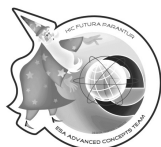




Executive Summary



Available on the ACT website
<http://www.esa.int/act>

Theme: informatics

Code and Title of the study:

07/5201 Gossip-based Strategies in Global Optimization

Contract characteristics :

**University/Department: University of Szeged, Inst. of Informatics and
University of Trento, DIT**

ACT researcher: Dario Izzo and Tamas Vinko

Duration of the study: 4 months

Picture:



Methodology:

Hyper-heuristics are heuristics for selecting and/or combining other heuristics to adaptively solve a global optimization problem. They are also suitable for parallelization. Indeed, ESA's ACT has deployed a master-slave distributed hyper-heuristic Digma on their local Grid. On the other hand, having a central controller greatly reduces scalability and fault tolerance. Gossip algorithms offer a way to implement control in a fully decentralized way. In a gossip protocol, participating nodes send messages to random peers without centralized control. Through this random message exchange one can implement a wide range of functions from simple information dissemination (broadcast) to distributed computation of averages and other statistics. Our primary goal was to explore the possibilities of implementing global optimization strategies, such as Digma, as well as others, relying only on peer-to-peer gossip communication thereby ensuring scalability and fault tolerance, and to study their performance empirically.

Results:

We developed a fully distributed gossip based branch-and-bound algorithm and analyzed its performance empirically

We developed a gossip-based version of ESA ACT's hyper-heuristic Digma allowing it to run in a peer-to-peer fashion, This allows it to avoid communication and control bottlenecks thereby increasing its scalability significantly

We developed alternative hyper-heuristics as well for the same fully distributed environment using gossip protocols and compared them with each other empirically, including the space probe trajectory optimization problems Cassini1 and Cassini2 as test problems.

Publications:

M. Biazzi, B. Banheli, A. Montresor, and M. Jelasity: "Peer-to-peer Optimization in Large Unreliable Networks with Branch-and-Bound and Particle Swarms", in *Proc. of 6th European Workshop on the Application of Nature-inspired Techniques for Telecommunication Networks and other Parallel and Distributed Systems*. 2009.

M. Biazzi, B. Banheli, A. Montresor, and M. Jelasity: "Distributed Hyper-Heuristics for Real Parameter Optimization", submitted for publication, 2009.

Highlights:

We developed scalable, gossip-based, distributed versions of ESA ACT's hyper-heuristic Digma as well as novel gossip-based hyper-heuristics, and performed an empirical study of these algorithms in several network sizes and available function evaluations over a set of test problems. The test problems included the space probe trajectory optimization problems Cassini1 and Cassini2. The hyper-heuristics we proposed show a stable good performance over a wide range of settings. One surprising result of our study is that one of the best hyperheuristics in this fully distributed environment is the trivial baseline method that assigns heuristics to all nodes independently and, apart from gossiping information such as the current best solution, keeps the assignment unchanged. In general, conservative methods that only rarely change the applied algorithm on a given node perform clearly better.