Isnad Disambiguation

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Reframing the Problem

- Historians are interested in scholarly transmission
  - Captured by *isnads*
- Name disambiguation problem
  - Manually time consuming
- Can we make suggestions based on limited manual labeling to speed up the process?

حدثنا أبو داود قال :حدثنا هشام، عن قتادة، عن الحسن عن سمرة، أن النبي صلى الله عليه وسلم

Abū Dāwūd transmitted to us, saying, ‘Hishām transmitted to us, from Qatādah, from al-Ḥasan, from Samurah that the Prophet, may the peace and blessing of God be on him[1]

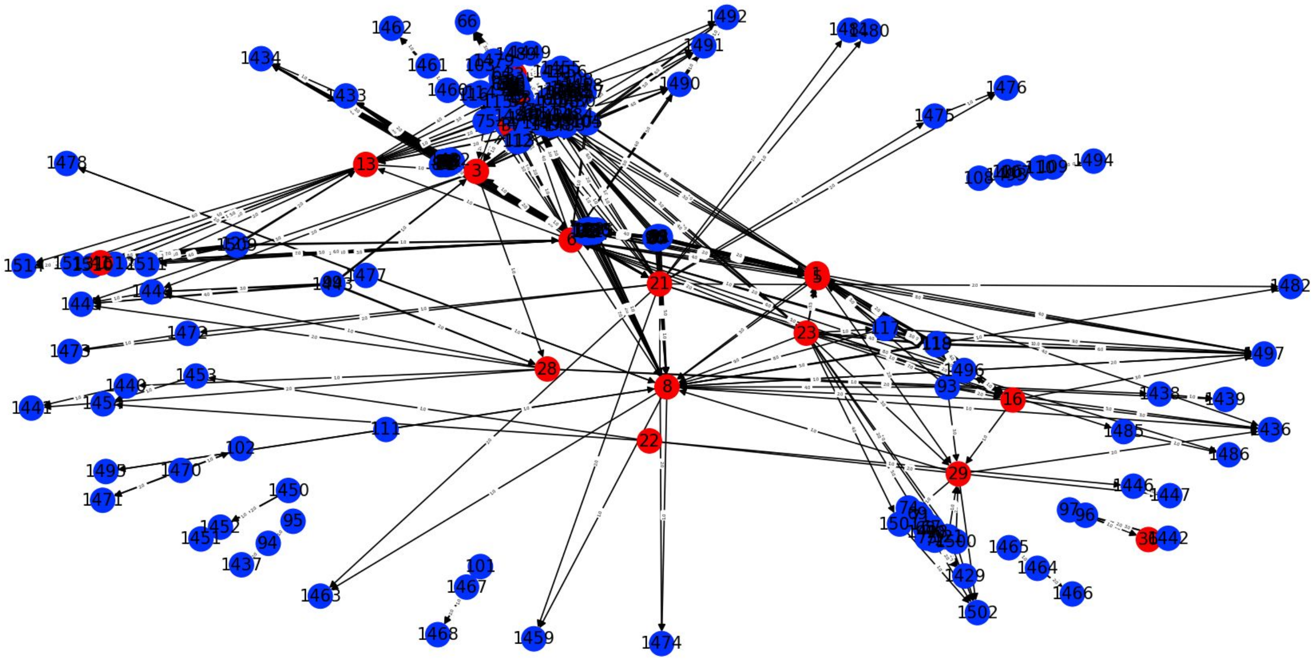
Starting Data

- Partially disambiguated chains
  - From Ta’rikh Madinat Dimashq by Ibn ‘Asakir
  - All connecting through Muhammed Ibn Sa’d
- 2,380 chains
- 14,454 mentions
  - 13,072 labeled by domain expert
    - 44 unique individuals

1. Building the Graph

Graph at t_0

- Read in the data
  - Select some labels to cover up
  - Connect nodes based on co-occurrences
  - Weight directed edges by average position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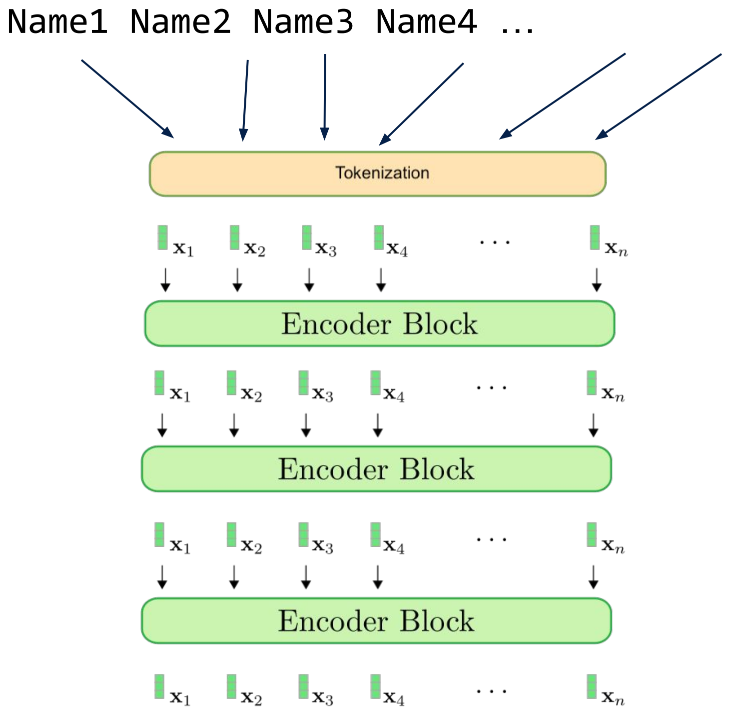
2. Calculating Features

Social Hashing

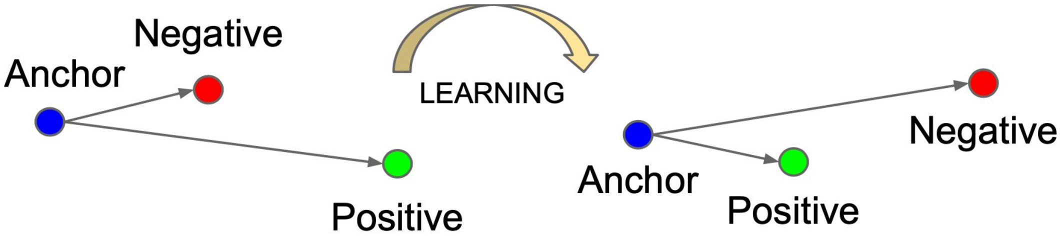
- 2 social feature vectors
  - # co-occurrences
  - average relative position in co-occurrences
- Length equal to the number of nodes in the graph

Context Embedded Tokens



Contrastive Name Embeddings

- Supervised learning of name representations
- Initially used the same test set for contrastive learning and graph prediction, but found it was unnecessary

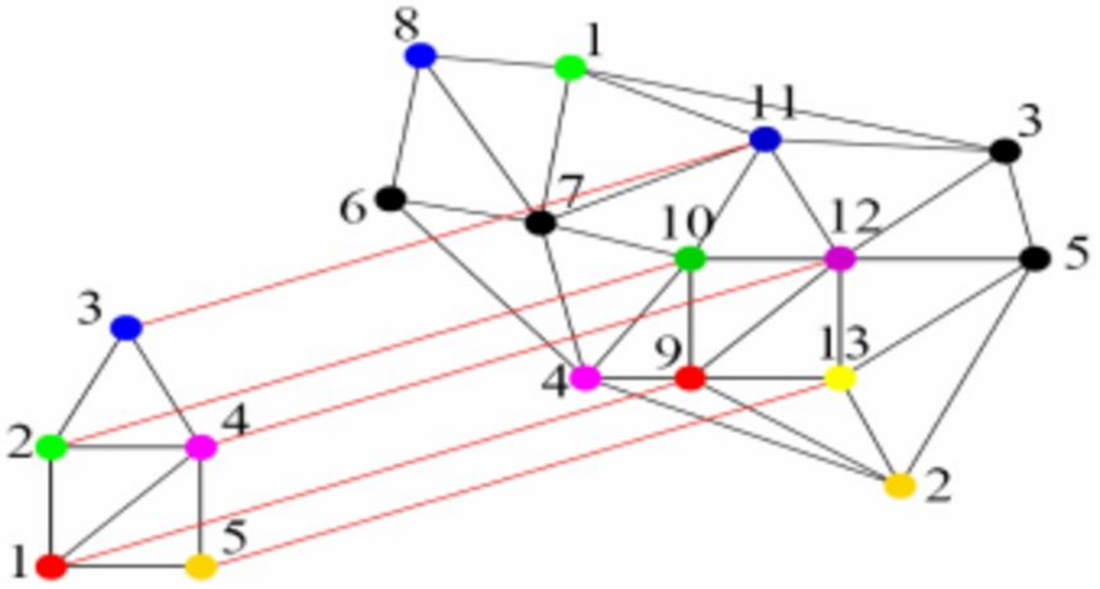


3. Match and Merge

Calculate Similarity Matrix

- Cosine similarity between all nodes
- Dynamic computation
- Memoization of results
- Multithreaded computation (limited)

Subgraph Matching



Merge Until Stable

- Each unlabeled node matched to label
  - Uniquely assigned
  - Assigned to an existing label
- Recompute features each iteration
  - Using features from composite nodes
- Stop when all ambiguous nodes have been assigned a label

4. Concessions for Performance

Computational Limits

- Size of the similarity matrix
- Networkx limits multithreading (graph tool)
- Recomputation after every merge

- More efficient hash recomputation
- Locality sensitive hashing

Processing

- Batches of top 50 nodes at each stage of recalculation
- Can’t match unlabeled node to unlabeled node
  - If nodes begin to resemble each other later on, matches are already fixed
- Only check labeled neighbors

5. Results

Evaluating

- CoNLL
  - Composite measure of cluster similarity
    - MUC, B^3, $CEAF_e$
- Did we re-cluster nodes known to share a label?

Comparison with Muther & Smith

	kNN100_leiden	Surface Form	Our Method (33%)
B^3	**.756**	**.868**	**.603**
$CEAF_e$	**.444**	**.523**	**.664**
CoNLL	**.727**	**.790**	**.753**

Our Method

	Muther & Smith Embeddings (33%)	Contrastive Embeddings (33%)	No Social Features (33%)
B^3	**.603**	**.742**	**.979**
$CEAF_e$	**.664**	**.530**	**.826**
CoNLL	**.753**	**.755**	**.934**

Conclusion

- NLP embeddings seem to be a better way to tackle this problem than social features
- Contrastive embeddings appear more effective

5. What’s Next?

This Project

- Parameter tuning
- Ambiguous to ambiguous matching
  - No known starting labels
- Shifting weights
  - Move from NLP to social as more is known

Future Work

- Locality sensitive hashing
  - Similarity -> collisions
- Deep features
  - *Neural Subgraph Matching (Rex Ying, Andrew Wang)*
- Jaccard Index for subgraph matching
- Other distance metrics for social features

Citations

Goebel, Peter & Vincze, Markus. (2007). Implicit Modeling of Object Topology with Guidance from Temporal View Attention.

R. Muther and D. Smith, ‘The Fellowship of the Authors: Disambiguating Names from Social Network Context’. arXiv, 2022.

R. Muther, D. Smith, and S. Savant, ‘From Networks to Named Entities and Back Again Exploring Classical Arabic Isnad Networks’. *Journal of Historical Network Research* 5, 2023.

Rex *et al.*, ‘Neural Subgraph Matching’. arXiv, 2020.