Formal Modelling for In-silico Experiments with Social Insect Colonies

Ioanna Stamatopoulou[1], Ilias Sakellariou[2], Petros Kefalas[2], George Eleftherakis[2]

[1]SEERC, 17 Mitropoleos Str, Thessaloniki, Greece, istamatopoulou@seerc.org
[2]City College, Dept. of Computer Science, 13 Tsimiski Str, 54624 Thessaloniki, Greece, {i.sakellariou, kefalas, eleftherakis}@city.academic.gr

Abstract

Social insect colonies present an interesting problem for formal modelling due to their outstanding characteristics, such as self-organisation and emergence. In this paper, we experiment with two different formal methods, Communicating X-machines and Population P Systems, which can be used separately to model biologically inspired. systems. The case of Pharaoh's ants is used as a vehicle of study. We discuss the advantages of each method and we present a framework that leads to a rapid implementation and simulation of such multi-agent systems.

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 artificial system that exhibits emergent behaviour. Such computational models would facilitate understanding of self-organisation phenomena that appear in those colonies. Part of bio-informatics technology aims at developing in-silico models and simulations that will complement in-vitro and in-vivo biological experiments. On the other hand, knowledge gained from observation in these experiments could be used to develop artificial multi-agent systems in which simple components with simple interactions will achieve a complex overall behaviour.

A social insect colony is an example of a multi-agent system where the capabilities of the entire colony are much greater than that of any individual. Members of a colony have a distinct role that determines what behaviour they must demonstrate. For example, in ant colonies we may find foraging ants, workers, queens etc. The behaviours of the social insects are directed towards the benefit of the colony as a whole and this is done through self-organisation. This is achieved through local interactions with other insects and the environment, since no insect has a global view of the environment. The major challenge for social insect research is the integration of individual behaviours, thereby understanding the emergent colony-level behaviour.