Leveraging the Crowds to Disrupt Phishing

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Phishing As a Persistent Problem

- Many progresses in anti-phishing have been made
- But not always effective
  - Taking down a phishing site takes time
  - Blacklists can be obsolete
  - New tools are only useful if users install them
  - Warnings are only meaningful if users heed them
  - Phishers are getting more smart
- The status quo: Phishers continue to find new victims!

From Preventative to Proactive

- A new approach from a different perspective is to become more aggressive
- Rather than preventing users from being trapped, focus on the phishers
- We look at how to disrupt phishing activities

Our Previous Approach: Humboldt 1.0

- Injects large amount of fake credentials into phishing sites
  - honey tokens
- Any usage of honey tokens will expose phishers (or their customers from the black market)
- Deploys a distributed network of honey token submitters
  - Submissions cannot all come from a small number of IPs

Limitations of Humboldt 1.0

- Depended on an *automated* submission procedure
  - Need to profile the phishing sites and then inject credentials accordingly
- Phisher can make the underlying structure of a phishing site more complex
  - Thus foiling automatic profiling of a phishing site
- Or use CAPTCHA!

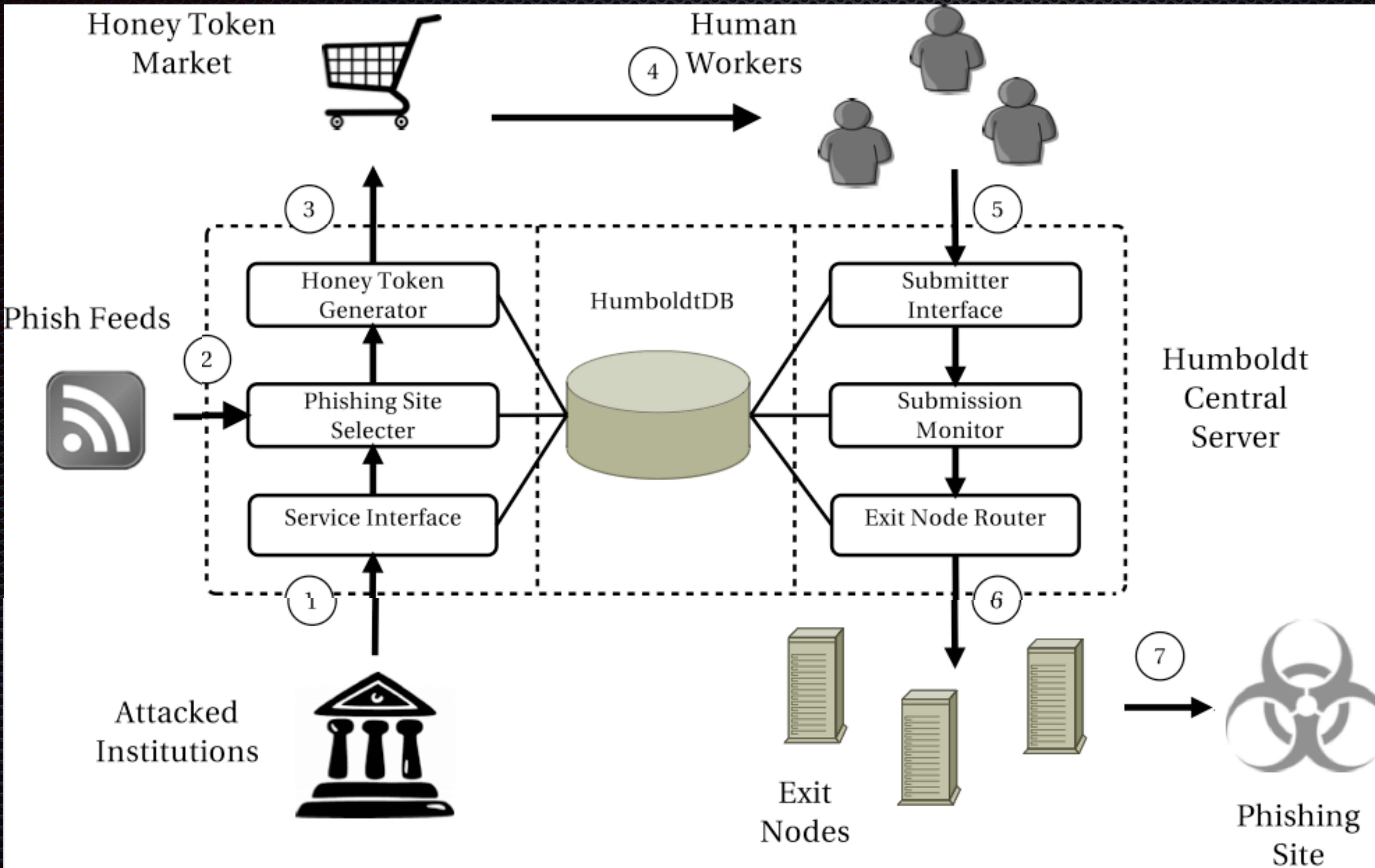
Humboldt 2.0

Basic Idea

- Humboldt 2.0 leverages actual people to submit honey tokens
- The phishing page must remain usable by people and must accept their submissions
  - otherwise there is no point in phishing!
- We evaluate the feasibility of this idea in this work

Architecture

- Central server: coordinate assignments and submission of honey tokens
- marketplace: distribute honey token submission tasks to people
- exit nodes: last hop in each submission
- phishing feeds: external sources for discovering new phishing sites


Honey Token
Market
Human
Workers
4
3
5
Honey Token
Generator
HumboldtDB
Submitter
Interface
Phish Feeds
2
Phishing Site
Selecter
Submission
Monitor
Humboldt
Central
Server
Service Interface
Exit Node Router
1
6
7
Attacked
Institutions
Exit
Nodes
Phishing
Site

Advantages

- Reasonable assurance on the submission
  - Every submission will go through the Humboldt server
- Distributed submission via exit nodes
  - Each with a different IP address
- Exit nodes are cheap, and Humboldt can have a large number of them

Arms Race with the Phisher: Is Humboldt 2.0 Resilient?

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Threat Model

- Phishers know about the existence of Humboldt and how it works
- Some human works and exit nodes can be malicious
- Phishers can collect statistics of their visitors
- Phishers can collaborate

Active Tactics

- DDoS the Humboldt server
  - Covered extensively in the literature
- Hire bots to do submission
  - CAPTCHA
- Enlist malicious human workers and/or exit nodes
  - Cannot affect the submission of benign workers and exit nodes
  - Humboldt can tight the recruiting and monitoring of its human workers

Passive Tactics

- Analysis of submitted data
  - E.g., legitimate credentials? IP address local if the target victim is a local bank?
- Indirect verification
  - E.g., email address used as username valid?
- Source heuristic
  - Filter submissions from IP addresses with high submission rates
  - Refer to paper for more theoretical analysis

Effectiveness of Humboldt 2.0

Metrics

- How many honey tokens should Humboldt submit?
  - Thus how many exit nodes to use?
- How many real victims can Humboldt save?
- What is the delay for a human worker to respond to a task?
- What is the reliability of human works?
- What is the effective cost per successful submission?

Number of Honey Tokens

- Totally *n* submissions, *h* from Humboldt, *r* (*i.e. n-h*) from real victims
- The phisher uses *k* out of *n*, with *X* honey tokens

$$P(X \geq 1) = 1 - \frac{\binom{n-h}{k}}{\binom{n}{k}}.$$

- If *n*=100, *k*=10, we need 20 honey tokens for *P* >= 0.9.

Number of Real Victims Unprotected

- Assume after *l* transactions using honey tokens, we can stop the phisher
  - note knowing a transaction is from phisher does not necessarily stop him from the next transaction
- Denote V unprotected victims targeted by phisher before that

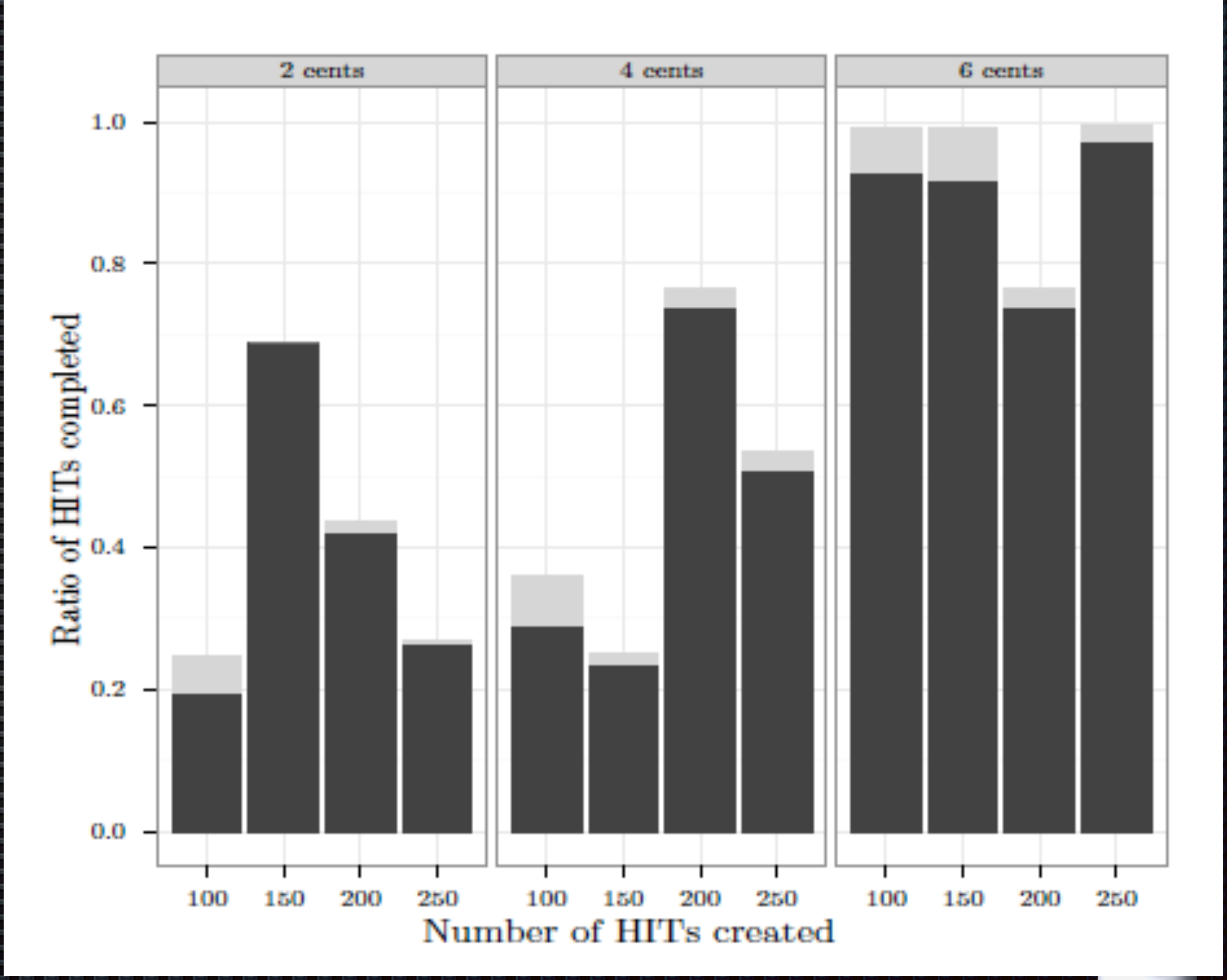
$$E(V) = \frac{l * r}{h + 1}.$$

Experimenting Humboldt w/ Amazon Mechanical Turks

Total HITs	4643
Submitted HITs	3829
Expired HITs	814
Total Worker Cost	181.42
Total Amazon Commission	18.14
Avg. Cost per HIT	0.052
Unique Workers	213
Avg. HITs per Worker	17.82

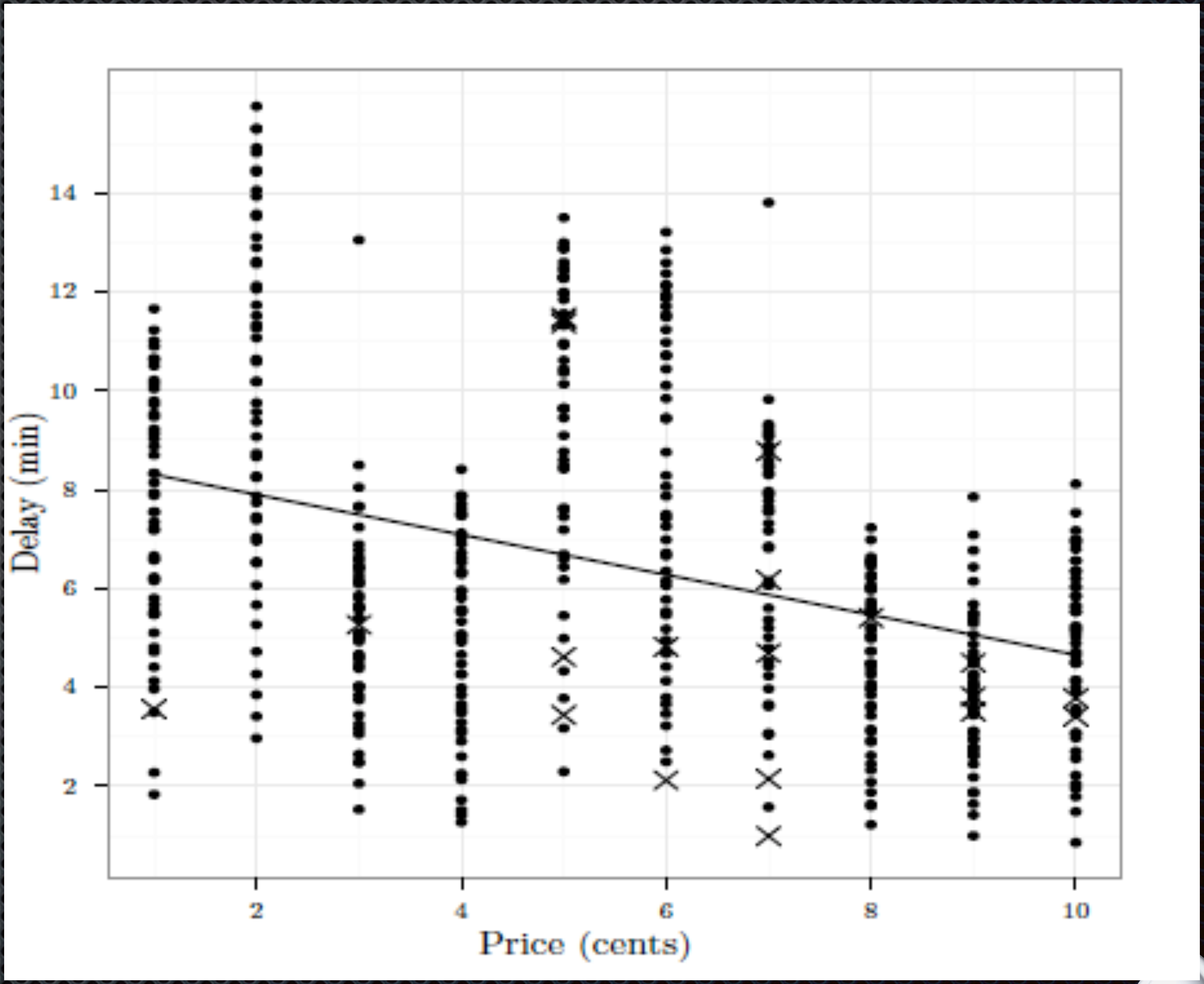
Human Worker Incentives

- Higher price leads to more completed HITs
- But does it lead to a higher quality?



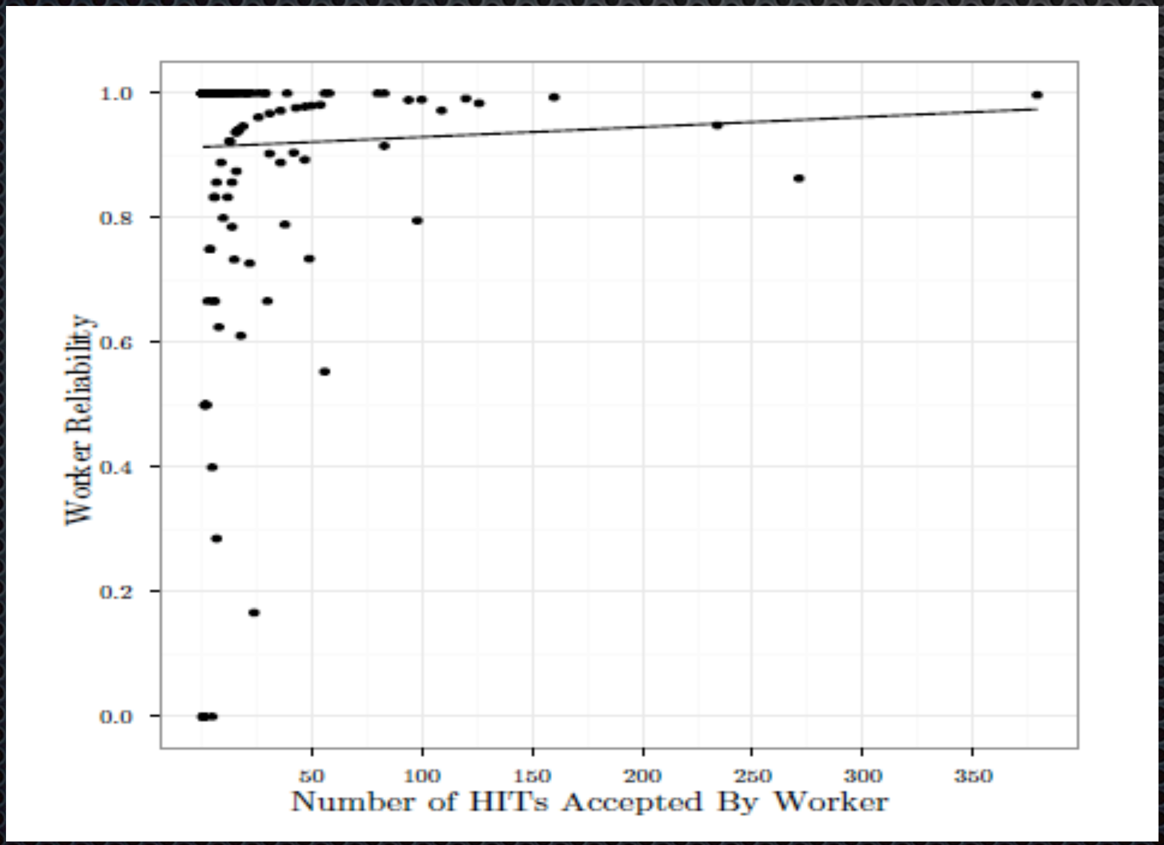
Human Worker Delay

- Delay is from time of HIT creation to the time of token submission
- X marks incorrect submissions
- Better payment does not lead to a noticeable difference



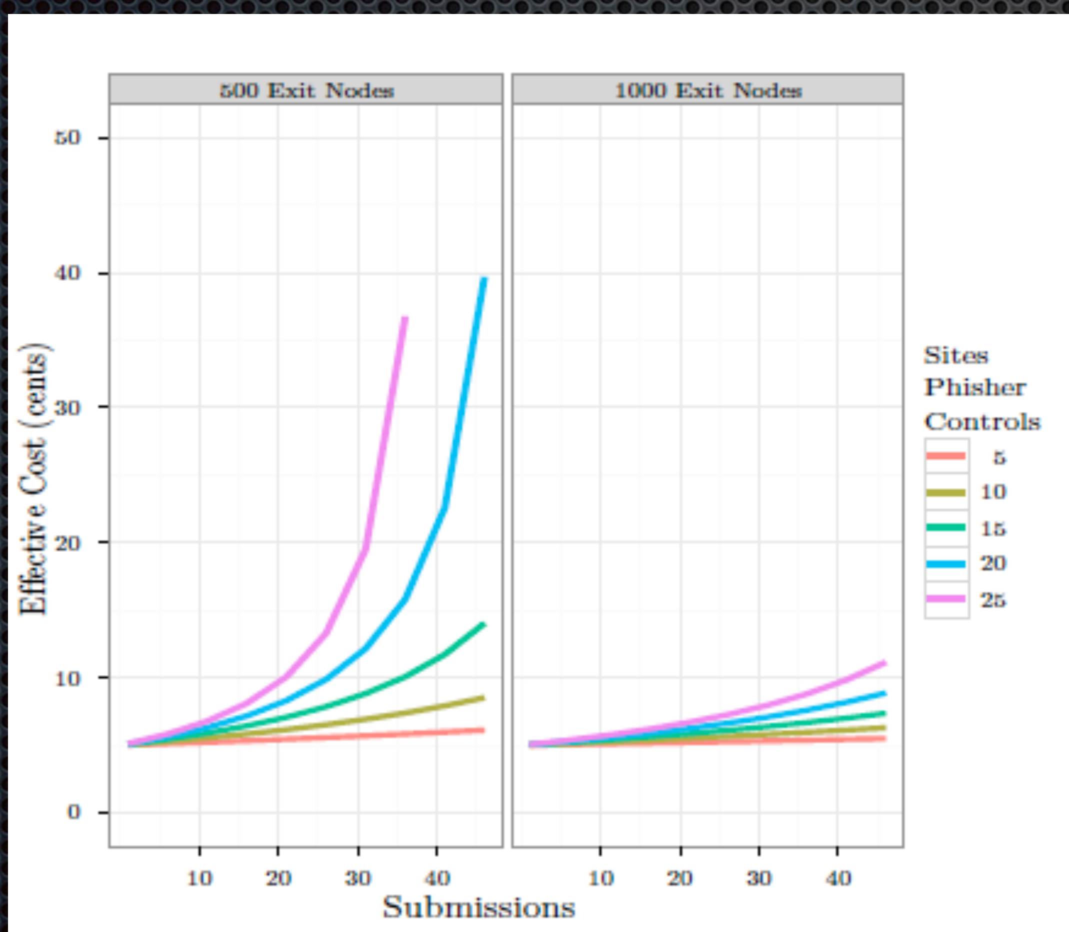
Human Worker Reliability

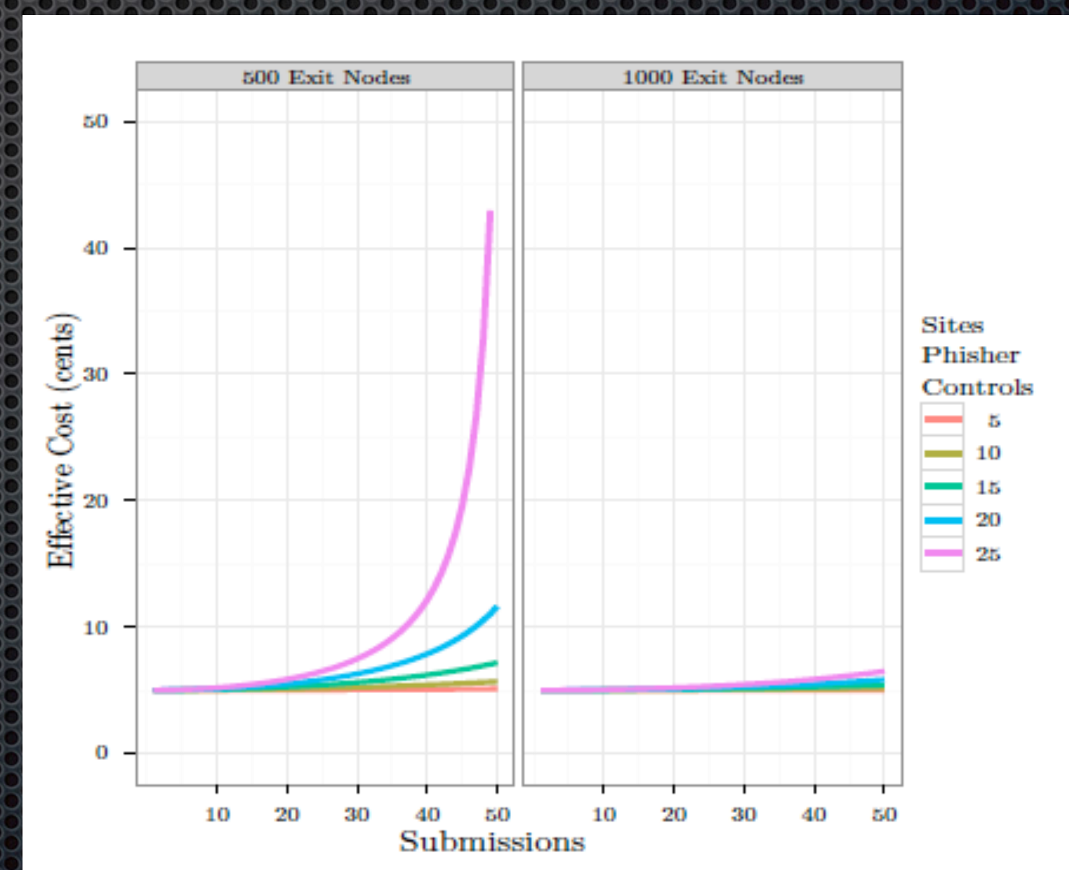
- Reliability = correctly submitted HITs / total number of accepted HITs.
- Workers with more HITs or better pay are not necessarily more reliable



Effective Cost

- Net price paid per successful submission: C/(1-fail rate)
- We consider the effect of source heuristic
- Details in the paper





(b) Conservative Filtering

Conclusions

- Anti-phishing has mostly been preventative, but the defense could be more proactive
- Via Humboldt 2.0, we demonstrated how we may leverage human workers to inject honey tokens to phishing sites and disrupt phishing
- We studied the resiliency and effectiveness of such an approach

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The End

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