

poloclub.github.io/#cse6242

CSE6242/CX4242: **Data** & **Visual** Analytics

# Analytics Building Blocks

## Duen Horng (Polo) Chau

Associate Professor, College of Computing  
Associate Director, MS Analytics  
Georgia Tech

## Mahdi Roozbahani

Lecturer, Computational Science & Engineering, Georgia Tech  
Founder of **Filio**, a visual asset management platform

Collection

Cleaning

Integration

Analysis

Visualization

Presentation

Dissemination

# Building blocks. **Not Rigid “Steps”.**

Collection

**Can skip some**

Cleaning

**Can go back (two-way street)**

Integration

- **Data types** inform **visualization** design

Analysis

- **Data size** informs choice of **algorithms**

Visualization

- **Visualization** motivates more **data cleaning**

Presentation

- **Visualization** challenges algorithm assumptions

Dissemination

e.g., user finds that results don't make sense

# How “big data” affects the process?

(Hint: almost **everything** is harder!)

Collection

Cleaning

Integration

Analysis

Visualization

Presentation

Dissemination

**The Vs of big data** (3Vs originally, then 7, now 42)

**Volume:** “billions”, “petabytes” are common

**Velocity:** think Twitter, fraud detection, etc.

**Variety:** text (webpages), video (youtube)...

**Veracity:** uncertainty of data

**Variability**

**Visualization**

**Value**

<http://www.ibmbigdatahub.com/infographic/four-vs-big-data>

<http://dataconomy.com/seven-vs-big-data/>

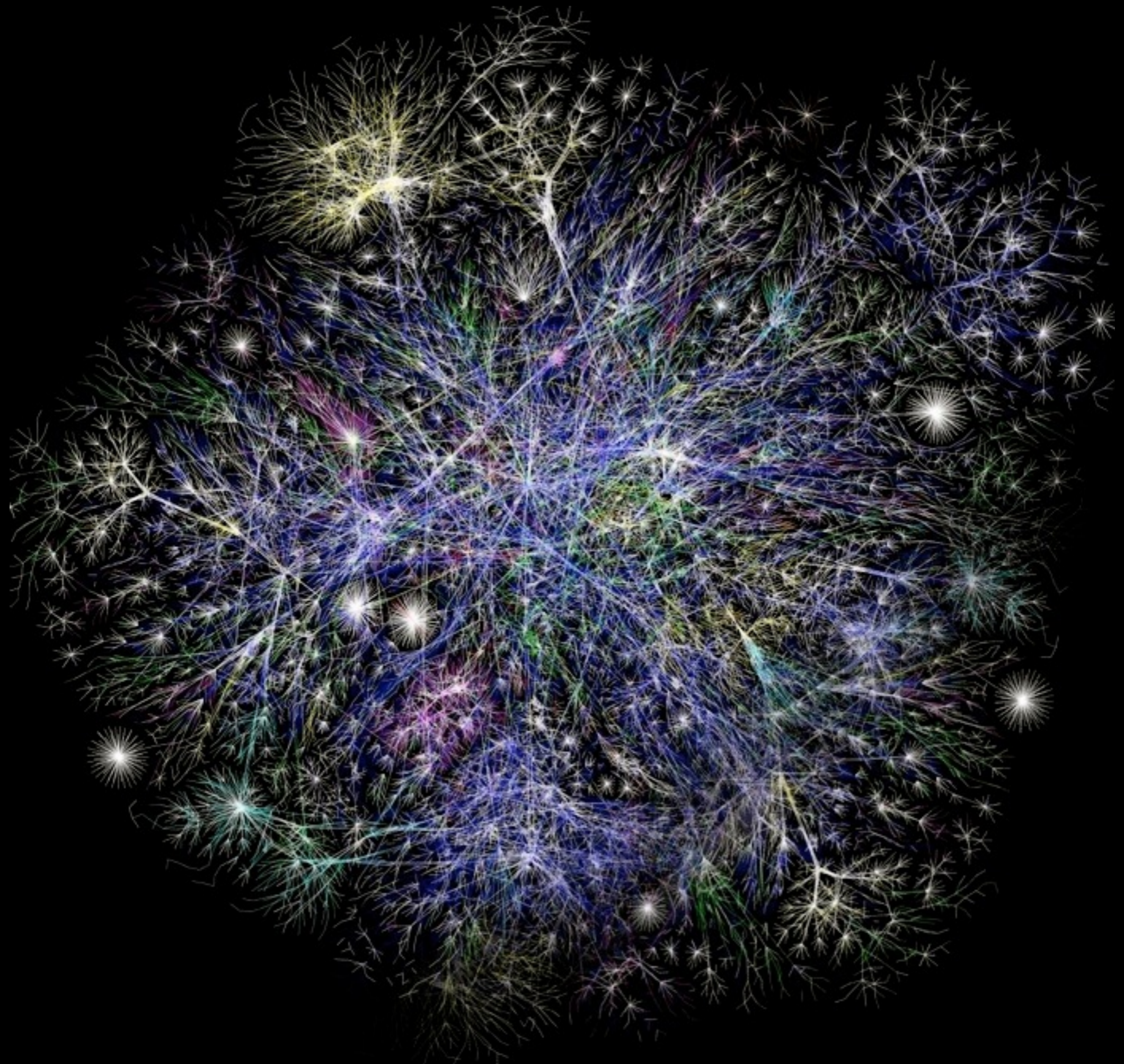
<https://tdwi.org/articles/2017/02/08/10-vs-of-big-data.aspx>

# Two Example Projects

from Polo Club

# Apolo Graph Exploration: Machine Learning + Visualization

**Apolo: Making Sense of Large Network Data by Combining Rich User Interaction and Machine Learning.**  
Duen Horng (Polo) Chau, Aniket Kittur, Jason I. Hong, Christos Faloutsos. CHI 2011.





**BEAUTIFUL HAIRBALL**

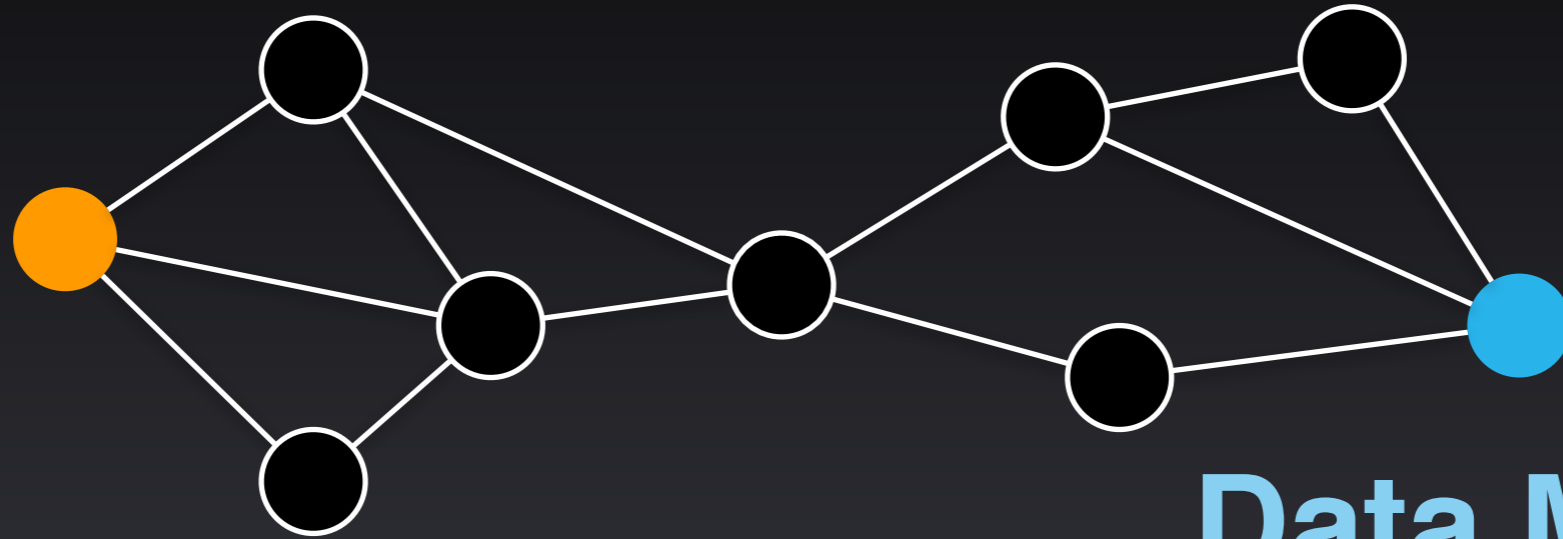
**DEATH STAR**

**SPAGHETTI**



# Finding **More** Relevant Nodes

**HCI**  
Paper

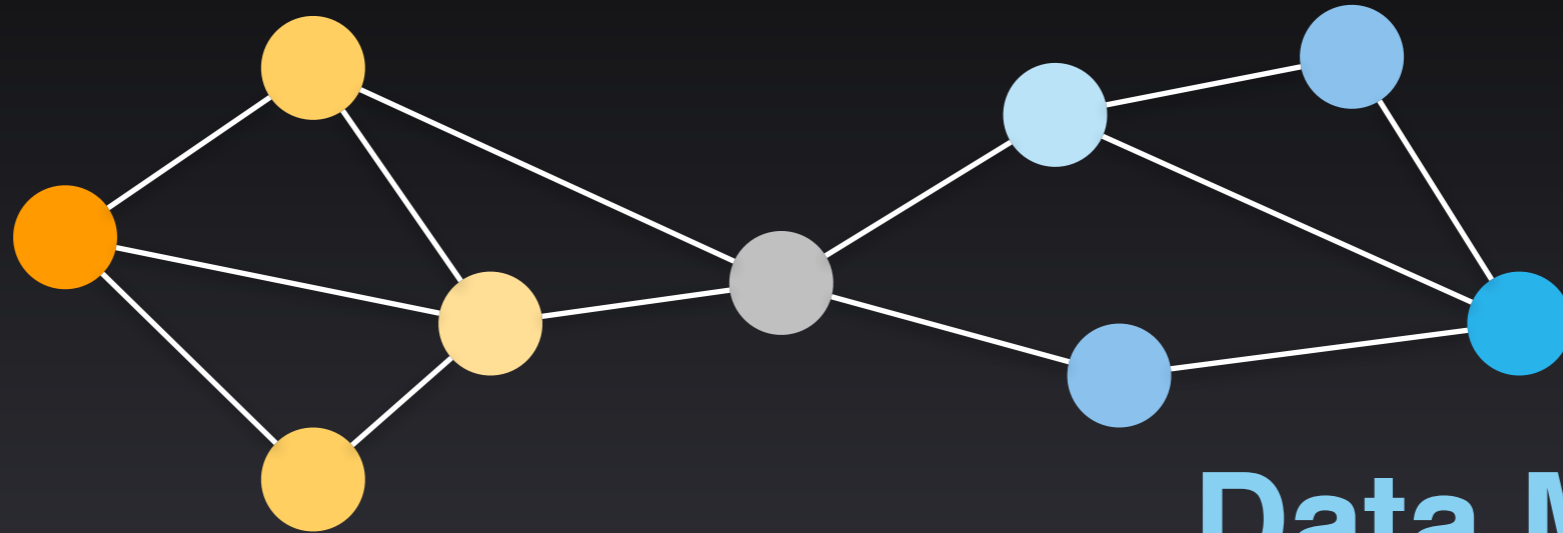


**Data Mining**  
Paper

Citation network

# Finding **More** Relevant Nodes

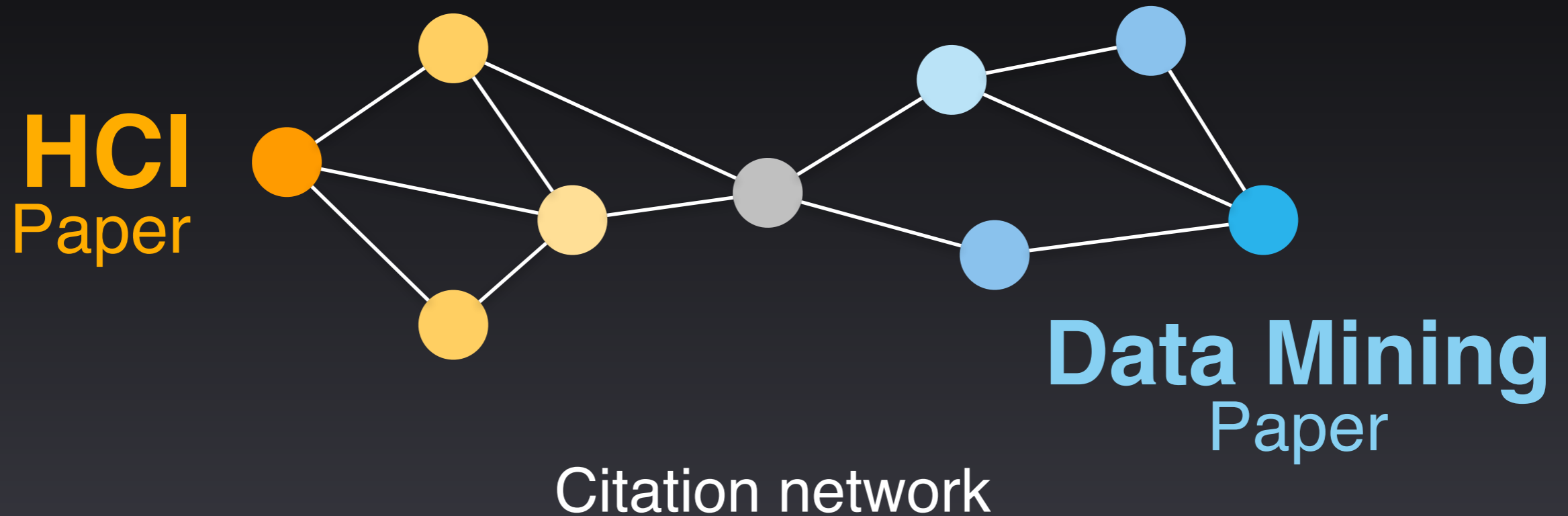
**HCI**  
Paper



**Data Mining**  
Paper

Citation network

# Finding **More** Relevant Nodes

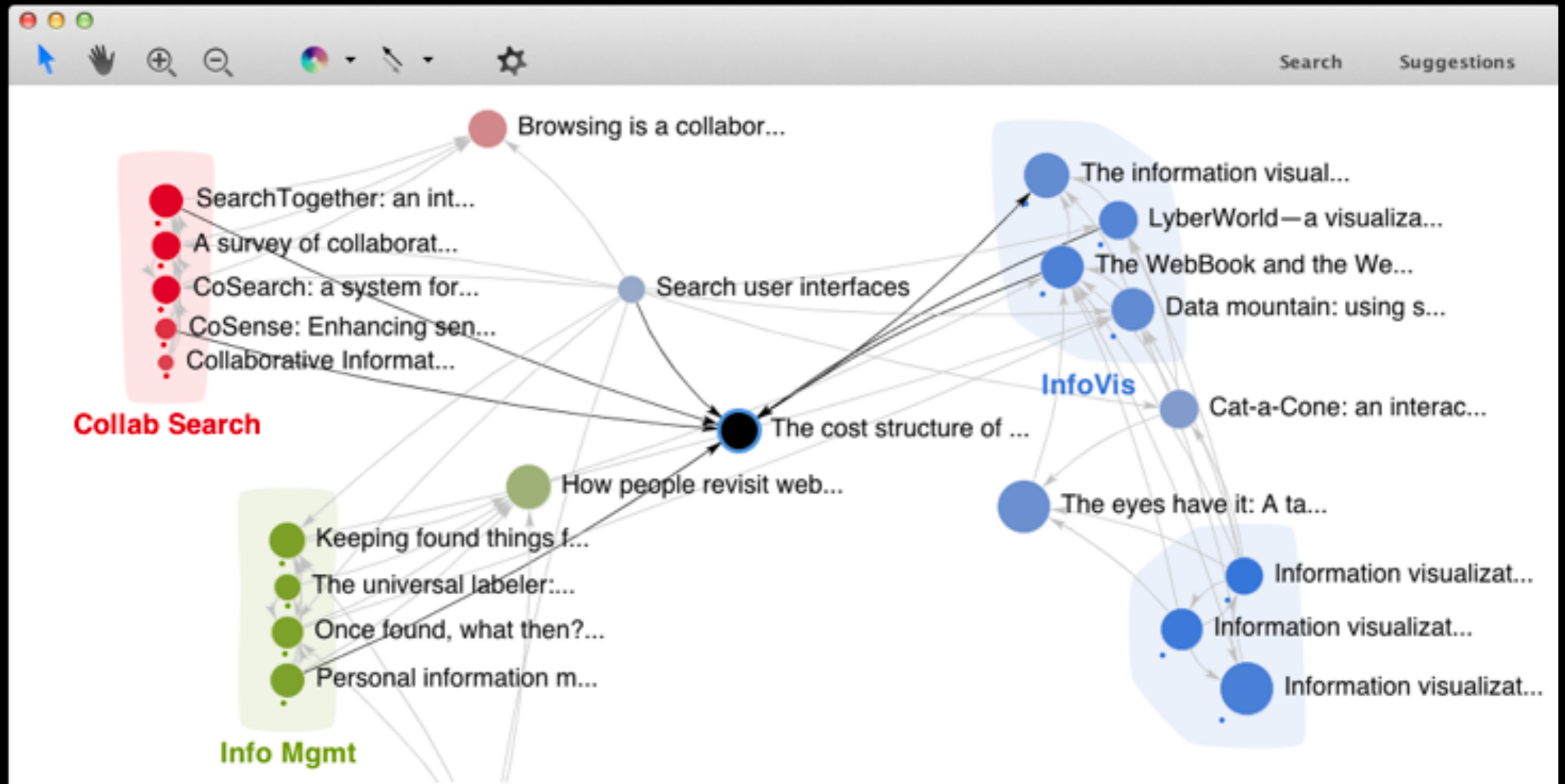


Apolo uses **guilt-by-association**  
(Belief Propagation)

# Demo: Mapping the Sensemaking Literature

Nodes: 80k papers from Google Scholar (node size: #citation)

Edges: 150k citations



**The cost structure of sensemaking**

Russell, D.M. and Stefik, M.J. and Pirolli, P. and Card, S.K.

245 citations 8 versions

PDF 1993

Search

Suggestions

For **The cost structure of sensemaking**

**The information visualizer, an inf...** 1991  
Card, S.K. and Robertson, G.G. and Macki... 532

**The WebBook and the Web Forag...** 1996  
Card, S.K. and Robertson, G.G. and York, W. 403

**LyberWorld—a visualization user...** 1994  
Hemmje, M. and Kunkel, C. and Willett, A. 223

**The structure of the information...** 1997  
Card, S.K. and Mackinlay, J. 198

**Information visualization** 2009  
Card, S. and Mackinlay, JD and Shneiderm... 180

**"I'll get that off the audio": a cas...** 1997  
Moran, T.P. and Palen, L. and Harrison, S... 143

**An organic user interface for sear...** 1995  
Mackinlay, J.D. and Rao, R. and Card, S.K. 123

**Using a landscape metaphor to re...** 1993  
Chalmers, M. 122

**Personal information management** 2007  
Jones, W.P. and Teevan, J. 109

**SearchTogether: an interface for c...** 2007  
Morris, M.R. and Horvitz, E. 108


**Information foraging theory: Ada...** 2007  
Pirolli, P. 107

**Investigating behavioral variabilit...** 2007  
White, R.W. and Drucker, S.M. 79

**Jigsaw: Supporting investigative...** 2008  
Stasko, J. and Görg, C. and Liu, Z. 71

**The cost-of-knowledge character...** 1994  
Card, S.K. and Pirolli, P. and Mackinlay, J.D. 54

**Collaborative conceptual design:...** 1996  
Potts, C. and Catledge, L. 45

 The cost structure of sen...



**The cost structure of sensemaking**

**PDF 1993**

*Russell, D.M. and Stefik, M.J. and Pirolli, P. and Card, S.K.*

245 citations 8 versions

Search

Suggestions

For **The cost structure of sensemaking**

**The information visualizer, an inf...** 1991  
Card, S.K. and Robertson, G.G. and Macki... 532

**The WebBook and the Web Forag...** 1996  
Card, S.K. and Robertson, G.G. and York, W. 403

**LyberWorld—a visualization user...** 1994  
Hemmje, M. and Kunkel, C. and Willett, A. 223

**The structure of the information...** 1997  
Card, S.K. and Mackinlay, J. 198

**Information visualization** 2009  
Card, S. and Mackinlay, JD and Shneiderm... 180

**"I'll get that off the audio": a cas...** 1997  
Moran, T.P. and Palen, L. and Harrison, S... 143

**An organic user interface for sear...** 1995  
Mackinlay, J.D. and Rao, R. and Card, S.K. 123

**Using a landscape metaphor to re...** 1993  
Chalmers, M. 122

**Personal information management** 2007  
Jones, W.P. and Teevan, J. 109

**SearchTogether: an interface for c...** 2007  
Morris, M.R. and Horvitz, E. 108


**Information foraging theory: Ada...** 2007  
Pirolli, P. 107

**Investigating behavioral variabilit...** 2007  
White, R.W. and Drucker, S.M. 79

**Jigsaw: Supporting investigative...** 2008  
Stasko, J. and Görg, C. and Liu, Z. 71

**The cost-of-knowledge character...** 1994  
Card, S.K. and Pirolli, P. and Mackinlay, J.D. 54

**Collaborative conceptual design:...** 1996  
Potts, C. and Catledge, L. 45

 The cost structure of sen...



**The cost structure of sensemaking**

**PDF 1993**

*Russell, D.M. and Stefik, M.J. and Pirolli, P. and Card, S.K.*

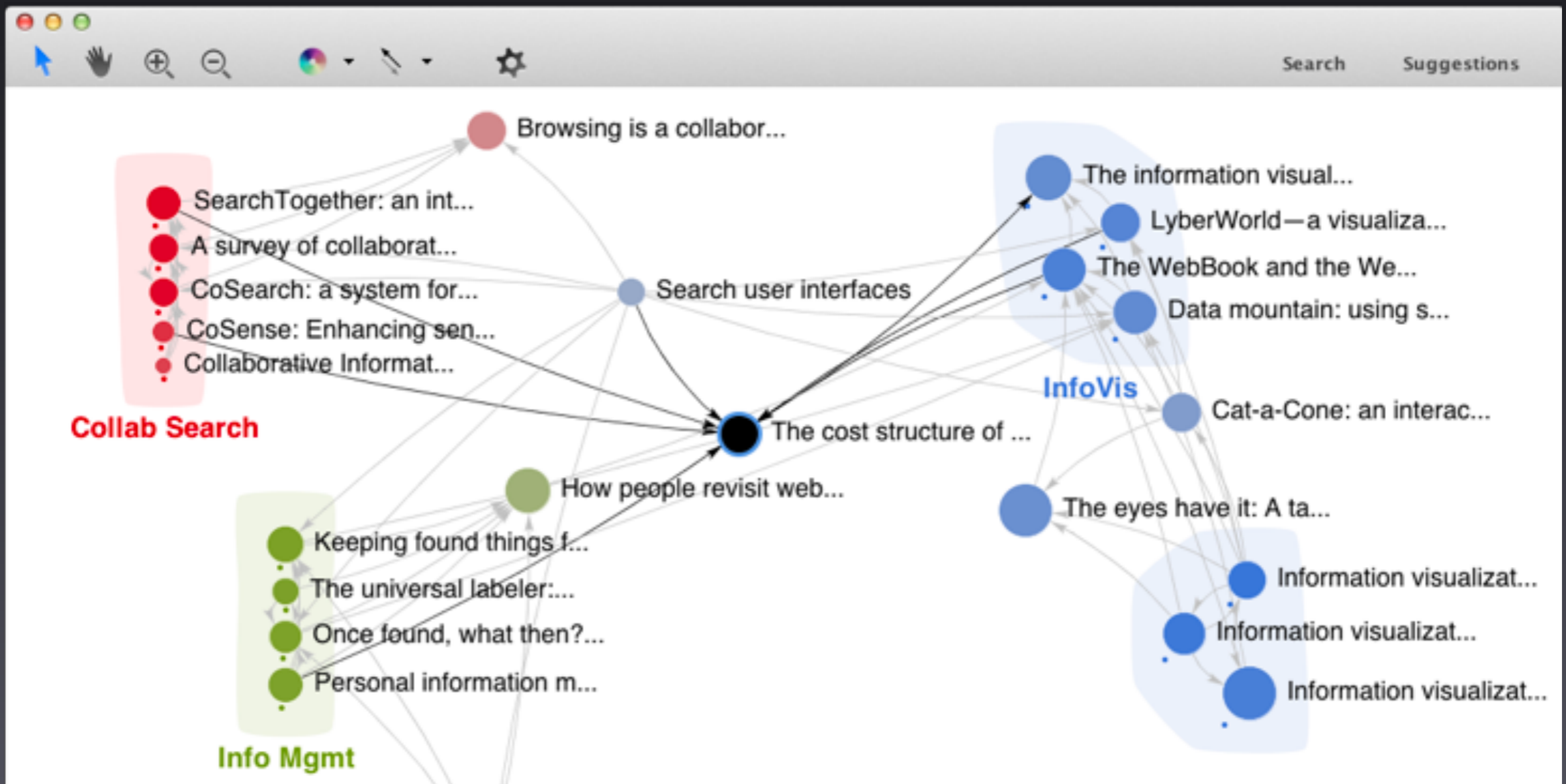
245 citations 8 versions

# Key Ideas (Recap)



Specify **exemplars**

Find **other** relevant nodes (BP)



# What did **Apolo** go through?

Collection

Scrape Google Scholar. No API. 🙄

Cleaning

Integration

Analysis

Design inference algorithm  
(Which nodes to show next?)

Visualization

Interactive visualization you just saw

Presentation

Paper, talks, lectures

Dissemination

You will a new Apolo prototype  
(called Argo)



# Apolo: Making Sense of Large Network Data by Combining Rich User Interaction and Machine Learning

Duen Horng (Polo) Chau, Aniket Kittur, Jason I. Hong, Christos Faloutsos

School of Computer Science

Carnegie Mellon University

Pittsburgh, PA 15213, USA

{dchau, nkittur, jasonh, christos}@cs.cmu.edu

## ABSTRACT

Extracting useful knowledge from large network datasets has become a fundamental challenge in many domains, from scientific literature to social networks and the web. We introduce Apolo, a system that uses a mixed-initiative approach—combining visualization, rich user interaction and machine learning—to guide the user to incrementally and interactively explore large network data and make sense of it. Apolo engages the user in bottom-up sensemaking to gradually build up an understanding over time by starting small, rather than starting big and drilling down. Apolo also helps users find relevant information by specifying exemplars, and then using a machine learning method called Belief Propagation to infer which other nodes may be of interest. We evaluated Apolo with twelve participants in a between-subjects study, with the task being to find relevant new papers to update an existing survey paper. Using expert judges, participants using Apolo found significantly more relevant papers. Subjective feedback of Apolo was also very positive.



Figure 1. Apolo displaying citation network data around the article *The Cost Structure of Sensemaking*. The user gradually builds up a mental model of the research areas around the article by manually inspecting some neighboring articles in the visualization and specifying them as exemplar articles (with colored dots underneath) for some ad hoc groups, and instructs Apolo to find more articles relevant to them.

**Apolo: Making Sense of Large Network Data by Combining Rich User Interaction and Machine Learning.** Duen Horng (Polo) Chau, Aniket Kittur, Jason I. Hong, Christos Faloutsos. *ACM Conference on Human Factors in Computing Systems (CHI) 2011*. May 7-12, 2011.

# NetProbe:

# Fraud Detection in Online Auction

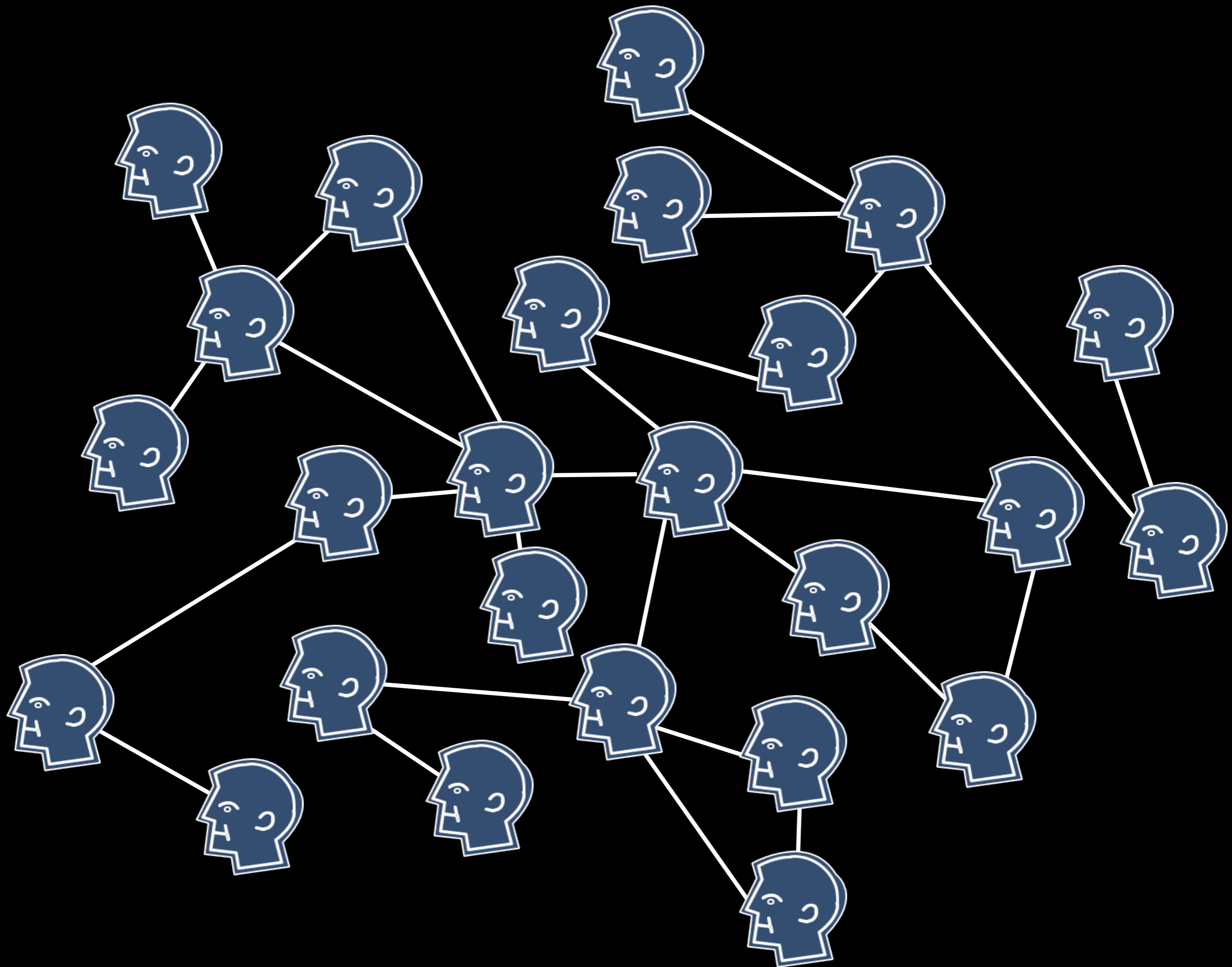


# NetProbe: The Problem

Find **bad sellers** (fraudsters) on eBay who don't deliver their items

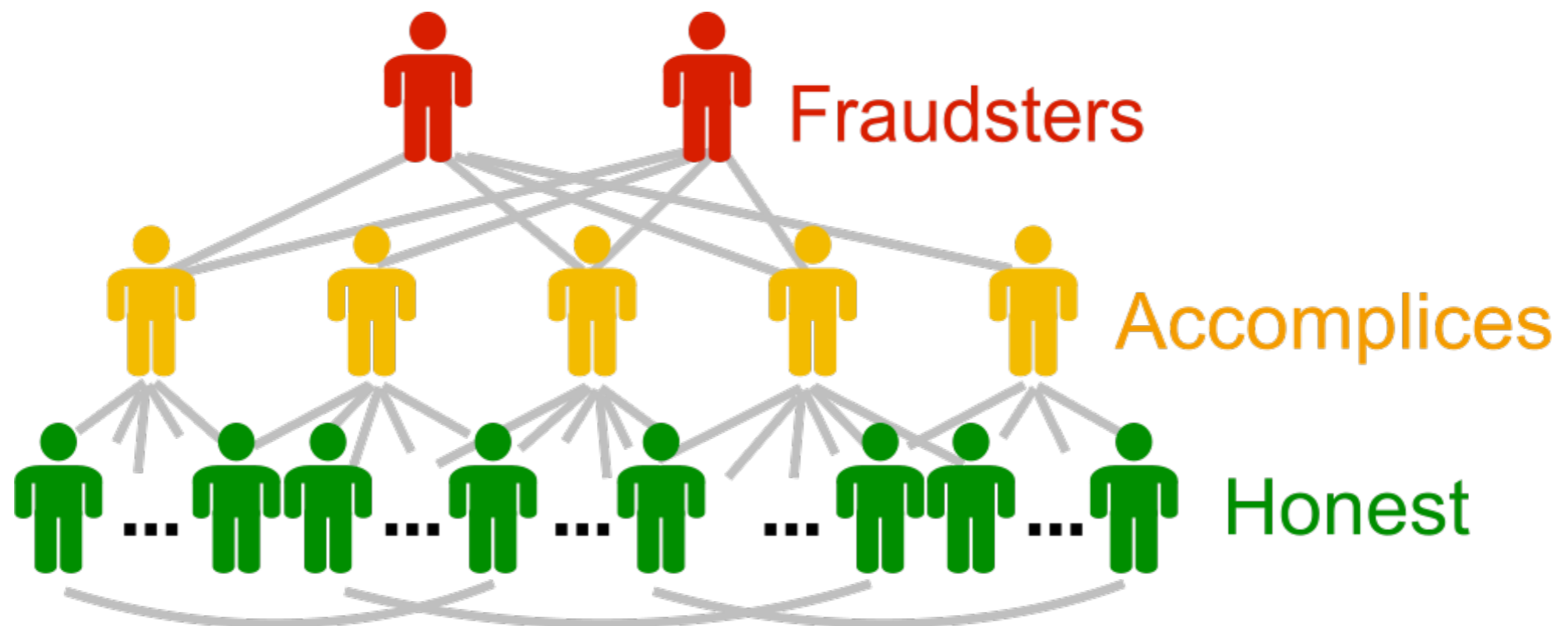


**Non-delivery fraud** is a common auction fraud



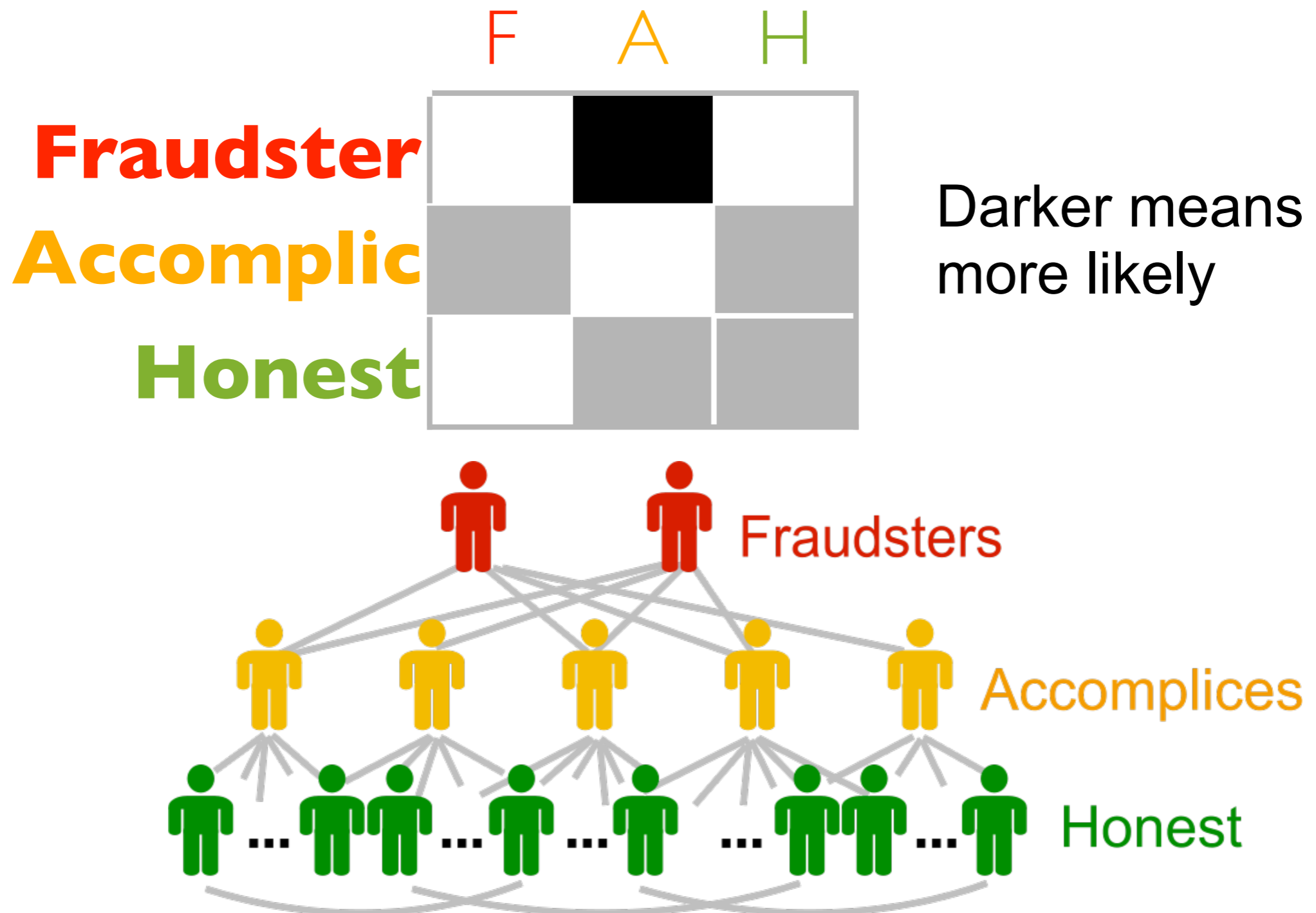
# NetProbe: Key Ideas

- Fraudsters **fabricate their reputation** by “trading” with their accomplices
- Fake transactions form **near bipartite cores**
- How to detect them?

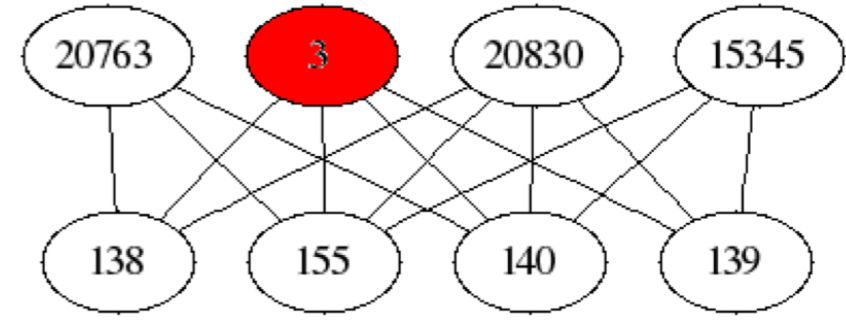
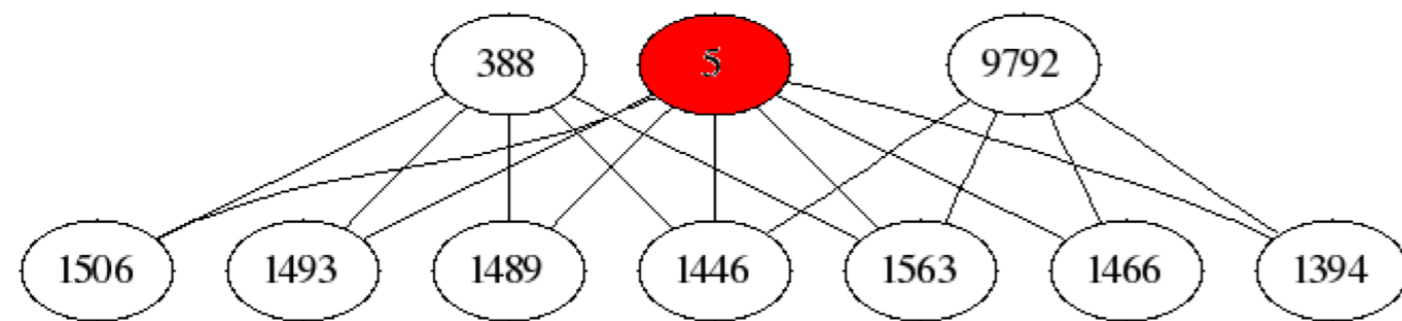
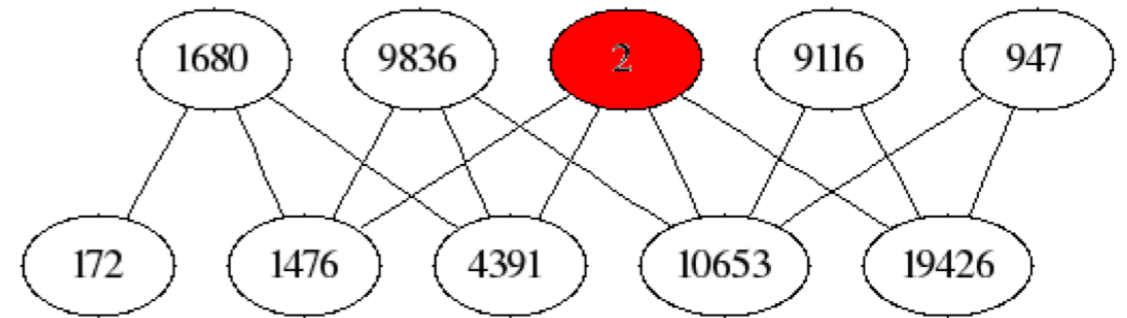
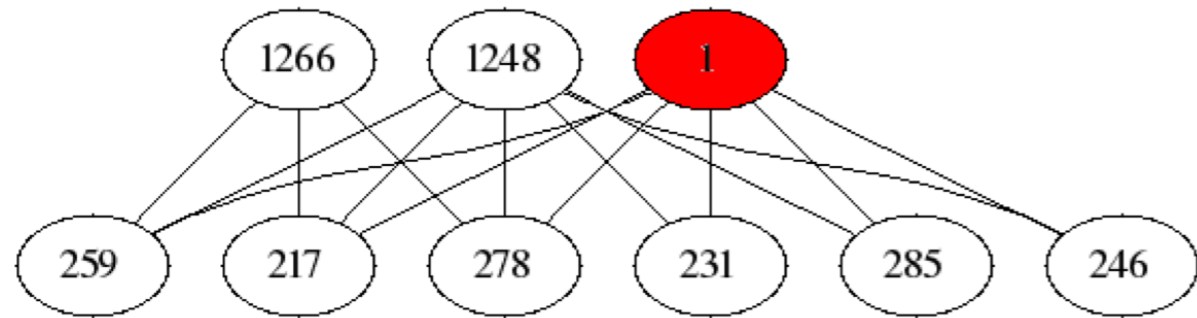


# NetProbe: Key Ideas

## Use Belief Propagation



# NetProbe: Main Results









THE WALL STREET JOURNAL.



PITTSBURGH  
TRIBUNE-REVIEW



Symantec™



THE WALL STREET JOURNAL.



PITTSBURGH  
TRIBUNE-REVIEW



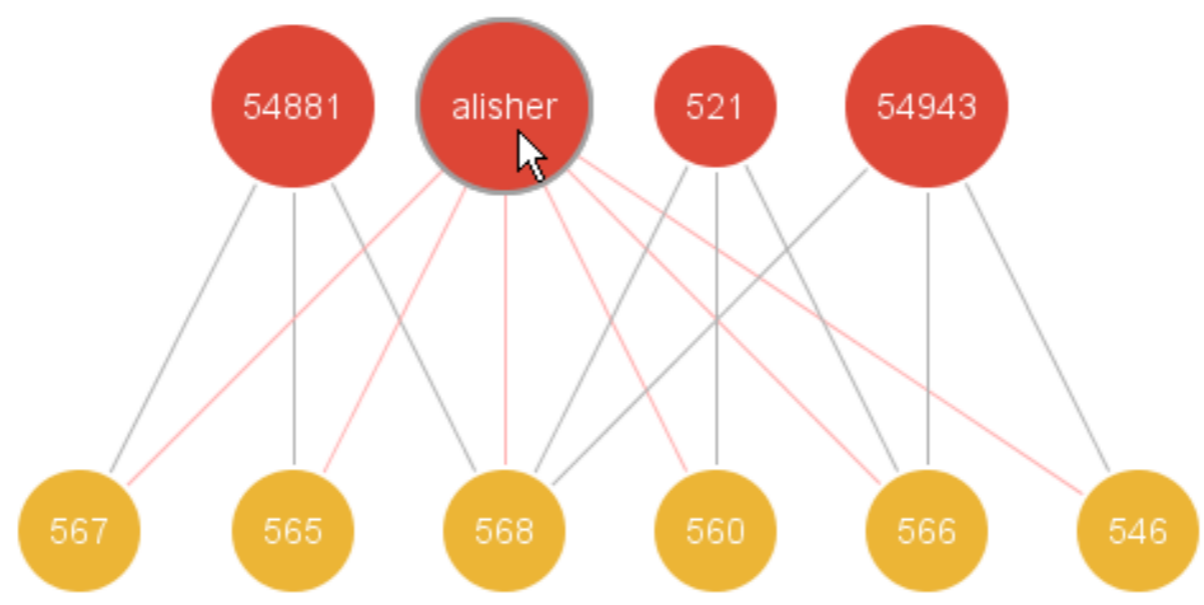
Symantec™

“Belgian Police”





Inspect user  for suspicious networks.



**alisher** Registration: Aug-13-06 Location: United States



Fraudsters:	95%
Accomplice:	4%
Honest:	1%

Suspected fraudster -- this user has been behaving much like the other suspects by trading with the similar sets of possible accomplices.

# What did **NetProbe** go through?

Collection

Scraping (built a “scraper”/“crawler”)

Cleaning

Integration

Analysis

Design detection algorithm

Visualization

Presentation

Paper, talks, lectures

Dissemination

Not released

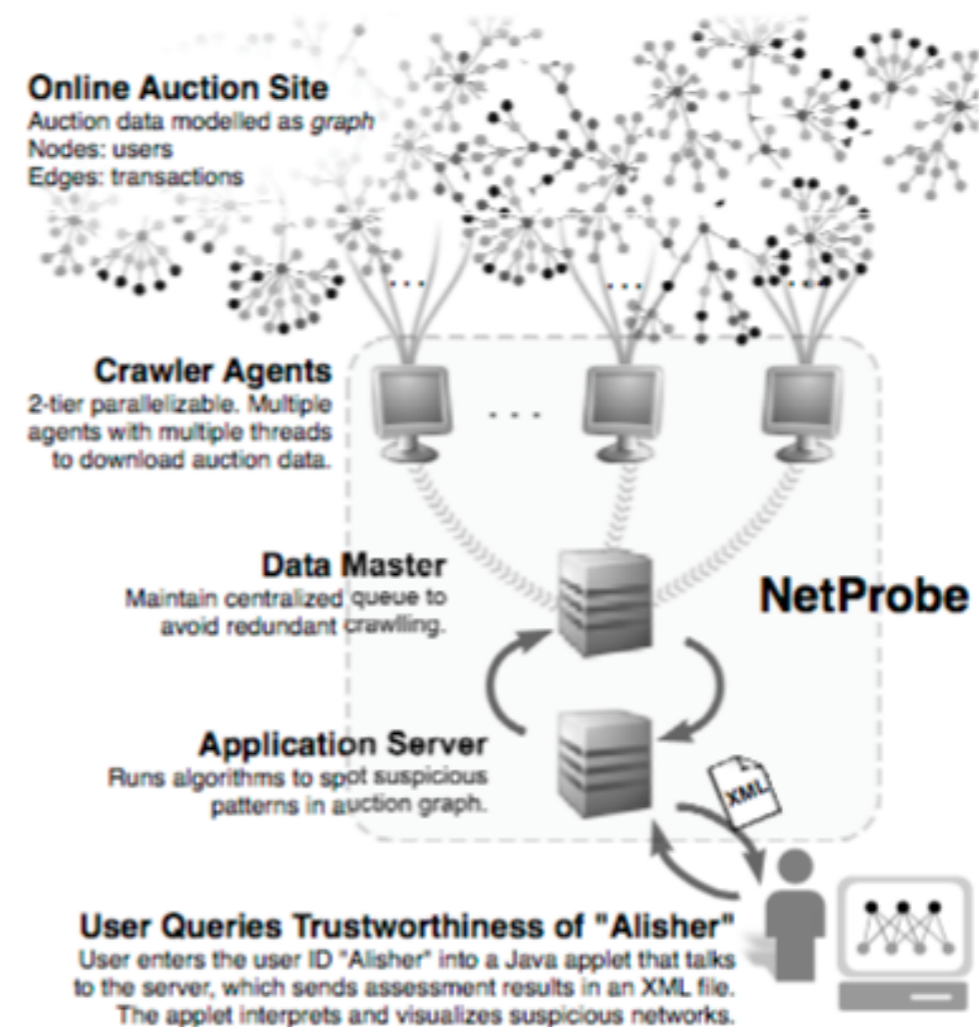
# NetProbe: A Fast and Scalable System for Fraud Detection in Online Auction Networks

Shashank Pandit, Duen Horng Chau, Samuel Wang, Christos Faloutsos ·  
Carnegie Mellon University  
Pittsburgh, PA 15213, USA

{shashank, dchau, samuelwang, christos}@cs.cmu.edu

## ABSTRACT

Given a large online network of online auction users and their histories of transactions, how can we spot anomalies and auction fraud? This paper describes the design and implementation of NetProbe, a system that we propose for solving this problem. NetProbe models auction users and transactions as a *Markov Random Field* tuned to detect the suspicious patterns that fraudsters create, and employs a *Belief Propagation* mechanism to detect likely fraudsters. Our experiments show that NetProbe is both efficient and effective for fraud detection. We report experiments on synthetic graphs with as many as 7,000 nodes and 30,000 edges, where NetProbe was able to spot fraudulent nodes with over 90% precision and recall, within a matter of seconds. We also report experiments on a real dataset crawled from eBay, with nearly 700,000 transactions between more than 66,000 users, where NetProbe was highly effective at unearthing hidden networks of fraudsters, within a realistic response time of about 6 minutes. For scenarios where the underlying data is dynamic in nature, we propose *Incremental NetProbe*, which is an approximate, but fast, variant of NetProbe. Our experiments prove that Incremental NetProbe



**NetProbe: A Fast and Scalable System for Fraud Detection in Online Auction Networks.** Shashank Pandit, Duen Horng (Polo) Chau, Samuel Wang, Christos Faloutsos. *International Conference on World Wide Web (WWW) 2007*. May 8-12, 2007. Banff, Alberta, Canada. Pages 201-210.

# Homework 1

Collection

Cleaning

Integration

Analysis

Visualization

Presentation

Dissemination

- Simple “End-to-end” analysis
- Collect data about LEGO via API
  - Store in SQLite database
- Create graph from data
- Analyze, using SQL queries (e.g., create graph’s degree distribution)
- Visualize graph using **ARGO Lite**
- Describe your discoveries