

# Modelling self-organization in ant colonies

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**Abstract.** Modelling colony organization is increasingly more focused on investigating the mechanistic processes or rules underlying the overall behaviour. The use of computational models reveals the dynamic structure of such systems and helps to understand self-organization phenomena occurring in such colonies. In this approach a model is presented which based on an extended version of X-machines exhibiting a dynamic structure that allows specifying simple rules governing local interactions between ants. The model is used to describe various self-organization principles of trail formation or foraging. The results of some simulations are presented.

## 1 Introduction

Self-organization and self-assembly are increasingly broadly used in various areas like physics, chemistry, biology and engineering. The use of these concepts holds the prospect of generic principles of organization being uncovered that can further our understanding of the behaviour of the systems under scrutiny.

Being such generic concepts and covering so many areas and phenomena they led to a number of different definitions and interpretations. Some of them are summarised below with the aim of clarifying the meaning of these concepts.

According to Wikipedia, self-organization refers to a process in which the internal organization of a system increases without being guided or managed from outside [22]. Examples of self-organization are cited in both the natural sciences and social sciences. Amongst the listed phenomena of self-organization it is mentioned that of structures creation by social insects.

In biology self-organization is a mechanism for building patterns, processes and structures at a higher level through multiple interactions among the components at the lower level, where the components interact through local, often simple rules [18]. Anderson [1] identifies 10 various definitions of self-organization. Summarising them, a number of key aspects of self-organization are identified. Firstly, self-organization investigates how a group-level pattern is created. This