A good reputation is more valuable than money
- Publilius Syrus (~100 BC)
Outline

- Introduction
- Challenges
- Current Research
- Conclusions
Outline

- Introduction
- Challenges
- Current Research
- Conclusions
Reputation \Rep\u*ta"tion\\

1. The estimation in which one is held; character in public opinion; the character attributed to a person, thing or action; repute

2. A feedback profile that allows prediction of future behavior based on past interactions
Properties

- A reputation system should
  1. Capture feedback
  2. Guide trust decisions
  3. Persist over time
Real World Reputation Systems
eBay Example

- Alice has bought and sold 10 items with 5 people
- After these transactions her feedback score has increased by 3 points
- We now examine each transaction and how it affected her score
eBay Example

- Score decreases by 1
eBay Example

- Score stays the same
eBay Example

- Score increases by 2
eBay Example

- Score increases by 1
eBay Example

- Score only increases by 1
Thin Lizzy / Bad Reputation / remastered cd

Starting bid: US $13.98
Place Bid >

Time left: 3 hours 57 mins
7-day listing
Ends Nov-11-04 17:15:19 PST

Start time: Nov-04-04 17:15:19 PST

History: 0 bids

Buy it Now: US $16.50
Buy It Now >

Item location: ALPHA, OH
United States / Dayton-Springfield

Ships to: United States, Mexico, Europe, Australia, Canada

Shipping costs: US $3.00 - Standard Flat Rate Shipping Service (within United States)
## Member Profile: www.thecdcellar.com (21010 ⭐️)

### Feedback Score:
- **Positive Feedback:** 97.9%
- **Negative Feedback:** 2.1%
- **Feedback Score:** 21010

**Members who left a positive feedback:** 21439
**Members who left a negative feedback:** 462
**All positive feedback received:** 31779

### Recent Ratings:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Past Month</th>
<th>Past 6 Months</th>
<th>Past 12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive</td>
<td>140</td>
<td>2261</td>
<td>6378</td>
</tr>
<tr>
<td>neutral</td>
<td>3</td>
<td>20</td>
<td>81</td>
</tr>
<tr>
<td>negative</td>
<td>2</td>
<td>48</td>
<td>127</td>
</tr>
</tbody>
</table>

**Bid Retractions (Past 6 months):** 0

**Member since:** Aug-22-98
**Location:** United States

- [ID History](#)
- [Items for Sale](#)
- [Visit my Store](#)
- [Add to Favorite Sellers](#)
- Learn more [About Me](#)

### Contact Member

---

### All Feedback Received

<table>
<thead>
<tr>
<th>Comment</th>
<th>From</th>
<th>Date / Time</th>
<th>Item #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent service and delivery. Thank you.......................5 STAR!!!!!!!!!</td>
<td>Buyer 94c12069 (14⭐️)</td>
<td>Nov-10-04 12:00</td>
<td>4048940647</td>
</tr>
<tr>
<td>Excellent service, great communication, would deal with again A+++</td>
<td>Buyer beatvox325 (8)</td>
<td>Nov-09-04 20:59</td>
<td>4038705884</td>
</tr>
<tr>
<td>ooo ooo ooo ooo ooo AWESOME EBAY SELLER ooo ooo ooo ooo ooo</td>
<td>Buyer tdwolf66 (267⭐️)</td>
<td>Nov-09-04 08:00</td>
<td>4049169403</td>
</tr>
<tr>
<td>CD new, as promised. No complaints.</td>
<td>Buyer macattack30 (171⭐️)</td>
<td>Nov-08-04 21:58</td>
<td>4037587477</td>
</tr>
<tr>
<td>Very quick delivery, great product, great seller!! A+..........................</td>
<td>Buyer antieroe1960 (217⭐️)</td>
<td>Nov-08-04 20:56</td>
<td>4048941176</td>
</tr>
</tbody>
</table>
| great ebayer fast shipment
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | Buyer mrs_myers (39⭐️) | Nov-08-04 09:35 | 4048938118 |
| Excellent item, Thanks! | Buyer blizard_of_ozz (91⭐️) | Nov-06-04 19:56 | 4039609641 |
| Excellent packaging. CD's in perfect condition Thanks!!!! | Buyer whatzup020 (14⭐️) | Nov-06-04 14:13 | 4040165769 |
eBay Feedback

--- Stars

The feedback rating system is easy. You receive:
- +1 point for each positive comment
- 0 points for each neutral comment
- -1 point for each negative comment
- A star icon ⭐️ for 10 or more comments.

Stars are awarded to eBay members for achieving 10 or more feedback points. Here's what the different stars mean:

Yellow Star (⭐️ ) = 10 to 49 points
Blue Star (⭐️ ) = 50 to 99 points
Turquoise Star (⭐️ ) = 100 to 499 points
Purple Star (⭐️ ) = 500 to 999 points
Red Star (⭐️ ) = 1,000 to 4,999 points
Green Star (⭐️ ) = 5,000 to 9,999 points
Yellow Shooting Star (⭐️⭐️ ) = 10,000 to 24,999 points
Turquoise Shooting Star (⭐️⭐️ ) = 25,000 to 49,999 points
Purple Shooting Star (⭐️⭐️ ) = 50,000 to 99,999 points
Red Shooting Star (⭐️⭐️⭐️ ) = 100,000 or higher

--- Feedback Forum: Reply to Feedback Received

An important part of the Feedback Forum is sharing with the community your experience with other members. In addition to leaving feedback, there may be occasions when you want to reply to a comment another member has left in your member profile; it will appear directly below that comment in your member profile.

Please note:
- You can reply only once to a comment. You cannot edit or retract your reply.
- It’s always best to keep your feedback factual; avoid making personal remarks.
- Leaving a reply does not affect your feedback score or number of ratings.
- If you have a dispute, contact your trading partner to try and resolve the dispute before replying.

Seller: linsmart.com (⭐️⭐️ )
Item: 2980284948
Date/Time left: Dec-20-02 08:03:02 PST
Feedback: 🌟 picked up item on time! thanks!
Reply:

80 chars max.

Leave Reply
Outline

- Introduction
- Challenges
- Current Research
- Conclusions
Properties

- A reputation system should
  1. Capture feedback
  2. Guide trust decisions
  3. Persist over time
Challenges

1. Capturing feedback

- Why leave feedback?
- “If you don’t have anything nice to say, don’t say anything at all”
- Why leave honest feedback?
Challenges

2. Guiding trust decisions
   - How do we summarize and display feedback?
   - Are all interactions created equal?
     - Weighted feedback
Challenges

3. Persist over time

- If reputation is easily built and discarded, we cannot place trust in it.
- How to be attribute feedback across name changes?
- Can we enable feedback across systems?
Outline

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Research

- Study of reputation not new
  - Rogerson 83, Schmalensee 78, Shapiro 82, Wilson 85 ...

- Current research of online markets
  - Empirical studies
  - Mathematical modeling
# Empirical Studies of eBay

<table>
<thead>
<tr>
<th>Citation</th>
<th>Items Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba and Pavlou, 2002</td>
<td>Music, Software, Electronics</td>
</tr>
<tr>
<td>Bjari and Hortacsu, 2003</td>
<td>Coins</td>
</tr>
<tr>
<td>Dewan and Hsu, 2001</td>
<td>Stamps</td>
</tr>
<tr>
<td>Eaton, 2002</td>
<td>Electric guitars</td>
</tr>
<tr>
<td>Houser and Wooders, 2000</td>
<td>Pentium chips</td>
</tr>
<tr>
<td>Kalyanam and McIntyre, 2001</td>
<td>Palm Pilots</td>
</tr>
<tr>
<td>Kauffman and Wood, 2000</td>
<td>Coins</td>
</tr>
<tr>
<td>Lee, Im and Lee, 2000</td>
<td>Computer monitors and printers</td>
</tr>
<tr>
<td>Livingston, 2002</td>
<td>Golf Clubs</td>
</tr>
<tr>
<td>Lucking-Reiley et al., 2000</td>
<td>Coins</td>
</tr>
<tr>
<td>Melnick and Alm, 2002</td>
<td>Gold coins</td>
</tr>
<tr>
<td>McDonald and Slawson, 2002</td>
<td>Dolls</td>
</tr>
<tr>
<td>Resnick and Zeckhauser, 2002</td>
<td>MP3 Players, Beanie Babies</td>
</tr>
<tr>
<td>Resnick, Zeckhauser Swanson and Lockwood, 2002</td>
<td>Vintage Postcards</td>
</tr>
</tbody>
</table>
Observations

- Mostly one-time deals
  - 89% of all buyer-seller pairings were not repeated
- Majority left feedback
  - 52.1% submitted feedback
- Feedback overwhelmingly positive
  - 99.1% of all comments
Analysis of eBay

- Dellarocas constructs a model for eBay-like binary reputation systems
- Examines whether such a model can be well functioning
  1. Advertised quality does not oscillate
  2. Buyer’s can predict true quality
Analyzing the Economic Efficiency of eBay-like Online Reputation Reporting Mechanisms

Chrysanthos Dellarocas
Paper Outline

- We will examine
  - Model of buyer, seller, feedback
  - Analysis of estimating seller deception
  - Steady-state behavior of advertised quality
Model Outline

- Model Assumptions
- Notions of quality
- Seller & buyer motivations
- Buyer satisfaction
- Quality assessment
- “Binary” rating function
Model Assumptions

The following assumptions are stated explicitly

a. True quality of item unknown to buyer

b. Seller has complete control over advertised quality

c. Buyer only knows advertised quality and reputation of seller
Kinds of Quality

\[ q_r \xrightarrow{\xi} q_e \xleftarrow{\text{Buyer}} q_a \xrightarrow{\text{Seller}} \]
Motivations

Seller wishes to maximize profit by over advertising quality

\[ \pi(x, q_r, q_a) = G(x, q_r, q_a) - c(x, q_r) \]

Buyer wishes to maximize (subjective) utility

\[ U = \theta \cdot (q_r \cdot \epsilon) - p \quad \epsilon \sim \mathcal{N}(0, \sigma) \]
Buyer Satisfaction

Buyer satisfaction is how quality exceeds expectations

\[ S = U - U_e = \theta \cdot (q_r + \epsilon) - p - (\theta \cdot q_e - p) = \theta \cdot (q_r + \epsilon - q_e) \]
Quality Assessment

A buyer makes an estimate of quality with which to compare the real quality

\[ S = \theta \cdot (q_r + \epsilon - q_e) \]

\[ f(q_a, R) = q_e \]
Quality Assessment

- A buyer makes an estimate of quality with which to compare the real quality.

- The estimated quality is:
  - The advertised quality, unless Seller is deceptive.

  \[ q_e = f(q_a, R) = \begin{cases} 
  q_a & \text{if } \hat{\xi}(R) \leq 0 \\
  0 & \text{if } \hat{\xi}(R) > 0 
\end{cases} \]
Rating Function

- A Buyer will
  - Rate Positive if they are satisfied
  - Rate Negative if they are “really” unsatisfied

\[ r(S') = \begin{cases} 
  + & \text{if } S' > 0 \\
  - \lambda & \text{if } -\lambda < S' \leq 0 \\
  - & \text{if } S' \leq -\lambda 
\end{cases} \]
Model Summary

\[ q_e = f(q_a, R) = \begin{cases} 
q_a & \text{if } \hat{\xi}(R) \leq 0 \\
0 & \text{if } \hat{\xi}(R) > 0 
\end{cases} \]

\[ S = \theta \cdot (q_r + \epsilon - q_e) \]

\[ r(S) = \begin{cases} 
+ & \text{if } S > 0 \\
- & \text{if } S \leq -\lambda \\
0 & \text{if } -\lambda < S \leq 0 
\end{cases} \]
Well Functioning

WF1: It optimal for sellers to settle down to a steady-state pair of real and advertised qualities

WF2: The quality of sellers as estimated by buyers before transactions take place is equal to their true quality
WF2: Model Review

\[ q_e = f(q_a, R) = \begin{cases} 
q_a & \text{if } \hat{\xi}(R) \leq 0 \\
0 & \text{if } \hat{\xi}(R) > 0
\end{cases} \]

\[ S = \theta \cdot (q_r + \epsilon - q_e) \]

Decide to buy

\[ r(S) = \begin{cases} 
+ & \text{if } S > 0 \\
\text{if } -\lambda < S \leq 0 \\
- & \text{if } S \leq -\lambda
\end{cases} \]
WF2: Deception Estimation

- Assuming steady state behavior from seller
- A buyer can estimate how deceptive the seller is using:
  - The fraction of positive feedback
  - The fraction of negative feedback
  - The ratio of negative to positive feedback
Deception Estimation: Positives

1. A Seller is honest if the fraction of positive ratings exceeds some threshold (0.5)

\[ \hat{\eta} \equiv \frac{\Sigma_+}{N} = \Pr[S > 0] = \phi[-\xi/\sigma] \]

\( H_0 : \eta \geq 0.5 \) given \( \hat{\eta} \)

\[ q_e = \begin{cases} q_a & \text{if } \hat{H}_0 \text{ accepted} \\ 0 & \text{if } \hat{H}_0 \text{ rejected} \end{cases} \]
Deception Estimation: Positives

- Does not depend on $\lambda$, $\Theta$ or $\sigma$
- Need knowledge of number of ratings $N$
- Could allow for sellers to oscillate between good and bad reputation
Deception Estimation: Negatives

1. A seller is honest if the fraction of negative ratings is less than the optimal trustworthiness threshold, $k^*$

$$\hat{\zeta} \equiv \frac{\Sigma_-}{N} = \Pr[S \leq -\lambda] \leq \phi[-\lambda/(\theta \cdot \sigma)]_{k^*}$$

$$H_0 : \zeta \leq k^*$$

$$q_e = \begin{cases} q_a & \text{if } \hat{H}(R) \text{ accepted} \\ \emptyset & \text{if } \hat{H}(R) \text{ rejected} \end{cases}$$
Deception Estimation: Negatives

- The threshold $k^*$ depends on $\lambda$, $\Theta$ or $\sigma$
  - We can estimate $k^*$ from $\Sigma_+ \Sigma_- \text{ and } N$
  - Unless correct threshold $k^*$ is used, buyer will not be able to estimate true quality
Deception Estimation: Ratio

Can we estimate deception without $N$?

\[ \hat{\rho} \equiv \frac{\Sigma_-(\xi)}{\Sigma_+(\xi)} > 2 \cdot \Phi\left[ -\lambda / (\theta \cdot \sigma) \right], \quad \forall \xi > 0 \]

\[ H_0 : \rho \leq 2 \cdot \Phi\left[ -\lambda / (\theta \cdot \sigma) \right] \]

\[ q_e = \begin{cases} q_a \quad \text{if} \quad \hat{H}_R \text{ accepted} \\ 0 \quad \text{if} \quad \hat{H}_R \text{ rejected} \end{cases} \]
Deception Estimation: Summary

- We can find reliable estimates of deception.
- To do so, we need knowledge of $\lambda$, $\Theta$ and $\sigma$, however we can make good guess using $\Sigma$ and $N$.
- If we can accurately estimate deception, then it becomes optimal for the seller to advertise true quality.
WF1: Steady State Behavior

In some situations it may be profitable for a buyer to oscillate between high and low quality advertisements

1. We model how this occurs
2. We analyze the model and find conditions under which advertised quality is stable
Oscillation Model

The transactions are divided into three time periods

P₀ Seller advertises true quality

P₁ Seller over-advertises quality, milking reputation

P₂ Seller under-advertises quality, rebuilding reputation
Oscillation Model

Period 0

- Seller completes some transactions
- Accumulates good reputation since $q_r = q_a$

At the end of Period 0:

$$\frac{\sum_{-}}{N} \bigg|_{P_0} = k^*$$
Oscillation Model

Period 1

- Seller decides to milk reputation
- Over-advertises quality by $\xi_1$ for $N_1$ transactions

At the end of Period 1:

$$\left[ \frac{\sum_{-}}{N} \right]_{P_1} > k^*$$
Oscillation Model

Period 3

Assuming some buyers will buy with quality estimate of zero

Seller must under-advertise quality by $\xi_2$ for $N_2$ transactions

At the end of Period 2:

$$\frac{\Sigma -}{N} \bigg|_{P_2} = k^*$$
Conditions for Stability

跛 We would like the time it takes to rebuild a reputation $N_2$ to be high compared to the time during which a seller can milk it, $N_1$

$$\frac{N_2}{N_1} = \frac{\Phi[\xi_1/\sigma - \lambda/(\theta \cdot \sigma)] - \Phi[-\lambda/(\theta \cdot \sigma)]}{\Phi[-\lambda/(\theta \cdot \sigma)] - \Phi[-\xi_2/\sigma - \lambda/(\theta \cdot \sigma)]}$$

$$= g(\lambda, \xi_1, \xi_2)$$

$$\frac{\partial g}{\partial \lambda} > 0$$
Minimum ratio vs Leniency factor

\[ N_2/N_1 \]

\[ \lambda \]

ksi = ξ = ξ_1 = ξ_2 ?
WF1: Summary

Given a strict quality assessment function, a lenient satisfaction threshold when giving feedback make it optimal for sellers not to oscillate.

The lack of oscillation makes it possible to better predict real quality.
Given a binary reputation mechanism it is theoretically possible to have it be well functioning:

**WF1:** It optimal for sellers to settle down to a steady-state pair of real and advertised qualities

**WF2:** The quality of sellers as estimated by buyers before transactions take place is equal to their true quality
Outline

- Introduction
- Challenges
- Current Research
- General Conclusions
Paper Summary

- Given a suitable seller assessment function we can ensure
  - Seller’s reputations will be stable
  - The buyer will accurately predict true quality of seller’s product
Dellarocas is successful in showing that his binary reputation model is well functioning, but what assumptions are made?

- Explicit Assumptions
- Implicit Assumptions

All models are wrong, some are more useful than others

- George Box
Explicit Assumptions

- Some buyers never rate
  - Incorporate probability of rating B
- Buyers differ in quality sensitivity and leniency
  - Define $\omega = \lambda/\theta$ in some distribution
Implicit Assumptions

- Strategic interests of buyer not taken into account when rating a seller
- Buyers all use same rating process
- Each Well Functioning theorem relies on the other
Conclusion

- Reputation mechanisms can be well functioning
  - Using reputation information not necessarily simple
  - We need to provide information to aid the buyer in the use of reputation
Conclusion

“Reputation systems are the worst way of building trust on the Internet, except for all those other ways that have been tried from time-to-time”

-Paul Resnick by way of Winston Churchill
Related Work

- Distributed reputation systems
  - peer 2 peer networks
- Reputation in Multi Agent Systems
  - Results of interactions are known, but limited to direct interactions
References


