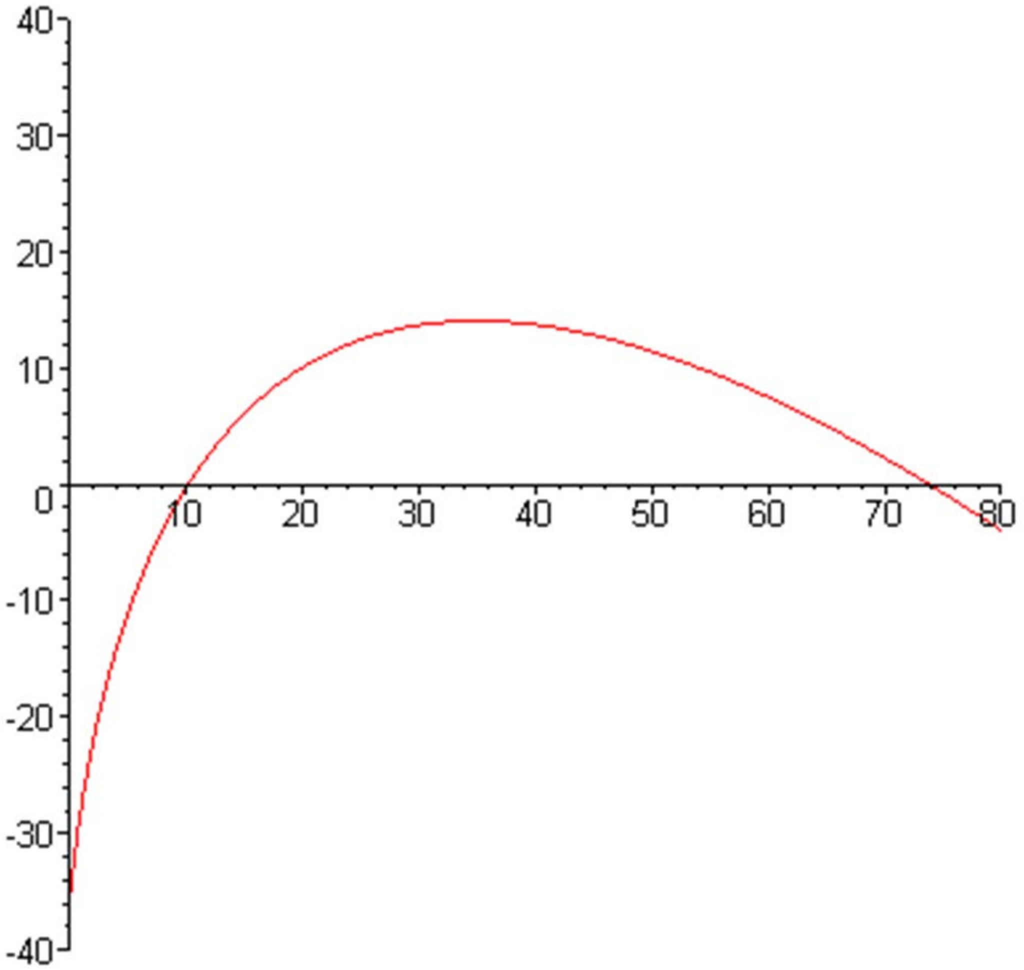
Derivative

Function f

f: $D \to \mathbb{R}$ where $D \subset \mathbb{R}$
$x \to y = f(x)$

Ex.: $f(x) = 24\sqrt{x+1} - 2x - 60$



What do we want to know?

Slope of the tangent to the graph of the function f at a certain point $A(x_0 \mid f(x_0))$.

Why do we want to know the slope?

- relative **maximum/minimum** (slope = 0)
- **increasing** (slope > 0), **decreasing** (slope < 0)
- **concavity** (concave up if slope increases, concave down if slope decreases), points of inflection

Applications in economics

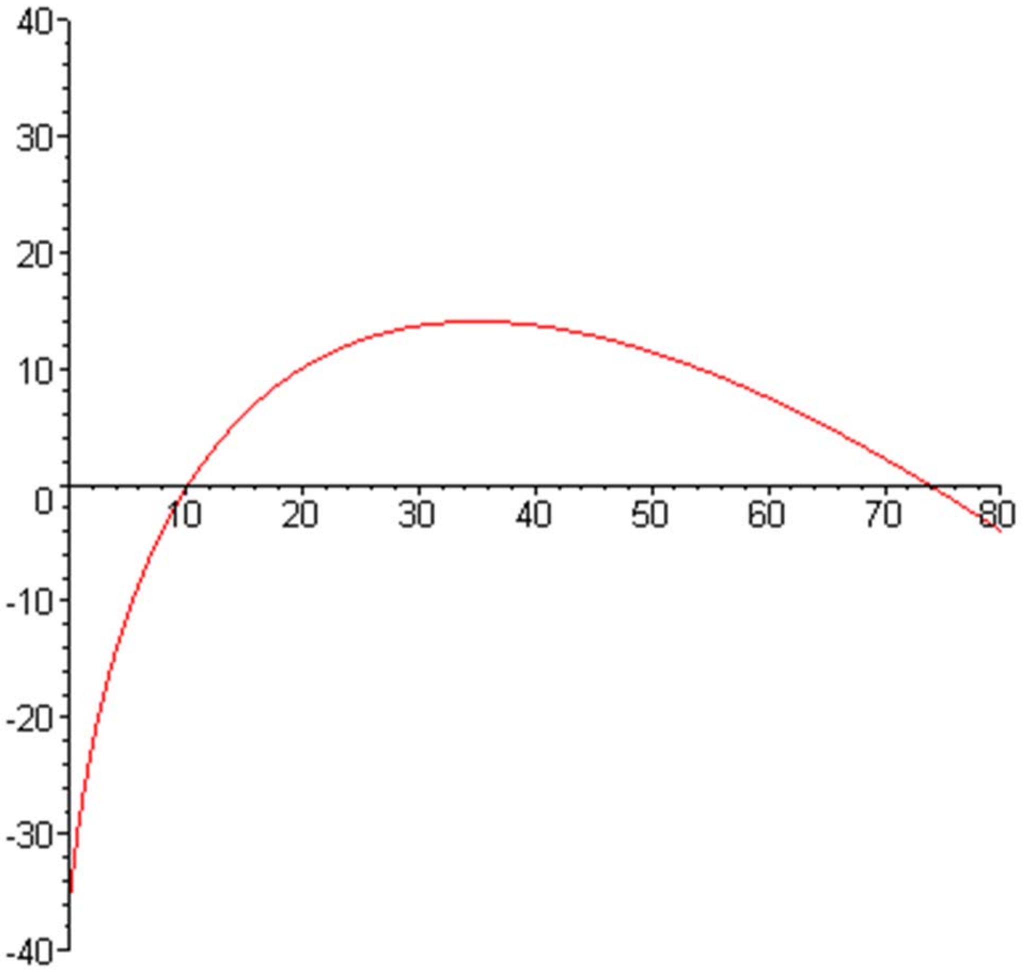
- maximum/minimum of costs/revenue/profit
- tendency of costs/revenue/profit
- **marginal costs/revenue/profit** (change of costs/revenue/profit if number x of items increases by one)

Definition

The slope of the tangent to the graph of f at the point $A(x_0 \mid f(x_0))$ is called the **derivative** or the **rate of change of f at x_0**, denoted $f'(x_0)$.

How can we determine the slope?

The slope of the **secant** through the points $A(x_0 \mid f(x_0))$ and $B(x_0+\Delta x \mid f(x_0+\Delta x))$ tends towards the slope of the **tangent** at $A(x_0 \mid f(x_0))$ as Δx tends towards 0.



Ex.: $f: \mathbb{R} \to \mathbb{R}$

$x \to y = f(x) = x^2$

$f'(x_0) = 2x_0$

Definition

Suppose that the rate of change $f'(x_0)$ exists for all $x_0 \in D_1$, where $D_1 \subset D$.

The function f'

$$f': D_1 \rightarrow \mathbb{R}$$
$$x \rightarrow y = f'(x)$$

is called the **derivative of the function f**.

Ex. 1: $f: \mathbb{R} \rightarrow \mathbb{R}$, $x \rightarrow y = f(x) = x^2$ $\qquad$ $f': \mathbb{R} \rightarrow \mathbb{R}$, $x \rightarrow y = f'(x) = 2x$

Ex. 2: $f: D \rightarrow \mathbb{R}$, $x \rightarrow y = f(x) = 24\sqrt{x+1} - 2x - 60$ $\qquad$ $f': D_1 \rightarrow \mathbb{R}$, $x \rightarrow y = f'(x) = \frac{12}{\sqrt{x+1}} - 2$