Def: \[ f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} \]

Eq: 

[Diagram showing a graph with a curve and labels a and b.] 

\[ y = f'(x) \]

[Another diagram showing a graph with a curve and labels a and b.] 

\[ y = f''(x) \]
Let \( f(x) = x^3 + 4x + 2 \)
Find a formula for \( f'(x) \).

Let \( g(x) = \sqrt{x-1} \)
Find the derivative and state its domain.
Notation: If \( y = f(x) \) we might denote the derivative as

\[
f'(x) = y' = \frac{dy}{dx} = \frac{df}{dx} = \frac{d}{dx} f(x) = D_x f(x).
\]

Def.: A fc. \( f \) is differentiable at a \( \iff \)
\( f'(a) \) exists. It is differentiable on \((a,b)\)
if it is differentiable at every number in \((a,b)\).

Eg.: Where is \( f(x) = |x| \) differentiable?

Recall \(|x| = \begin{cases} -x & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases}\)
Thm: If \( f \) is differentiable at \( a \), then it is continuous at \( a \).

- Note: cont. does not imply diff. (e.g., \( f(x) = |x| \) is cont. but not diff. at 0.)

How can a function fail to be diff.?

1. It could fail to be cont.

2. It could have a sharp point.

3. It could have a vertical tangent line.

\( y = \lfloor x \rfloor \)