# Lecture notes, Part 1: Population Dynamics

The class is divided in two parts. The first part of the class deals with models for population dynamics. We are going to explore:

- Models for a single population
- Models for two populations
- Models for disease dynamics
- Models for many populations (if time allows)

## Computing

The GitHub associated with the lecture notes contains the code to generate the lectures and all the figures and simulations. Crucially, these depend on the following `R` packages:

```r
library(tidyverse) # plotting, data organization
library(deSolve) # integrate differential equations
```

## Notation

- We write $x(t)$ for the **density** of population $x$ at time $t$. In many cases, we will write simply $x$, as the dependency on time is always assumed. For discrete-time models, we write $x_t$ instead. Typically, $x(t)$ is measured in either [mass]/[area/volume] or [number of individuals]/[area/volume]

- The density of a population typically changes in time, and the change is modulated by several parameters. Unless specified, we use **Greek letters for scalars**, **lower-case Latin letters for vectors**, and **upper-case Latin letters for matrices**.

- Other useful notation:

  - $i$ is the imaginary unit, such that $i^2 = -1$
  - $0_n$ is a vector of zeros of lenght $n$
  - $1_n$ is a vector of ones of lenght $n$
  - $I$ is the identity matrix (i.e., a matrix with $1_n$ on the diagonal, and zeros elsewhere)
  - $D(a)$ is a diagonal matrix with vector $a$ on the diagonal
  - $\dfrac{dx(t)}{dt}$ is sometimes written as $\dfrac{dx}{dt}$ or $\dot{x}$