

Differential Equations

A differential equation is a mathematical equation **that relates a quantity to its own derivative** (or relates a particular quantity to that quantity's **rate of change**). These types of equations are very common in even basic studies of Science, Business, and Mathematics.

Examples: Population

The **rate of change of population** depends on... **population!**

$$(\text{Rate of change of population at time } t) = k (\text{Current population at time } t)$$

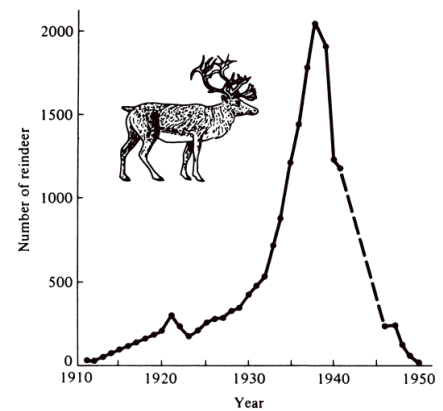
In mathematical terms, this can be written as

$$\frac{dP}{dt} = kP.$$

Solving for k gives

$$k = \frac{1}{P} \frac{dP}{dt}$$

The value k is known as the *relative growth rate* and is a constant.



Newton's cooling law

The **Rate of change of temperature of cooling soup** depends on... the **Temperature** of soup! (relative to its surroundings)

$$\frac{dT}{dt} = -k(T - T_a).$$

$T(t)$ = Temperature of the soup at time t (in min).

$T(0) = T_\sigma$ = Initial Temperature of the soup = 100 deg.

T_a = Ambient temperature (temp of water in sink) = 5 deg .



Remember: These relations are **extremely** common when modeling the world around us. They play a **prominent** role in many disciplines including engineering, physics, economics, and biology