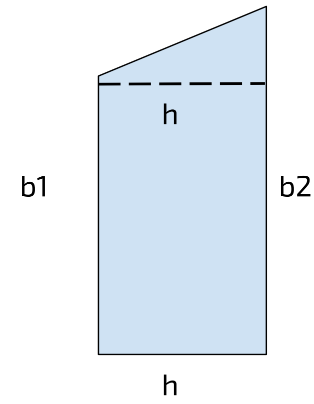
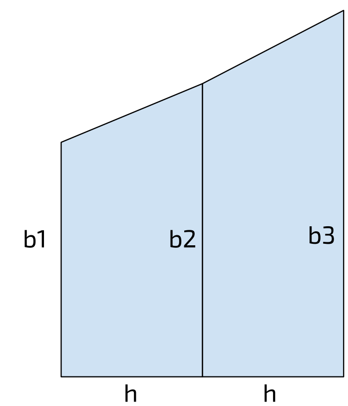
Breakdown of Trapezoidal Formula

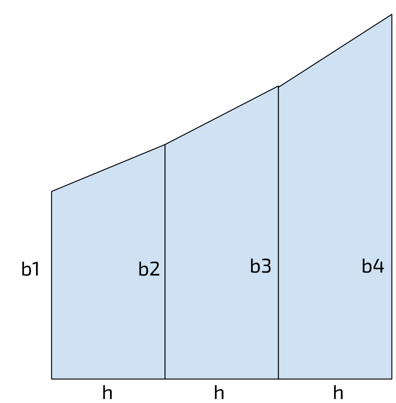
The formula for the area of a regular trapezoid is
$\frac{1}{2}(b_1 + b_2)(h)$



If we add a second trapezoid, the area becomes
$\frac{1}{2}(h)(b_1 + b_2) + \frac{1}{2}(h)(b_2 + b_3)$



If we added a third trapezoid, the area would be
$\frac{1}{2}(h)(b_1 + b_2) + \frac{1}{2}(h)(b_2 + b_3) + \frac{1}{2}(h)(b_3 + b_4)$



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Notice that we can can factor out the $\frac{1}{2}(h)$:

$\frac{1}{2}(h)[(b_1 + b_2) + (b_2 + b_3) + (b_3 + b_4)]$

Also, we can combine the terms in the middle (b_2 and b_3) because there are two of each

$\frac{1}{2}(h)[b_1 + 2b_2 + 2b_3 + b_4)]$

See the pattern?

Let's change h to Δx to represent the equal width of sections under a curve and change the base values to represent the output of a function at each x-value. If we continue following the pattern above, then we get the formula:

$$A = \frac{\Delta x}{2}(f(a) + 2f(a + \Delta x) + 2f(a + 2\Delta x) + \ldots + 2(f(b - \Delta x) + f(b))$$