Reputation in Multi Agent Systems and the Incentives to Provide Feedback

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Outline

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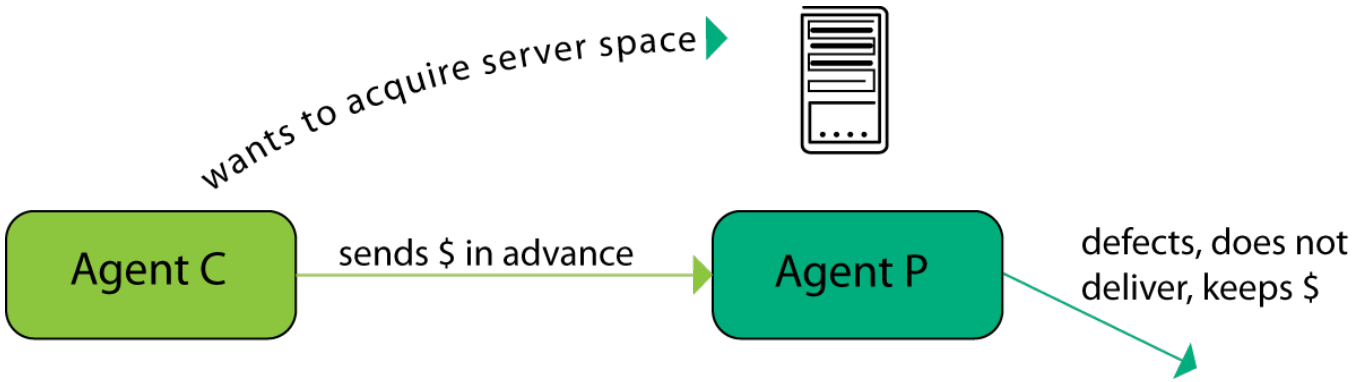
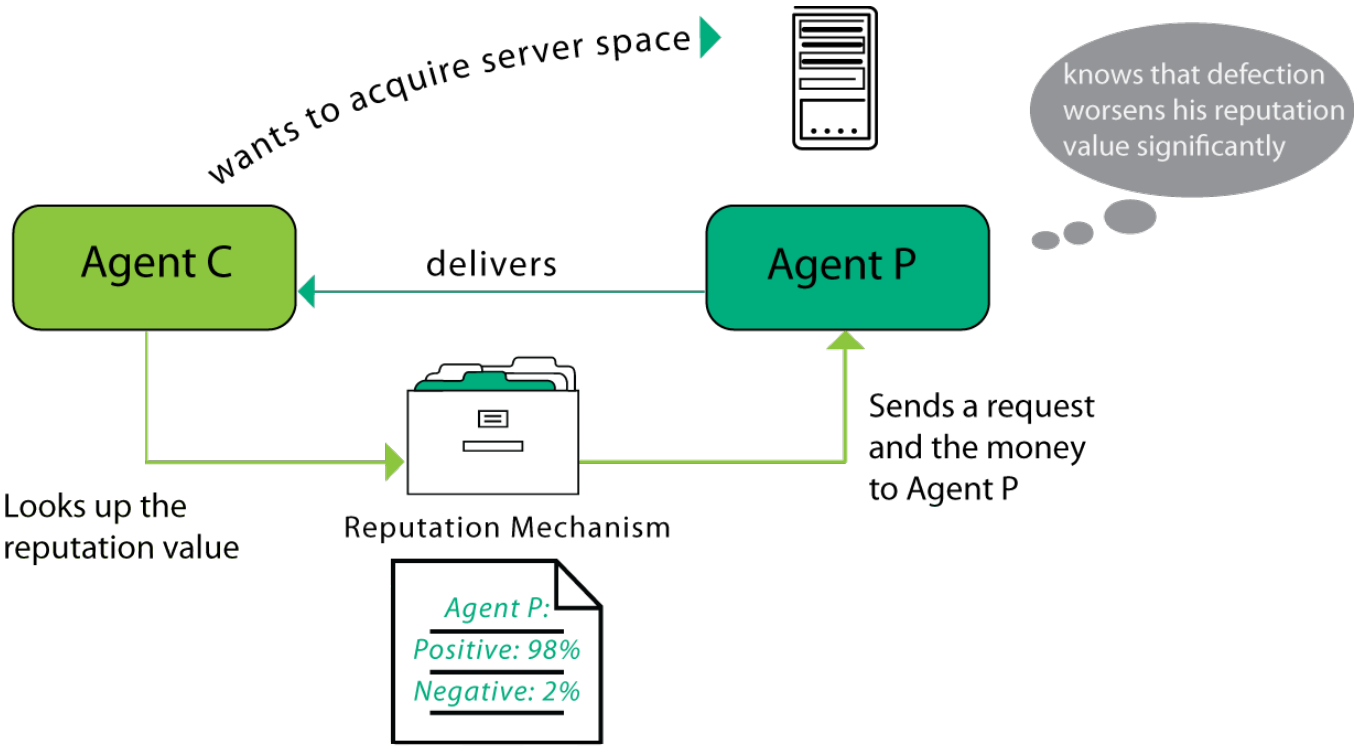
Why is reputation necessary?



Example: Transactions **with** a reputation mechanism



Problems with Rationality

Rational agents will not submit feedback at all because it is not rational for them to do so

- feedback is a public good,
- giving feedback is associated with costs but no direct gain.

Reputation Mechanism needs to set incentives

- to submit feedback
- to further trustworthy feedback

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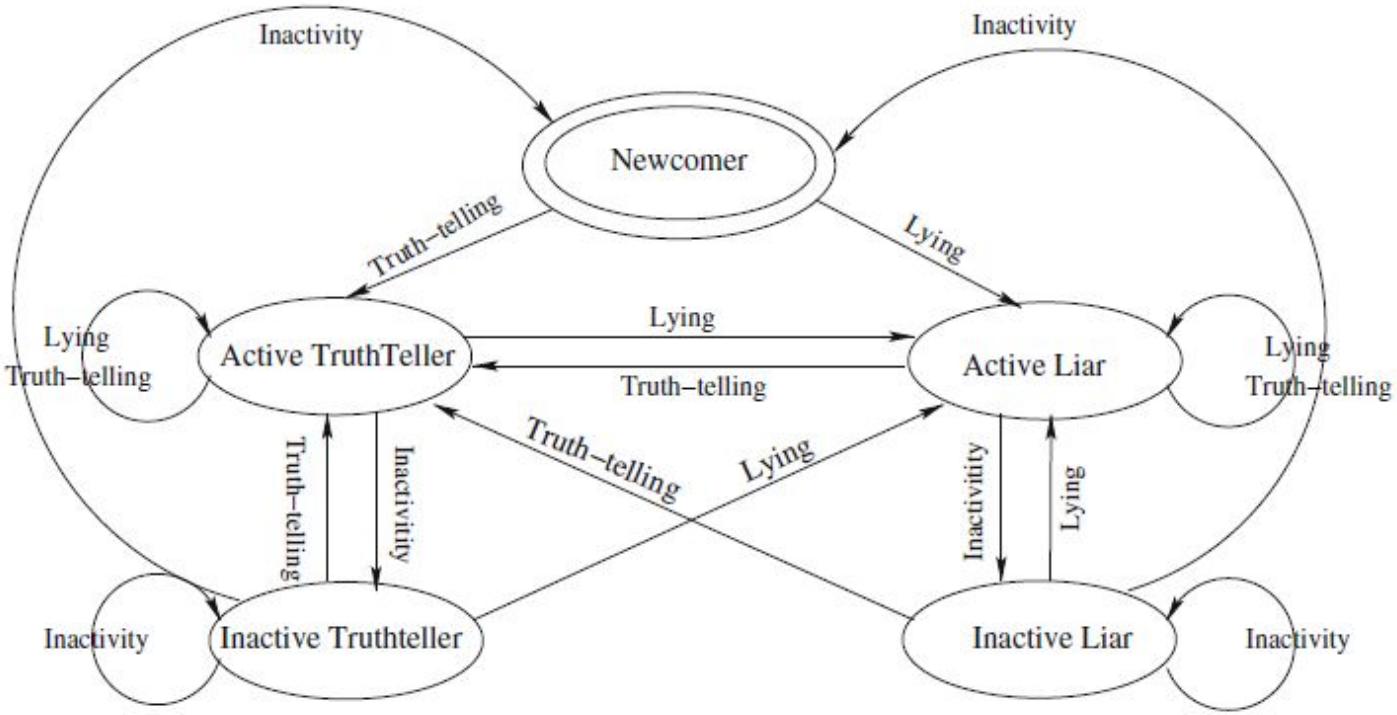
Liu and Issarny: An Incentive compatible Reputation Mechanism for Ubiquitous Computing Environments

- Main Objective: distinguishing between trustworthy and untrustworthy, and between honest and dishonest agents
- Untrustworthy feedback is ignored,
- old feedback values are discounted over time
- The outcome of the transaction is measured with the help of three different kinds of reputation and a measure for the discrepancy for the advertised and the delivered service.

States of the Recommender



Incentives

Liu et al. set incentives with the meta rating.

Example:

1. Agent a asks agent r for recommendations
2. Agent r evaluates the state of the agent a and if it has a significant number of direct experiences.
3. Agent r sends back the recommendation due to the state of agent a:

   active truthteller sends back the recommendation immediately.

   inactive recommenders sends back the reputation with the probability of $diff = \delta_a - (r_p + r_n - 2)$. Liars and truthtellers are distinguished by a small value of ϵ (decreasing for liars and increasing for truthtellers)

   active liar does not send anything back.

Therefore the less active an entity is, the less possible that it receives helpful recommendations from others.

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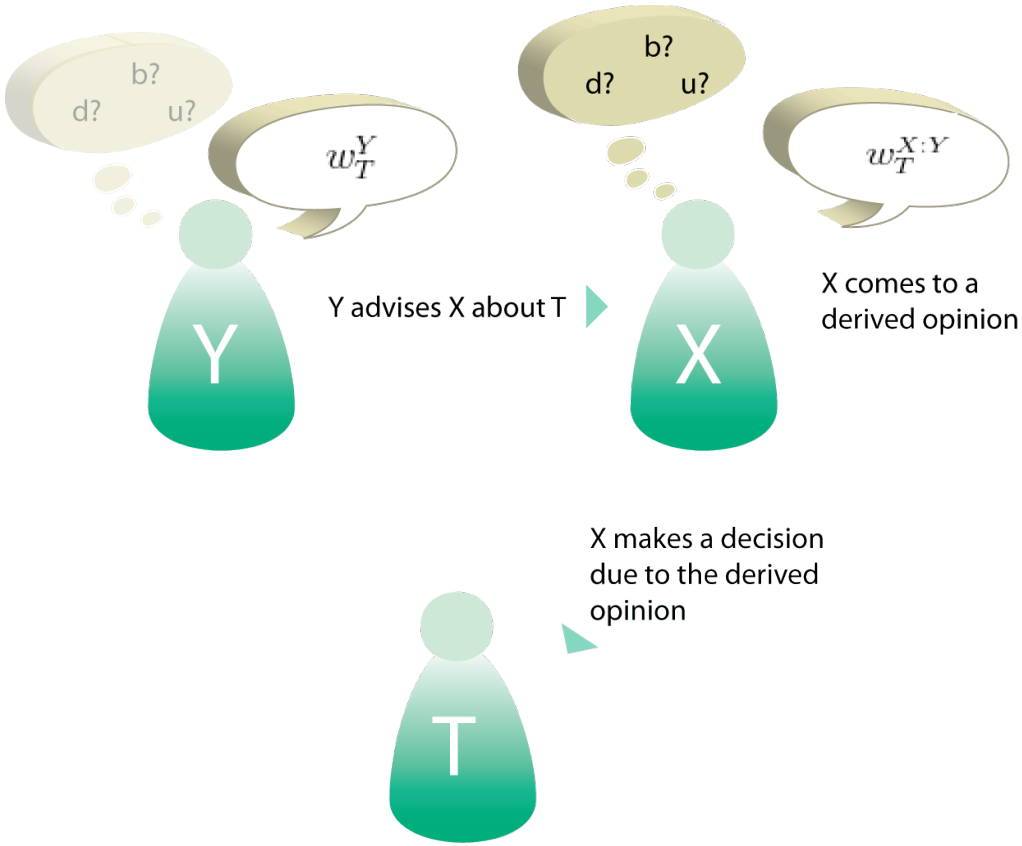
Jøsang and Ismail: The Beta Reputation System

The advised X rates the opinion and comes to a derived opinion about T.
X's opinion about T as a result of Y's advice to X is represented as:
$w_T^{X:Y} = (b_T^{X:Y}, d_T^{X:Y}, u_T^{X:Y})$



Incentives

Jøsang et al. establish a system that uses a kind of meta rating which consists of the opinion one agent has about another agent.

However, the recommendations are given to a requesting agent right away.

In order to set incentives the authors would have to introduce a mechanism similar to Liu et al. which distributed recommendations due to the honesty and activity of a requesting agent.

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Buchegger and Boudec: A Robust System for P2P and Mobile Ad-hoc Networks

Buchegger et al. use reputation fading and provide a very precise method to compute the time fading factor u.

Example:

1. Agent i (consumer) and agent j (provider) interact.
2. Agent j defects and misbehaves ($s = 0$).
3. Agent i incorporates that first hand information ($F_{i,j} = (\alpha, \beta)$ into his reputation rating of agent j:
   - $\alpha := u\alpha + s$
   - $\beta := u\beta + (1 - s)$
   - u is the factor that enables reputation fading.

A Good value for u

The following formula has to fulfill three criteria

- more weight should be given to recent observations
- reputation should still fade even if no new observations occur
- it should evaluate the number of observations during which stationary behavior of the other agent can be assumed.

The standard formula for a new α after n observation is:

$$\alpha_n = s_n + us_{n-1} + \ldots + u^{n-1}s_1 + u^n$$

Now the authors introduce an integer m defined as $m = \frac{1}{1-u}$ representing the number of observations during which stationary behavior can be assumed. So that:

$$u = 1 - \frac{1}{m}$$

Hence, the discounting factor is dependent on the behavior volatility.

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Incentives

Buchegger et al. create meta ratings which consist of the trust rating and the reputation rating.

However, the recommendations are published in the system where all agents have access to them.

In order to set incentives the authors would have to introduce a mechanism similar to Liu et al. which distributed recommendations due to the honesty and activity of a requesting agent.

Jurca and Faltings: Towards Incentive Compatible Reputation Management

Jurca et al. introduce a mechanism which

- detects false feedback
- gives a framework of incentives which makes it rational to report truthfully

They introduce a side payment scheme which is maintained by broker agents. Those are called R-Agents.

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Assumptions

The following assumptions are made by Jurca et al.:

1. Payments are only conducted by R-Agents. No side payments occur between any normal agents.
2. All agents behave rationally.
3. There are n agents in the system with a_i for $i = 1...N$.
4. Agents play in pairs iterated prisoner's dilemmas.

Acquiring and Selling Feedback

Jurca et al. introduce a process where agents can buy and sell feedback about agents.

Example:

1. Agent i buys feedback from a R-Agent about agent j at the cost of F
2. Agent i now decides depending on the acquired feedback if he wants to interact with agent j.
3. After the transaction, given that it has taken place, the agent can sell reputation information anticipating C.
4. The R-Agent checks the feedback and estimates if it is a truthful report. If so, he pays agent i an amount of C.

Agents are only allowed to sell reputation about an agent that they have purchased information about before.

Payment Scheme

The model has the following features:

1. Agents which report truthfully at all times should not lose any money as a result of an interaction with another agent: $E[F] \leq E[C|\text{truthful report}]$
2. Agents who do not report truthfully should gradually lose their money as a result of an interaction with another agent: $E[F] \geq E[C|\text{false report}]$

Price at which reputation can be sold

R-Agents will pay only for reports which match the next report about the concerned agent.
F is determined depending on

- the price that the R-Agent paid to acquire information,
- the sum of all reputation given,
- the probability that business is conducted and the other agent behaves accordingly in the next round,
- the number of agents in the system.

$$E[payoff] = C \cdot \frac{\sum_{j=1}^{N} q^2(1 - 2p + 2p_j^2)}{N} = F$$

Outline

A "Perfect" Reputation Mechanism for MAS

1. Reputation Values
   - using *Liu and Issarny*'s approach with the three kinds of reputation: SRep, ORep and RRep,
   - creating different states of the recommender (active and inactive truthteller/liar, newcomer).

2. Discounting and Weighting Reputation
   - Using *Jøsang and Ismail*'s method to discount feedback.
   - Determining the discount factor with *Buchegger and Boudec*'s calculation.

3. Incentives

- Setting incentives with a payment scheme presented by *Jurca and Faltings* where an agent pays a broker agent to view feedback about a future partner and thereafter decide if he wants to conduct business. After a transaction takes place he can sell his feedback again to the broker agent,
- Setting incentives through varied influence of own opinion: meta-rating in *Jøsang et al.* and *Buchegger et al.*
- Possibility to gain information from others (Reputation) based on own behaviour: agent states (*Liu et al.*)

Outline

- Comparing simulation experiments with proposed reputation mechanisms
- Deriving a framework with design recommendations for reputation mechanism designers

Thank you for your attention!