Effects of local information on group behavior

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Researchers in the field of Distributed Artificial Intelligence have studied the effects of local decision-making on overall system performance in both cooperative and self-interested agent groups (Bond & Gasser, 1988) . The performance of individual agents depends critically on the quality of information available to it about local and global goals and resources. Whereas in general it is assumed that the more accurate and up-to-date the available information, the better is the expected performance of the individual and the group, this conclusion can be challenged in a number of scenarios.

The populace in human societies tend to look for opportunities and search for better opportunities in their environment (Bartos, 1967) . The theory of migration in social behavior and occupational mobility suggests that the stability of the population depends on how an individual chooses its action based on the prevailing circumstances. As agent designers, we are faced with the problem of developing decision mechanisms that allow agent societies to stabilize in states where system resources are effectively utilized.

In this research, we focus on a particular aspect of distributed decision-making: the effect of limited global knowledge on group behavior. The research question that we are asking is the following: Can limited local knowledge be a boon rather than a bane in a multiagent system? To investigate this issue we use a resource utilization problem where a number of agents are distributed between several identical resources. We assume that the cost of using any resource is directly proportional to its usage. This cost can be due to a delay in processing of the task in hand, or a reduction in the quality of the resource due to congestion. Hence, there is a justified urge in agents to seek out and move to resource with lesser usage. Other researchers have shown that such systems can exhibit oscillatory or chaotic behavior where agents move back and forth between resources (Hogg & Huberman 1991; Kephart, Hogg & Huberman 1989) resulting in ineffective utilization of system resources. Whereas asynchrony, heterogeneous agent decision mechanisms, etc. has been suggested as possible means for solving the instability problem, our proposed solution of using locally differing global views is a novel mechanism to introduce asymmetry in group decisions that expedites group stability.

We have developed a decision mechanism to be used by individual agents to decide whether to continue using the same resource or to relinquish it in the above-mentioned resource utilization problem. We show that a spatially local view of an agent can be effectively used in a decision procedure that enable the system to quickly converge to a stable optimal global state (in terms of effective resource utilization). In addition, increasing the information available to an agent increases the time taken to reach the desired equilibrium state. We explain this phenomenon with a probabilistic analysis. This analysis also suggests a promising line of future work where adaptive agents use varying amounts of global information to further accelerate convergence.

References

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