

OPERAS for Social Insects: Formal Modelling and Prototype Simulation

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Abstract. Social insect colonies present an interesting problem for formal modelling due to characteristics such as self-organisation and dynamic structure. In this paper, we present a formal model of a colony of Pharaoh ants using *OPERAS_{XP}*, which combines two different formal methods, communicating X-machines and population P systems as well as a framework that leads to a rapid simulation prototype of such multi-agent systems, based on their formal models.

1. Introduction

Study of social insects colonies, such as ants and bees, reveal the need for computational models which are able to handle the highly dynamic structure of any biological or nature-inspired artificial system that exhibits emergent behaviour. These systems can be directly mapped to multi-agent systems (MAS) by considering each entity as an agent, with its own behavioural rules, beliefs, goals, decision making mechanisms and means of communication with the other entities and with the environment. The overall behaviour of the system is merely the result of the agents' individual actions, the interactions among them and between them and the environment.

A key aspect that has to be dealt with at the modelling level is the dynamic nature of such MAS and how their structure is constantly reconfigured. By *structure* we