GRAPH RECONSTRUCTION FROM NEIGHBORHOOD DATA AND PARTIAL EDGE KNOWLEDGE

Does **collaboration** to analyze distributed graphs reveal **sensitive information** about **private subgraphs** ?

FORUM MobiliT.AI

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1.PRIVACY-PRESERVING GRAPH ANALYSIS

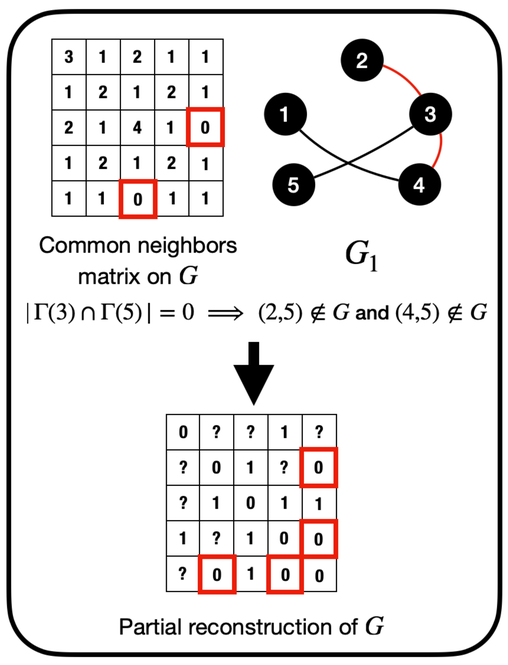
To overcome the limitations of isolated analysis, collaborative graph analysis allows graph owners to combine their distributed graph data for a more comprehensive understanding. Since such graph owners might want to keep their graphs private (intellectual property, users privacy), **privacy-preserving methods for collaborative graph analysis [1, 2]** have been proposed in order to benefit from the abondance of data without revealing the private structure of individual graphs.

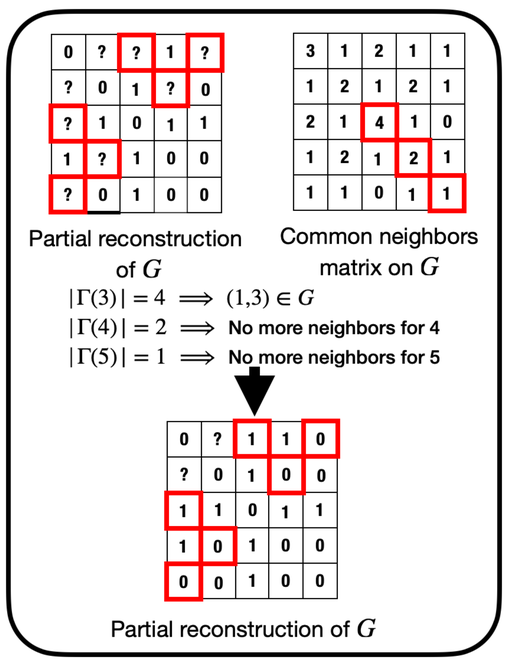
We join the lineage of other works [3] and show how the outputs of such protocols might **indirectly reveal infomation about the private graphs**.

3.OBJECTIVES

- How accurately can the dishonest agency **reconstruct the union graph** based on the common neighbors matrix and the partial graph ?
- How accurately can the dishonest agency leverage the previous reconstuction of the union graph to **retrieve the private graph of the other** ?

4.DETERMINISTIC GRAPH RECONSTRUCTION





6.CONCLUSION

- Simple algorithms can be applied to retrieve the union graph.
- Although the reconstruction is precise (no false positive) it is not complete for all graphs
- Future directions:
  - Charaterization of the reconstructibility of graphs
  - Reconstruction of the other private graph by leveraging the union graph (link prediction, matrix completion)

REFERENCES

[1] Sofiane Azogagh, Zelma Aubin Birba, Sébastien Gambs, Marc-Olivier Killijian (2024). Crypto'Graph: Leveraging Privacy-Preserving Distributed Link Prediction for Robust Graph Learning. Scheduled to appear at CODASPY24

[2] Didem Demirag, Mina Namazi, Erman Ayday, and Jeremy Clark (2023). Privacy-Preserving Link Prediction. In Data Privacy Management, Cryptocurrencies and Blockchain Technology.

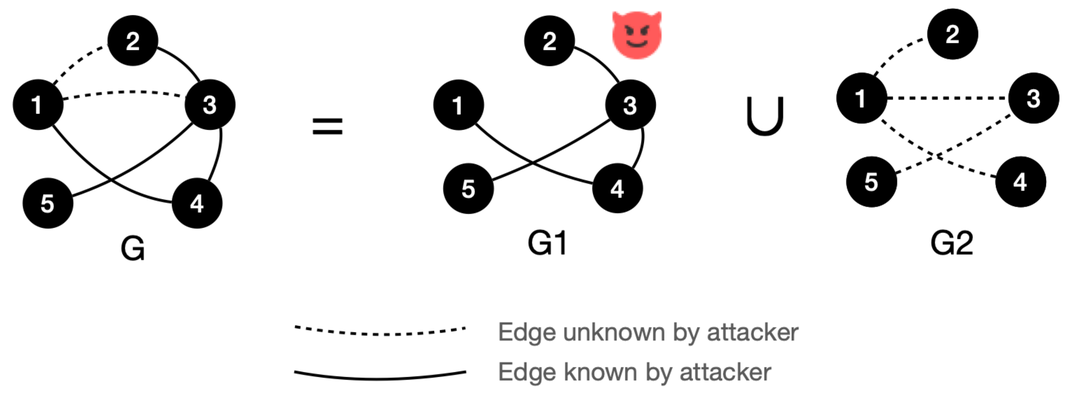
[3] Dora Erdös, Rainer Gemulla Evimaria Terzi (2012). Reconstructing Graphs from Neighborhood Data. In 2012 IEEE 12th International Conference on Data Mining.

DEEL DEpendable & Explainable Learning

2.CONTEXT

Consider two transportation agencies owning graphs that represent different locations (nodes), and the routes between them (edges).

- All locations (nodes) belong to both graphs
- Each agency has its own network of routes between locations (i.e. the edges are distributed between the two graphs such that each edge belongs to the first, the second or both)

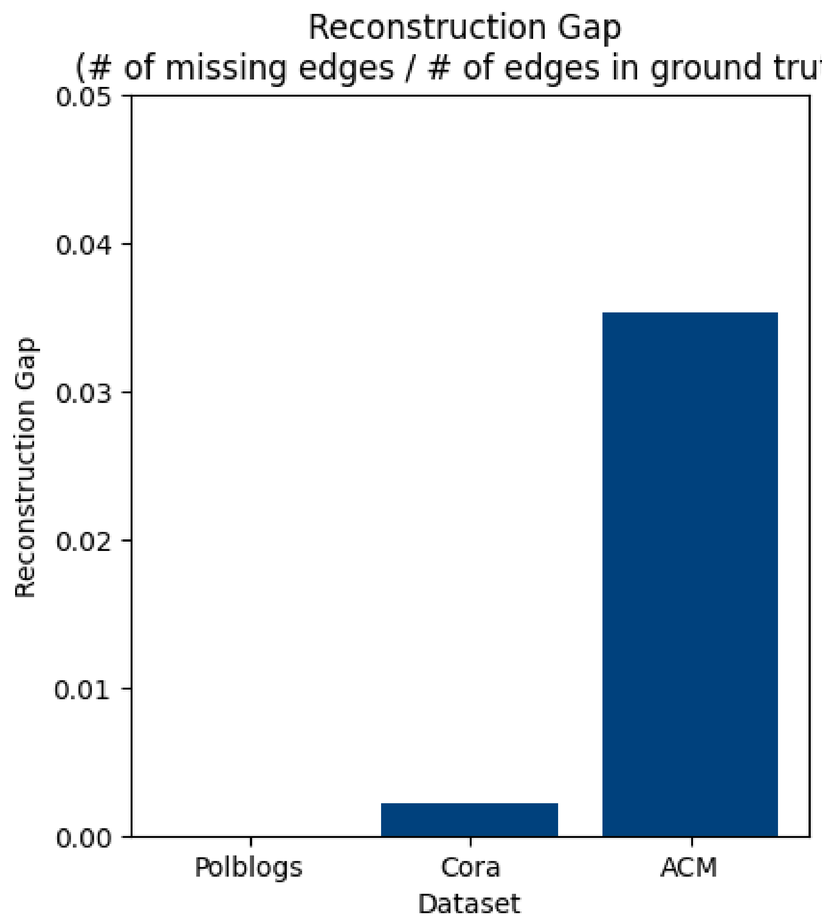


To provide seamless navigation and more diverse route options, both parties can collaborate **privately** to identify common connections between the locations. This information will pinpoint routes needing improvement, enhancing the user experience without compromising sensitive network data.

3	1	2	1	1
1	2	1	2	1
2	1	4	1	0
1	2	1	2	1
1	1	0	1	1

Common neighbors of each pair of locations on the joint graph G

5.ANALYSIS



The two subgraphs are randomly sampled from the normal dataset.