Combating Crowdsourced Review Manipulators: 
A Neighborhood-Based Approach

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User reviews impact decision making

... and so are targets of manipulation.
Amazon Deletes Negative Clinton Book Reviews

The Anti-Hillary Clinton Camp Has Already Hijacked Amazon Reviews of Her New Book

By CLAIRE ZILLMAN  Updated: September 12, 2017 8:55 AM ET
"In the matter of restoring Internet freedom, I'd like to recommend the commission to undo The Obama/Wheeler power grab to control Internet access. Americans, as opposed to Washington bureaucrats, deserve to enjoy the services they desire. The Obama/Wheeler power grab to control Internet access is a distortion of the open Internet. It ended a hands-off policy that worked exceptionally successfully for many years with bipartisan support."

"Chairman Poi: With respect to Title 2 and net neutrality, I want to encourage the FCC to rescind Barack Obama's scheme to take over Internet access. Individual citizens, as opposed to Washington bureaucrats, should be able to select whichever services they desire. Barack Obama's scheme to take over Internet access is a corruption of net neutrality. It ended a free-market approach that performed remarkably smoothly for many years with bipartisan consensus."

"Mr Poi: I'm very worried about restoring Internet freedom. I'd like to ask the FCC to overturn The Obama/Wheeler policy to regulate the Internet. Citizens, rather than the FCC, deserves to use whichever services we prefer. The Obama/Wheeler policy to regulate the Internet is a perversion of the open Internet. It disrupted a market-based approach that functioned very, very smoothly for decades with Republican and Democrat support."

"FCC: My comments re: net neutrality regulations. I want to suggest the commission to overturn Obama's plan to take over the Internet. People like me, as opposed to so-called experts, should be free to buy whatever products they choose. Obama's plan to take over the Internet is a corruption of net neutrality. It broke a pro-consumer system that performed fabulously successfully for two decades with Republican and Democrat support."

"FCC: In reference to net neutrality. I would like to suggest Chairman Poi to reverse Obama's scheme to control the web. Citizens, as opposed to Washington bureaucrats, should be empowered to buy whatever products they prefer. Obama's scheme to control the web is a betrayal of the open Internet. It undid a hands-off approach that functioned very, very successfully for decades with broad."

https://hackernoon.com/more-than-a-million-pro-repeal-net-neutrality-comments-were-likely-faked

Key Finding: **More than 99% of the “real” comments were in favor of keeping net neutrality.**
Detecting Manipulation: Labels?

Typical approaches:

• Manual or proprietary labeling of fake reviews
e.g., Mukherjee et al. 2013, Akoglu et al. 2015, Amazon?

• Ex-post analysis of outliers
e.g., Liu 2011 et al., Akoglu et al. 2013, 2015, Jeff Kao

• Simulation of bad behavior
e.g., Ott et al. 2013

We investigate the strategies of a collection of actual fake review writers by monitoring crowdsourcing sites.
Crowdsourced Review Manipulation

- Read the product description before writing down a review.
- Go to https://goo.gl/7QfW0h
- Leave a relevant 5-star review with at least 40 words.
- Provide the proof that you left the review yourself.

★★★★★ Best cortisol blocker to reduce high levels of stress, July 24, 2017
My stress levels have increased lately due to heavy work loads in my office and that directly impacting my life. I have gained weight and easily gets tired. I have tried many products to reduce my cortisol levels which is causing stress, but those products don’t fetch any results and based on my uncle recommendation I have tried this product and it has relieved my stress and assisted in returning my cortisol levels to a more natural state. I feel more energized and active than before and the product also helped in losing body fat. Must try the product.
Our Data Collection

- 300 Products
- Amazon
- 21,000 reviews
- 12,212 unique reviewers on these targeted products
- 580,000 reviews
- 39,500 reviewers from “nearby” products
### How Do We Label Reviewers?

<table>
<thead>
<tr>
<th>Number of Target Products</th>
<th>Number of Reviewers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9,096</td>
</tr>
<tr>
<td>2</td>
<td>1,669</td>
</tr>
<tr>
<td>3-5</td>
<td>1,093</td>
</tr>
<tr>
<td>6-8</td>
<td>126</td>
</tr>
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<td>141</td>
</tr>
<tr>
<td>&gt;20</td>
<td>87</td>
</tr>
</tbody>
</table>

We say a reviewer is **fraudulent** if it has reviewed **two or more** target products.

1 reviewer with more than 140 reviews on target products!
How Big Are Crowd Campaigns?

- **Observation**: Most crowd campaigns are small, so there may not be obvious repetitive/coordinated signals.
Many Traditional Features Are Weak …

We find that these (and other) traditional features do a poor job distinguishing fraudulent reviewers from non-fraudulent ones.

• **Assumption**: Workers engage in mix of legit and non-legit (“two-faced”) behaviors.
How Much Do Crowd Campaigns Pay?

• **Assumption**: Crowd workers participate in multiple campaigns to maximize their profit.
Our Two-Face System Design

1. We assume system operators have only some small, partial evidence of review manipulation

2. Propagate suspiciousness to nearby users

3. Uncover (hidden) distant users who serve structurally similar roles

**Goal:** Find as many fraudulent reviewers as possible (recall-oriented)
Propagate Suspiciousness: The Co-Review Graph
Propagate Suspiciousness: Random Walk w/ Restart
Propagate Suspiciousness: Random Walk w/Restart

\[ \vec{r}_{i+1} = c \times \tilde{M} \times \vec{r}_i + (1 - c) \times \vec{e} \]

- Ranking Vector
- Adjacent Matrix
- Starting Vector

Graph representation with nodes and edges, showing propagation of suspiciousness with different values.
How to Select Initial Seeds?

“Best” choice (lucky): Most active reviewers.

Random choice (realistic): Random reviewers.

“Worst” choice (unlucky): Least active reviewers.
Impact of Seed Selection

One initial seed

- **Best Choice**
- **Random Choice**
- **Worst Choice**

Precision @k
Impact of Seed Selection

5 initial seeds

Precision @k
Uncover Distant Users

- **Goal**: Find distant users who are nearby in a latent representation.

- **Intuition**: Fraudulent users may serve structurally similar roles in other parts of the graph.
Uncover Distant Users

Find a mapping of nodes to $d$-dimensions using node2vec.

In node embedding representation distant but similar nodes are close together.
We then train a classifier over the embedding space, where the positive examples (the fraudulent reviewers) drawn from the ranked list of suspicious users are seeded to the training data.
Experiments
Train new model with a few number of seeds.

<table>
<thead>
<tr>
<th>Training</th>
<th>1%</th>
<th>2%</th>
<th>3%</th>
<th>4%</th>
<th>5%</th>
<th>6%</th>
<th>7%</th>
<th>8%</th>
<th>9%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall(%)</td>
<td>73</td>
<td>85</td>
<td>88</td>
<td>90</td>
<td>91</td>
<td>91</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>Precision</td>
<td>34</td>
<td>33</td>
<td>32</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>F1-macro</td>
<td>72</td>
<td>71</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
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</tr>
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Good news: High recall in presence of very few seeds
What Is the Impact of Suspiciousness Propagation?

Recall jumps from 73% to 83% with just 1% of seeds.
Revisiting our Conservative Definition ...

Low precision implies many non-fraudulent reviewers are misclassified

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## Impact of Relaxed Ground Truth

<table>
<thead>
<tr>
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<th>Recall(%)</th>
<th>Precision(%)</th>
<th>F1-Macro(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conservative</strong></td>
<td>83</td>
<td>35</td>
<td>89</td>
</tr>
<tr>
<td><strong>Relaxed</strong></td>
<td>91</td>
<td>77</td>
<td>90</td>
</tr>
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Reviewers historically are connected to other fraudulent reviewers.
### Comparing Two-Face to Alternatives

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<th>Recall (%)</th>
<th>Precision (%)</th>
<th>F1-macro (%)</th>
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<tbody>
<tr>
<td><strong>TwoFace</strong></td>
<td>91</td>
<td>77</td>
<td>90</td>
</tr>
<tr>
<td><strong>Traditional Features</strong></td>
<td>61</td>
<td>24</td>
<td>54</td>
</tr>
<tr>
<td><strong>D-cube/ 30 blocks</strong></td>
<td>69</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td><strong>D-cube/ 40 blocks</strong></td>
<td>82</td>
<td>24</td>
<td>64</td>
</tr>
</tbody>
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D-cube performs well on “blocks” of abnormal behaviors, but our fraudulent reviewers do not always behave abnormally.

Two-Face provides encouraging performance for uncovering these reviewers with mixed legit + non-legit.
Conclusion and Next Steps

Explored how monitoring tasks on sites like RapidWorkers can provide a window into fraudulent reviewers on sites like Amazon.

Proposed Two-Face design that exploits:

(1) The locality of suspicious users who tend to cluster; and

(2) The structure of the graph to identify fraudulent distant reviewers.

Two-Face can indeed uncover many fraudulent reviewers.

Next steps: (1) Explore how linguistic evolution may provide new insights into the strategies of review manipulation. (2) Monitor tasks that target other platforms (Play Store, App Store, Yelp, …)
Thank you