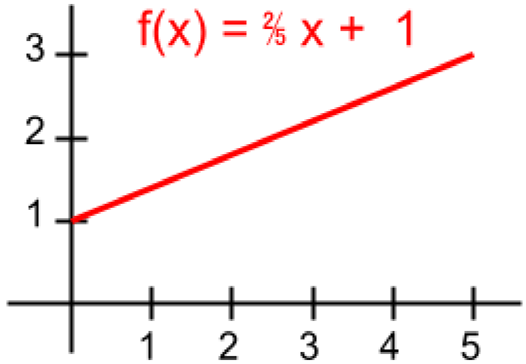
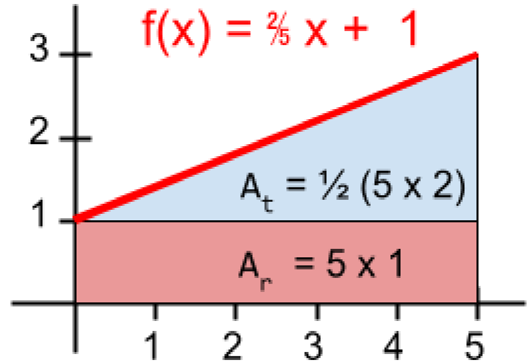
The area under a "curve" is the area bounded by a function and the x and y axis. For the function $f(x) = \frac{2}{5}x + 1$ between x=0 and x=5, this area is the sum of the area of the rectangle and the area of the triangle **$A = A_r + A_t = (5 \times 1) + ½(5 \times 2) =$ 10**





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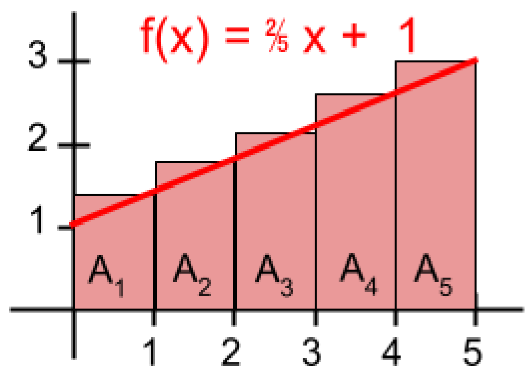
*The area under **any** curve can be **approximated** by dividing the area into vertical rectangles of equal widths and then adding up the area of all the rectangles.*

When using 5 rectangles for the area under $f(x) = \frac{2}{5}x + 1$ between x=0 and x=5 the total area is given by **$A = A_1 + A_2 + A_3 + A_4 + A_5$** where the width of each rectangle is 1 and the height of each rectangle is given by evaluating the function **f(x)** at **x=1,2,3,4,** and **5**.



Calculating the total area of the 5 rectangles gives

A = 1 x f(1) + 1 x f(2) + 1 x f(3) + 1 x f(4) + 1 x f(5)
A = 1 x 7/5+ 1 x 9/5 + 1 x 11/5 + 1 x 13/5 + 1 x 15/5
A = 55/5
A = 11

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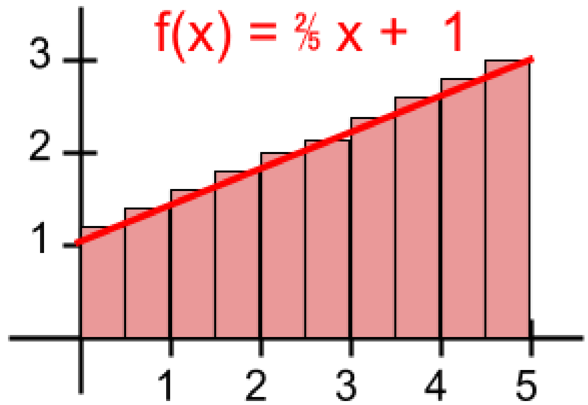
*Using **more rectangles** gives a better approximation of the actual area.*

For example, with 10 rectangles the width of each rectangle becomes $\frac{1}{2}$ and a more acurate area is calculated as



A = $\frac{1}{2}$f(0.5) + $\frac{1}{2}$f(1) + $\frac{1}{2}$f(1.5) + $\frac{1}{2}$f(2) + $\frac{1}{2}$f(2.5) + $\frac{1}{2}$f(3) + $\frac{1}{2}$f(3.5) + $\frac{1}{2}$f(4) + $\frac{1}{2}$f(4.5) + $\frac{1}{2}$ f(5)

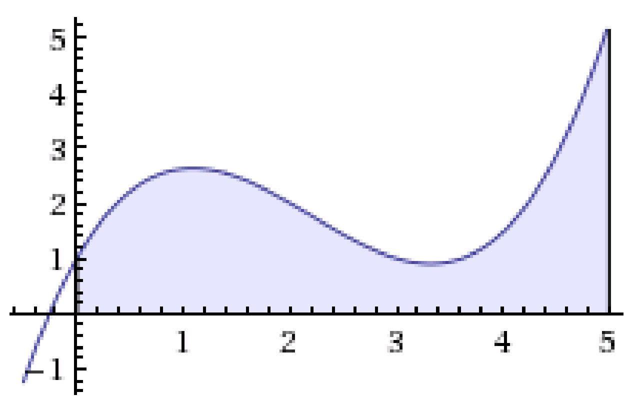
A = 6/10 + 7/10 + 8/10 + 9/10 + 10/10 + 11/10 + 12/10 + 13/10 + 14/10 + 15/10

A = 105/10

A = 10.5

For a given function **f(x)**

- write a **Python function**, that given a value for x **returns** the height of the rectangle (i.e. the value of **f(x)**).
- Use this new function in a **for loop** to approximate the area under the curve **between 0 and 5** by dividing the area into equal width rectangles and summing up the area of all the rectangles.
- Test your functions with $f(x) = \frac{2}{5}x + 1$ used in the previous examples for 5 rectangles. Then try it for 10 & 100 rectangles.
- **Finally use the function** $f(x) = \frac{17x^3}{55} - \frac{45x^2}{22} + \frac{369x}{110} + 1$ **graphed below**



- use another **for loop** to calculate the area under by using 10,100,1000,10000, 100000, and 1000000 rectangles

```
for rectangles in [10,100,1000,10000,100000, 1000000]:
```

FYI, in Calculus you will learn how to calculate this area using the definite integral[1]

$$\int_0^5 \left(\frac{17x^3}{55} - \frac{45x^2}{22} + \frac{369x}{110} + 1\right)dx = 10$$

[1] Nov 11, 1675 – Gottfried Leibniz demonstrated integral calculus for the first time to find the area under the graph of good ol y=f(x).