UNIVERSITY OF DUNDEE

ECMTB 08

Friday 10:20
Session CT40

Menu

Animal growth in random environments

Carlos A. Braumann
University of Evora

(Co-authors: Patricia A. Filipe)

Friday 10:20
Session: CT40

Room: DHC

Abstract

The models commonly used for the growth of animals in terms of their weight (or size) X(t) at time t can assume, after a suitable change of variable Y(t)=g(X(t)) with g strictly increasing, the form of the differential equation dY(t)/dt=b(A-Y(t)). Here A=g(a), where a is the asymptotic (maturity) weight, and b is a rate of approach. Examples: a) g power function (Bertalanffy-Richards model); b) g log function (Gompertz model).

Usually, random environmental effects have been modelled by traditional regression models, totally unrealistic. In fact, they do not keep memory of past sizes (an individual with a weight much below average has equal probability of being above or below average immediately after). We should instead consider the growth of each individual as a random process (thus keeping past size information) governed by a growth rate that is perturbed by the random environmental fluctuations. We can then model growth through the stochastic differential equation (SDE) dY(t)=b(A-Y(t))dt+sdW(t), where s measures the fluctuations' strength and W(t) is a Wiener process.

The transient and stationary behaviours of this SDE model are well-known and the consequences to individual growth and to the distribution of weights (or sizes) in a population of individuals are considered. We also study the properties of the time required for an individual to reach a given size a*. These results are useful in the exploitation of farm animals to determine: a) the distribution of the market value of a set of animals at a given time; b) the distribution of the cost of animal raising up to a market desirable size a*. They are also useful in designing harvesting policies.

Realistically, however, one may expect different individuals to have different maturity values A. We therefore study the distribution of weights in a population when the distribution of A values among its individuals is Gaussian.

We also consider the problem of parameter estimation (by maximum likelihood and, for small samples, the use of bootstrap methods to obtain the distribution of the estimators). The problem of prediction of the future size of individuals is also considered. These statistical issues are extremely important for applications. We consider the case where we have data at several time instants coming either from a single individual or from several individuals.

The results and methods are illustrated using bovine growth data provided by C. Roquete (Univ. of Evora). More general models of the form dY(t)=g(Y(t))dt+h(Y(t))dW(t) with appropriate assumptions on g and h are then studied and non-parametric estimation of g and s is considered.