0.1 Integration by parts

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We have:

$$\frac{\delta y}{\delta x} = f(x)g(x)$$

We want that in terms of y.

We know from the product rule of differentiation:

$$y = a(x)b(x)$$

Means that:

$$\frac{\delta y}{\delta x} = a'(x)b(x) + a(x)b'(x)$$

So let's relabel f(x) as h'(x)

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$$\frac{\delta y}{\delta x} = h'(x)g(x)$$

$$\frac{\delta y}{\delta x} + h(x)g'(x) = h'(x)g(x) + h(x)g'(x)$$

$$y + \int h(x)g'(x) = \int h'(x)g(x) + h(x)g'(x)$$

$$y + \int h(x)g'(x) = h(x)g(x)$$

$$y = h(x)g(x) - \int h(x)g'(x)$$

For example:

$$\frac{\delta y}{\delta x} = x.\cos(x)$$

$$f(x) = \cos(x)$$

$$g(x) = x$$

$$h(x) = \sin(x)$$

$$g'(x) = 1$$

So:

$$y = x \int \cos(x) dx - \int \sin(x) dx$$

$$y = xsin(x) - cos(x) + c$$