# Making Sense of Social Networks using Pairwise Visualization and Analysis

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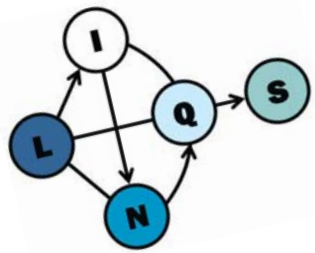

# Motivation

- Growing need for tools which help us understand and make sense of social networks
  - Many tools allow flexible overview and navigation the entire network
  - Some tools focus on a single actor-centric view of the network
- The tools I will describe today focus on a **pairwise** paradigm well-suited to certain visual analytic tasks

# Outline

- Problem #1
  - **Task: Entity Resolution**
  - Tool: D-Dupe
  - URL: http://www.cs.umd.edu/linqs/ddupe
  - *H. Kang, M. Bilgic, L. Licamele, B. Shneiderman, VAST06*
- Problem #2
  - Task: Geospatial Data Integration
  - Tool: GeoD-Dupe
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- Problem #3
  - Task: Dynamic Group Membership
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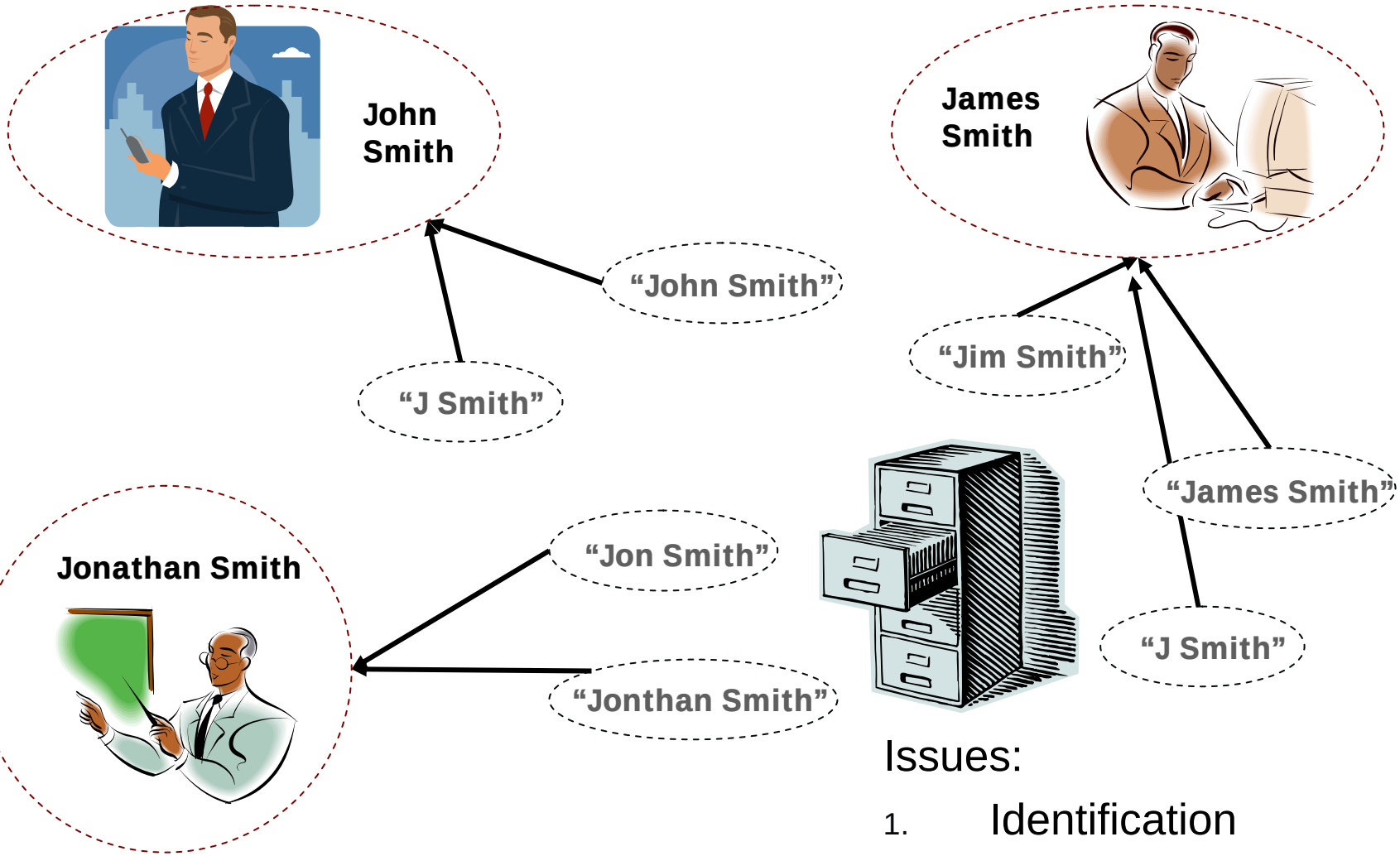
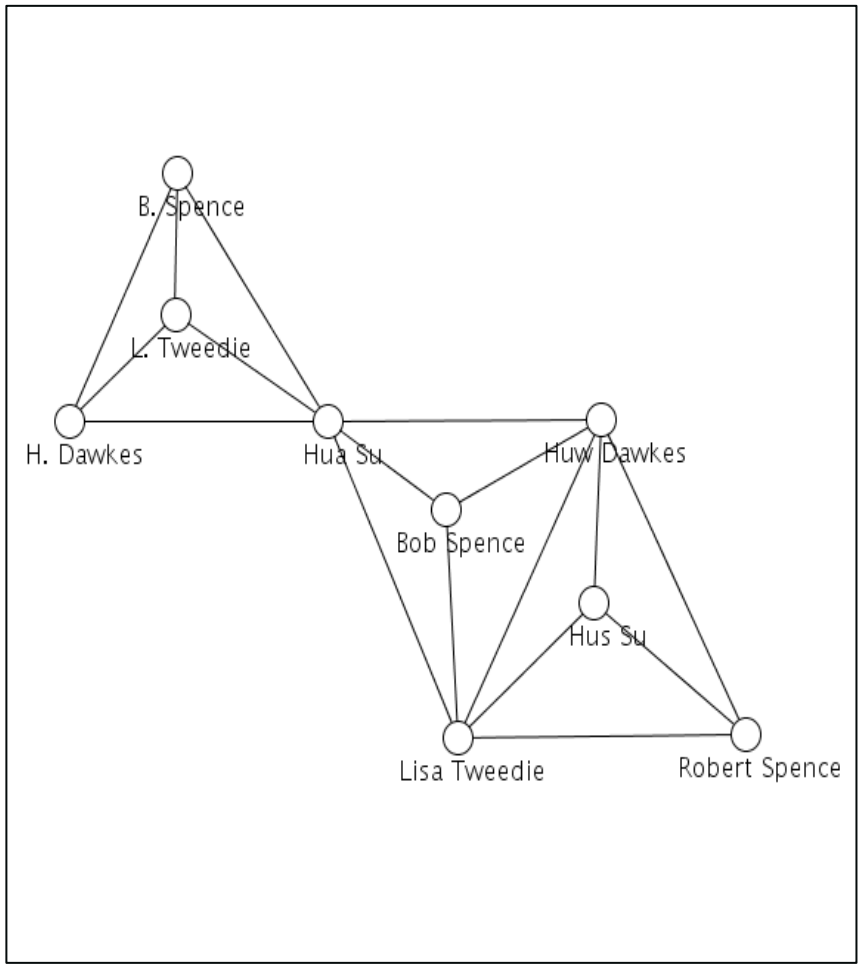
# The Entity Resolution Problem

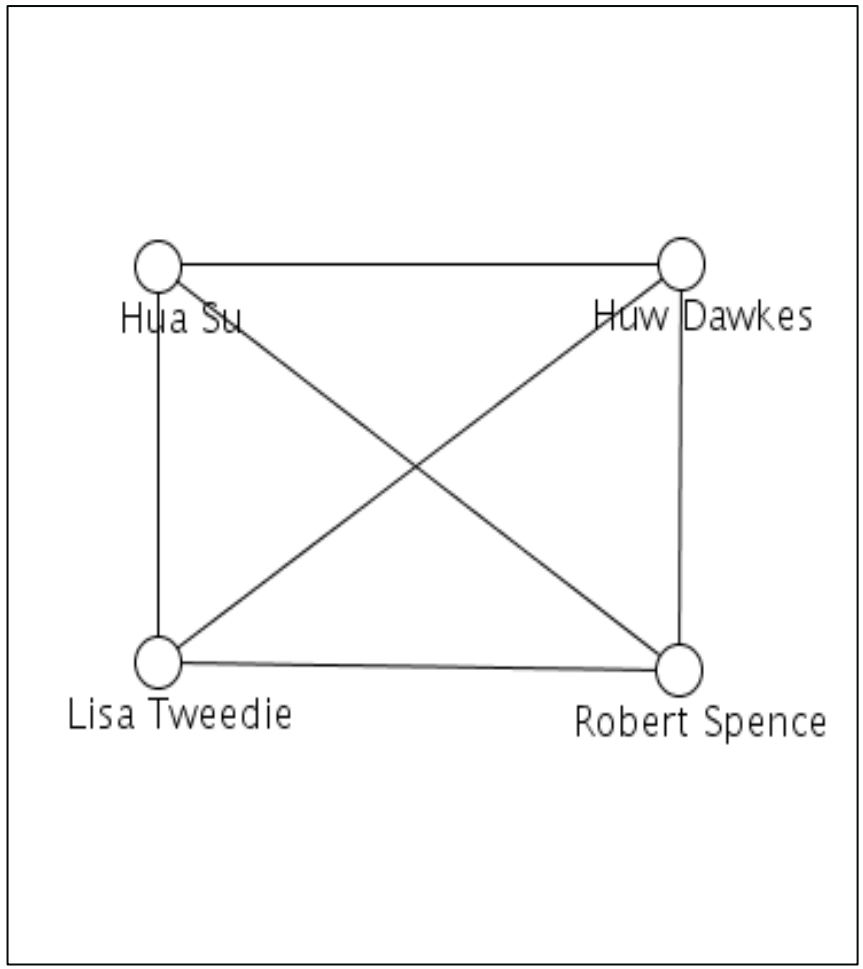



Issues:

1. Identification
2. Disambiguation

# InfoVis Co-Author Network Fragment



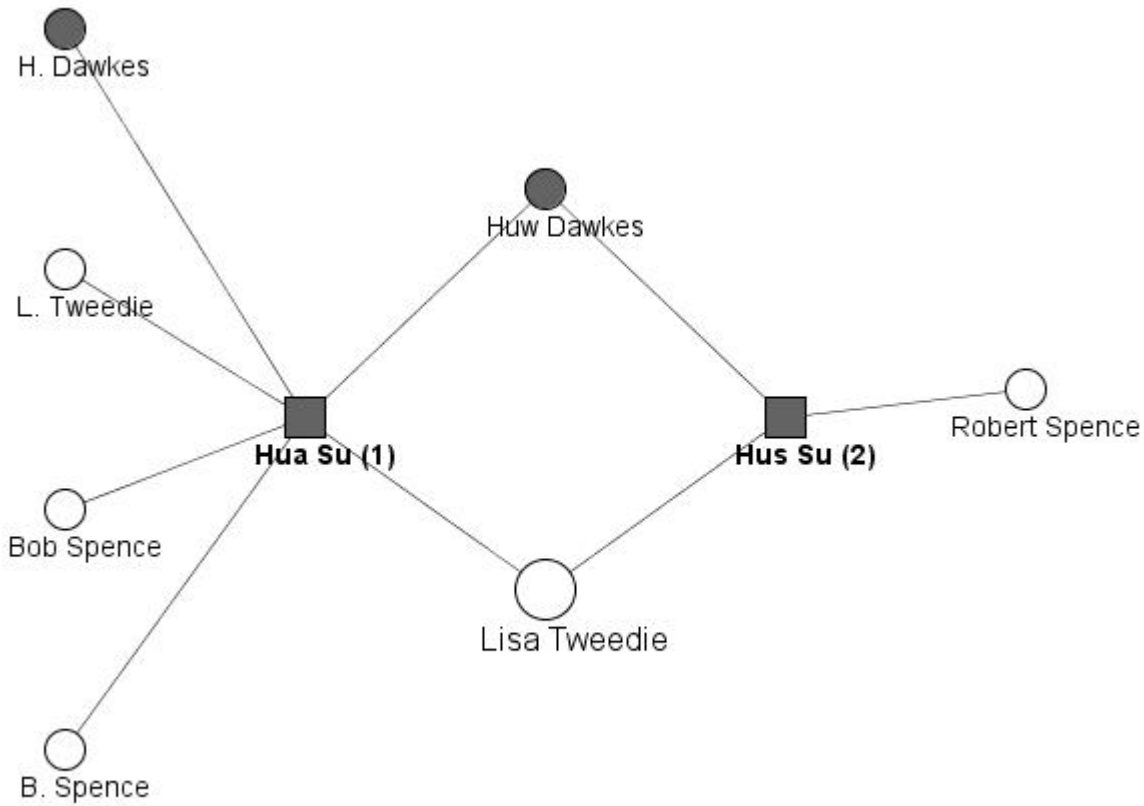

before

after

# Entity Resolution in Networks

- References not observed independently
  - Links between references indicate relations between the entities
  - Co-author relations for bibliographic data
  - To, cc: lists for email
- Use relations to improve identification and disambiguation

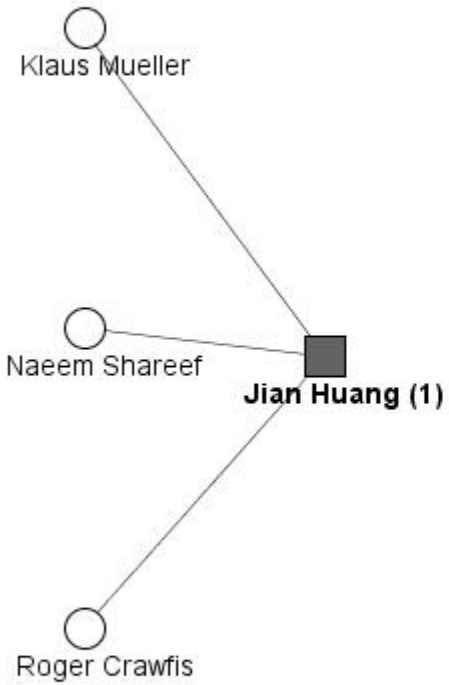
# Relational Identification

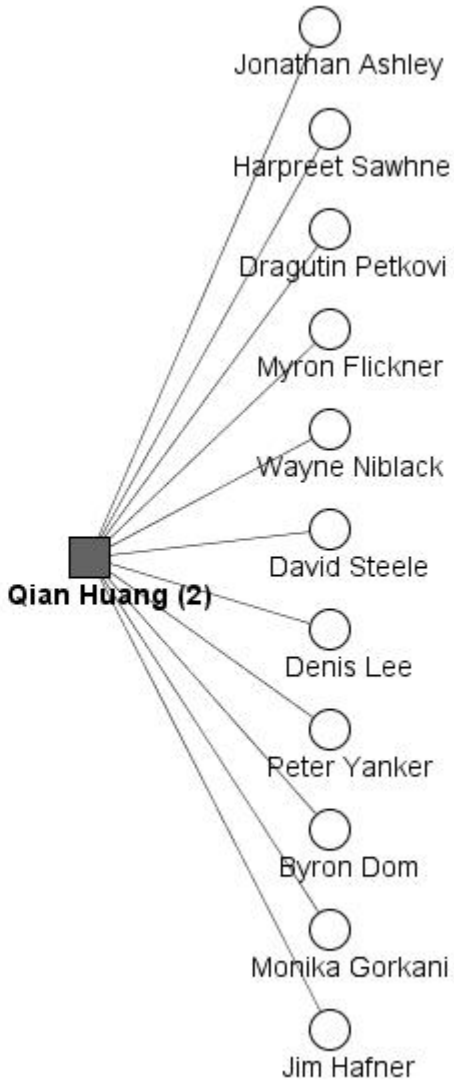



Very similar names.

Added evidence from shared co-authors

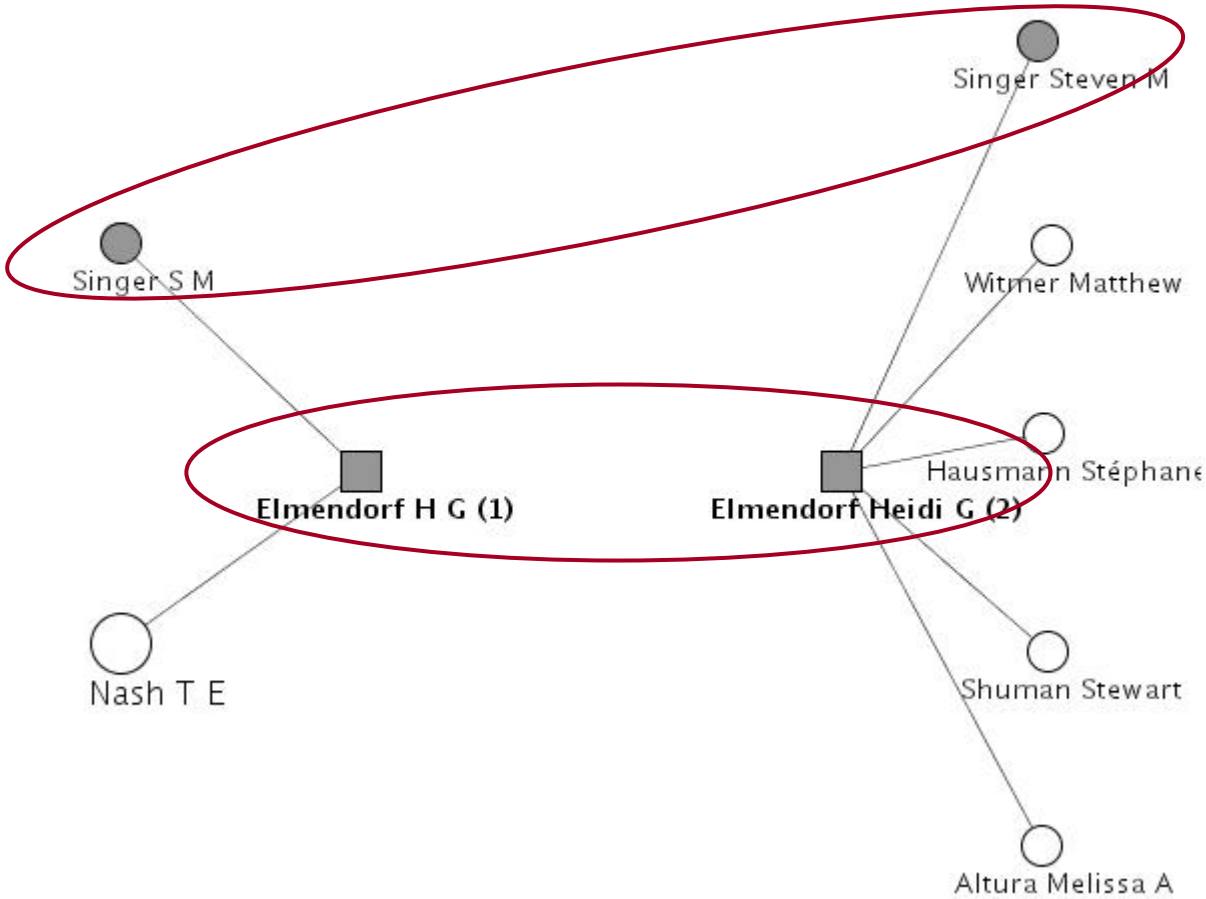
# Relational Disambiguation




Very similar names but no shared collaborators

# Collective Entity Resolution




One resolution provides evidence for another => joint resolution

# Entity Resolution Algorithms

- Relational Clustering
  - Agglomerative clustering algorithm which uses attribute and relational similarity
  - *Bhattacharya and Getoor, DMKD'04, Wiley'06, TKDD'07*

- Generative Probabilistic Model
  - Nonparametric Bayesian Model
  - Discovers underlying group structure
  - Allows overlapping groups
  - *Bhattacharya and Getoor, SIAM SDM'06, Best Paper Award*

# Objective Function

- **Minimize:**

$$\sum_i \sum_j w_A sim_A(c_i, c_j) + w_R \delta(c_i, c_j)$$

weight for attributes

similarity of attributes

weight for relations

1 iff relational edge exists between $c_i$ and $c_j$

- **Greedy clustering algorithm:** merge cluster pair with max reduction in objective function

$$\Delta(c_i, c_j) = w_A sim_A(c_i, c_j) + w_R(|N(c_i) \cap N(c_j)|)$$

Similarity of attributes

Common cluster neighborhood

# Relational Clustering Algorithm

1. Find similar references using ‘blocking’
2. Bootstrap clusters using attributes and relations
3. Compute similarities for cluster pairs and insert in priority queue

4. Repeat until priority queue is empty
5. Find ‘closest’ cluster pair
6. Stop if similarity below threshold
7. Merge to create new cluster
8. Update similarity for ‘related’ clusters

- **CODE AND DATA AND DATA GENERATOR AVAILABLE HERE:**
  **http://www.cs.umd.edu/~indrajit/ER/**

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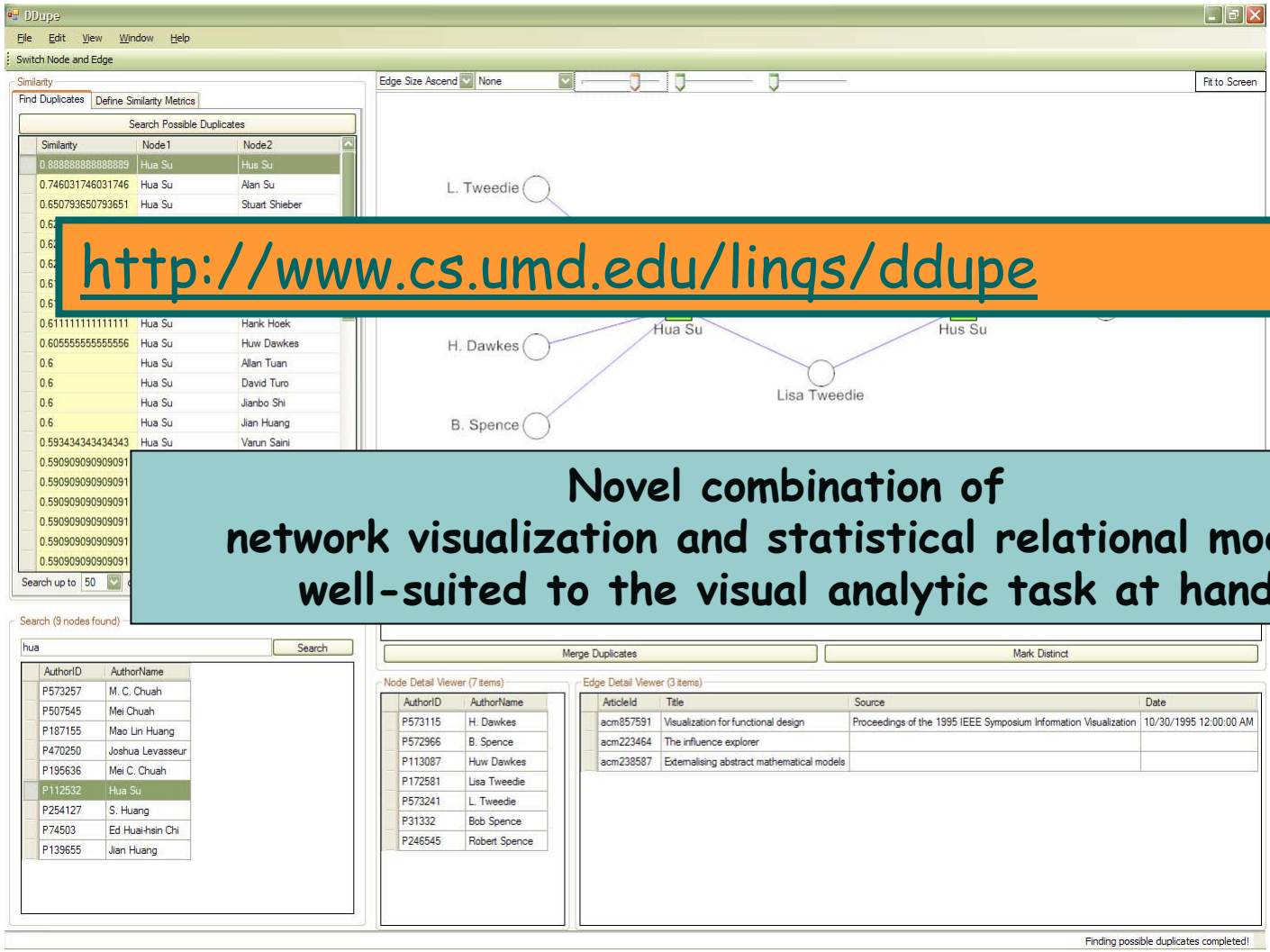
# D-Dupe: An Interactive Tool for Entity Resolution




http://www.cs.umd.edu/linqs/ddupe

**Novel combination of network visualization and statistical relational models well-suited to the visual analytic task at hand**

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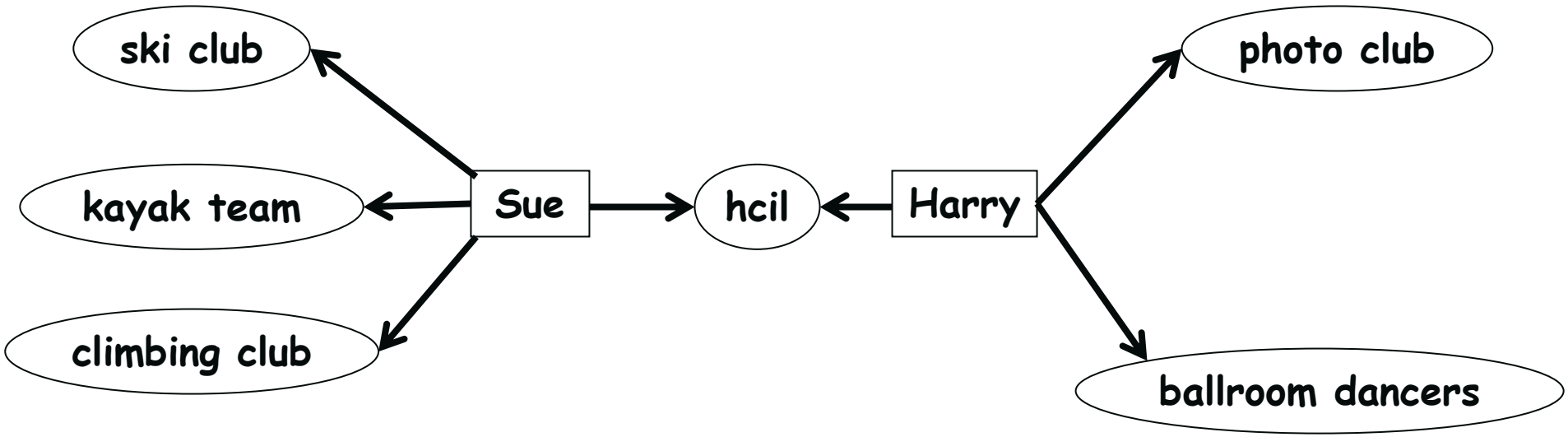
# Finding Groups in Social Networks

- Topic of intense interest
- Many methods proposed

- Here, we focus on **dynamic** group membership, how group membership changes over time
- And, we focus on comparing the group memberships of a **pair** of actors

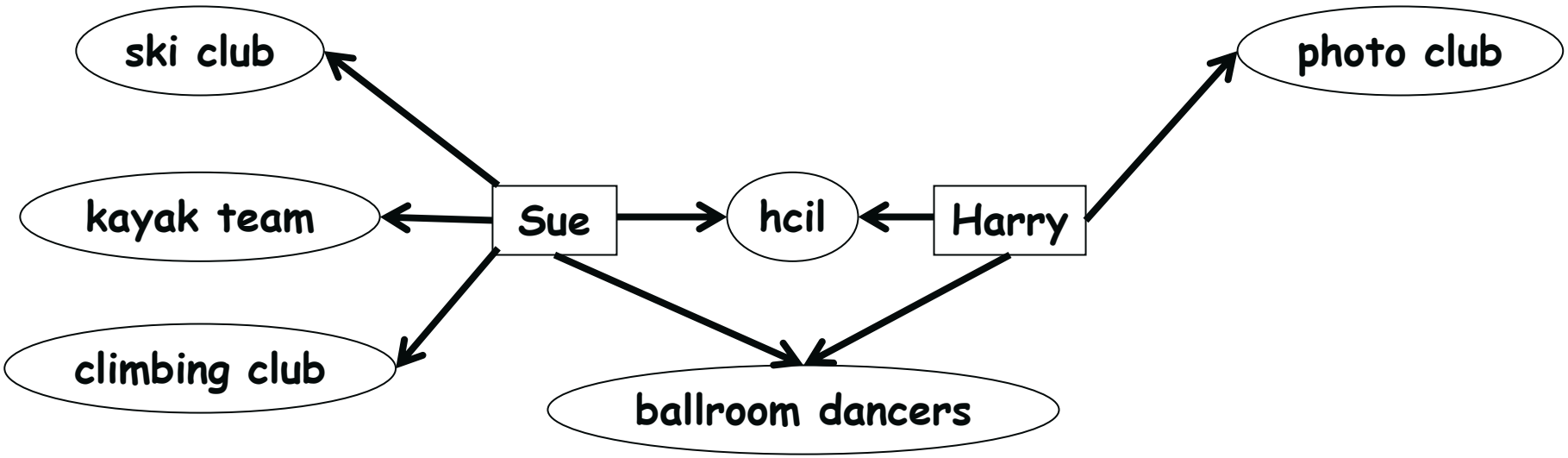
# Dynamic Group Membership

Year 1….



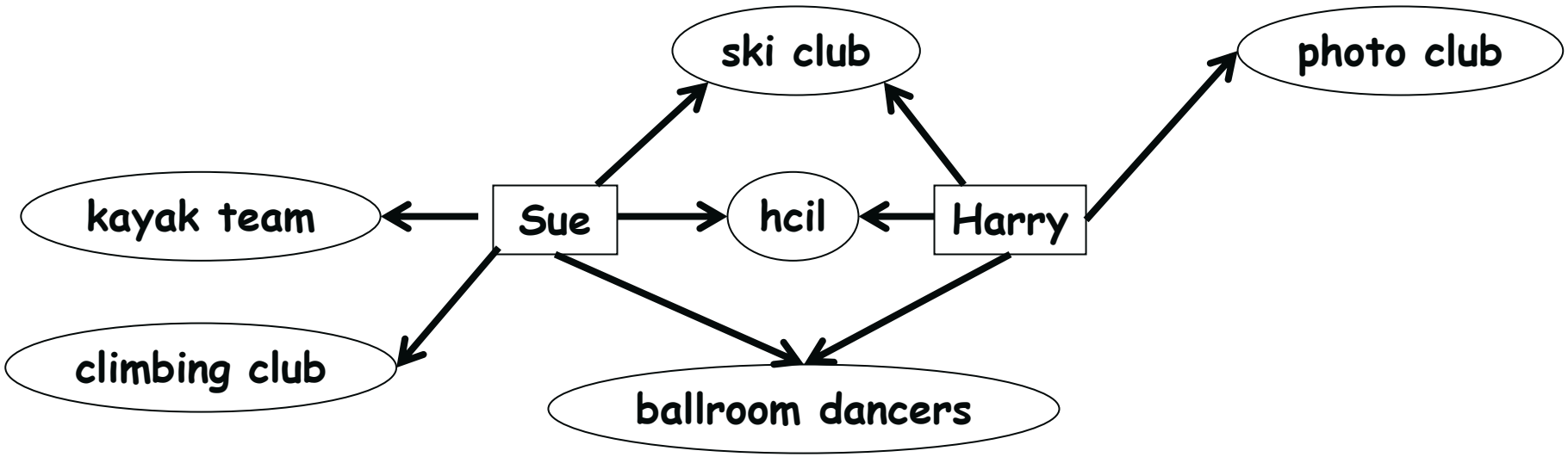
# Dynamic Group Membership

Year 2….



# Dynamic Group Membership

Year 3….



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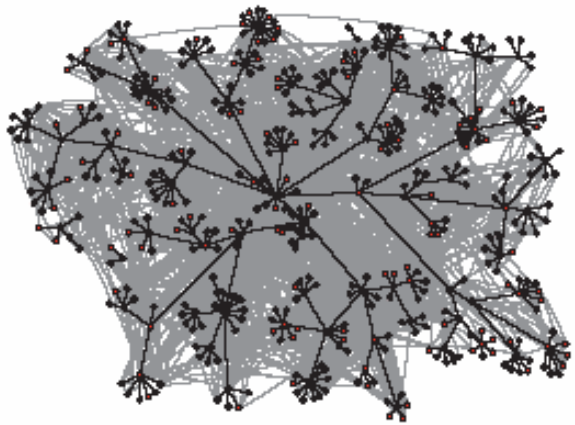
# Putting Everything together….

**Pairwise useful for certain tasks, but still want to see bigger picture**

Collaborative Social Network Discovery

*Entity Resolution*

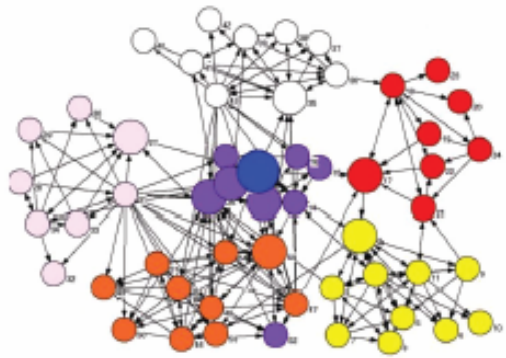
*Relationship Identification*



Communications Graph

*Nodes: Network References*

*Edges: Communications Events*



Network Graph

*Nodes: Entities*

*Edges: Social Relationships*

**Currently working on analytic and visual tools that support interactive, exploratory, dual view of data network and information network**

# Thanks!

http:www.cs.umd.edu/~getoor

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