

Adaptive dynamics (Fall 2010)

Adaptive dynamics is a mathematical theory that links population dynamics to longterm evolution driven by mutation and natural selection. It provides methods of model formulation, methods of model analysis as well as mathematical theorems that relate phenomena on an evolutionary time scale to processes and structures defined in ecological and population dynamical terms.

Adaptive dynamics combines processes on two separate time scales: an ecological time-scale and an evolutionary time scale:

1. Processes on the ecological time scale

The ecological time scale concerns the question which mutant phenotypes that are not yet present in a population of given resident phenotypes could invade if they were produced by a mutation, and what would be the outcome of such an invasion in terms of which phenotypes will remain in the population and which will be eliminated.

These questions concern dynamics in a space of population densities of different phenotypes. In the course we focus on the population dynamics given by (systems of) ordinary differential equations (ODEs).

2. Processes on the evolutionary time scale

The evolutionary time scale is about the long-term consequences of many successive ecological invasion-elimination events in terms of changes in the phenotypic composition of the population.

The evolutionary time scale thus concerns dynamics in the space of all possible phenotypes. This dynamics is essentially non-deterministic (e.g., due to the random nature of the effect of a mutation on the phenotype) and is studied using difference inclusions, and in limiting case of infinitesimally small mutation steps, the Fokker-Planck equation or the transport equation.

3. Examples

Examples are largely taken from recent publications in the scientific literature.

4. Perspective

Adaptive dynamics is a new but rapidly developing theory that poses various interesting and mathematically challenging problems. From an applications point of view, a great strength of adaptive dynamics is its capability to model evolution in systems with complicated ecological interactions. Adaptive dynamics is being applied by a growing number of researchers both within mathematics and biology to a wide variety of concrete ecological-evolutionary problems.

5. Lecture notes

Lecture notes will be published on this website keeping pace with the progress of the lectures.

6. Additional background material

For an extensive list of references to both theory and applications of adaptive dynamics, see the website http://mathstat.helsinki.fi/_kisdi/addyn.htm.