https://colab.research.google.com/github/ageron/handson-ml3/blob/main/math\_differential\_calculus.ipynb#scrollTo=Vev7qaj1ZLBB

**Differential Calculus:**

As you probably know, the slope of a (non-vertical) straight line can be calculated by taking any two points A and B on the line, and computing the "rise over run":

*slope*= *rise / run*= Δ*y /* Δ*x* = (*y*B – *y*A) / ( *x*B – *x*A)

In this example, the rise is 3, and the run is 6, so the slope is 3/6 = 0.5.

**Defining the slope of a curve**

But what if you want to know the slope of something other than a straight line? For example, let's consider the curve defined by *y* = *f*(*x*) = *x*2:

**Differentiation rules**

One very important rule is that **the derivative of a sum is the sum of the derivatives**. More precisely, if we define *f*(*x*)=*g*(*x*)+*h*(*x*), then *f*′(*x*)=*g*′(*x*)+*h*′(*x*). This is quite easy to prove:

Similarly, it is possible to show the following important rules (I've included the proofs at the end of this notebook, in case you're curious):

|  | **Function *f*** | **Derivative *f*′** |
| --- | --- | --- |
| **Constant** | *f*(*x*)=*c* | *f*′(*x*)=0 |
| **Sum** | *f*(*x*)=*g*(*x*)+*h*(*x*) | *f*′(*x*)=*g*′(*x*)+*h*′(*x*) |
| **Product** | *f*(*x*)=*g*(*x*)*h*(*x*) | *f*′(*x*)=*g*(*x*)*h*′(*x*)+*g*′(*x*)*h*(*x*) |
| **Quotient** | *f*(*x*)=*g*(*x*)*h*(*x*) | *f*′(*x*)=*g*′(*x*)*h*(*x*)−*g*(*x*)*h*′(*x*)*h*2(*x*) |
| **Power** | *f*(*x*)=*xr* with *r*≠0 | *f*′(*x*)=*rxr*−1 |
| **Exponential** | *f*(*x*)=exp(*x*) | *f*′(*x*)=exp(*x*) |
| **Logarithm** | *f*(*x*)=ln(*x*) | *f*′(*x*)=1*x* |
| **Sin** | *f*(*x*)=sin(*x*) | *f*′(*x*)=cos(*x*) |
| **Cos** | *f*(*x*)=cos(*x*) | *f*′(*x*)=−sin(*x*) |
| **Tan** | *f*(*x*)=tan(*x*) | *f*′(*x*)=1cos2(*x*) |
| **Chain Rule** | *f*(*x*)=*g*(*h*(*x*)) | *f*′(*x*)=*g*′(*h*(*x*))*h*′(*x*) |