Differentiation

Study Development Quickguide

Simple differentiation

If $f(x) = ax^n$ where a and n are constants, then

$$f'(x) = (a \times n)x^{n-1}$$

For a function of the form $f(x) = ax^n + bx^m + \cdots$ we simply differentiate each term from left to right to get:

$$f'(x) = (a \times n)x^{n-1} + (b \times m)x^{m-1} + \cdots$$

The differential of a constant is 0.

Common differentiation rules

$$\frac{\mathrm{d}\sin(\mathrm{x})}{\mathrm{d}x} = cos(x)$$

$$\frac{\mathrm{d}\cos(\mathrm{x})}{\mathrm{d}x} = -sin(x)$$

$$\frac{\mathrm{d}(-sin(x))}{\mathrm{d}x} = -cos(x)$$

$$\frac{\mathrm{d}(-cos(x))}{\mathrm{d}x} = sin(x)$$

$$\frac{\mathrm{d}\,tan(x)}{\mathrm{d}x} = sec^2(x)$$

Differential of natural log: $\frac{\mathrm{d}\,log\big(f(x)\big)}{\mathrm{d}x} = \frac{f'(x)}{f(x)}$

$$\frac{\mathrm{d}e^{f(x)}}{\mathrm{d}x} = f'(x)e^{f(x)}$$

The chain rule

$$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y(u)}{\mathrm{d}u} \times \frac{\mathrm{d}u}{\mathrm{d}x}$$

The product rule

$$\frac{\mathrm{d}f(x)g(x)}{\mathrm{d}x} = f(x)\frac{\mathrm{d}g(x)}{\mathrm{d}x} + g(x)\frac{\mathrm{d}f(x)}{\mathrm{d}x}$$

The quotient rule

$$\left(\frac{f(x)}{g(x)}\right)' = \frac{g(x)f'(x)-f(x)g'(x)}{\left(g(x)\right)^2}$$

Equation of a tangent

To find the equation of a tangent at a point on a function:

1. Differentiate the function. This gives you an expression for the gradient of the function.
2. Calculate the gradient using the expression from step 1 at the point you want the tangent at. Do this by plugging in the x value given.
3. Write a new expression of the form: $y = (\text{gradient at the point})x + c$.
4. Use the x and y values of the point given to calculate c.

Turning points

To find a turning point:

1. Differentiate the function.
2. Equate the differential to 0 and solve for x.
3. Substitute these x values into your original function to find the corresponding y values.

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