

Implicit Differentiation

Differentiate even when y is not isolated

$$y + \sin y = \cos x$$

x and y connected
inside the same equation.

Two Ways a Function Can Appear

Explicit

$$y = f(x)$$

Example:

$$y = x - \pi$$

Implicit

$$x + \sin(xy) - y = 0$$

y depends on x even though
it is not isolated.



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$$E=mc^2$$



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Remember: y Depends on x

$$\frac{d}{dx}(\sin y)$$

Wrong:

$$\cos y$$

Correct:

$$\cos y \cdot \frac{dy}{dx}$$

Then show: $\frac{d}{dx}(y) = \frac{dy}{dx}$

Differentiate the Relation Directly



Given:

$$y + \sin y = \cos x$$



Differentiate:

$$\frac{dy}{dx} + \cos y \cdot \frac{dy}{dx} = -\sin x$$

Collect dy/dx Terms

Start:

$$\frac{dy}{dx} + \cos y \frac{dy}{dx} = -\sin x$$

Factor:

$$\frac{dy}{dx} (1 + \cos y) = -\sin x$$

Therefore:

$$\frac{dy}{dx} = \frac{-\sin x}{1 + \cos y}$$

Restriction: $y \neq (2n + 1)\pi$ (denominator cannot be zero)

Implicit Differentiation Rule

When differentiating with respect to x :

Any function of y $\rightarrow$ use chain rule $\rightarrow$ multiply by $\frac{dy}{dx}$

Easy to isolate y ?

Maybe use explicit form.

Hard to isolate y ?

Differentiate the relation directly.



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