TrustE - An Emotional Trust Model for Agents

Guilherme K. Bitencourt, Ricardo A. Silveira, Jerusa Marchi

Departamento de Informática e Estatística
Universidade Federal de Santa Catarina
88040-000 - Florianópolis - SC - Brazil
e-mail: {bitencourt, silveira, jerusa}@inf.ufsc.br

13 de dezembro de 2013

Summary

- Motivation
- Proposal
- Regret Model
- Emotions in agents
- The TrustE Model
- Final Considerations

Motivation

- The study and modeling of trust has attracted the interest of researchers in several areas
- In Computer Science this interest is mainly in the Multiagent Systems (MAS) area
- Trust and reputation in MAS are essential, providing effective interaction among agents
- Several models of trust and reputation has been developed in the area
  - Regret, Travos, Fire, among others

Motivation

- The models found in the literature are based on algebraic analysis to determine the act of trust, which makes such models essentially mathematical and disconnected from the agent's history
- For humans, emotions directly influence the act of trust, imposing a subjective evaluation of trust

Proposal

Put together emotions and trust in order to achive a human like behavior

- Emotions are incorporating as symbolic evaluations that are related with the context in wich the agent is embedded

Regret + Emotions = TrustE Model

Regret model

Overview

- Reputation model based on 3 dimensions:
  - Individual dimension
  - Social dimension
  - Ontological dimension
- Distributed architecture
- Each agent has it own opinion about the others
- The *Outcome* of a dialogue between two agents is:
  - The initial contract that defines the terms and conditions of a transaction between two agents
  - The result of the actions taken in this transaction

Regret model

Individual dimension

- Individual reputation of agent (IR)
- Calculated directly from the agent impressions database
- Weighted Average - more recent Impressions have greater weight

$$R_{a \to b}(\varphi) = \sum_{\iota_i \in IDB_p^a} \rho(t, t_i).W_i \tag{1}$$

Regret model

Social dimension

- Social reputation of agent (SR)
- Social reputation takes into account three sources of information to calculate reputation:
  1. The interaction of the agent *a* (evaluator) with other members of the group that the agent *b* (rated) belongs.
  2. What members of the group *A* (the *a* agent group) think about the agent *b*.
  3. What members of the group *A* think about the group *B* (the *b* agent group).

Regret model

Social dimension - Source 1

$$R_{a \to B}(\varphi) = \sum_{b_i \in B} \omega^{ab_i} . R_{a \to b_i}(\varphi) \tag{2}$$

* $\sum_{b_i \in B} \omega^{ab_i} = 1.$

Social dimension - Source 2

$$R_{A \to b}(\varphi) = \sum_{a_i \in A} \omega^{a_i b} . R_{a_i \to b}(\varphi) \tag{3}$$

* $\sum_{a_i \in A} \omega^{a_i b} = 1.$

Social dimension - Source 3

$$R_{B \to B}(\varphi) = \sum_{a_i \in A} \omega^{a_i B} . R_{a_i \to B}(\varphi) \tag{4}$$

* $\sum_{a_i \in A} \omega^{a_i B} = 1.$

Regret model

Final value of reputation

$$SR_{a\to b}(\varphi) = \xi_{ab}.R_{a\to b}(\varphi) + \xi_{aB}.R_{a\to B}(\varphi) + \xi_{Ab}.R_{A\to b}(\varphi) + \xi_{AB}.R_{A\to B}(\varphi) \quad (5)$$

* $\xi_{ab} + \xi_{aB} + \xi_{Ab} + \xi_{AB} = 1.$

Emotions in agents

- In recent years the study of emotions is present in research in AI and Computer Science
- Today it is widely accepted among psychologists that emotions play an important role in cognitive actions
- Psychological models of emotions are proposed mainly in terms of cognitive states and processes such as beliefs and actions selections

Emotions in agents

OCC Model

- OCC model (Ortony, Clore and Collins) describes a hierarchy that classifies 22 types of emotions
- Specifies the conditions that trigger the emotions and the variables that affect the intensities of these emotions
- Examples of motions described in the OCC model:
  - *joy* - *pleased* about a desirable event;
  - *fear* - *displeased* about the prospect of an undesirable event;

Emotions in agents

Intensity of Emotions

- The *intensity function* of an emotion can be represented by:

$$I_a(E,t) = max(0, P_a(E,t) - L_a(E,t)) \tag{6}$$

  - $P_a(E,t)$ represents the *potentiality* of emotion E of the agent a.
  - $L_a(E,t)$ the *thresholds* of E of the agent a.
  - t the current time.

TrustE - Model

Presentation

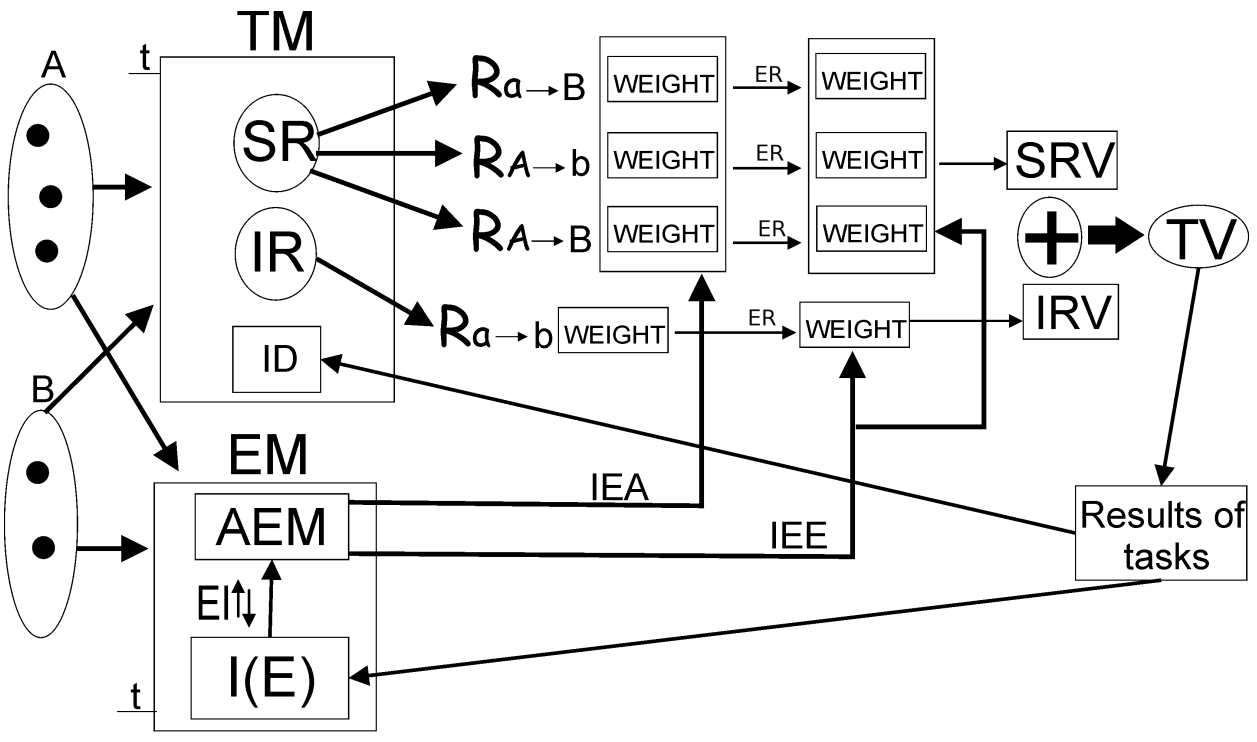
- TrustE adds emotions to the calculation of trust and reputation in agents
- The proposed model incorporates to the trust model estimates derived from symbolic reasoning, making the act of trust more dynamic and dependent on the agent's history
- It is done by the incorporation of emotional factors in the Regret model - the weights ω and ξ of the Regret model are replaced by emotional symbols (*IEA* and *IEE* respectively)

TrustE Model

IEE and IEA

- *IEA* - Represents the *Intensity of Emotions triggered by Actions*
  - This group of emotions involves the emotions that are based on the judgment of an action's praiseworthiness.
- *IEE* - Represents the *Intensity of Emotions triggered by Events*
  - This group of emotions is related to the evaluation of an event with respect to the agent's goals.

TrustE Model



Legends:

ER - Equations Results
TV - Trust Value
SR - Social Reputation
IR - Individual Reputation
ID - Impressions Database
EI - Emotion Intensities
t - time ● Agent

TM -Trust model
EM - Emotion model
IEA- Intensity of Emotions-Actions (admiration)
IEE - Intensity of Emotions-Events (joy)
I(E) - Intensity Functions of Emotions
AEM - Agent's Emotional Memory

TrustE Model

Regret equations in TrustE

- The first weight used in the calculation of Individual Reputation, $R_{a \to b}(\varphi)$, is the same used in Regret, which assigns higher values to the ratings given recently.
- The first weights in Social Reputations, $R_{a \to B}(\varphi)$, $R_{A \to b}(\varphi)$ and $R_{A \to B}(\varphi)$, are calculated from *IEA*.
- In the next step the weights used in $SR_{a \to b}(\varphi)$ take into account the *IEE*.
- The four values of reputations are combined to form the Trust Value (TV).

TrustE Model

Regret equations in TrustE

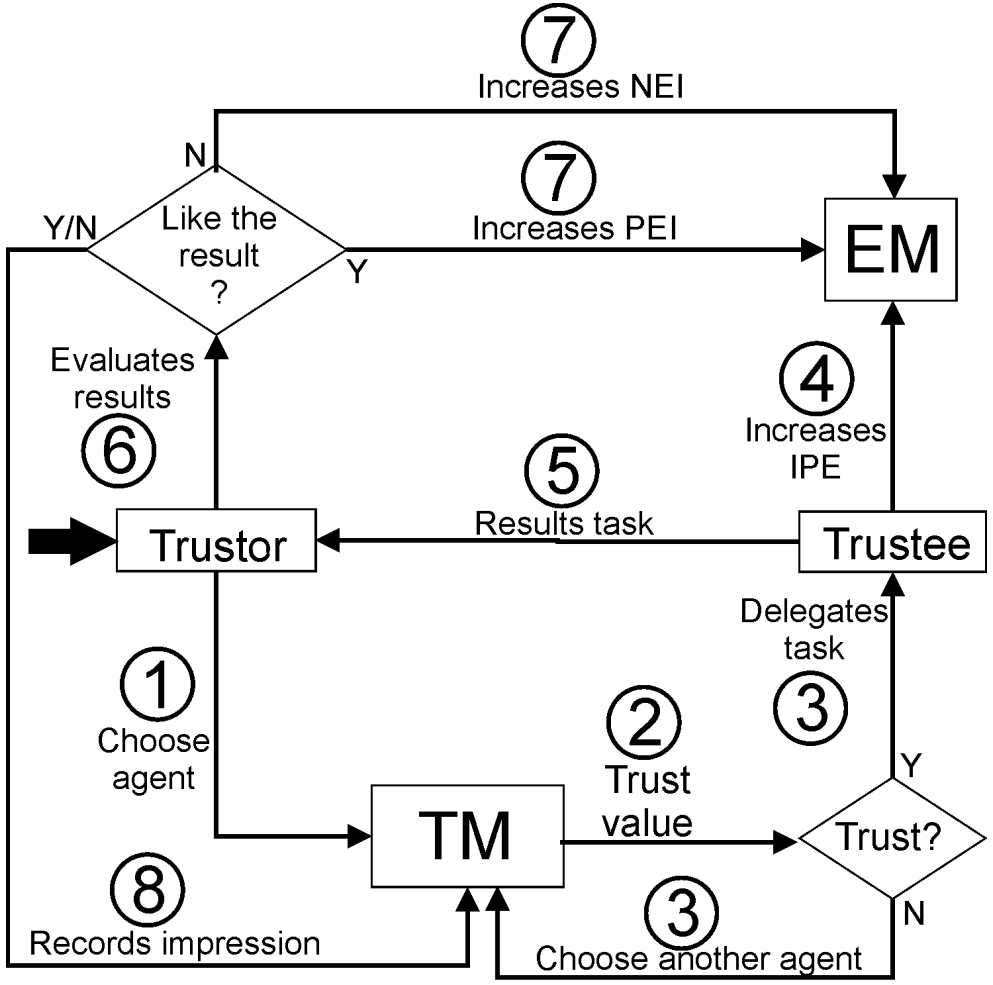
$$R_{a \to B}(\varphi) = \sum_{b_i \in B} IEA^{ab_i} . R_{a \to b_i}(\varphi) \tag{7}$$

$$R_{A \to b}(\varphi) = \sum_{a_i \in A} IEA^{a_i b} . R_{a_i \to b}(\varphi) \tag{8}$$

$$R_{A \to B}(\varphi) = \sum_{a_i \in A} IEA^{a_i B} . R_{a_i \to B}(\varphi) \tag{9}$$

$$SR_{a \to b}(\varphi) = IEE_a^{RI} . R_{a \to b}(\varphi) + IEE_a^{RS} . R_{RS} \tag{10}$$

TrustE Model - Conceptual View



Legends:

TM - Trust model
EM - Emotion model
PEI - Positive emotions intensity
NEI - Negative emotions intensity

TrustE Model

Example:

Given a scenario in which a agent wants buy a product of good quality

1. *a* is a buyer agent that will choose an seller agent *b* among all the knowed sellers
2. *a* calculates the trust in *b*
3. If the trust value is low, *a* will looking for another seller, if it is high, *a* will buy the product from *b*
4. After has received the trust of *a*, *b* increases its positive emotions

Example:

5. After some time, *b* will delivery the product to the agent *a*.
6. *a* will evaluate the product quality
7. If the quality is good, the positive emotions of *a* will increase. Otherwise, the negative emotions of *a* will increase
8. Finally *a* will evaluate, positively or negatively, the agent *b*.

Final Considerations

- TrustE model aims to capture the complexity of human reasoning and turn it flexible quantitative evaluations by introducing elements of a qualitative nature
- The inclusion of emotions and their intensities can provide greater realism to the trust model
- The decision-making processes becomes directly related to the emotional state of the agent
- The proposed model can be further expanded to include a greater number of emotions
- The model needs to be implemented and validated in scenarios of negotiation among agents.