

Agent Trust Evaluation and Team Formation in Heterogeneous Organizations

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ABSTRACT

This demonstration highlights different aspects of the bottom-up assembly of multi-agent teams; illustrating trust evaluation of potential partners via experience- and reputation-based trust models, multi-dimensional trust evaluation of potential partners, task selection through personality-based modeling and team selection strategies that maximize a team's ability to function in dynamic environments. The demonstration format will be a software live demo with supporting slide shows.

Categories and Subject Descriptors

I2.11 [Distributed Artificial Intelligence]: Multiagent systems – Multiagent systems

General Terms

Algorithms, Design, Experimentation

Keywords

Trust Evaluation, Team Formation

1. INTRODUCTION

Creating a task force of agents targeted towards a multi-faceted problem from within a single organization can be a daunting task, even when each agent has relatively a relatively good knowledge of other agents' trustworthiness and capabilities. Building agent teams from dissimilar heterogeneous organizations, where such mutual knowledge is lacking, is far more difficult. Agents forming such teams must also face dynamic problems and environments that change without warning. Moreover, even in organizations where individual agents are primarily autonomous, one or more managers or supervisors may inject command instructions that must be followed.

This research demonstrates a set of techniques allowing agents to evaluate the trustworthiness of potential teammates across multiple dimensions, including quality, timeliness, and personality. The research then shows how trustworthiness evaluation assists agents in constructing teams to solve

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problems, even as the problems change unpredictably and various factors (including unforeseen instructions from human or agent supervisors) are introduced.

2. TRUST EVALUATION

Trust evaluation within teams is essential when an agent must rely on others to perform tasks for accomplishing its goals, since potential team members may choose not to—or be unable to—complete promised tasks. When deciding whether to trust, an agent may rely on, among other types of trust information, its past experience with the trustee or on reputations provided by third-party agents [1]. However, each type of trust modeling—experience- or reputation-based—has strengths and weaknesses: trust models based on past experience are more certain, yet require numerous transactions to build, while reputations provide a quick source of trust information, but may be inaccurate due to unreliable reputation providers.

This research examines how the effectiveness of experience- and reputation-based trust models is influenced by parameters such as: frequency of transactions with the trustee, trustworthiness of the trustee, and accuracy of provided reputations. More importantly, this research demonstrates a technique for dynamically learning the best source of trust information given these parameters. Experiments show that dynamically adapting trust-modeling technique for given system characteristics achieves payoffs equal to those achieved by utilizing the best single trust information source (experience or reputation) [2].

A potential partner's trustworthiness in several dimensions must be considered. A task may have multiple requirements (in terms of quality, completion time, or cost, for example) influencing the reward received by the team. An agent evaluating potential team members must therefore consider the trustworthiness of potential teammates relative to multiple dimensions accounting for multiple task requirements (which determine rewards) and multiple partner constraints (which estimate partner behavior).

This research demonstrates the importance of assessing multiple facets of a potential team members' behavior—the availability of the teammate to deliver quality and on-time solutions within cost—in the context of multiple goal requirements [3]. A partner selection algorithm allows an agent to use multiple dimensions (related to both goal requirements and estimated partner behavior) to estimate the trustworthiness of a potential team member for achieving goals. This suitability assessment helps agents jointly form the best teams.

3. TEAM FORMATION

Teams of agents attempting to solve novel problems face many difficulties. The skill set of a team formed to solve a given problem may prove inadequate. Alternatively, novel problems may change in unforeseen ways, or rationally bounded agents may be incapable of predicting how and when problem requirements might change. Accordingly, once other agents have been evaluated for trustworthiness, availability, quality, etc., agents may begin to consider what jobs they wish to pursue, and which teammates given job based on the knowledge gained from the trust evaluation phase.

This work introduces strategies for bottom-up team formation between independent agents in unpredictable, dynamic environments [4]. More particularly, these strategies utilize heuristics to help an agent earning more reward by determining which jobs (problems) to work on and which agents to work with. These heuristics are combined to form broad strategies for maximizing an agent's utility by, alternatively, selecting jobs and teams that quickly solve low-risk jobs, by forming teams which have redundant skill sets in case of a team member defection, and by forming teams which have adaptive skill sets capable of dealing with unforeseen changes to a job.

Moreover, by forming teams according to these strategies, agents may better tolerate dynamic changes to the problem they are working on, or unexpected changes to the team itself. For example, if an agent cannot find a reliable partner who has a specific skill, the agent may include multiple untrustworthy partners with that ability on the team, thereby increasing the chance that the skill will still be available even if one of the untrustworthy agents leaves the team.

In addition to the strategies for team formation described above, this work presents a decision-theoretic approach based on the idea of personality to construct an expected utility function to guide agents in choosing jobs to work on and selecting prospective team members [5]. The research also defines a set of personalities dictating an agent's behavior in the team formation and provides a method to incorporate these personalities in constructing the utility function. In this way, personalities define the priority that an agent places on the various choices it may have regarding both job selection and team member selection.

Two layers of personality model are used in the research as a parameter to dictate an agent's behavior: a personality model to dictate job selection behavior (Shyness, Ambition, and Optimism) and a personality model to dictate team member selection behavior (Reliability, Agreeableness and Openness). These models may be constructed with the information gained from the previous trust evaluations and the feedback from the past performance result. A utility function is built using the proposed personality models to give priority to possible rewards or potential risks during the job selection and team member selection process. In addition, this research incorporates a learning mechanism to adjust the level of personality to address changes in the project requirement and environmental situation.

Command instructions issued by a supervisor agent before the formation of a team are handled by constraining the potential jobs and partners that an agent may or must consider, while command instructions issued after the formation of a team are handled by simply assigning or removing tasks from a team's workload

and/or assigning or removing agents from a team. For example, a supervisor may instruct a given agent to only work on a particular job, or not to work with another given agent, which would in turn constrain the jobs and partners that an agent would examine. Agents are thus able to form teams to work on dynamic, high-utility problems in a peer-to-peer fashion while still responding to managerial dictates.

4. SUMMARY

This research demonstrates how heterogeneous agents may assess trustworthiness of potential teammates and form teams. Agents evaluate trustworthiness based on both past experience and the reputation exchange. Further, agents evaluate trust in a multi-dimensional manner, accounting for such factors as quality, timeliness, and cost.

Upon performing trust assessment, agents form teams using strategies designed for dynamic problems. Alternatively, personality metrics may be used to form teams of agents to solve problems in dynamic environments.

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