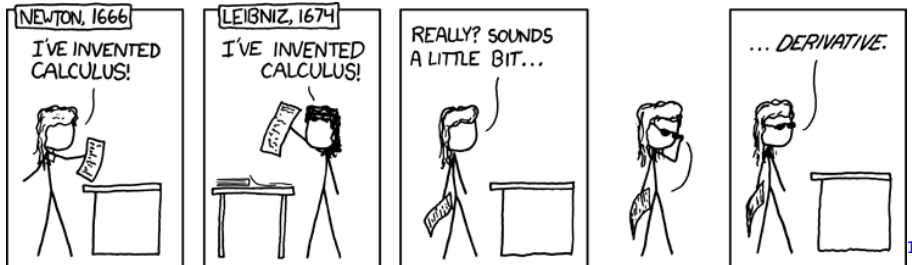


# Maths and Statistics

## Integral and Differential Calculus



Calculus was created to describe in mathematical language how a quantity changes over time. It is an extremely useful and powerful tool for building **dynamics** models. That's why calculus has been used for over a century to understand the behavior of ecological systems.

The following are tutorials to help you understand basic calculus concepts that we use in many mathematical models in ecology.

### Growth rates, derivatives and exponential function

Here you find that the exponential function is the limit of a discrete growth at a constant rate, when we make the time intervals very small. For this, we will go through the concept of derivatives and the notion of limit of a function.

- [Growth rates, derivatives and exponential function](#)

### Antiderivatives and definite integral

Know the integral, inverse derivative operation. Learn the difference between definite and indefinite integrals.

- [Antiderivatives and definite integral](#)

### Introduction to Differential Equations

A differential equation is a relationship between the derivative of a function and some other mathematical function. Understand how these equations can be proposed and solved.

- [Introduction to differential equations](#)

### Numerical integration of differential equations

Tutorials to solve differential equations with the help of computer programs. Computational numerical integration is the basic tool for mathematical modeling in biology.

- [Numerical integration of differential equations](#)

### Stability Analysis

Does an ecological dynamic tend to a state of equilibrium? Does this equilibrium resist

disturbances? Here's how to answer these questions with the help of calculus.

- [Stability analysis](#)

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## Introduction to stochastic processes



A stochastic dynamic happens when we have more than one possible state for a system, and we can *jump* to each one with a certain probability. Therefore, even systems that start out the same can differ over time. For example, populations under stochastic dynamics can have different sizes at any given time, each with a probability of happening. In this case, the population size is a [random variable](#).

Considering stochasticity is very important to understand ecological dynamics. With the stochastic models there were important theoretical advances, such as the [neutral theory of biodiversity](#). Stochastic models also made the risk of extinction more evident in [small populations](#) or under large [environmental variation](#).

### Random walks



The [Markov Chains](#) are used to describe ecological dynamics. They are models of stochastic processes in which time is discrete, and at each interval the system can change state, with a certain probability. The probabilities of changing from one state to another depend only on the present state ((Therefore, they can be expressed in transition matrices from time  $t$  to time  $t+1$ , as in [Population matrix models - Tutorial in spreadsheets](#)

The following are simple case scripts for Markov Chains.

#### Random walk

See why a walking drunk will do poorly, even if on average he walks in a straight line.

- [Random Walk Tutorial](#)

## Zero-sum Game

In a [zero-sum game](#) you only win what others have lost. Discover the properties of this dynamic if gains and losses occur at random.

- [Dynamic Zero-Sum Tutorial](#)

1)

Don't understand? see [here](#).

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