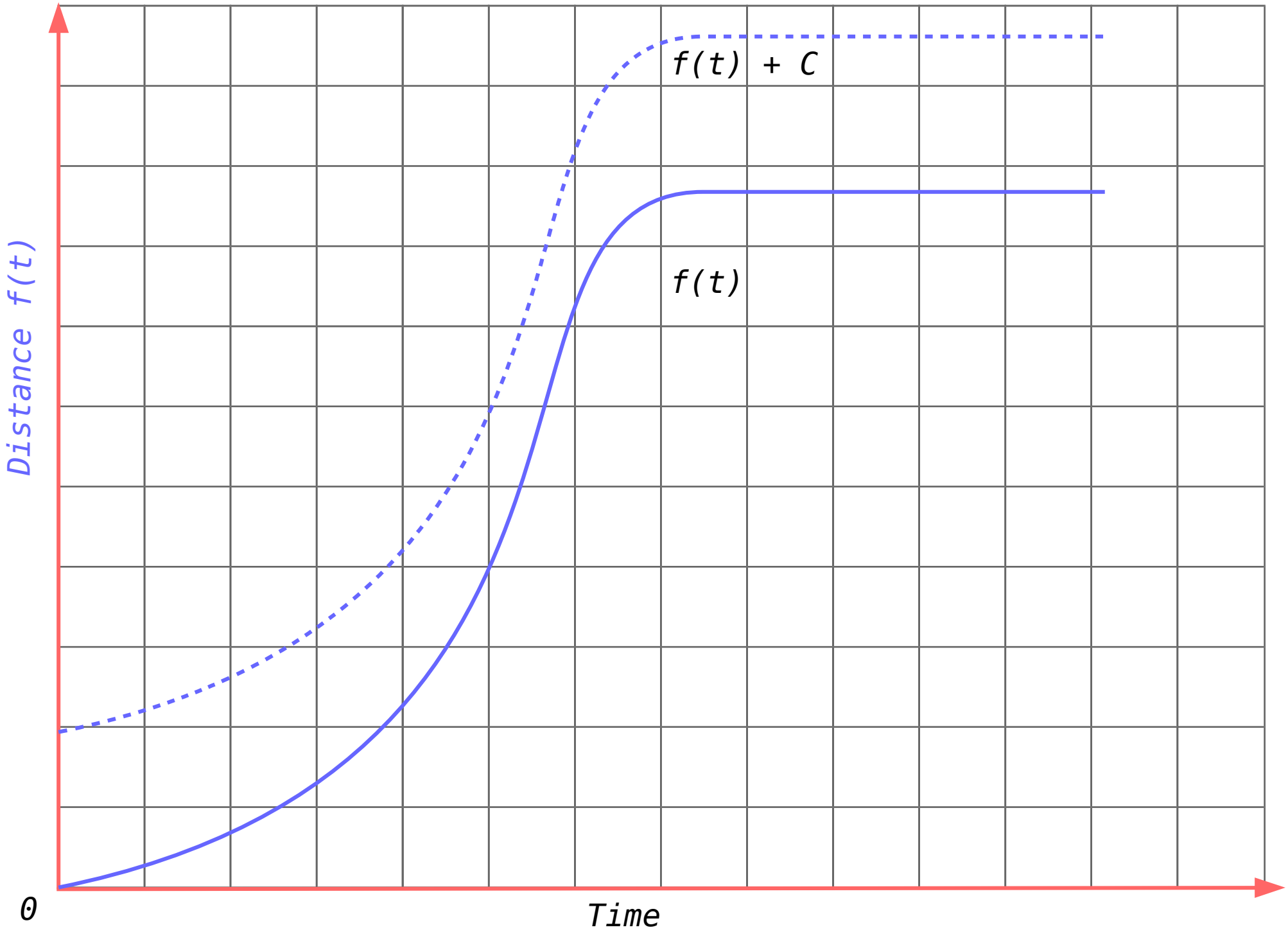
h – small, positive, fixed epsilon

Integrals


Velocity
0
Time


Distance
Velocity
0
Time

Integrals Bounds


f(t) + C
f(t)
Distance f(t)
0
Time

What about integral of the discrete function?

Approximate!

$$\int_a^b f(x)dx \approx \frac{h}{2}\sum_{k=0}^{n-1}(s_{k+1}+s_k)$$

h – small, positive, fixed epsilon

Question