

# Perseus – A Personalized Reputation System

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# Introduction

- Internet provides many possibilities for online transactions
  - Auctioning second-hand items (eBay, Amazon, ...)
  - Shopping in online stores
- Characteristics of online transactions
  - Buyer and seller seldom have prior interaction history
  - Possibility of financial loss
  - Lack of conventional cues for assessing the trustworthiness of the other
    - Buyer and seller cannot engage in face-to-face communications
    - Buyer cannot examine the quality of the products
- Many opportunities for misbehavior
  - Seller not sending products even if buyer has paid for them
  - Sending products of lower quality
  - Buyer can badmouth the seller
- Trust is a critical factor for these transactions to succeed
  - If buyers do not trust sellers they will not buy items
- How can we make the setting more trustworthy?

# Reputation Systems

- Reputation systems are systems that help users to assess the trustworthiness of an individual
  - Gather information about the opinions and experiences of individuals
  - Aggregate the information
  - Use the aggregated information to provide cues that help assessing the trustworthiness of an individual
- Hence, reputation systems can be understood as word-of-mouth systems in situations where the object of interest is an active user
  - Collaborative / content-based filtering: object of interest is passive







# Example: eBay


**eBay My World: whostheboss ( 3465 ★ )** 

Feedback earned for transactions on eBay [View your eBay My World page](#)

Feedback score: **3465** Positive feedback: **99.5%** [See All Feedback](#)

[Learn about](#) what these numbers mean.


Latest Feedback:	From	Date	Item#
 great headset	Buyer <a href="#">hberry75</a> (17 ★)	Nov-03-07	<a href="#">140170787122</a>
 great product fast shipping	Buyer <a href="#">moon2-2</a> (28 ★)	Nov-03-07	<a href="#">140169093773</a>
 Recd it perfect Godly Vendor!!!	Buyer <a href="#">powtom</a> (70 ★)	Nov-03-07	<a href="#">140169292698</a>
 Bluetooth received in a timely fashion.. great condition.. Would purchase again.	Buyer <a href="#">masterminds</a> (2)	Nov-03-07	<a href="#">140172421662</a>
 Thank You Verry Good seller!	Buyer <a href="#">itsmery</a> (432 ★)	Nov-03-07	<a href="#">140169292698</a>
 fast shipping and good product.	Buyer <a href="#">peewee2u</a> (59 ★)	Nov-03-07	<a href="#">140167335012</a>



Member since: Aug-22-04  
Location: United States  
Views: 845 total

[Items for sale](#)  
[Add to favorite sellers](#)  
[Contact member](#)

**Listings**



**MOTOROLA H700  
BLUETOOTH HEADSET  
FREE SHIPPING**

# Reputation Systems

- Reputation systems can consider reputation as a
  - Global property: the reputation of an individual is shared by all members of the community
    - Typically used in settings where the size of the community is huge
  - Subjective property: the reputation of an individual depends on the person who examines it
    - Typically used in smaller communities where the probability of repeated interactions is higher than in larger communities
- Global reputation has one severe vulnerability
  - Examine own reputation has potential for misuse
    - Studies have shown the buyers are willing to pay more when the reputation of the seller is high
    - Hence an individual can gather up a high reputation and then misuse it
    - Also possible to collude with others and to perform bogus transactions which increase the reputation of an individual
- To overcome this vulnerability, we have developed Perseus
  - Reputation is subjective, but if no interaction history works similarly as a global reputation system

# Perseus

- Perseus is a subjective reputation system
  - The reputation of an individual depends on the person who examines it
  - Reputation values consider three aspects
    - Personal experiences (first hand reputation)
    - Experiences of others (third party reputation)
    - How much I value the experiences of others
  - Uses stochastic approximation algorithms  $\hat{=}$  computationally effective
- For concreteness, we fix the problem setting to online marketplaces
  - Two actors, buyer and seller
  - Buyer must send money before the seller will ship the item
  - Seller can be dishonest and not send the item
  - After the transaction is concluded (product sent or buyer gives up hope) both parties can rate each other
    - We assume ratings can be either negative (-1), neutral (0) or positive (+1)

# First hand reputation

- The first hand reputation represents personal experiences
  - the most important source of information for decisions
- We require that the reputation values lie in the interval [0,1]
  - value 0 = complete distrust (dishonest)
  - value 1 = complete trust (honest)
- Model
  - we assume that the “honesty” of an individual depends on an unknown parameter
  - and we estimate the parameter over time
- Estimator
  - stochastic approximation algorithm used to estimate

$$\gamma_i^t(j) = \gamma_i^{t-1}(j) + \alpha (\rho_i(t) - \gamma_i^{t-1}(j))$$

estimator  $\nearrow$        $\uparrow$  Previous value of estimator       $\nwarrow$  rating  
 $\swarrow$  step-size (we use  $\max\{0.01, 1/t\}$ )

## Third party reputation

- Third party reputation integrates information from other individuals
  - also called *witness information*
  - two main approaches
    - social-network based: value of witness information depends on the “closeness” of the individuals in a social network
    - generic: all persons considered equally
  - The generic approach is usually used in large communities and in situations where user involvement needs to be minimized
    - We focus on the generic approach since this is the common approach for online marketplaces

$$\varphi_i^t(j) = \frac{1}{\#T} \sum_{k \in \#T} \gamma_k^t(j)$$

Set of  
trustworthy  
individuals

- Third party reputation in Perseus
  - Calculated as an average of the ratings for an individual
  - Opinions of non-trustworthy individuals excluded
    - Trustworthiness is determined using a threshold on the reputation values

# Reputation aggregation

$$R_i^t(j) = \frac{\pi_1}{\pi_1 + \pi_2} \gamma_i^t(j) + \frac{\pi_2}{\pi_1 + \pi_2} \phi_i^t(j)$$

- In many cases we need a single value (per buyer - seller pair)
  - E.g., for ranking sellers according to their reputation
  - Hence, we need a way to aggregate the different information sources
  - In our case, we use a weighted linear sum
    - Most common approach found in the literature
    - Also analysis of voting mechanisms suggests this approach
  - Require that the weights are in the interval  $[0,1]$  and sum up to one
  - The weights can be understood as measures of agreement between the rating and the individual information sources
- How to set the weights?
  - Initially, we set the weights to the values 0.25 and 0.75
  - Weights are updated over time using a stochastic approximator
  - When rating and information source *agree* we increase the weight towards the value 1.0 (disagree decrease towards 0.0)
    - Agree = both the rating and the estimate given by the individual information source are the same (both positive or both negative)

## Coping with unfair ratings

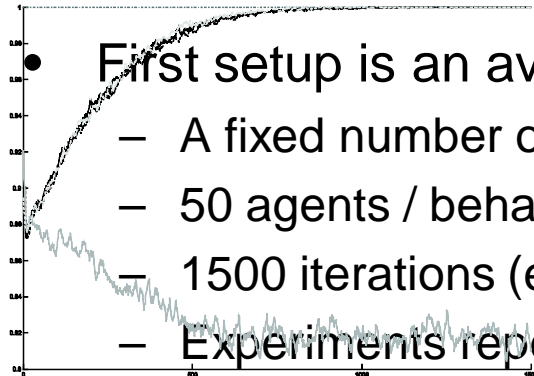
- Buyers and sellers may provide false or misleading ratings
  - can cause unwanted biases to the estimates
  - provides several attack opportunities
- To cope with unfair ratings, Perseus uses a set of heuristics
  - We require that buyer and seller give their ratings independently
  - First step is to determine whether the ratings agree or disagree
    1. When ratings agree, we update only the reputation of the seller
      - Prevents artificially increasing the reputation of the buyer
    2. When ratings disagree, we have two options
      1. When negative rating is given by buyer
        - The buyer does not want to interact with the seller  $\Rightarrow$  decrease the reputation of the seller
      2. Negative rating given by seller
        - Seller does not want to interact with the buyer  $\Rightarrow$  decrease the reputation of the buyer
        - But also decrease the reputation of the seller  $\Rightarrow$  makes transactions between the individuals less likely, but the reputation of seller remains neutral for others
  - Our mechanism encourages giving ratings as otherwise a person could be falsely accused

## Experiments: Setup and Metrics

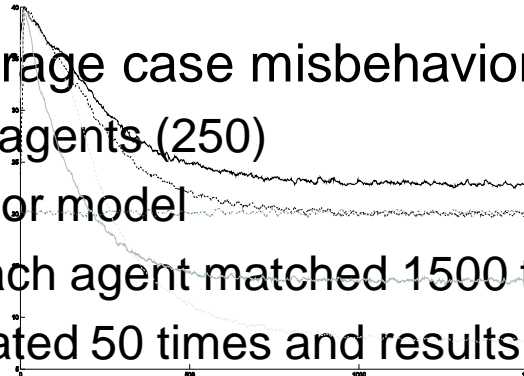
- We have evaluated Perseus using a set of simulation experiments
  - Setup adapted from Schlosser et al., imitates an online marketplace
  - Individuals are modelled as agents with fixed behaviour patterns
    - A fixed set of agents who act both as sellers and buyers
    - All goods have the same price
  - Behaviour patterns:
    - **Honest:** accept transactions with neutral and trustworthy agents, carry out transactions honestly and give fair ratings
    - **Selfish:** passive sellers, never buy anything and never provide ratings
    - **Malicious:** as buyer accepts transactions with neutral and trustworthy agents; as seller accepts all transactions and acts honestly or dishonestly by chance
    - **Disturbing:** attempt to build up a good reputation by acting honestly and then attempt to misuse the good reputation
    - **Spamming:** act otherwise similarly as the honest agents, but they always provide unfair ratings
- Evaluation metrics:
  - Transaction rate: portion of transactions completed successfully
  - Number of transactions

# Experiments I

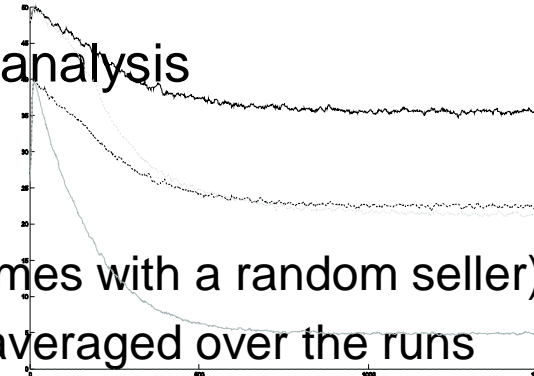
1. Transaction rate as a buyer



2. Number of transactions as a buyer

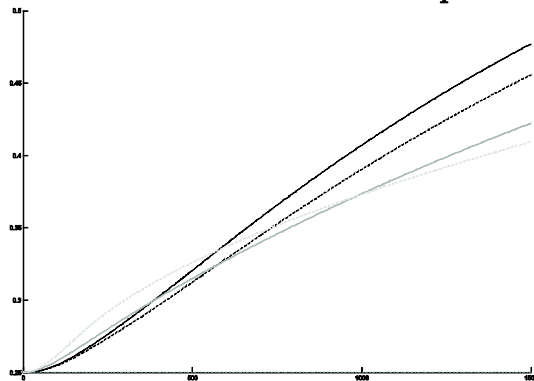


3. Number of transactions as a seller

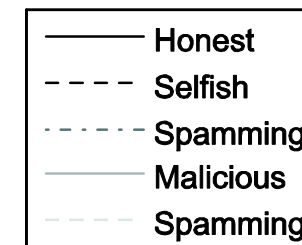
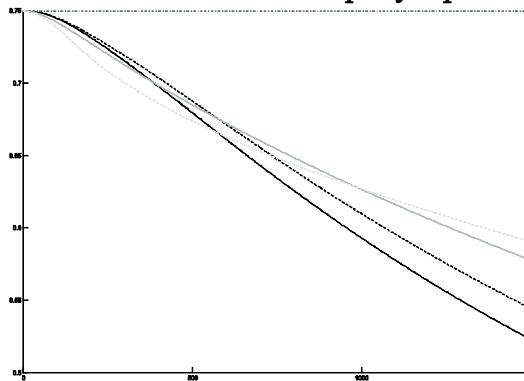


- First setup is an average case misbehavior analysis
  - A fixed number of agents (250)
  - 50 agents / behavior model
  - 1500 iterations (each agent matched 1500 times with a random seller)
  - Experiments repeated 50 times and results averaged over the runs

5. Coefficient for first hand reputation



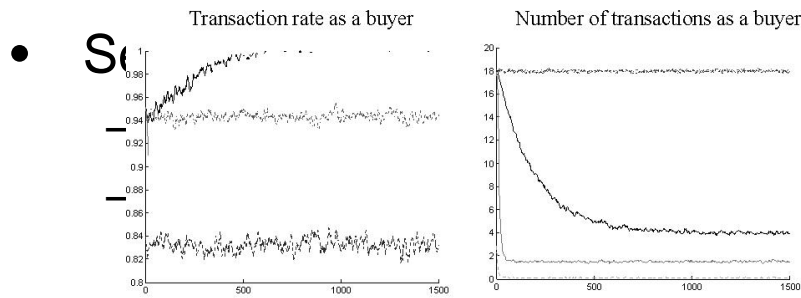
6. Coefficient for third party reputation



- Results
  - Indicate that the rate of successful transactions remains high over time
  - The performance system converges rapidly
  - Able to correctly identify malicious agents and insensitive to spammers

# Experiments II: Comparison

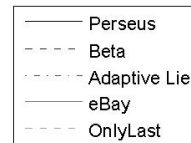
## 1. Spamming



## 2. Disturbing



Legend



aving type

thus always 20 honest agents

the performance of Perseus

g other reputation systems

adaptiveLie (Sakai et al.)

## Results

- Perseus performs well even under extreme conditions
- All transactions of Honest agents are successful
- Other mechanisms can support more transactions, but have worse transaction rate (i.e., less successful transactions)
- Biggest difference to other mechanisms when the number of disturbing agents is high

# Summary

- Perseus is a subjective reputation system
  - As the mechanism is subjective, individuals cannot examine and misuse information about their own reputation
  - Utilizes three forms of information: personal experiences, observations of others and reliability of others' opinions
  - Based on stochastic approximation
    - Also incorporates a set of heuristics for coping with unfair ratings
- Evaluated Perseus under extreme conditions of misbehaviour
  - Experiments show that the mechanism is robust against misbehaviour, under extreme conditions
  - Current work: implementing a web-based experiment setup and evaluating performance / usefulness with real users