Applying a Distributed Swarm-Based Algorithm to Solve Instances of the RCPSP

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This paper addresses distributed task scheduling problems generalized as a distributed version of the Resource-Constrained Project Scheduling Problem (RCPSP) [1]. We apply and evaluate a novel approach for the RCPSP that is distributed and based on theoretical models of division of labor in social insects.

Our approach uses a probabilistic decision model, based on paradigms from swarm intelligence such as the tendency social insects have for performing certain tasks [2]. It has been implemented as an algorithm called Swarm-DRCPSP and was experimented in an abstract simulation environment. We show that Swarm-DRCPSP performs better than a distributed greedy algorithm, and that this performance is not much far from the best known solutions for the RCPSP, with the advantage of being computed in a distributed way.

Swarm-DRCPSP

In [3] the authors present a model where the interactions among members of the colony and the individual perception of local needs result in a dynamic distribution of tasks. Using our approach, agents decide which task to schedule based on that model. Furthermore, worker ants in several species retrieve preys or food items larger and heavier than a single individual capability using a mechanism of cooperative transport. We use this mechanism to handle simultaneous task allocation.

Experiments and Results

Empirical evaluations of Swarm-DRCPSP were conducted using three RCPSP instances available in the “j120” benchmark data set of the *Project Scheduling Problem Library* library [4]. Contrarily to our algorithm, the best known solution for those instances is not distributed. Thus, to analyze the performance of our algorithm in a fair way we have implemented a distributed greedy algorithm. This algorithm works almost as Swarm-DRCPSP, except that all perceived tasks are scheduled if resources are available. As mentioned, both Swarm-DRCPSP and the greedy algorithm are compared with the best approximate solution available for those three instances of the PSPLIB.

Figure 1 shows the comparison regarding the total time makespan achieved by using the Swarm-DRCPSP, the greedy algorithm, and the best heuristic solution, for three experimentation instances from the PSPLIB. The greedy algorithm

M. Dorigo et al. (Eds.): ANTS 2008, LNCS 5217, pp. 399–400, 2008.

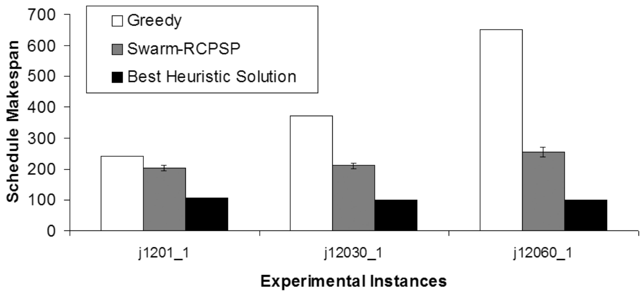

Fig. 1. Comparing the total time makespan of Swarm-DRCPSP, a greedy algorithm and the best heuristic solution, for 3 instances of the PSPLIB

achieves the worst result, obtaining schedules that are two to six times larger than the best approximate solution. Swarm-DRCPSP is much more efficient than the greedy algorithm, especially in the case of the most complex instance. The schedule makespans obtained by Swarm-DRCPSP are at worst twice that of the best known solution. However this performance is achieved despite its distributed computation and has a further advantage of not needing specific heuristics used by the best known solutions for the RCPSP.

Conclusion

Our approach for the DRCPSP is simple and effective. Empirical results show that the theoretical models of the division of labor in social insects may be successfully applied to the distributed task scheduling.

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