

Probabilistic study of the hyper-logistic random growth model and its application to a real database

J.-C. Cortés^b A. Navarro-Quiles[‡] and S.-M. Sferle^{b, 1}

- (b) Instituto Universitario de Matemática Multidisciplinar,
Universitat Politècnica de València,
Camino de Vera s/n, 46022, Valencia, Spain.
- (‡) Departamento de Estadística e Investigación Operativa,
Universitat de València,
Dr. Moliner, 50, 46100, Burjassot, Spain.

Abstract

Logistic-type differential equations play a key role in mathematically modelling growth processes in many contexts such as population dynamics, chemical reactions, nucleation theory, etc. The solution of logistic models is usually referred to as sigmoidal function and it is obtained from different differential equations as Verhulst, Gompertz, Bertalanffy, etc. The formulation of such differential equations is based on the choice of the function that defines the right-hand side of equation. In this paper we study, from a probabilistic standpoint, the case of the so called hyperlogistic differential equation. We present a full stochastic analysis of the random hyperlogistic differential equation assuming that all its parameters and initial condition are absolutely continuous random variables defined on a common complete probabilistic space. We then obtained the first finite distribution of the solution as well as some other significant probabilistic quantities. Afterwards we show in detail how the random hyperlogistic model can be applied to study the growth dynamics of multicellular tumor spheroids using real data.

References

- [1] Marušić, M., Bajzer, Ž., Freyer, J. P., Vuk-Pavlović, S., Analysis of growth of multicellular tumour spheroids by mathematical models *Cell proliferation*, 27(2):73–94, 1994.
- [2] Soong, T. T., Random Differential Equations in Science and Engineering. New York and London, Academic Press, 1973.
- [3] Turner, Jr., Malcolm, E., Edwin, L., Bradley, Jr., Katharine, A., K., Kenneth, M., P., A theory of growth *Mathematical Biosciences*, 29(3-4):367–373, 1976.

¹smsferle@doctor.upv.es