

## 3.4 The Chain Rule

Marius Ionescu

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### Theorem

Let  $(f \circ g)(x) = f(g(x))$  be the function defined from  $f$  and  $g$  by composition. Assume that  $g$  is differentiable at the point  $x$  and that  $f$  is differentiable at the point  $g(x)$ . Then the composite function  $f \circ g$  is differentiable at the point  $x$ , and

$$(f \circ g)'(x) = [f(g(x))]' = f'(g(x))g'(x)$$

Using Leibniz's notation:

$$\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}.$$

Example

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- Differentiate

$$f(x) = \sqrt{x^2 + 1}.$$

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$$f(x) = \sqrt{x^2 + 1}.$$

- Differentiate

$$y = (x^2 + 2)^{10}.$$

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$$y = e^{\frac{1}{x}}.$$

- Differentiate

$$y = 10^{1-x^2}.$$