

Master Programme in Physics of Complex Systems

ECOLOGY AND EVOLUTION (4 ECTS)

(By J.Grilli)

COURSE DESCRIPTION:

The goals of this class are both to teach students fundamental concepts in ecology and evolution and provide them with basic notions and tools in dynamical systems and stochastic processes. The class will be divided into two main parts. The first part will be devoted to introducing the students with classic models in population and community dynamics. The second part will focus on evolutionary theory and population genetics. We will discuss classic and modern experimental evidence of Darwinian (micro)evolution and the observational pieces of evidence of macroevolution. The students will study the effect of selection, mutations, and drift on the fixation of neutral, beneficial, and deleterious mutations in the context of simple stochastic models of population genetics.

EXPECTED LEARNING OUTCOMES:

At the end of the first part, the students are expected to be able to quantitatively model community dynamics in the presence of different interaction types, identifying and justifying the important assumptions. They should also be able to perform stability analysis, identify the presence of bifurcations and have basic notions of limit cycles and chaos. At the end of the second part, the student will know how to quantify the relative importance of the fundamental mechanisms of evolution (reproduction, mutation, selection, genetic drift and recombination) using the tools of stochastic processes.

PRE-REQUIREMENTS:

Calculus, Basics of Linear Algebra, Basics of Probability

COURSE TOPICS

1. Single population dynamics (exponential growth, logistic growth, Allee effect)
2. Two species dynamics. Fixed points and stability. Lotka-Volterra
3. Multispecies communities
4. Experimental and observational evidence of evolution
5. Genetic Drift
6. Mutation and Selection
7. Coevolution

COURSE STRUCTURE: Theory classes

READING MATERIALS:

Murray, Mathematical Biology vol I
Strogatz, Non-linear dynamics and Chaos

STUDY MATERIALS: lecture notes will be provided to students

ASSESSMENT AND GRADING CRITERIA: The exam is only oral. The students will be assigned homework that will be discussed during the oral exam.