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Synonymy relationship and stochastic processes in determination of flow equations in ecological models

Josué-Antonio Nescolarde-Selva[a,b,*], Josep-Lluis Usó-Doménech[a], Miguel Lloret-Climent[a], Meng Fan[b]

[a] Department of Applied Mathematics. University of Alicante, Alicante, Spain
[b] School of Mathematics and Statistics. Northeast Normal University, Changchun, China

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ABSTRACT

A flow equation obtained through multiple linear regressions is a static concept fixed for a time *t*. However, experience says that the temporal component makes the information obtained from the flow equation in terms of coefficients of determination. In this paper we show that a 1-degree variation in such coefficients behaves like a Wiener process based on the Gaussian distribution. As an application, we study the destruction of fruits in *Cistus albidus* L.

1. Introduction

The modeling process that authors use to deal with ecological reality (Usó-Domènech et al., 1995, 2000), is based on the following assumptions:

a) Choose relevant objects or variables related to the proposed goals. Ecological, biological, etc. theories would be the theoretical base of this phase. However, subjective components (intuition, brainstorming, etc.) play an important role.
b) Identify the cause-and-effect relationship between the considered elements. Subsystems diagram, policy structuring diagram, multivariate analysis, etc., may be added.
c) Give a functional representation to the detected relations; that is to say; write them as state equations. The mathematical meta-language gives the laws for this.
d) Experimentation to obtain variable (measurable attributes) data.
e) Creation of flow equations through experimental data.
f) Integration of the system of the ordinary differential equations (state equations) through numerical methods.

Fig. 1 shows a clear representation of this process.

The theorical set-up in this paper is based on the following algorithm: Consider that a slight variation in the data of the primitive variable is carried out, i.e., it should move from $\Psi_{ij} \Rightarrow \Psi'_{ij}$ where Ψ'_{ij} is synonymous flow equation of Ψ_{ij}. This movement is erratic defining a Wiener process and has the following consequences:

1) The state equations will be stochastic differential equations.
2) It is a possible an explanation of the differences between calculated and real values in the process of validation.

The rest of the paper is organized as follows: Section 2 provides the modelling process theory: generative grammar of transformed function, generative grammar of flow equatins, recognoscitive grammars; in Section 3 the textual theory. The synonymy relationship and recognosciability grammars in Section 4. In Section 5, fundamental concepts of Wiener processes; in Section 6 the Wiener processes in flow equations with an application: destruction of fruits in *Cistus albidus* L. Finally Section 7 conclusions and further remarks.

* Corresponding author.
E-mail address: josue.selva@ua.es (J.-A. Nescolarde-Selva).

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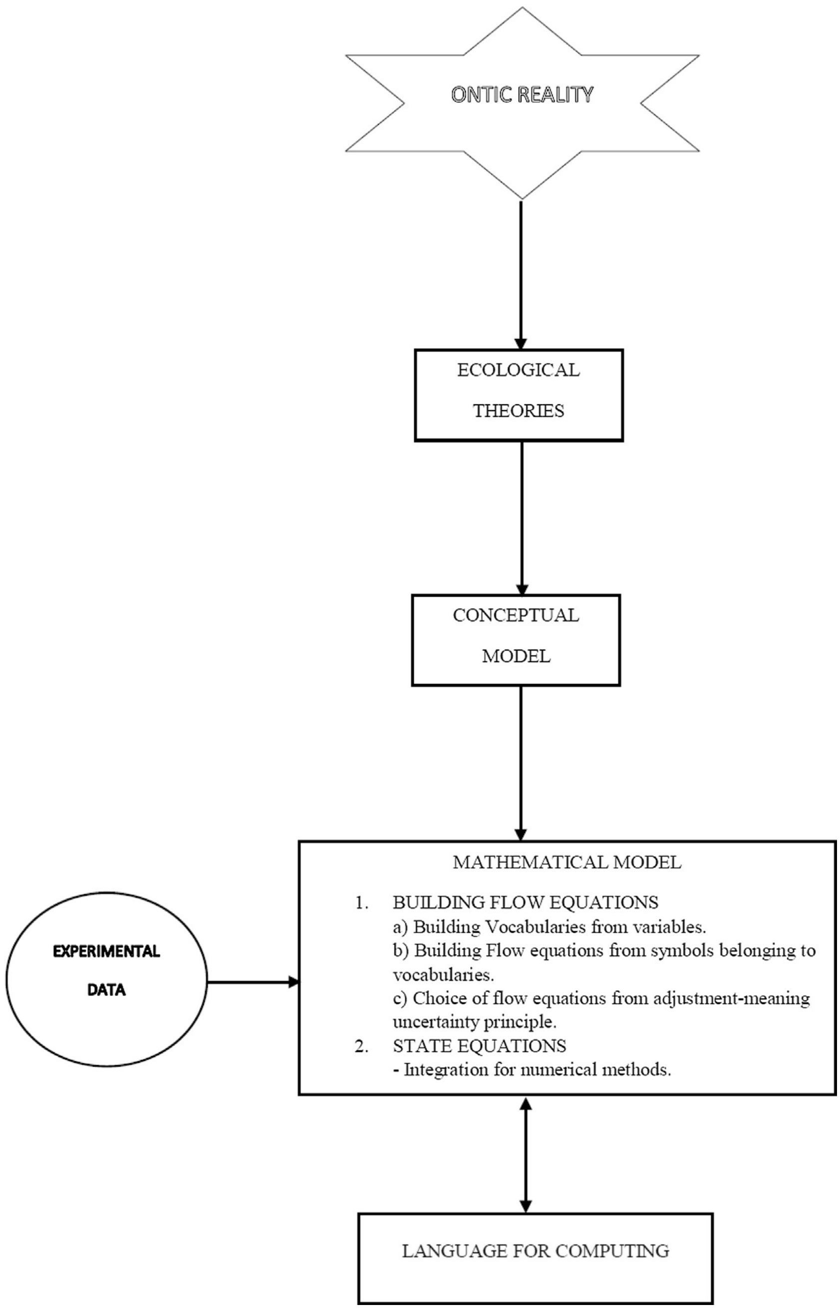

Fig. 1. Diagram of authors' methodology.

2. Modeling process theory

In the classic method of Dynamic of Systems (Forrester, 1961), non linear process are built through tables (graphics). The process is carried out by linear or, more generally, polynomial interpolations. The authors replace this method with the construction of equations based on the lineal combination of transformed functions (Cortés et al., 2000; Nescolarde-Selva et al., 2014, 2015; Sastre-Vazquez et al., 1999, 2000; Usó-Domènech and Sastre-Vazquez, 2002; Usó-Domènech et al., 2006a,b, 2014, 2015a, b; Usó-Doménech and Nescolarde-Selva, 2014; Villacampa et al., 1999; Villacampa and Usó-Domènech, 1999).

We assume that the dynamics of the system can be modeled starting off with a set of ordinary differential equations as follows:

$$\frac{dy_i}{dt} = F(x), \bar{x} = x(t), t \geq 0; \bar{x}(0) = x_0, \forall j \tag{1}$$

$$x : [0, +\infty] \rightarrow R^n; y(t) = F(x(t)); F : R^n \rightarrow R$$

where R^n is the phase space, t the time and y is the state variable.