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The use of Formal Concept Analysis in Modelling of Environmental Interface as a Complex System

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Plants, as part of the so called environmental interface, significantly contribute to the exchange of mass, energy and momentum through biophysical and/or chemical processes from small to large scales. In the last three decades, a remarkable effort has been invested in modelling their presence and impacts on the aforementioned exchanges. The comprehensiveness of parameterisation of vegetation in environmental models has been varied from crude approaches to the recently used sophisticated ones. However, in the new generation of models there exists a need for the treatment of environmental interface as a complex system containing plants as a biological subsystem. Interactions of biological systems with their environment are governed not only by the summary effect of environmental factors on them (such as heat, humidity, presence/absence of certain nutrients, growth factors, etc.) but also, and more importantly, by the ability of a given biological system to functionally incorporate these factors. In other words, it should transform them into a set of “meaningful” data. Such process is characterized by the reduction of wholeness of environment into a number of discrete sets of recognizable objects which are (only then) susceptible to certain systemic, functional actions (e.g. activation/deactivation of regulative genes, enzymatic transformations, etc.) having impacts on the larger scales. One elegant and efficient way to represent such process of assimilation of environment is through the branch of applied lattice theory entitled Formal Concept Analysis. Here, each object is associated with a corresponding attribute in order to form the proper concept within a given context.

In this paper, we will present a simplified example of the formation of interface between plant and its environment based on Formal Concept Analysis. Given in such a model is a set of attributes that corresponds to the set of plant (particularly legume) receptors and/or mechanisms of interaction with the environment and a set of objects that corresponds to the set of environmental objects which can be recognized by the given biological system. The process of assimilation of environment can then be represented as a process of formation of concepts within a given context. These concepts establish a natural hierarchical order which can be easily represented through line diagram.