Distribute the Task Swapping Assignment Method under Communication Constraints

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Multi-agent task allocation (assignment) is a problem of "assigning which agent to do what task" in order to maximize the performance of the whole team. Task allocation has been recognized as one of the most fundamental mechanisms to coordinate various distributed multi-agent systems. Recently, we proposed a *task swapping* task allocation method inspired by task-exchange primitives and Balinski-Gomory's optimal assignment algorithm. Important features of this new method include: (1) it is an anytime algorithm so that the algorithm can stop at any moment during the computation; (2) in each algorithmic stage only a subset of agents are involved (communicated); (3) the solution optimality is ensured under a complete communication network (i.e., all pairwise agents can be directly communicated).

However, there are still some issues worthy of further examination, which are also our ongoing and future work. One critical problem is the communication constraints. More specifically, since this method still requires a complete communication network in which every pair of agents is connected, this may be too strong an assumption for many distributed multi-agent systems. For example, some systems can guarantee only local communications within certain ranges and an agent might not be able to establish a communication channel with a distant agent. In such a case searching for a swap loop may fail due to the unavailable communication channels.

We are working on a fully decentralized algorithm that takes into account such communication limitations. Since the search for swap loops relies on a special tree whose leaf nodes (searched under certain rule) are added by communicating with other team members, thus one idea to address those unavailable connections is to discard those unreachable agents and prune the associated tree edges, and simultaneously search the swap loops in a coordinated and distributed fashion. Inevitably, pruning will lose the view of the whole problem which may, consequently, sacrifice global optimality. However, one significant advantage of this method is that it makes the maximum use of the local network and obtains the largest/best swap loops under the communication limitations, thus it is a completely decentralized approach due to the local computation and communication. We will provide preliminary results for this distributed variant.