Trust Modeling Based on Friendship and Similarity of Agents

Kamal Mirzaie and Mehdi N. Fesharaki
Department of Computer Engineering,
Maybod Branch, Islamic Azad University, Maybod, Yazd, Iran
Department of Computer Engineering,
Science and Research Branch, Islamic Azad University, Tehran, Iran
k.mirzaie@srbiau.ac.ir , fesharaki@mut.ac.ir

Paper Reference Number: 412-143
Name of the Presenter: Kamal Mirzaie

Abstract
Trust is an important research topic in many fields including economics, business, AI, and IT. As a complex concept with different definitions, trust is the root of almost any personal interaction. An agent does not usually have direct access to the mental state of other agents, hence we need models of trust that determine where the agents can be trusted or not. In this paper, we have proposed trust model based on friendship and similarity. Every agent in this model has properties such as personality, responsibility, and specialty. Dynamic trust is made up of agents' properties and interaction between them that are essential for trust making. A general process for decision making, OODA is used for updating the trust. Each agent in this process observes the environment (Observe) and makes knowledge from the observation (Orient). Decision-making is based on knowledge (Decide), and finally this decision is executed (Act). These four are the main stages of the simulation cycle of the proposed model. In the first stage, agents' properties and interactions are initialized. The second stage provides essential knowledge for trust and the output of this stage is computed trust. In the third stage, the computed trust is compared with the trust threshold. If computed trust is greater than the threshold, agent might trust a given agent. Finally, in the fourth stage, trust value is updated based on the performance of trusted agents. These four stages are repeated and the dynamic trust is updated at the simulation run.

Key words: Trust, MAS, OODA, Friendship, Similarity

1. Introduction
Recently, many researchers have been interested in the concept of trust, its modeling and simulation. This interest is due to its high importance in various applications and domains

2

5thSASTech 2011, Khavaran Higher-education Institute, Mashhad, Iran. May 12-14.

such as Net Centric Organizations (NCO), e-Commerce, as well as distributed, decentralized, and multi Agent systems.

From the viewpoint of artificial intelligence, creation and development of trust is necessary to form the concepts such as cooperation, coordination, collaboration, and delegation among agents (Gambetta 1988, Fetanat & Naghian 2010, Josang et al 2007, Marsh 1994).

Trust became a topic of research by Diego Gambetta. According to him "Trust, (or symmetrically, distrust) is a particular level of the subjective with which an agent will perform a particular action, both before he can monitor such action (or independently of his capacity to monitor it) and in a context in which it affects his own action." Gambetta's definition of trust is a good starting point (Gambetta 1988). Also, Marsh used this definition for trust modeling with mathematical approach (Marsh 1994).

Castelfranchi extended Gambetta's work about trust. In Castelfranchi's definition of trust, two critical extensions were identified. First, only cognitive agents can trust other agents. Second, goals and beliefs are essential to trust those agents (Castelfranchi & Falcone 1999). Castelfranchi's view on trust is cognitive. In this view trust is made up of underlying beliefs.

As we mentioned above, another view for trust modeling is mathematical view as in Marsh's trust model (Gambetta 1988, Marsh 1994). This view uses a trust metric based on variables such as perceived_competence, perceived_risk, utility of situation for the agent involved, importance of a situation, etc (ElSalamouny et al 2009, Marsh 1994, Seo & Han, 2010, Wang & Wu, 2010, Ziegler & Lausen 2005). Hybrid approaches can also be used. For example (Esfandiari and Chandrasekharan 2001) considers trust in both cognitive and mathematical perspectives.

However, there is a controversy over the concept of trust. Researchers have presented and used different definitions for it in various books and articles. Usually each definition utilizes certain features of trust, in a way that different studies use an approximate or hypothetical definition for it based on the scope of expectations. Lack of a common definition has made precise discussion about trust more difficult.

In this paper, cognitive dynamic trust has been modeled based on friendship and similarity. The paper is organized as follows: first MAS as a test bed for trust modeling is introduced. Then, decision making based on trust and the proposed model are explained respectively. Conclusions are finally drawn.

2. Multi Agent Systems for Trust Modeling

Agent and multi agent system is a conventional approach for analyzing, modeling and simulation of trust. In general, the agent concept is a tool for understanding complex concepts such as trust. Multi agent systems are made of a set of agents that interact with each other for problem solving. In other words, such systems solve a problem with a distributed and decentralized approach (Weiss 2001). There are various definitions and interpretations for multi agent systems. Most researchers, however, agree that multi agent systems consist of several agents interact with each other to achieve a certain goal (Bernon et al 2005, Stone & Veloso 2000, Weiss, 2001). Today, MAS is used as an advanced method for modeling and simulation. This method provides the test bed for examining models and theories from different perspectives (Gilbert & Troitzsch 2005).

Likewise, in trust modeling, agent is a basic concept that serves as a trustor or a trustee having his own intentions, cognitive abilities and knowledge on how to full fill its requirements. Today, most trust models have been developed based on MAS because two essential concepts

for trust modeling are agents and interactions among them that can be described in this approach. Interaction usually refers to coordination, cooperation and negotiation.

3. Decision Making based on Trust

When two agents with no prior knowledge of each other want to engage in an interaction (for example Electronic Commerce transaction) they must each ask themselves "Should I trust this agent and engage in this interaction (or not)?" The problem arises when each agent must choose the indicators that should be used for this decision making and request it from the other agents. When an agent is faced with these complex questions, trust can be a tool to simplify decision making. Moreover, it can guide an agent in a certain direction and limit the number of decisions that has to be considered (AL-Mutairi 2007, Stranders 2006).

Decision making can be related to trust by considering the opponent. For example, an agent needs to decide whether or not to delegate a task to another. To do this, the decision model needs to know the agent's goals and risk-profile regarding to trust.

Trust can be the result of decision making and we should decide whether to trust or not. In this process, the assessments are compared to a threshold. If they are higher than the threshold we trust, otherwise we do not. The threshold value depends on decision making type (or agent type). In an optimistic decision making, for instance, this value is lower and in a pessimistic decision making, it is higher. There is an expression in English which says: A pessimist is an optimist with experience.

We can also take into account decision making prior to trust as a probability. If we assume Boolean decision making, a simple definition is as follows:

$$T : A \times A \rightarrow [0,1] \tag{1}$$

Ex: T(Jim, Watts) = 0.8 Jim trusts Watts 80%.

4. The Proposed Model

As the proposed model is based on MAS approach, agent is the most important concept. Agent is modeled as a set of properties. Three important properties of specialty, responsibility, and personality have been used in this model (Fig 1). The first two properties are from zero (lack of the property) to one (having the property completely).

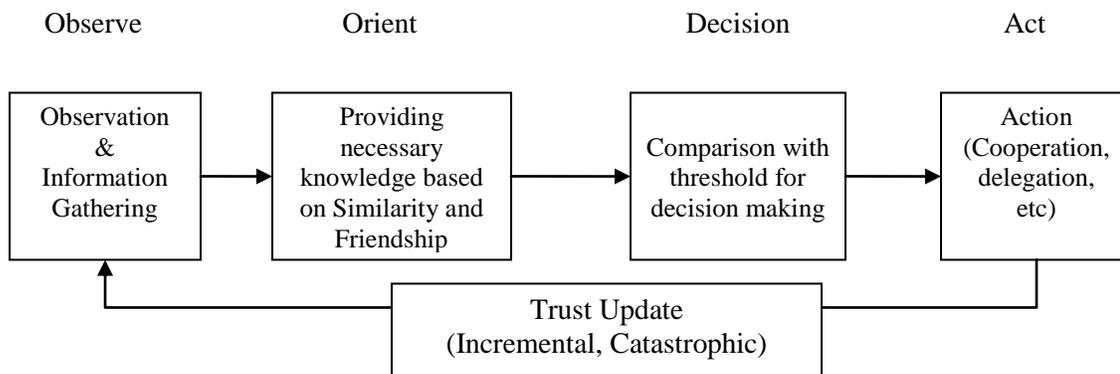| Specialty	Responsibility	Personality

Fig 1: Parametric Model for Agent

We use binary numbers for personality property. In single bit, we define two personality properties, for two bits four personality property, and for n bit 2^n personality property for agents. We have utilized binary numbers for personality property to compare it with the following equation (2).

4

5thSASTech 2011, Khavaran Higher-education Institute, Mashhad, Iran. May 12-14.

$$disSimilarity(P_a, P_b) = \frac{\sum_{i=1}^{n}\left|P_{a_i} - P_{b_i}\right|}{n} \qquad (2)$$

$$Similarity = 1 - (disSimilarity)$$

This model is also based on interaction among agents because it is very important in MAS. Interaction concept in the proposed model is friendship which is modeled as friendship network. If service is needed, each agent sends its request to a friend or familiar agent based on friendship network. This network not only express relationship but also its strength. Thus, network is described as a weighted matrix. The strength of relationship can be interpreted as the amount of trust one agent has another. The more trust, the higher the probability of delegating a service to an agent. Given trust is decision making process for trust, OODA loop is used in the proposed model (Fig 2). OODA is a general process for decision making. Each agent in this process observes the environment (Observe) and makes knowledge from the observation (Orient). Decision-making is based on knowledge (Decide), and finally this decision is executed (Act). These four stages are main stages of the simulation cycle of the proposed model. Trust is formed incrementally and distrust catastrophically.

Observe	Orient	Decision	Act
Observation & Information Gathering	Providing necessary knowledge based on Similarity and Friendship	Comparison with threshold for decision making	Action (Cooperation, delegation, etc)

Trust Update
(Incremental, Catastrophic)

Fig 2: Parametric Model for Agent

Social manner includes three different kinds of trust. Interpersonal trust is the direct trust that an agent has an another agent. Impersonal trust deals with the trust within a system that is perceived trough different properties. And finally, Dispositional trust is the general trusting attitude. The proposed model focuses Interpersonal trust more and evaluates the influence of friendship network, similarity, specialty, and responsibility in developing trust. In other words, the simulator developed based on the proposed model examines several different scenarios as "What … If …". For example, if most of the agents providing service are specialists, how will trust developed? Scenarios can be defined regarding to the number and diversity of parameters in a given model. This paper examines two scenarios among many.
Scenario 1: In this scenario, more than 50% of agent service providers have specialty and responsibility. The simulation results indicate that trust increases gradually with 500 iterations (Fig 3).
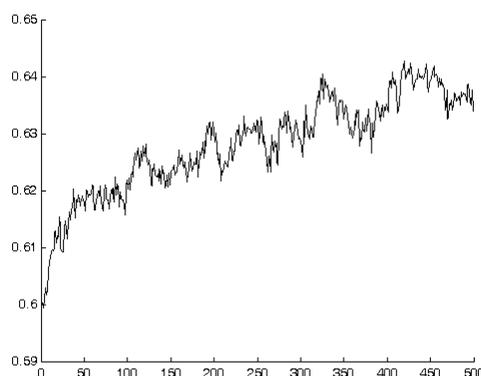
Fig 3: The simulation results of scenario 1

Scenario 2: In this scenario, more than 50% of agent service providers are specialist but not responsible. The results show fluctuation (Fig 4).
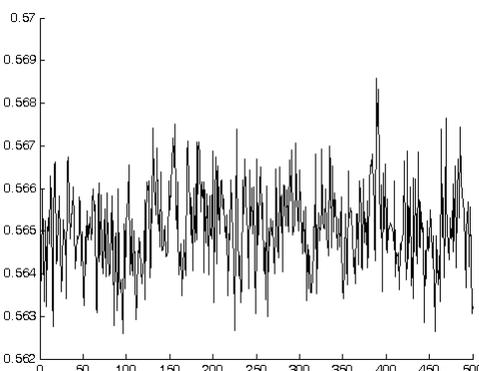
Fig 4: The simulation results of scenario 2

5. Conclusions and Future Works

As trust is a complex concept, it has various definitions, interpretations, and models in different areas. In this paper, a model is proposed based on friendship and similarity. This model assumes trust a cognitive dynamic. A Value is calculated based on friendship, similarity and prior trust and then it is compared with the threshold. As trust concept is closely related to decision making, we use OODA decision making loop in this model. OODA process also provides the update mechanism for trust. The simulation of the examined scenarios shows that specialty and responsibility of service providers lead to an increase in trust. On the other hand, trust can not develop if the specialists are not responsible. Future works can extend agent's parametric model with more properties and include other networks besides friendships network.

References

6

5thSASTech 2011, Khavaran Higher-education Institute, Mashhad, Iran. May 12-14.

AL-Mutairi, M. (2007). Preference Uncertainty and Trust in Decision Making, Ph.D. Thesis, Waterloo, Ontario, Canada.

Bernon, C., et al. (2005). An Overview of Current Trends in European AOSE Research, Informatica 29, 379-390.

Castelfranchi, C., & Falcone, R. (1999). The Dynamics of Trust: From Beliefs to Action, Proceeding of the Autonomous Agents Workshop on Deception, Fraud and Trust in Agent Societies.

ElSalamouny, E., et al. (2009). An analysis of the exponential decay principle in probabilistic trust models, Theoretical Computer Science, 410 (41), 4067 – 4084

Esfandiari, B., & Chandrasekharan, S. (2001). On How Agent Makes Friends: Mechanisms for Trust Acquisition, Proceedings of the Fourth Workshop on Deception, Fraud and Trust in Agent Societies, 27-34.

Fetanat, A., & Naghian, M. F. (2010). A Trust Model in Sensemaking Process, International Journal of Computational Cognition, 8(2), 1-3.

Gambetta, D. (1988). Can We Trust Trust? Basil Blackwell, Oxford.

Gilbert, N., & Troitzsch, K. G. (2005). Simulation for the Social Scientist, Open University Press, McGraw-Hill Education, Second Edition.

Josang, A., et al. (2007). A Survey of Trust and Reputation Systems for Online Service Provision, Decision Support System, 618-644.

Marsh, S. (1994). Formalising Trust as a Computational Concept, Ph.D. Thesis, Department of Computing Science and Mathematics, University of Stirling, Stirling, Scotland.

Seo, Y., & Han, S. (2010). Local Scalar Trust Metrics with a Fuzzy Adjustment Method, KSII Transactions on Internet and Information Systems, 4(2), 138-153.

Stone, P., & Veloso, M. (2000). Multiagent Systems: A Survey from a Machine Learning Perspective, Autonomous Robotics, 8(3), 345-383.

Stranders, R. (2006). Argumentation Based Decision Making for Trust in Multi-Agent Systems, MSc. Thesis, Parallel and Distributed Systems group, Delft University of technology.

Wang, K., & Wu, M. (2010). Cooperative communications based on trust model for mobile ad hoc networks, Information Security, IET, 4(2), 68 – 79.

Weiss, G. (2001). Multiagent Systems: A Modern Approach to Distributed Modern Approach to Artificial Intelligence, MIT Press, Cambridge, MA, 3rd edition.

Ziegler, C., & Lausen, G. (2005). Propagation Models for Trust and Distrust in Social Networks, Information Systems Frontiers, 7(4-5), 337-358.