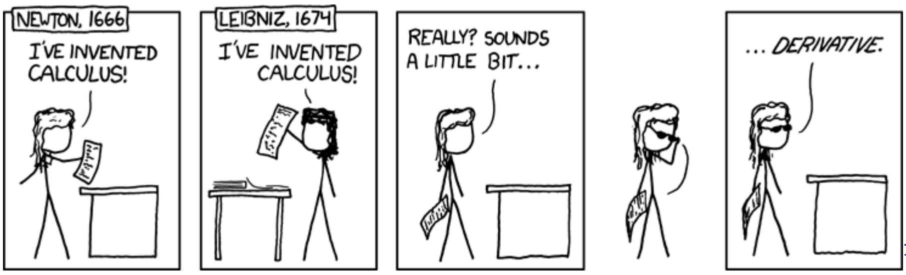
Maths and Statistics

Integral and Differential Calculus



[1)]

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 turorials 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

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.