A Reputation System for Market Security and Equity

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Deception Leads to Unfairness

- Scamming and Oligopoly interfere with free markets by distorting the truth
  - Scammers make their products look better than they are by buying reviews
  - Oligopolists make their products look better than they are by not letting other products be known
- A Reputation system can find the truth if it:
  - is capable of weeding out nearly all the scammers
  - is used in a way that suppliers participate in the market in proportion to the value they are capable of adding
    - Reputation Systems employed using a Winner Take All approach do not ensure proportion
    - Example: One must be on the first page of a google search to participate in the market
    - A roulette wheel approach may be used to ensure Reputation Systems allow proportionate participation
- Counterintuitive Result: We found that systems that have greater equity for suppliers also have greater utility for customers. If you only give customers “the best” you know of, the best will never be known.

Simulation of the Marketplace

- Input: Consumer and Trade Behaviors
- Output : Metrics, Agent Qualities, Transactions Ranks

1. Assign agents to behaviors based on normal distribution
2. Every day for 6 months:
    1. Each Consumer makes a shopping list
    2. In Winner Take All usage

        Agents choose new suppliers with the highest Reputation Score

        Else if Roulette Wheel usage

        Agents choose new suppliers in proportion to Reputation Score
    3. Agents make purchases and send ratings to the Reputation System

Measurements

- A Weighted Pearson Correlation Coefficient (PWCC)
    - Measures the correlation between the reputation score and the true talent, weighting either scammers or honest agents
    - Weighting helps to take into account the balancing act between equity for honest agents and security against scam agents
        - Weighted Average is used to weight the correlation
        - $PWCC_{good}$ - based on weighted average avg(x,w), where w is "expected goodness" or true talent (in range 0.0 to 1.0)
        - $PWCC_{bad}$ - based on avg(x,w), where w is "expected badness" or 1 minus true talent

- Loss to Scam : The percentage of consumer dollars that are spent on scams
- Inequity: A Gini Coefficient that considers participation in the economy in proportion to talent
    - Minimizing the Gini Coefficient alone lacks incentives
    - We replaced “Wealth” in the Gini with Individual market volume over talent
- Utility measures consumer satisfaction with purchases

Metrics

$$PCCW = \frac{cov(x,y,w)}{\sqrt{cov(x,x,w) * cov(y,y,w)}} \qquad cov(x,y,w) = \frac{\sum w\,(x - avg(x,w))(y - avg(y,w))}{\sum w}$$

$$B = \frac{\sum_{a,i} \frac{sorted\,(Wa)(N-i)}{Rcea}}{N(\sum Wa)} \qquad V_a = \frac{(Vxa + Vax)}{2} \qquad W_a = \frac{Va}{R}$$

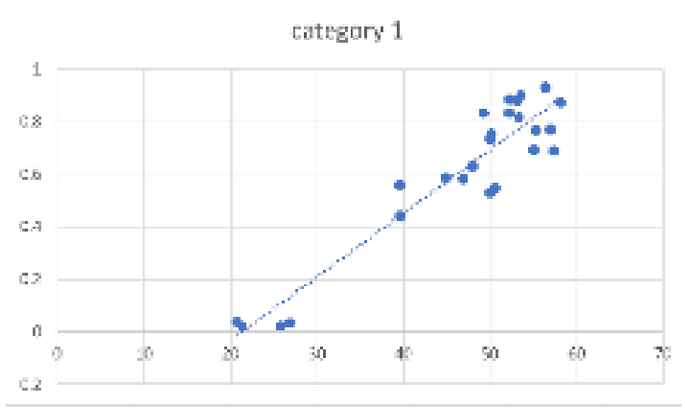
Vxa is the market volume received by agent a and Vax is the market volume spent by agent a.
Wa is the equitable share of agent a where R is reputation score.
Rcea is the expected goodness of agent a, and N is the number of agents.

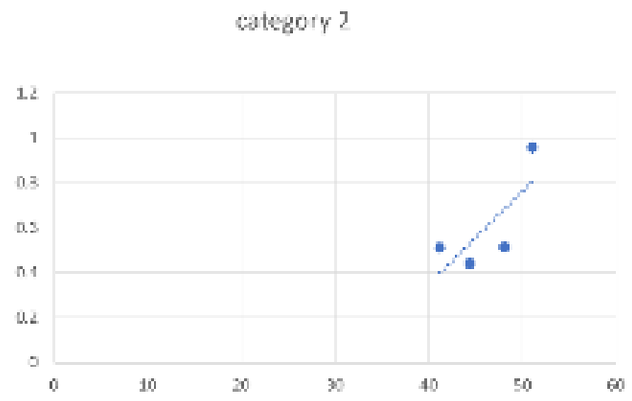
$$\boldsymbol{Inequity} = 1 - \frac{1}{N} - 2B \qquad \boldsymbol{Utility} = \frac{\sum(Ratings)}{N}$$

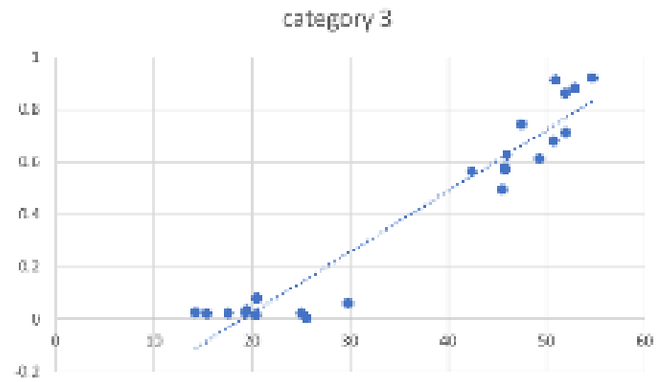
Experiments and Results

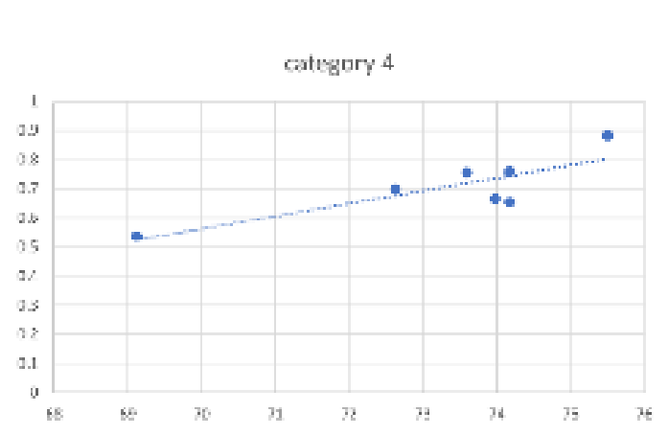
- Experiment 1 : Result: RS is Very Accurate
    - No Consumer and Supplier Overlap
    - Medium Ratio of Honest agent Market Volume to Dishonest agent Market Volume
    - 6 month duration, 1000 agents
    - Pearson by Category = 0.95
        - $PCCW_{good} = 0.92$, $PCCW_{bad} = 0.96$
- Experiment 2: Result: Fairness to suppliers leads to customer satisfaction
    - Consumer and Supplier Overlap
    - High Ratio of Honest agent Market Volume to Dishonest agent Market Volume
    - 6 month duration, 1000 agents
    - No Reputation System
        - Loss to Scam (LTS) = 0.82%, Inequity = 50%, Utility = 85.7%
    - Winner Take All
        - Loss to Scam (LTS) = 0.88%, Inequity = 79%, Utility = 84.9%
    - Roulette Wheel
        - Loss to Scam (LTS) = 0.67%, Inequity = 60%, Utility = 86.1%

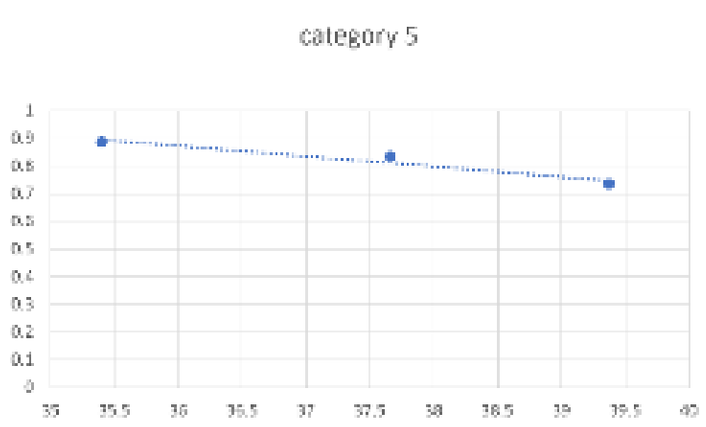
Reputation Score vs. Expected Goodness

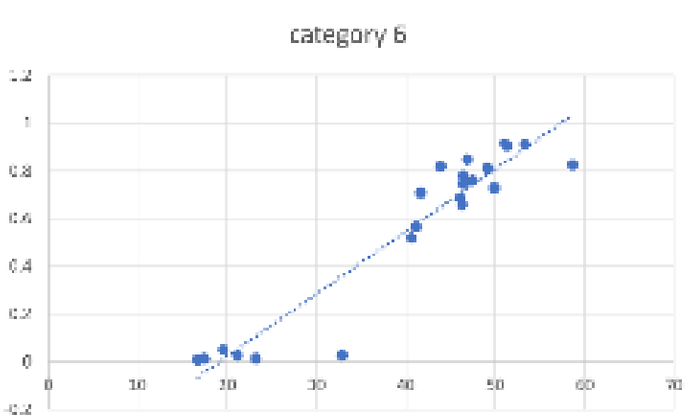


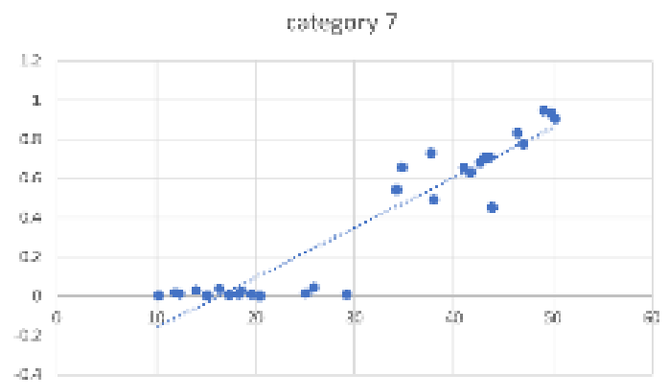


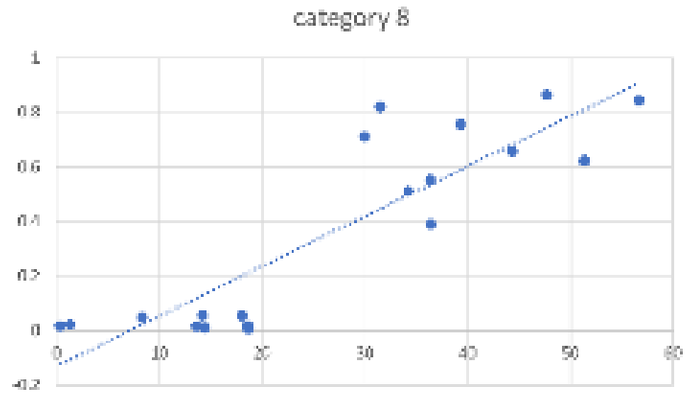


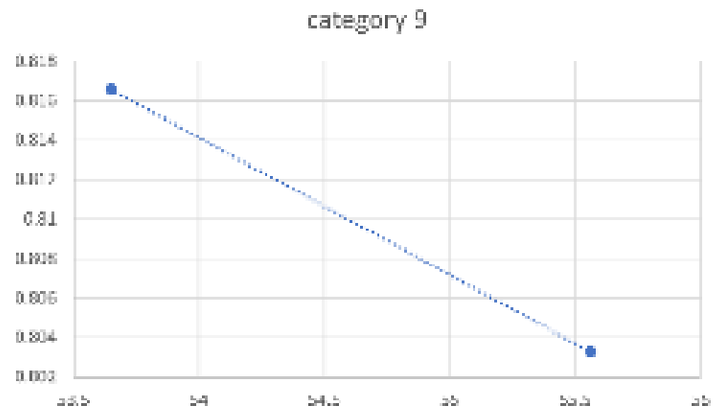












Inequity and Customer Satisfaction

Reputation System Usage	LTS	Inequity	Utility
None	0.82%	50%	85.7%
Winner Take All	0.88%	79%	84.9%
Roulette	0.67%	60%	86.1%