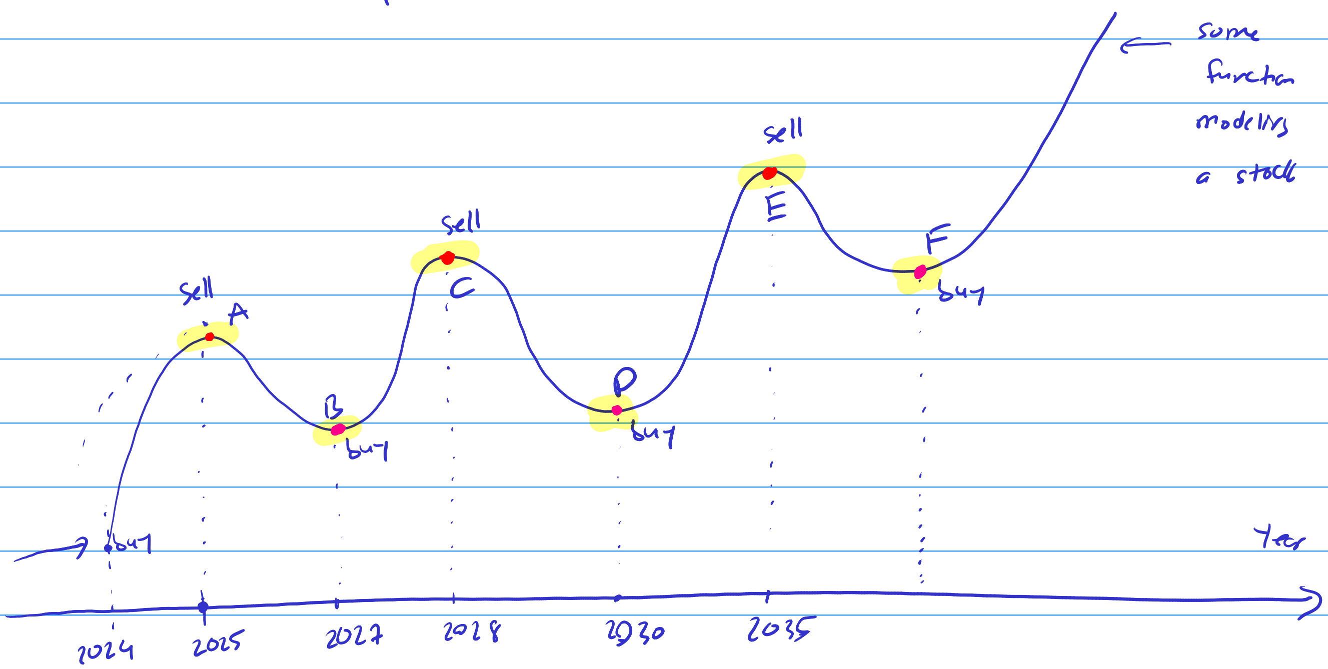
we can use function to model data / real-world issues

why we want to do that ?

The benefit is: - Make future predictions / estimation

- Find some optimal value of the function. For example: Find the number of items that a company should produce to maximize their profit.

use Derivatives to solve it



A, B, C, D, E, F are called local extrema of the function.

we can use "Derivatives" to find these points for a given function

Points A, C, E : local max where the 1^{st} derivatives are zeros and 2^{nd} derivatives are negative

Points B, D, F : local min 1^{st} derivative are zeros and 2^{nd} _____ are positive.

Derivatives

we will cover the following functions:
- polynomial f.
- Rational f.
- Exponential f.
- Logarithmic f.

Rule 1 (power rule)

The derivative of $f(x)$ is denoted by $f'(x)$

$$\boxed{f(x) = x^n \Rightarrow f'(x) = n \cdot x^{n-1}}$$

Example: Find $f'(x)$

① $f(x) = x^4 \Rightarrow f'(x) = 4 \cdot x^{4-1} = 4x^3$

② $f(x) = x^{2024} \Rightarrow f'(x) = 2024 \cdot x^{2024-1}$

$= 2024 \cdot x^{2023}$

③ $f(x) = x = x^1 \Rightarrow f'(x) = \underbrace{1 \cdot x^{1-1}}$ $= x^0$

$= 1$

$\Rightarrow f'(x) = 1$

④ $f(x) = \sqrt{x} = x^{1/2}$

$\Rightarrow f'(x) = \frac{1}{2} x^{1/2 - 1} = \frac{1}{2} x^{-1/2}$

⑤ $f(x) = \sqrt[3]{x} = x^{1/3}$

$$f'(x) = \underbrace{\frac{1}{3} x^{1/3 - 1}} = \frac{1}{3} x^{-2/3}$$

In general: $f(x) = \sqrt[n]{x} = x^{1/n}$

$$f'(x) = \frac{1}{n} \cdot x^{1/n - 1}$$

$\boxed{\text{Assignment 12}}$ Find $f'(x)$

① $f(x) = x^{1000}$

② $f(x) = x^{3}$

③ $f(x) = x^{7}$

④ $f(x) = x$

⑤ $f(x) = \sqrt[4]{x}$

⑥ $f(x) = \sqrt[5]{x}$

⑦ $f(x) = x^{2/3}$

⑧ $f(x) = x^{7/3}$

⑨ $f(x) = x^{-6}$

⑩ $f(x) = \frac{1}{x}$ (extra credit)

Show all the work as in the example.

Do not just give the final answer.