OverSwarm: A Framework for the Development and Evaluation of Distributed Swarm Intelligence Algorithms on the OverSim Simulation Platform

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Abstract. OverSwarm aims at enabling a comprehensive experimental validation and comparison of network oriented swarm solutions, by simplifying the development and execution of distributed swarm algorithms in a simulated network environment. OverSwarm includes a domain specific language for describing agent's behavior and leverages the tools available within an existing P2P simulation platform, namely OverSim. Accordingly, it supports the development of new P2P overlays, extension of existing protocols, and execution of swarm algorithms on top of existing P2P overlays.

Keywords: Distributed Swarm Intelligence, P2P, Simulation, OverSim

1 Introduction

Peer-to-peer overlay networks have emerged as powerful solutions to enable the deployment of robust large-scale distributed applications. Meanwhile, the increasing complexity and scale of such system raised the need for flexible and self-manageable distributed systems, which has led the research toward novel mechanisms for the autonomic management of peer-to-peer overlays. The use of self-organized algorithms based on the concept of swarming colonies of insects [1,2] can provide efficient solutions that dynamically adjust to application needs or adapt to network conditions. We deem that an essential step toward the acceptance and deployment of bio-inspired solutions in the domain of peer-to-peer systems, is the comprehensive analysis and comparison between novel and existing approaches, in order to prove the advantages and reveal the drawbacks of each solution. To achieve such goal, a common evaluation platform that provides the necessary analysis tools is required. Unfortunately, a notable drawback of the existing swarm-agent oriented simulation platforms (such as [3,4]) is their heterogeneous nature: while they all provide the tools needed to evaluate the collaborative behavior of swarm algorithms, they are all based on different assumptions that complicate or prevent a valid comparison between different systems. On the contrary, network-oriented simulation environments (such

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as [5,6]) provide very precise simulations, but only focus on traditional network protocols, and fail at providing comprehensive support for testing swarm-agent based algorithms. Accordingly, OverSwarm aims at filling the gap by providing the necessary tools to easily develop swarm protocols on top of a recognized network-simulation platform and enable a side-by-side comparison of different algorithms under the same assumptions and conditions.

2 OverSwarm

In contrast to traditional network protocols, swarm-based ones are typically described by detailing the behavior of agents. In this regard, OverSwarm allows the programmer to exploit strong, transparent migration of agents and focus on the collaborative aspect of the algorithm rather than on network related issues such as data serialization or the details of agents' execution. Because OverSwarm integrates with the OverSim P2P simulation platform [7], distributed swarm intelligence solutions can be deployed and evaluated on top of already implemented peer-to-peer overlays, thus reducing the development effort and increasing flexibility. Moreover it is possible to target different levels of the OverSim framework: more specifically, swarm algorithms can either be run on top of an existing overlay, as extensions of existing protocols (for example Chord, Pastry, etc.), or as standalone overlay protocols. Finally, thanks to the provided domain specific language and compiler, algorithms are easily written and tested through high-level programming, while still being able to access and integrate with existing C++ objects such as OverSim modules. OverSwarm is released as open-source software and is available for download at http://syscall.org/doku.php/overswarm .

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