Graph-based Analytics for Decentralized Online Social Networks

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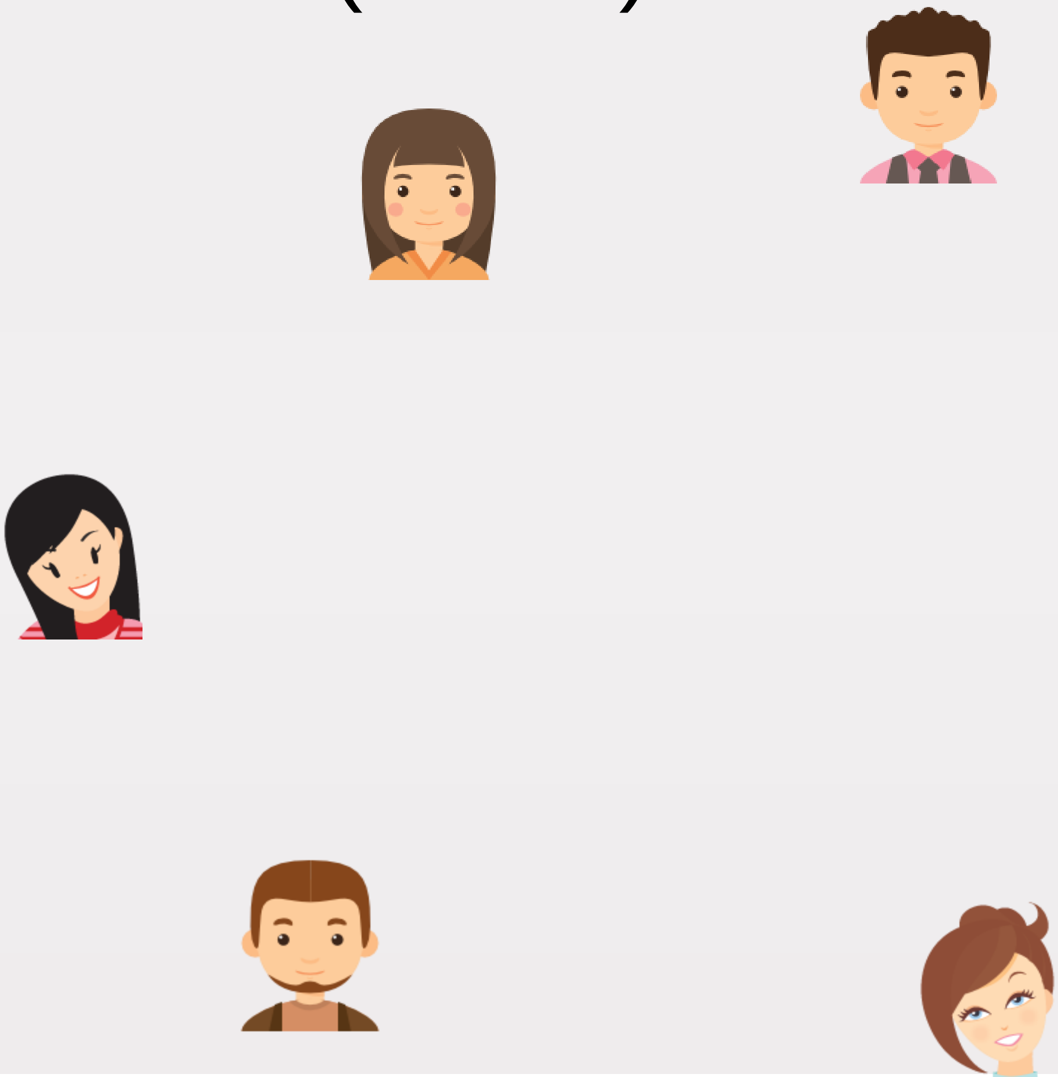
Interactions on top of Online Social Networks (OSNs)



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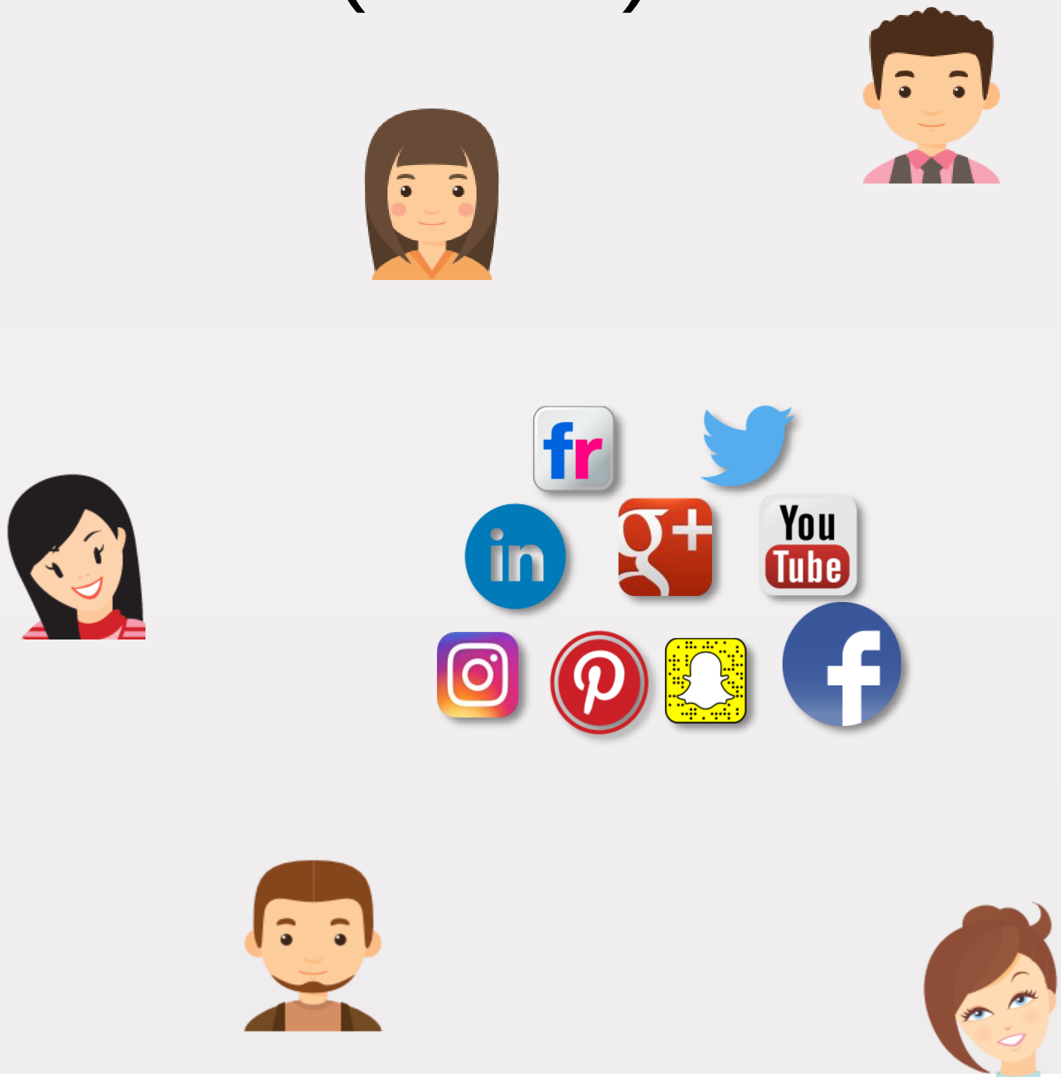

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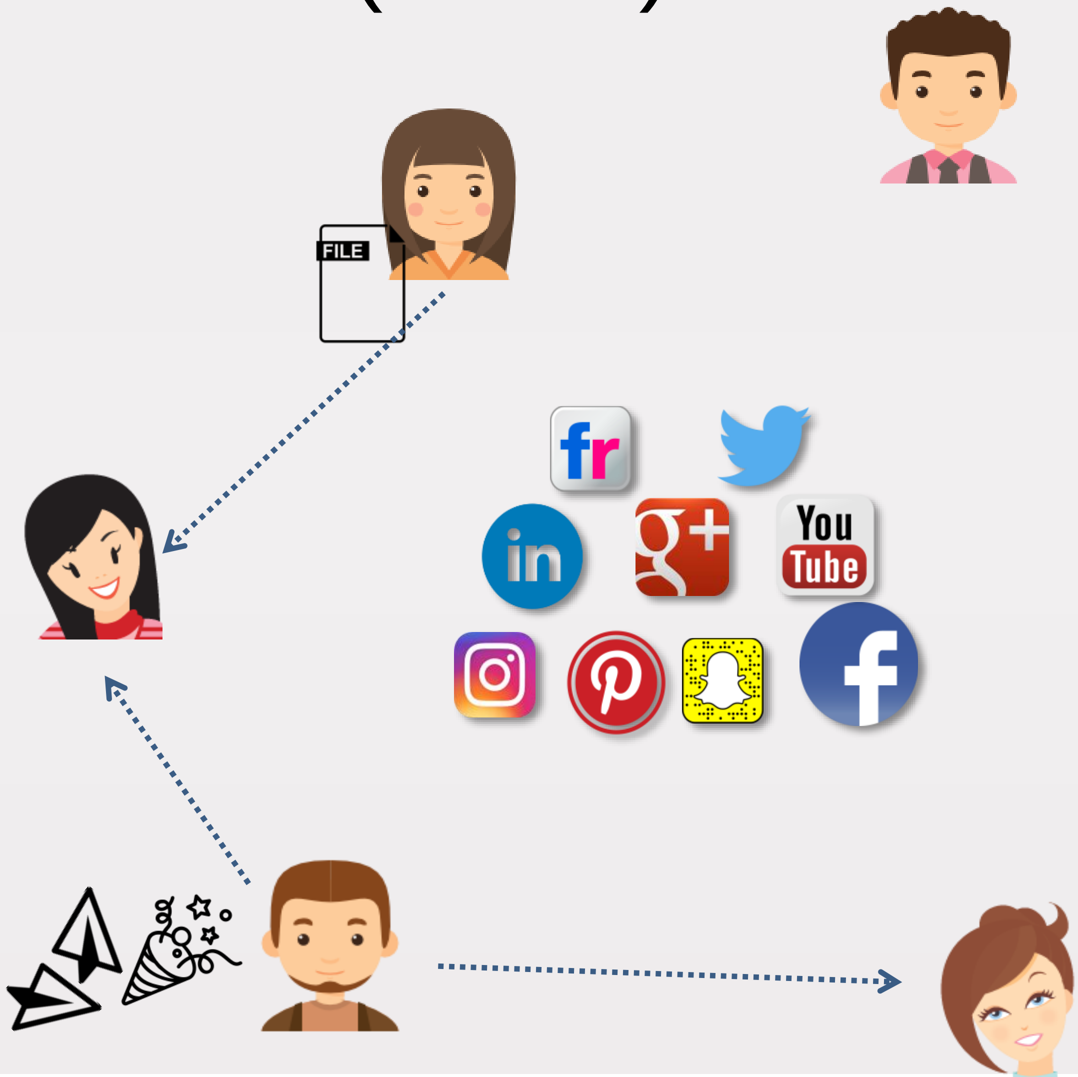

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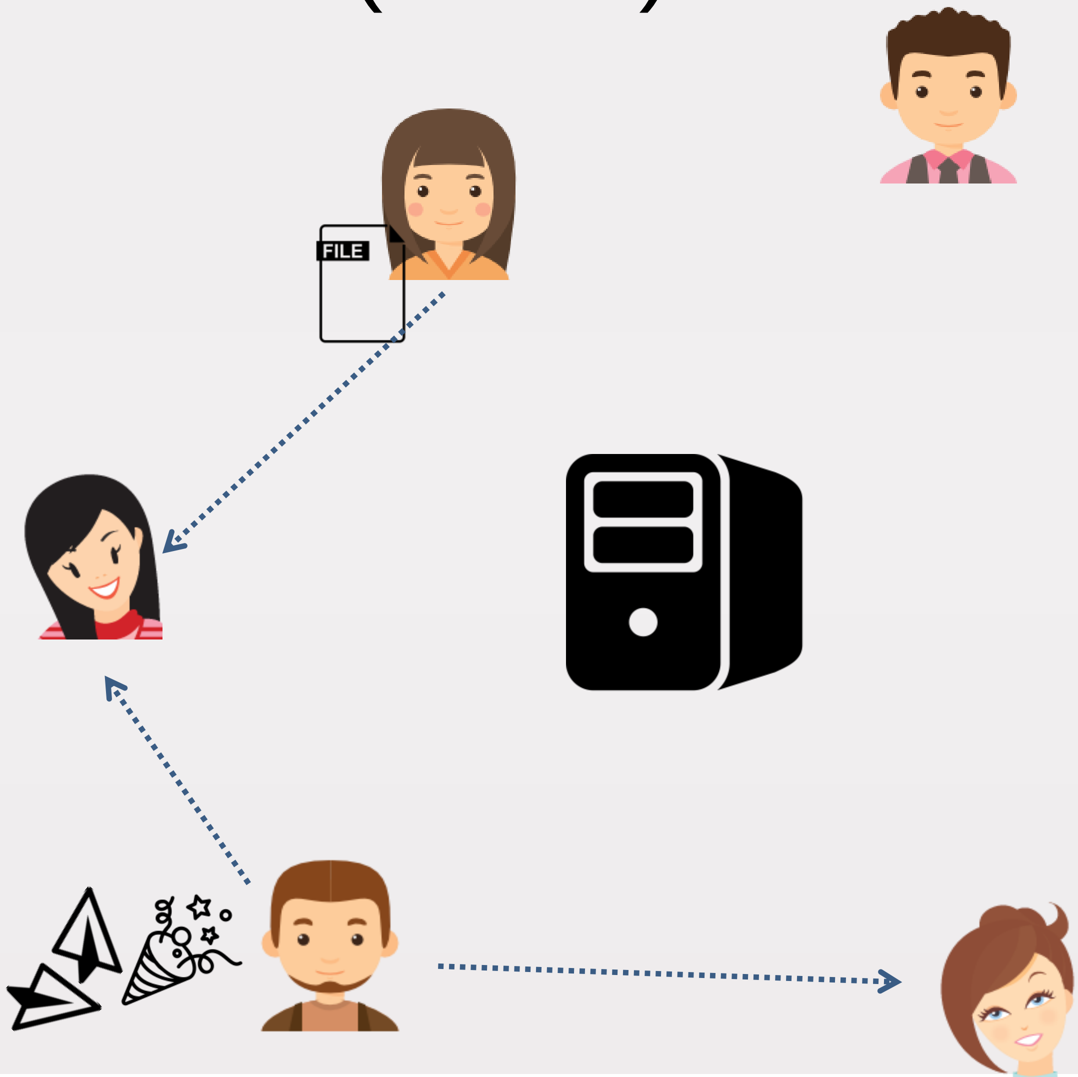

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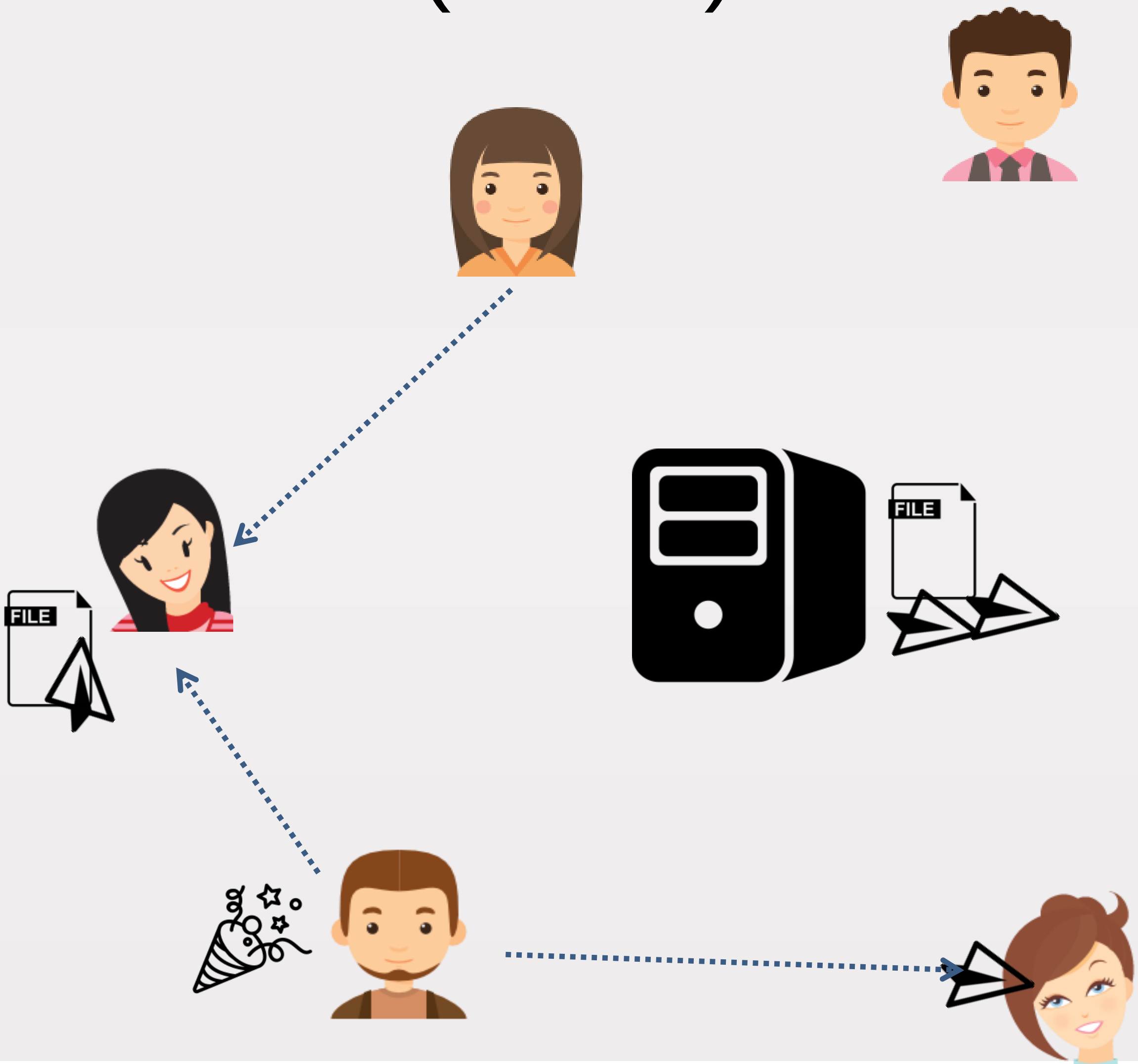

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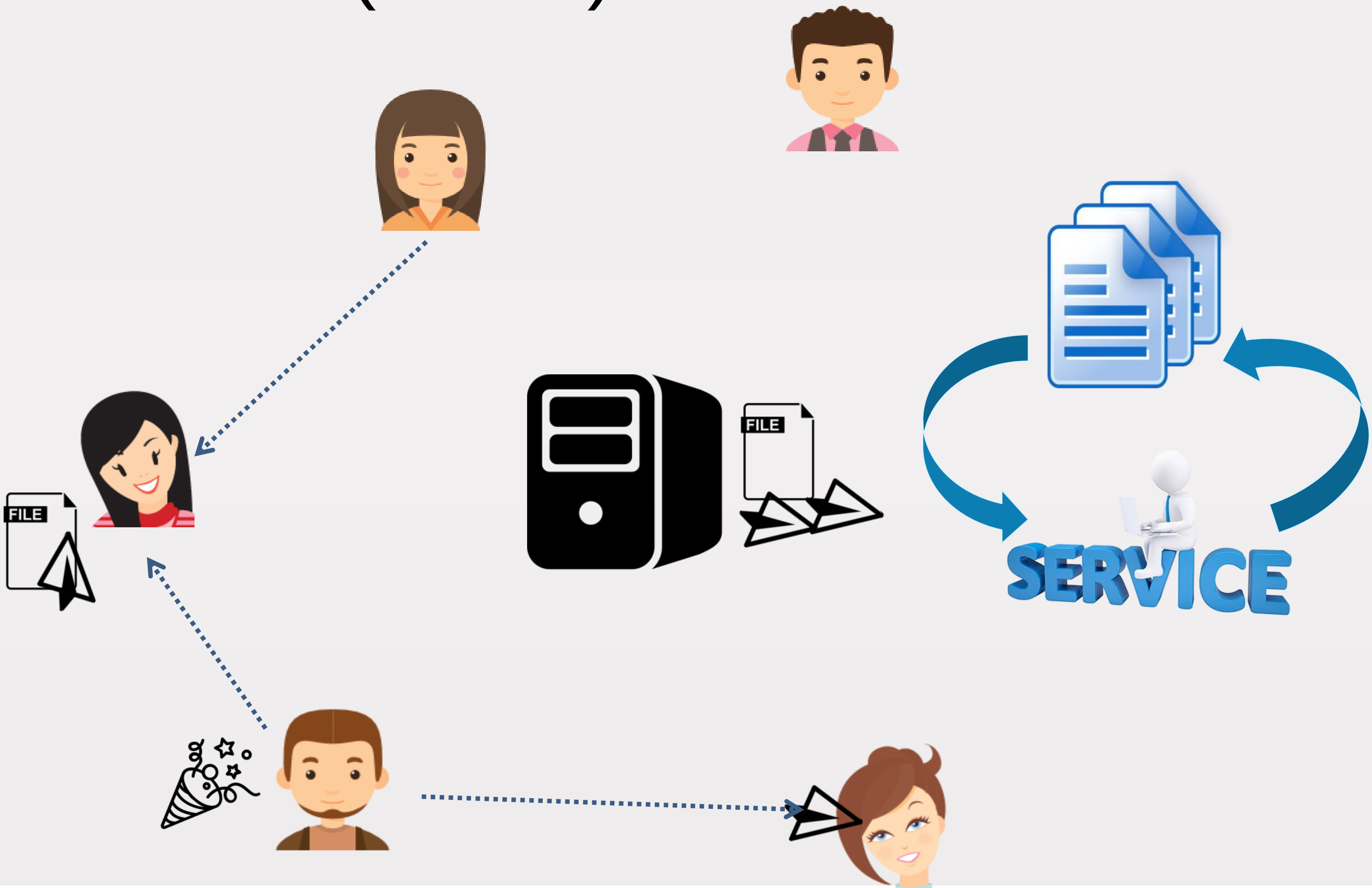

Data Repurposing: we have no idea about how our data is being used!

- Providers analyze what people share for public, yet they also scan private messages.
- Providers collect personal tastes and navigation from third party applications.
- AI can guess whether a person is gay or straight using profile picture.
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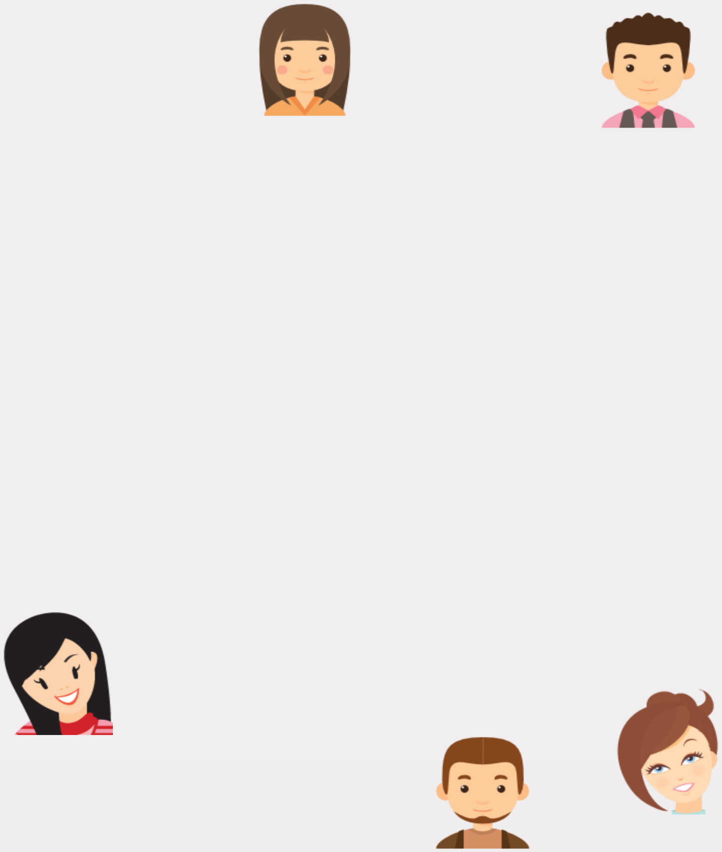
Decentralized OSNs – (DOSNs)

- Users have control over privacy, ownership, and dissemination of their data.



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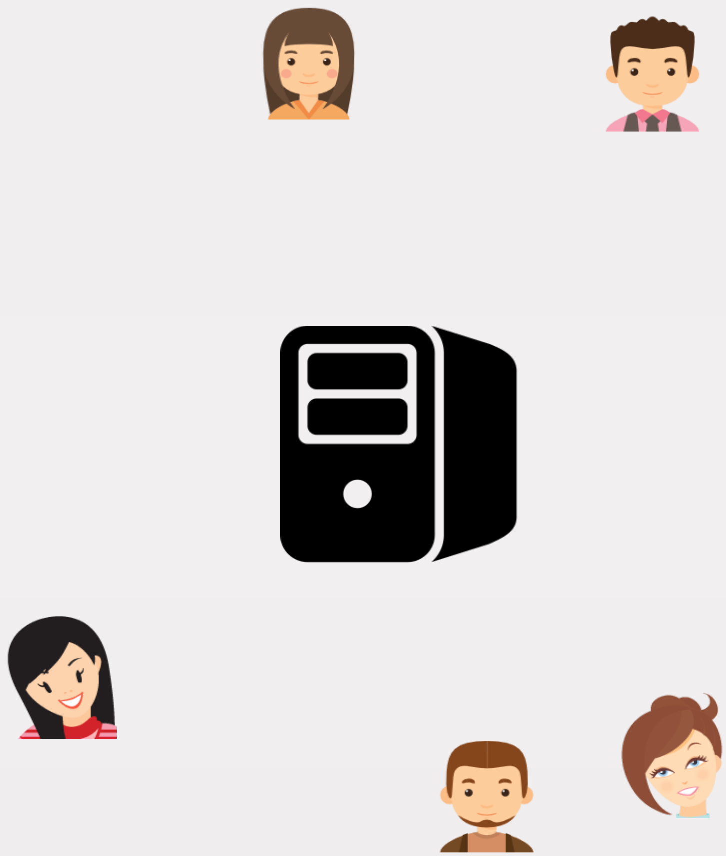

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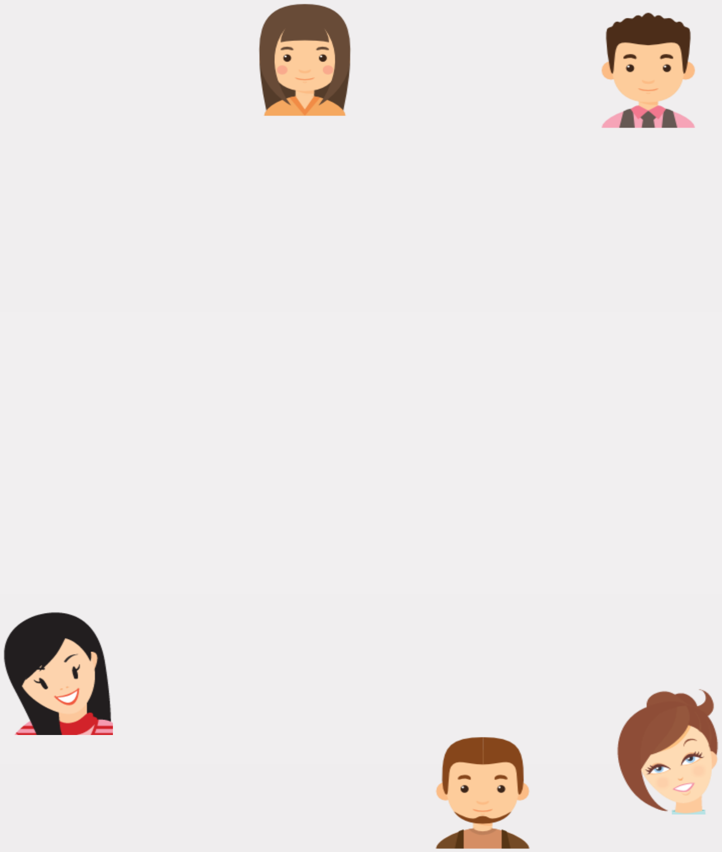

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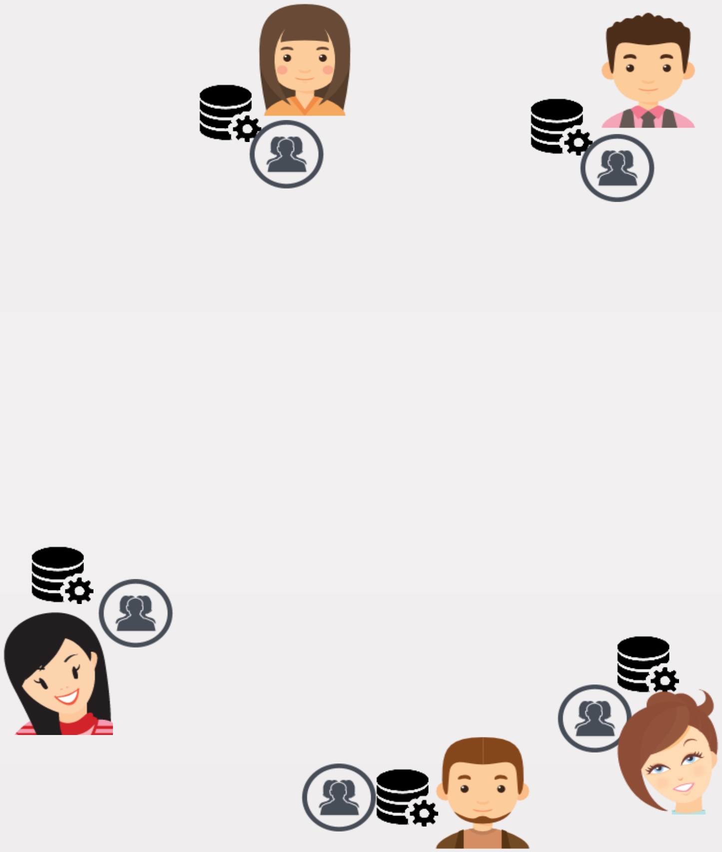

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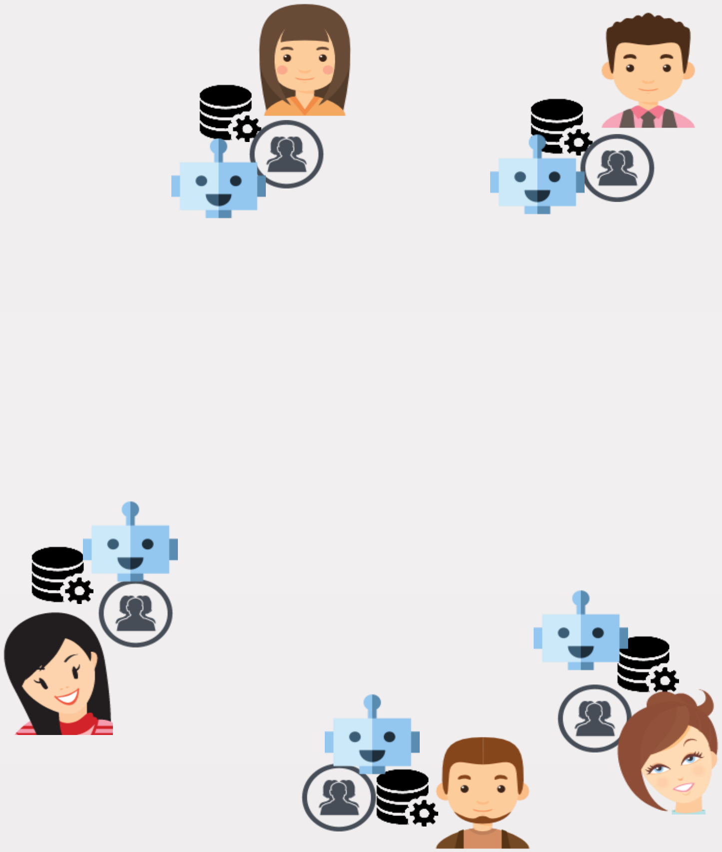

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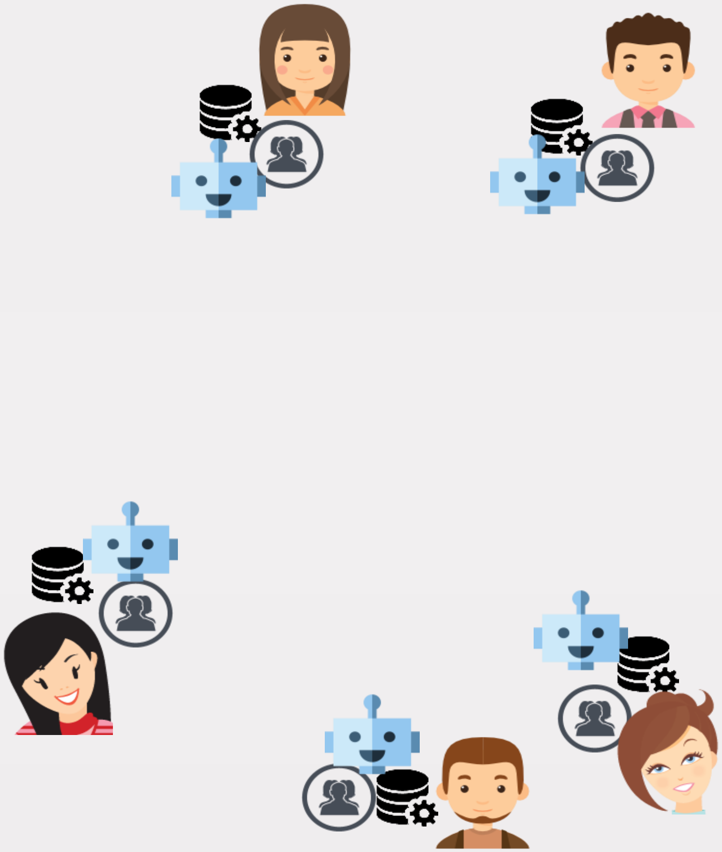

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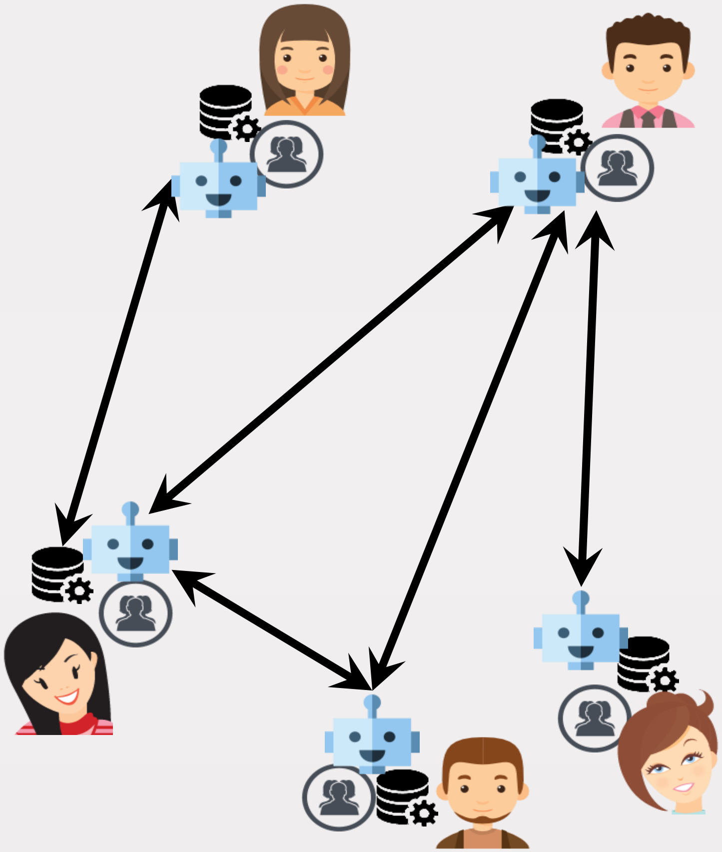

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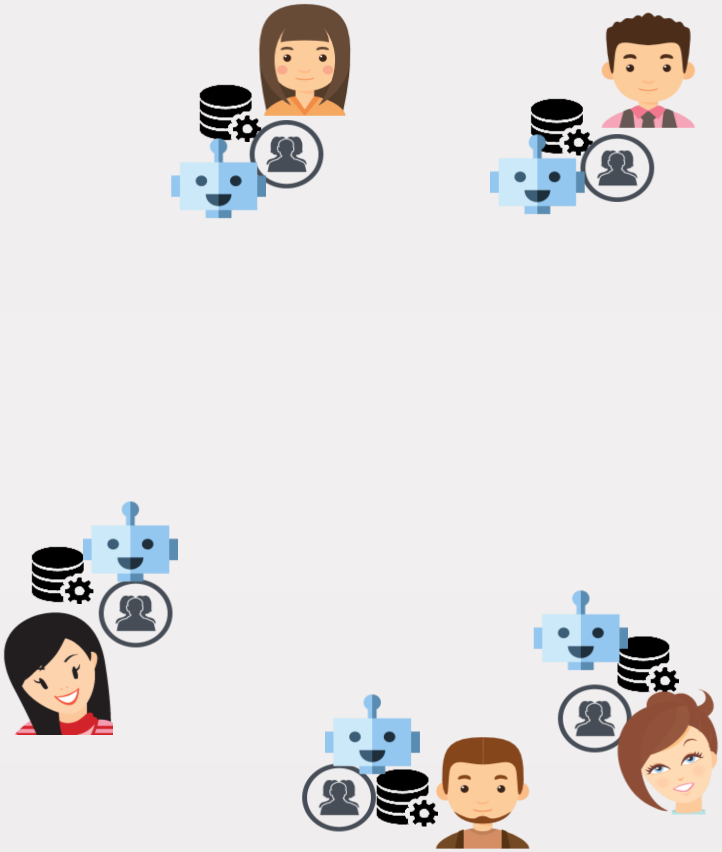

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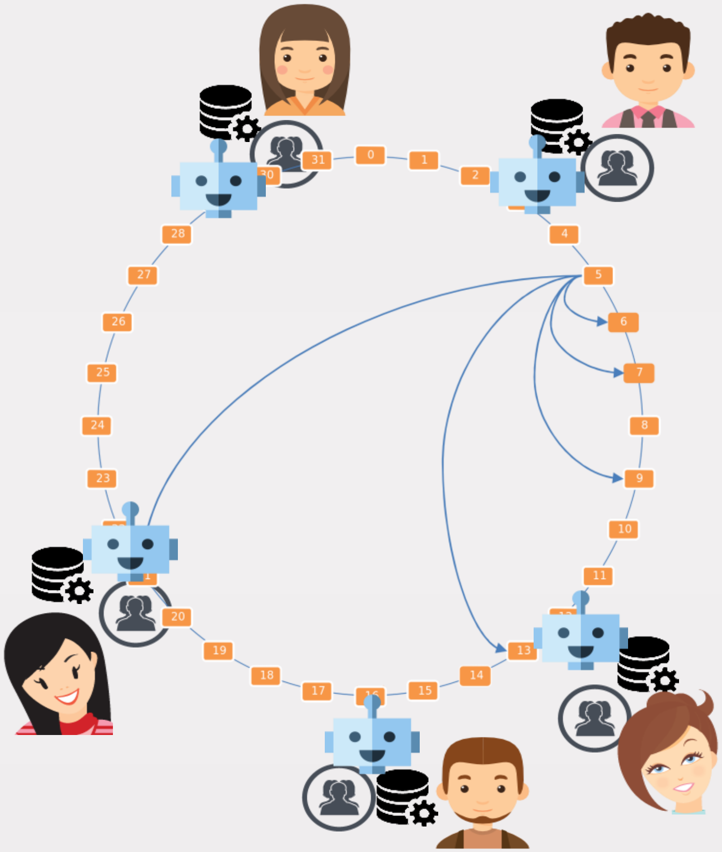

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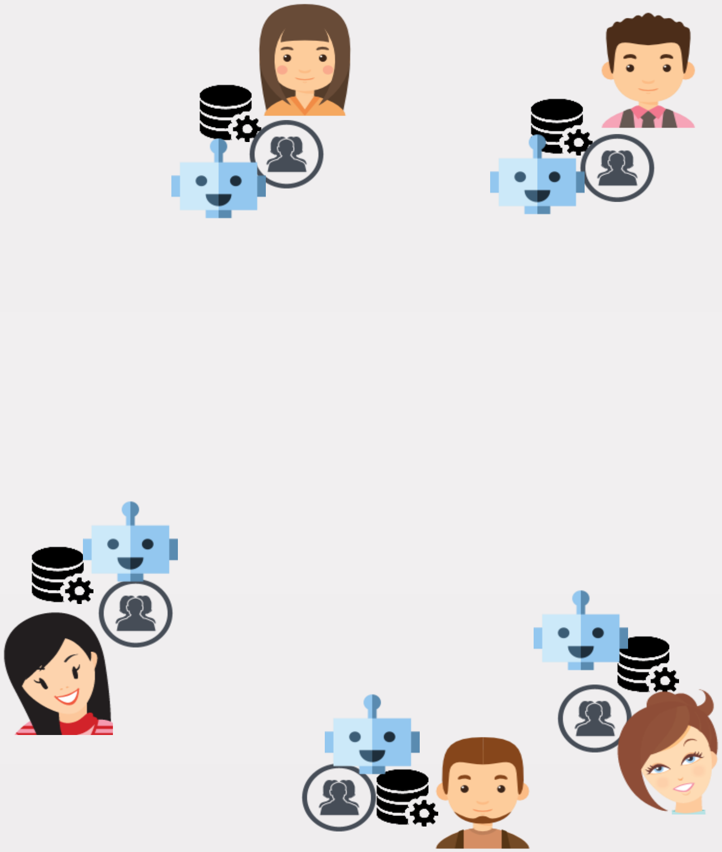

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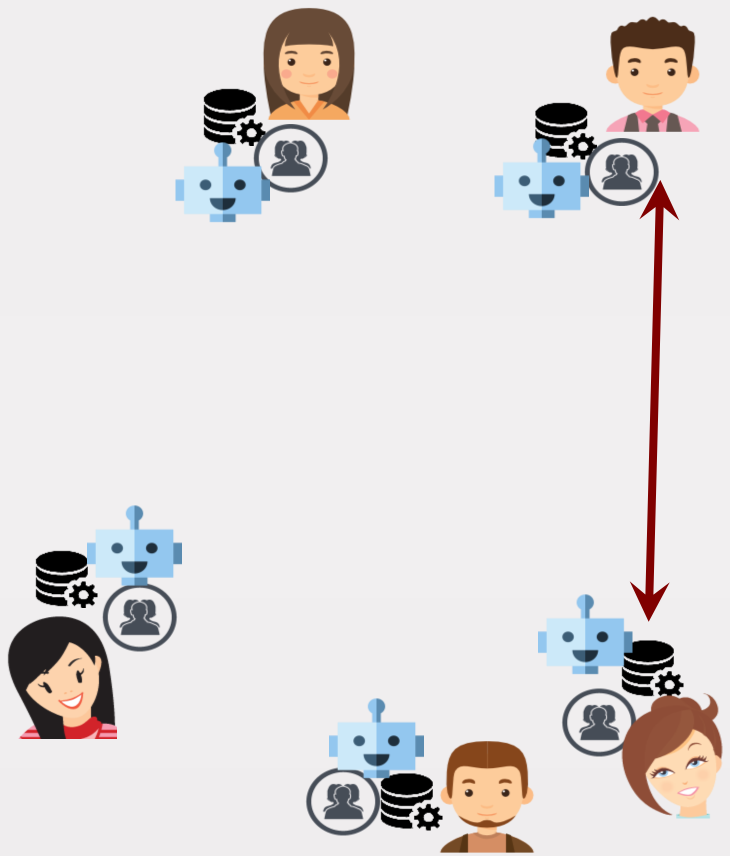

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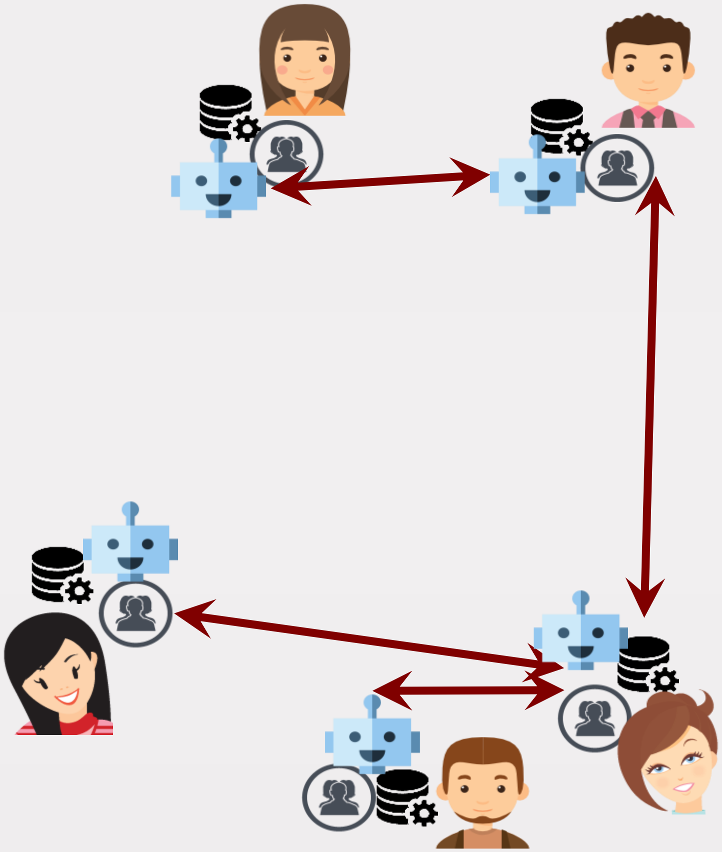

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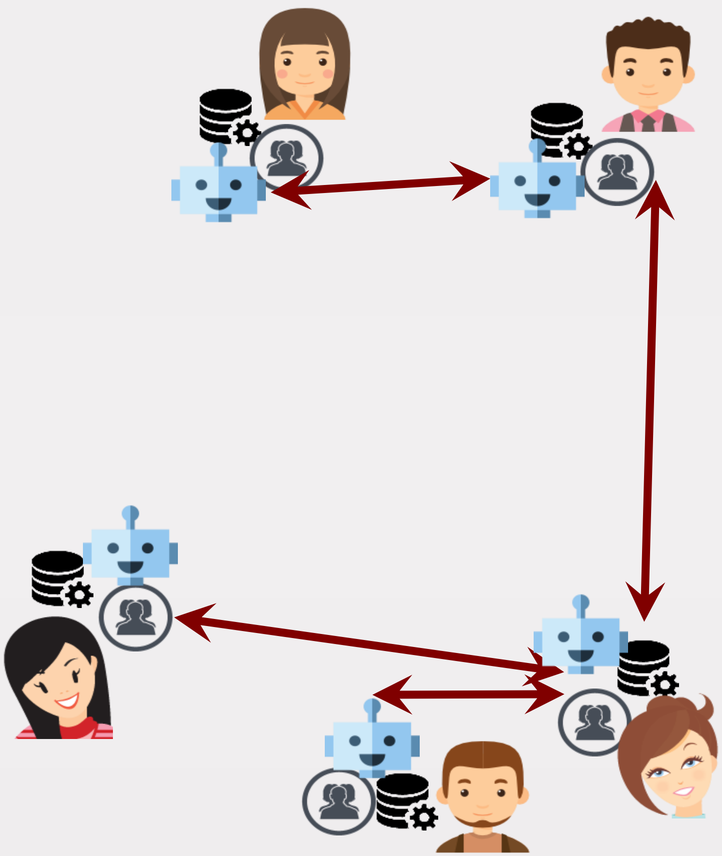

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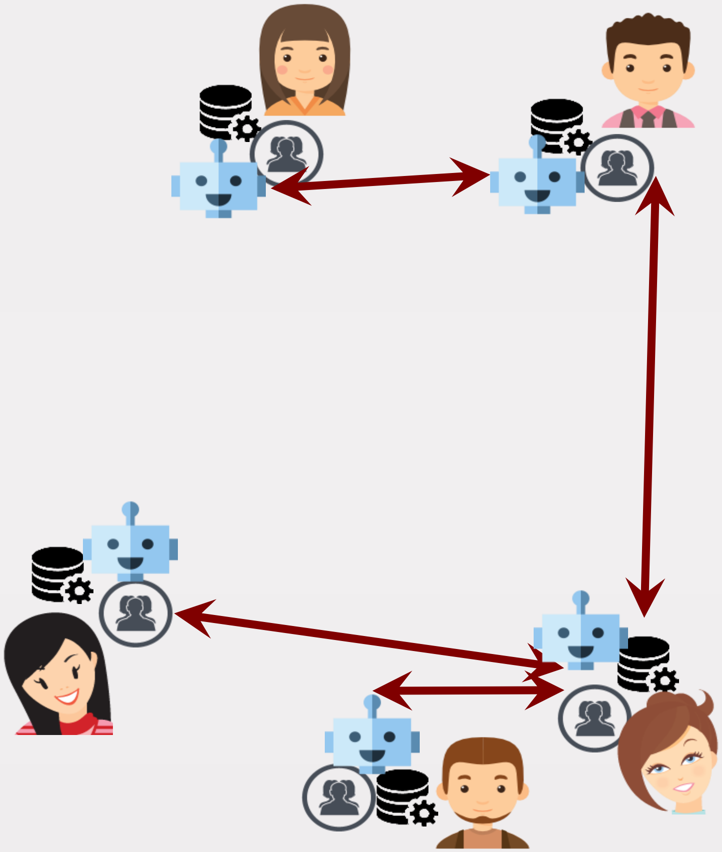
- E.g., Diaspora active user rate:
  - During 2014: 1M.
  - By end of 2015 till now: 660K.



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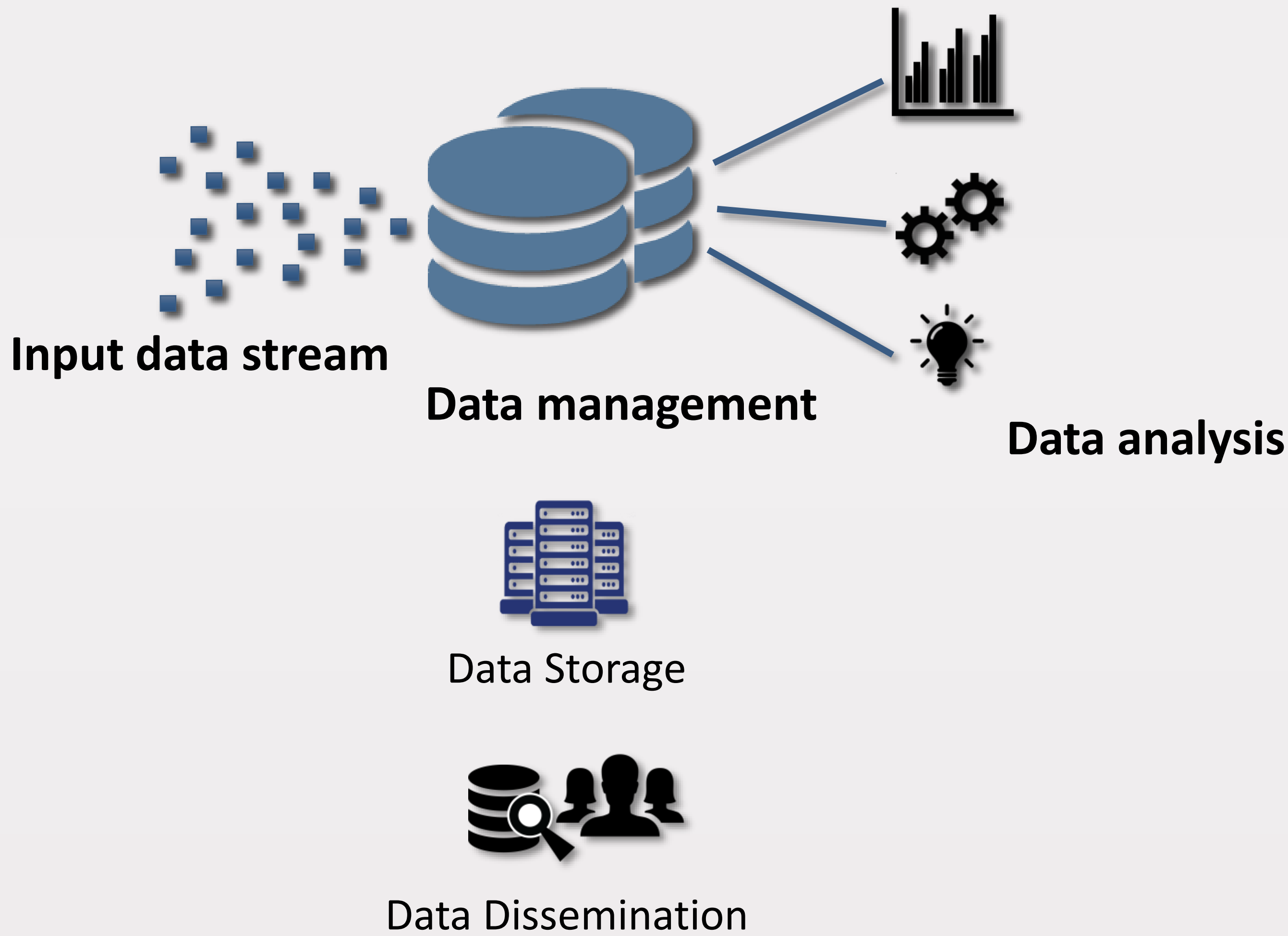

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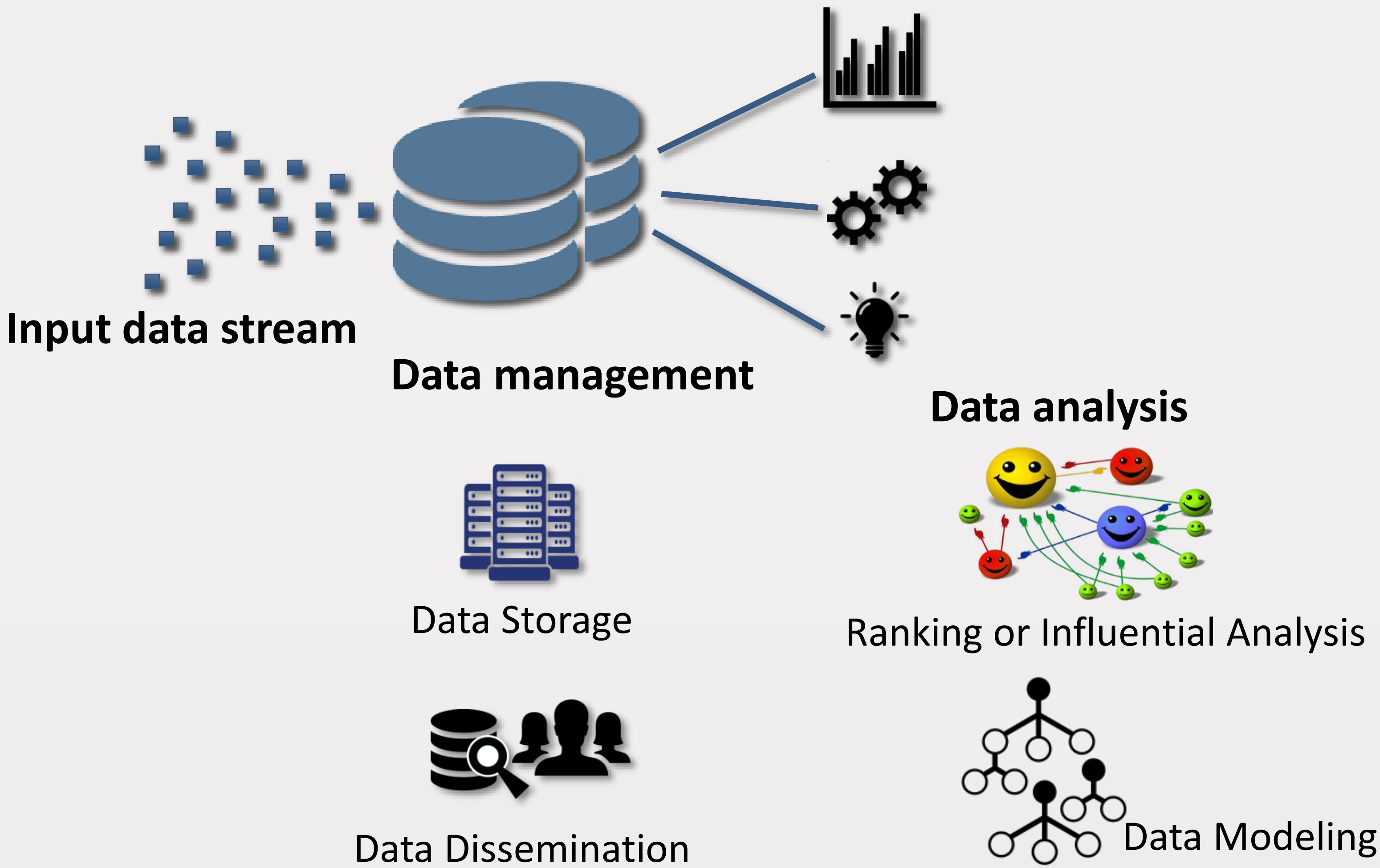

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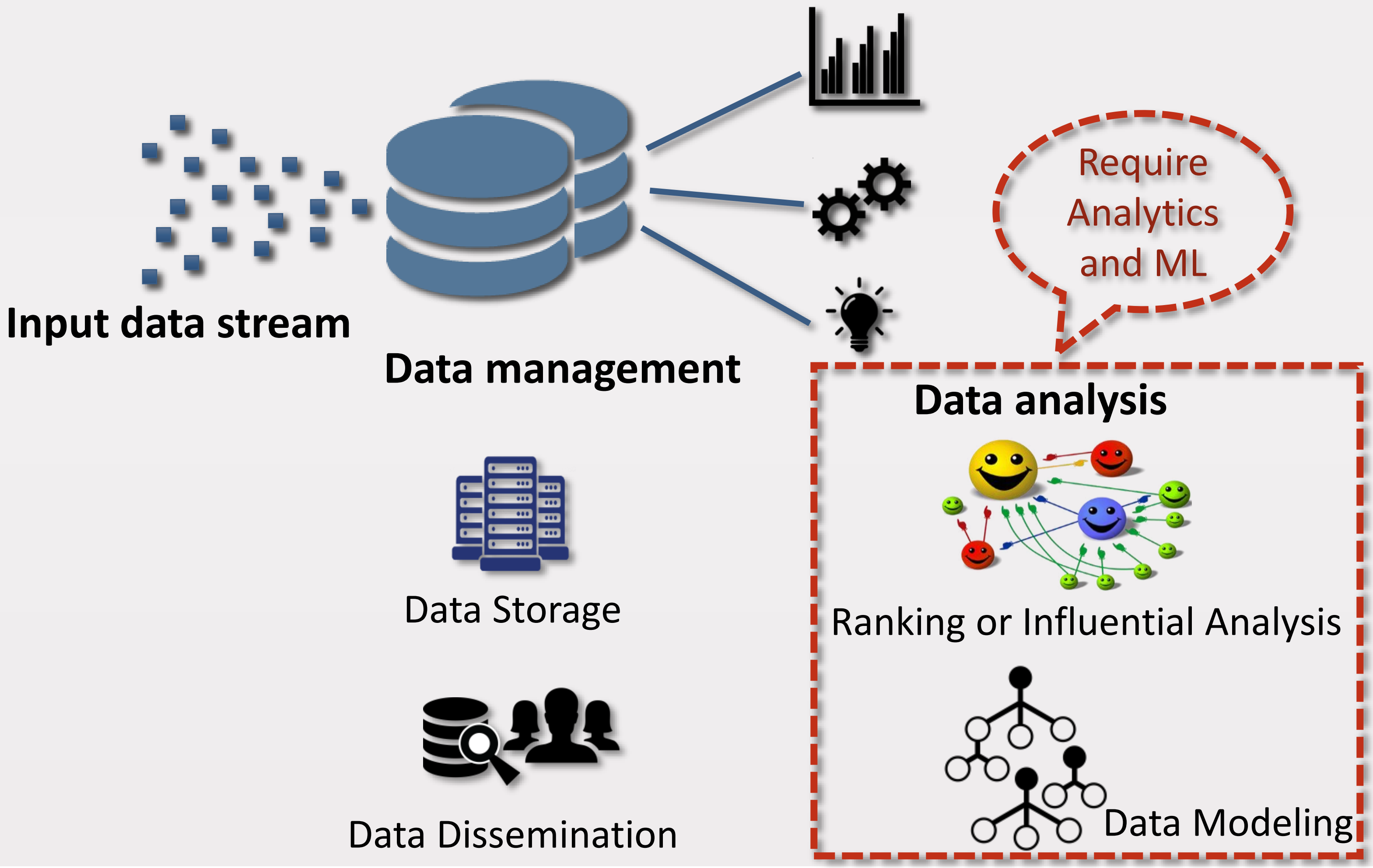
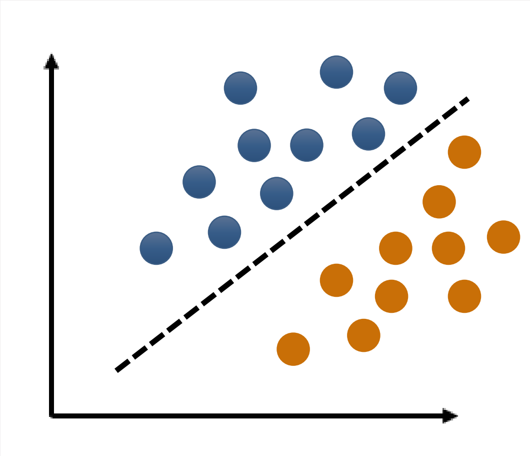


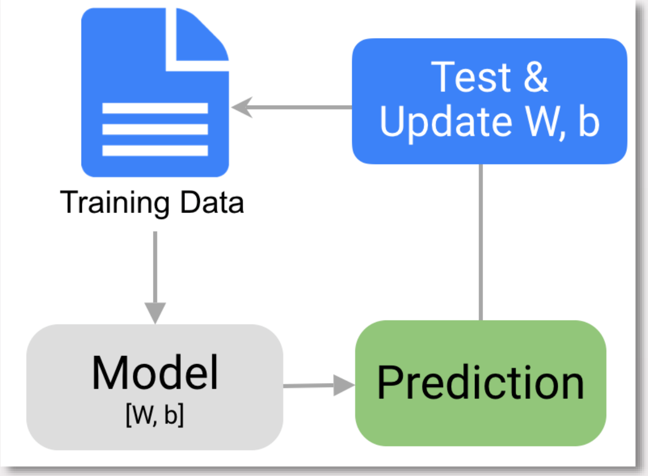
Machine Learning (ML) and DOSNs

- ML applications are iterative.



$$y = W * x + b$$

OUTPUT SLOPE INPUT Y-INTERCEPT



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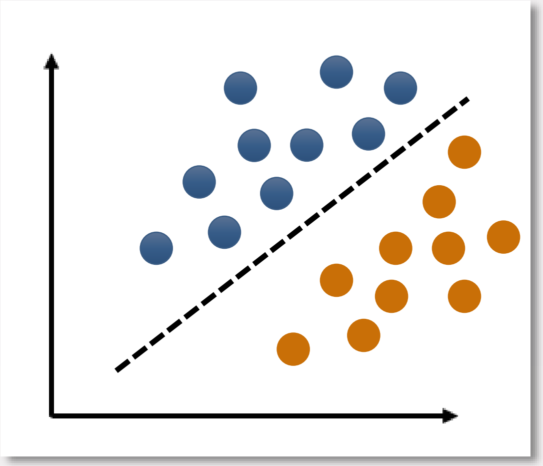

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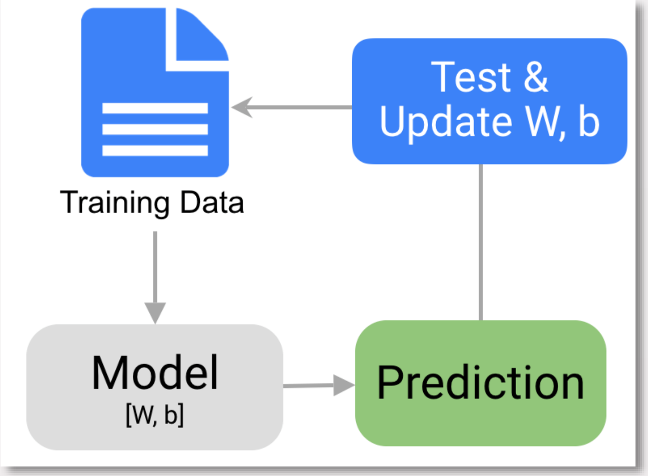

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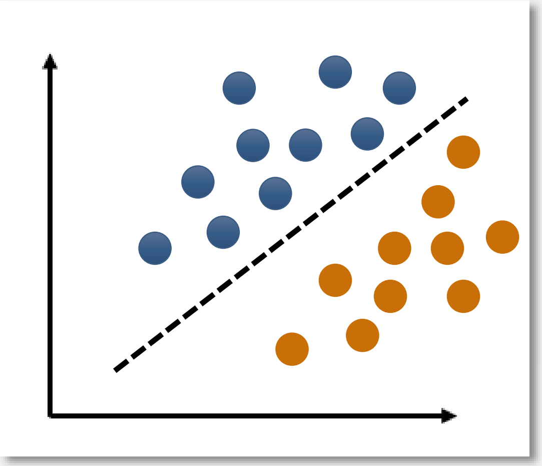

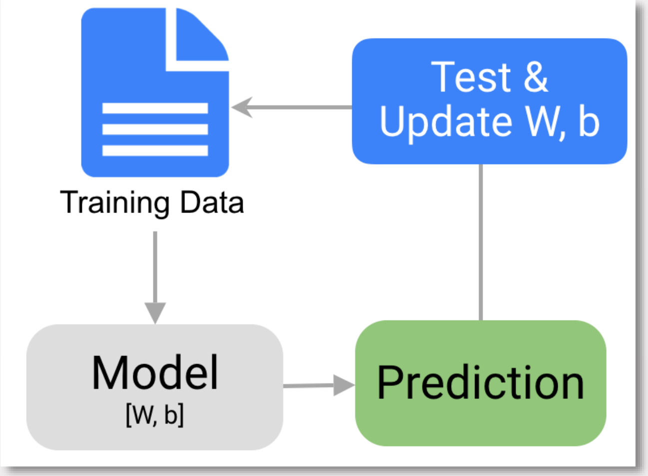

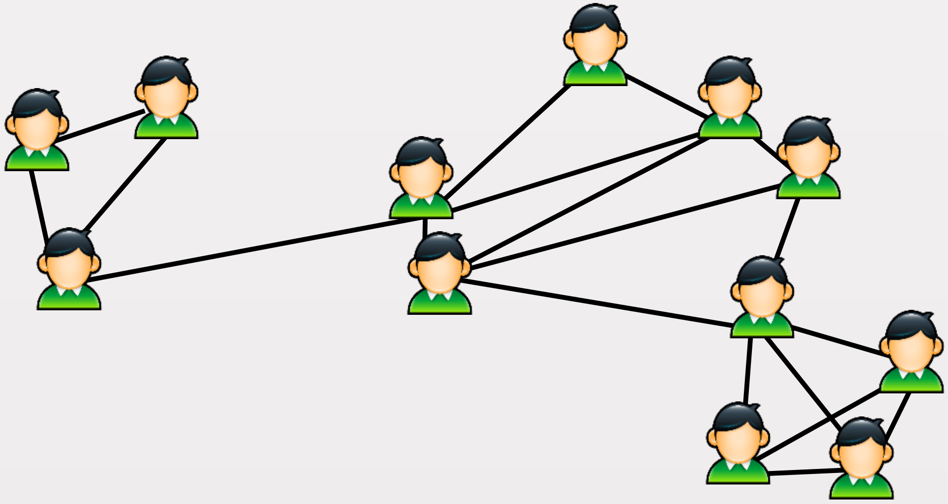

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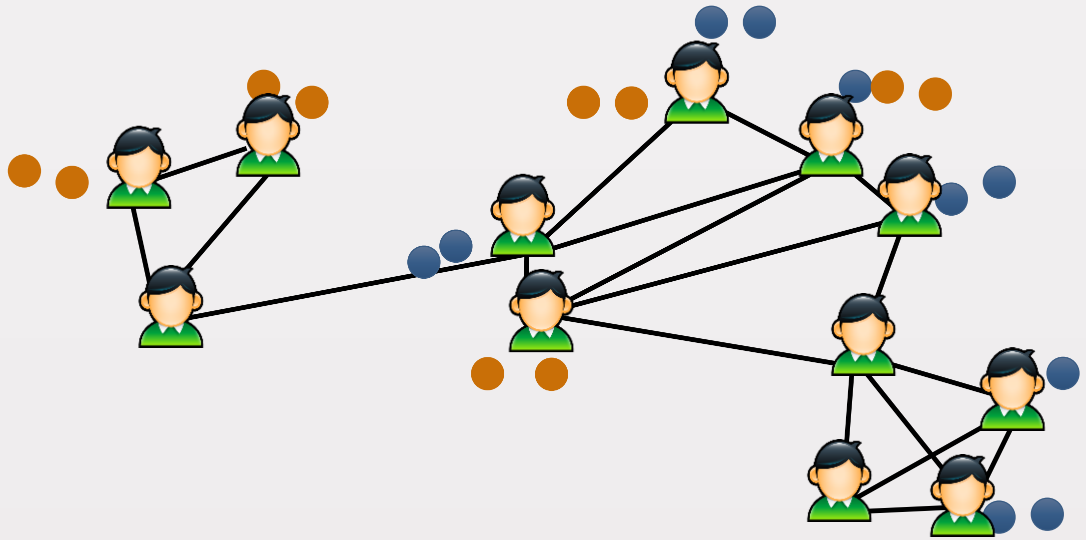

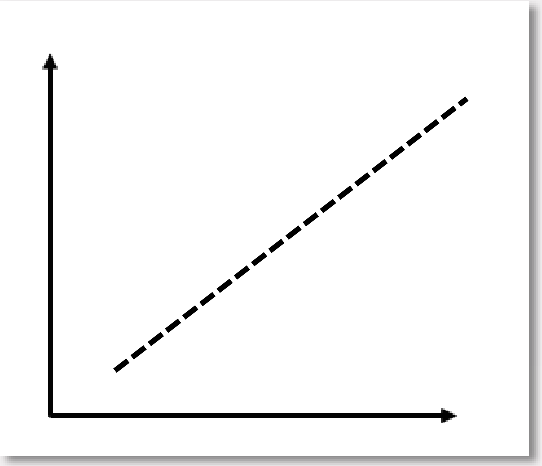

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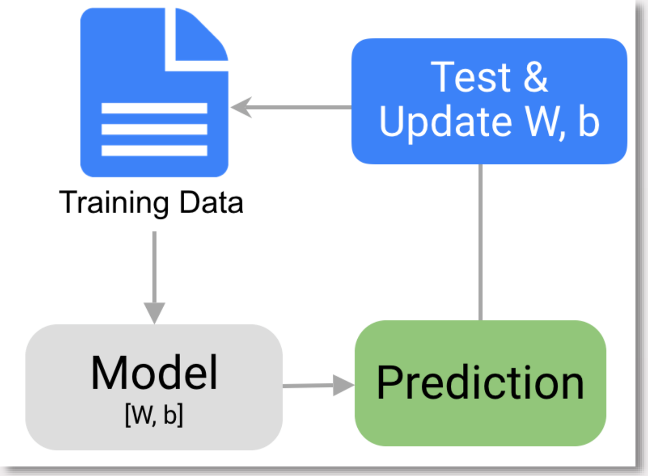

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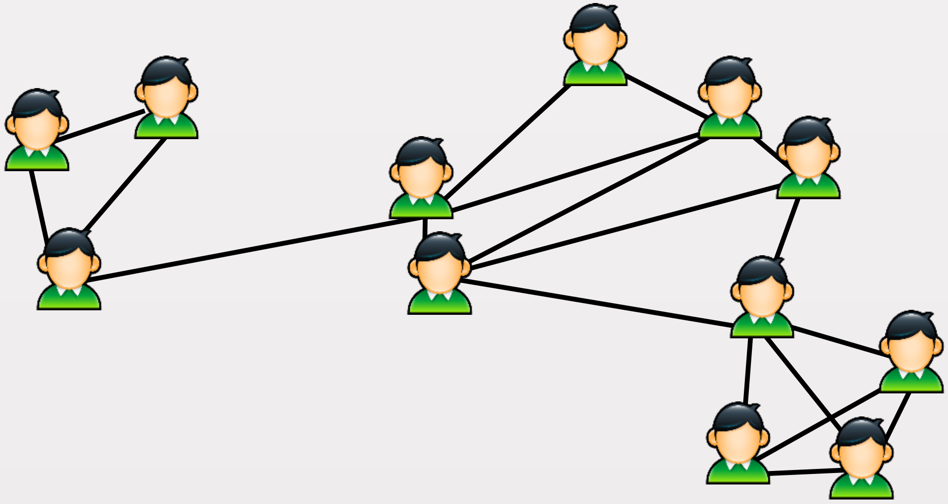

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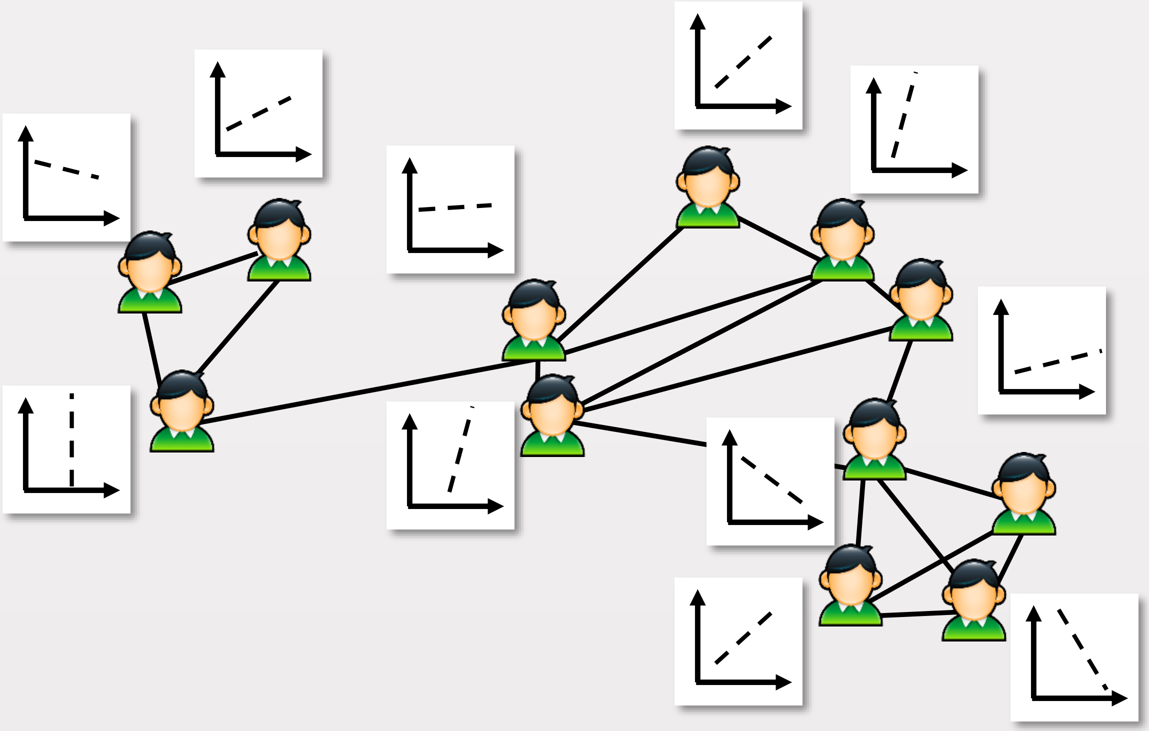

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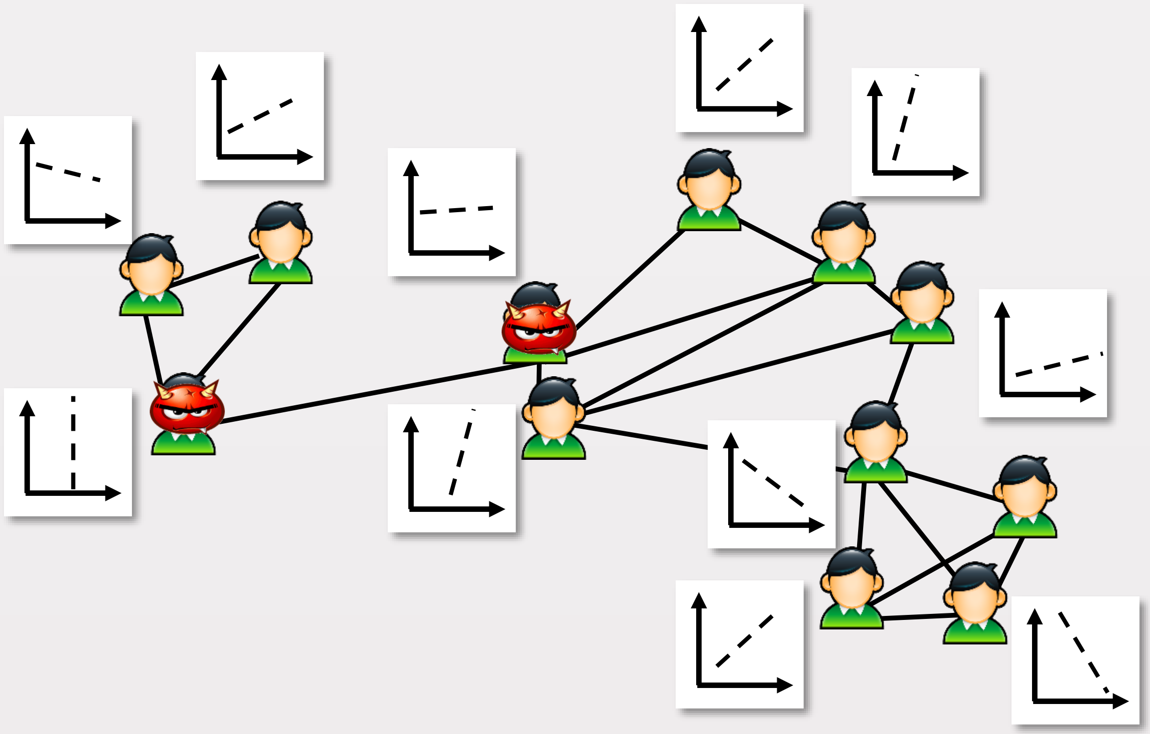

Machine Learning (ML) and DOSNs

- ML applications are iterative.
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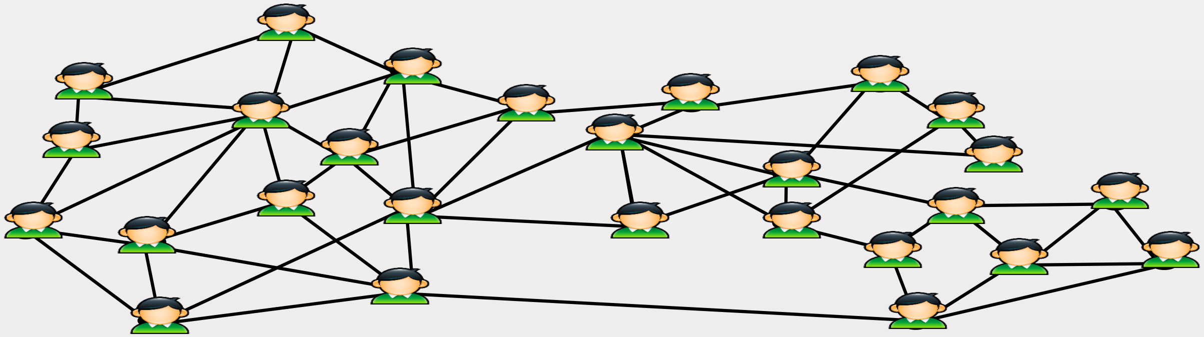
  - Data is fully distributed.
  - Data movement is constrained.
  - Communication is limited.
  - Deviation from workflow protocol is possible.

Community-aware Learning

- Homophily: from ancient Greek ὁμοῦ (homou, “together”) and Greek φιλία (philia, "friendship") is the tendency of individuals to associate and bond with similar others [Wikipedia].
- Integrating community structure with analytic tasks enhances data analytic insights and improves results (e.g., validating online identities and spam detection).



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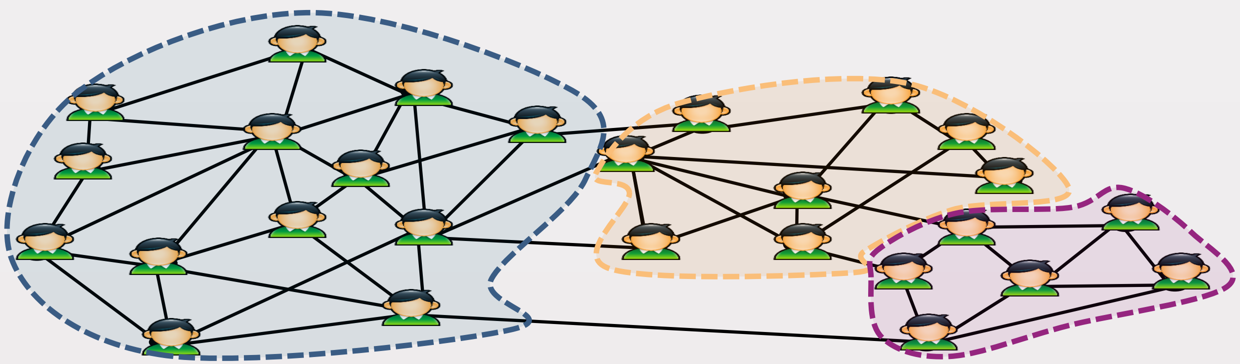

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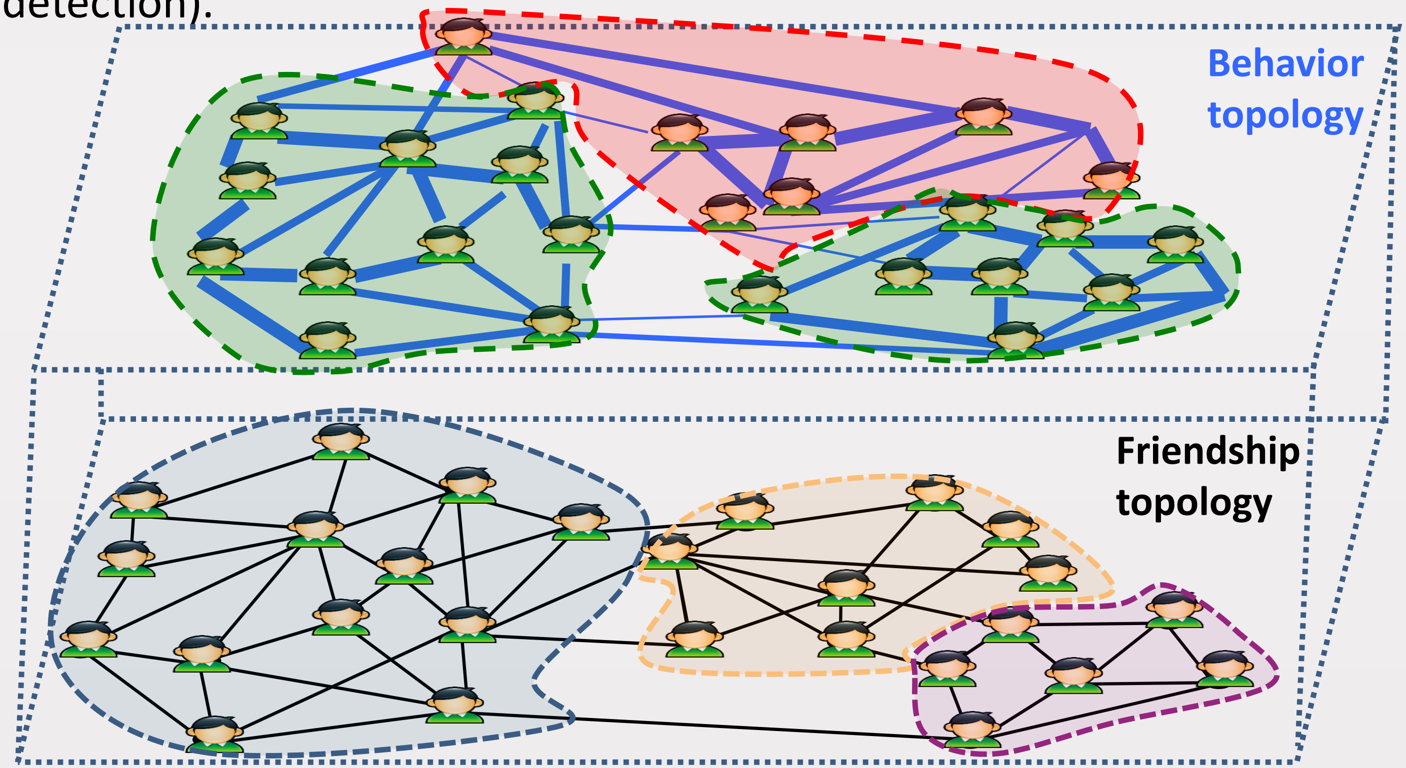
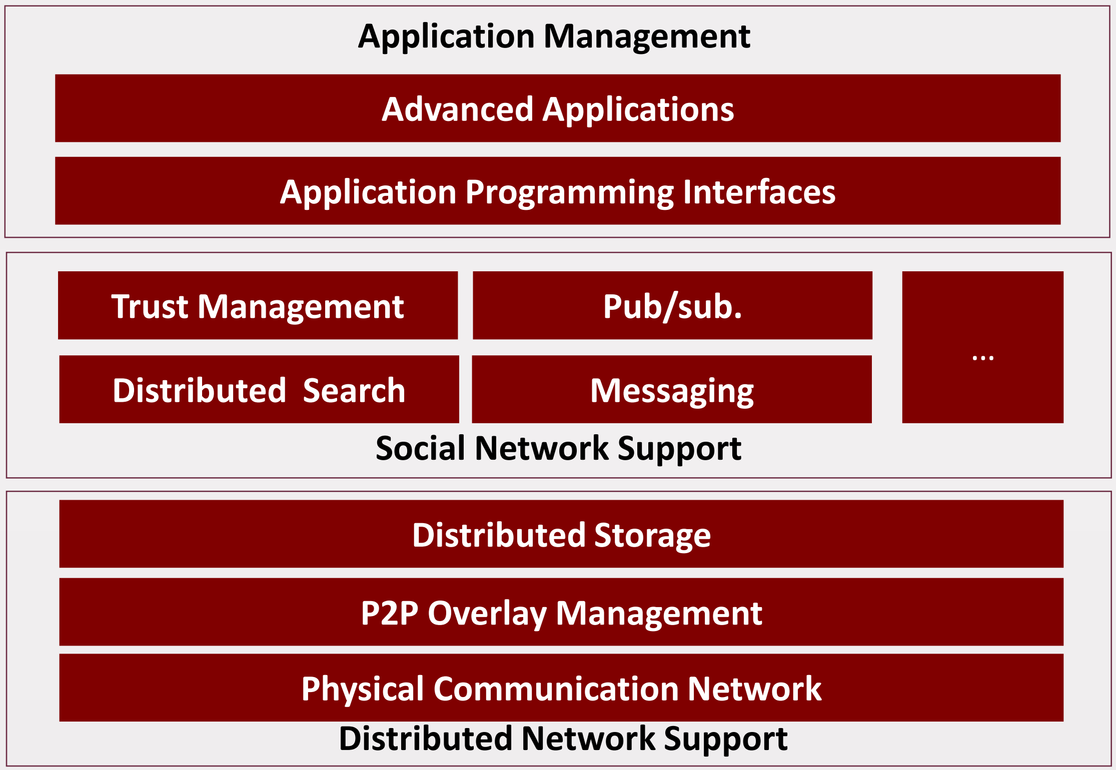


Main Objectives

DOSN requires graph-based algorithms and methods that allow generation of efficient ML models using user local data in fully decentralized, iterative, massively parallel, and highly scalable manner, thereby ***enabling decentralized ML and analytic tasks on DOSNs, without violating privacy preservation constraints***.

The Stack of Services



A. Datta, S. Buchegger, L.-H. Vu, T. Strufe, and K. Rzadca, "Decentralized online social networks," in Handbook of Social Network Technologies and Applications . Springer, 2010, pp. 349–378.

The Stack of Services

Application Management

- Advanced Applications
- Application Programming Interfaces

*** Graph-based Analytics**

- Incremental Analysis
- F2F Analysis
- Community Analysis
- Navigation
- Validation Overlay
- Decentralized Learning

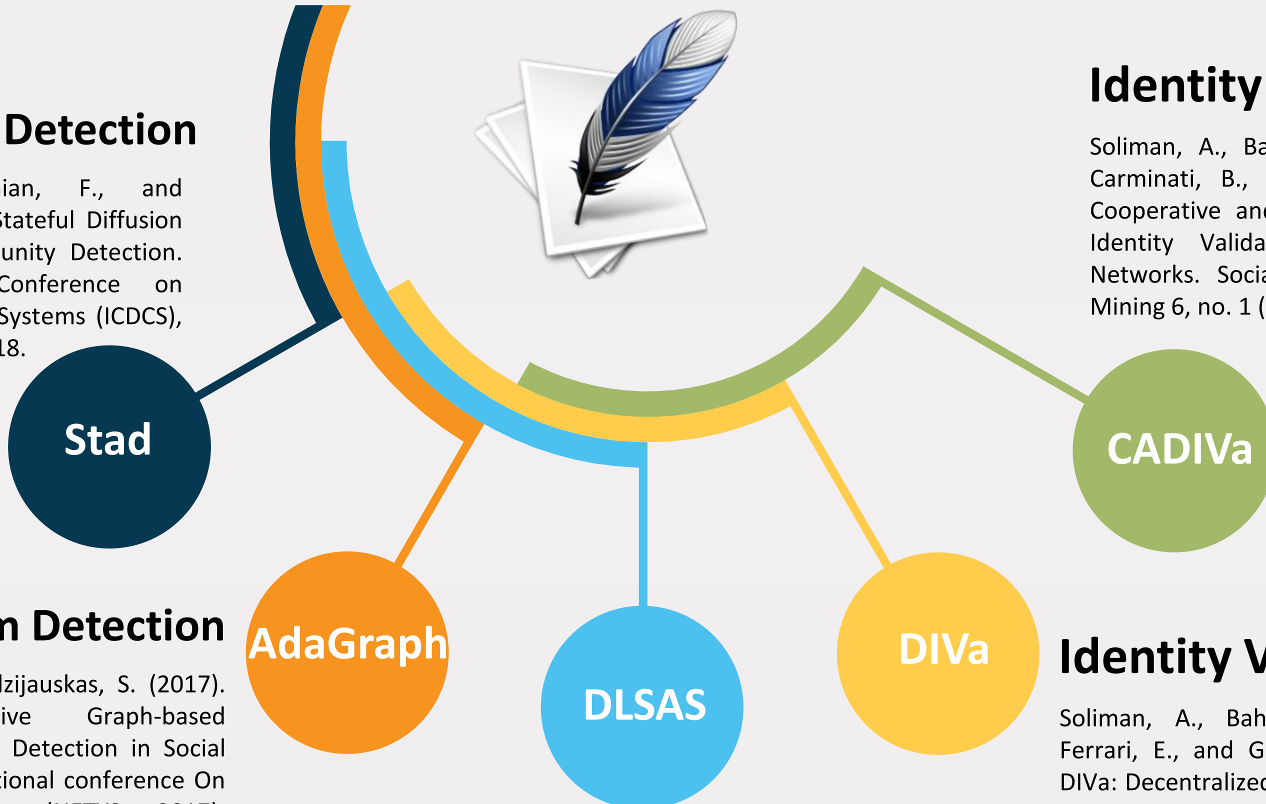
- Trust Management
- Pub/sub.
- Distributed Search
- Messaging
- …

Social Network Support

- Distributed Storage
- P2P Overlay Management
- Physical Communication Network

Distributed Network Support

Our Contributions



Community Detection

Soliman, A., Rahimian, F., and Girdzijauskas, S. Stad: Stateful Diffusion for Linear Time Community Detection. 38th International Conference on Distributed Computing Systems (ICDCS), pp. 1074-1085. IEEE, 2018.

Identity Validation

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Spam Detection

Soliman, A. and Girdzijauskas, S. (2017). AdaGraph: Adaptive Graph-based Algorithms for Spam Detection in Social Networks. In International conference On Networked Systems (NETYS 2017), Springer, pages 338-354.

Validation Mechanism

Soliman, A. and Girdzijauskas, S. (2016). DLSAS: Distributed Large-Scale Anti-Spam Framework for Decentralized Online Social Networks. Invited paper in the 2nd IEEE International Conference on Collaboration and Internet Computing, IEEE, pages 363-372.

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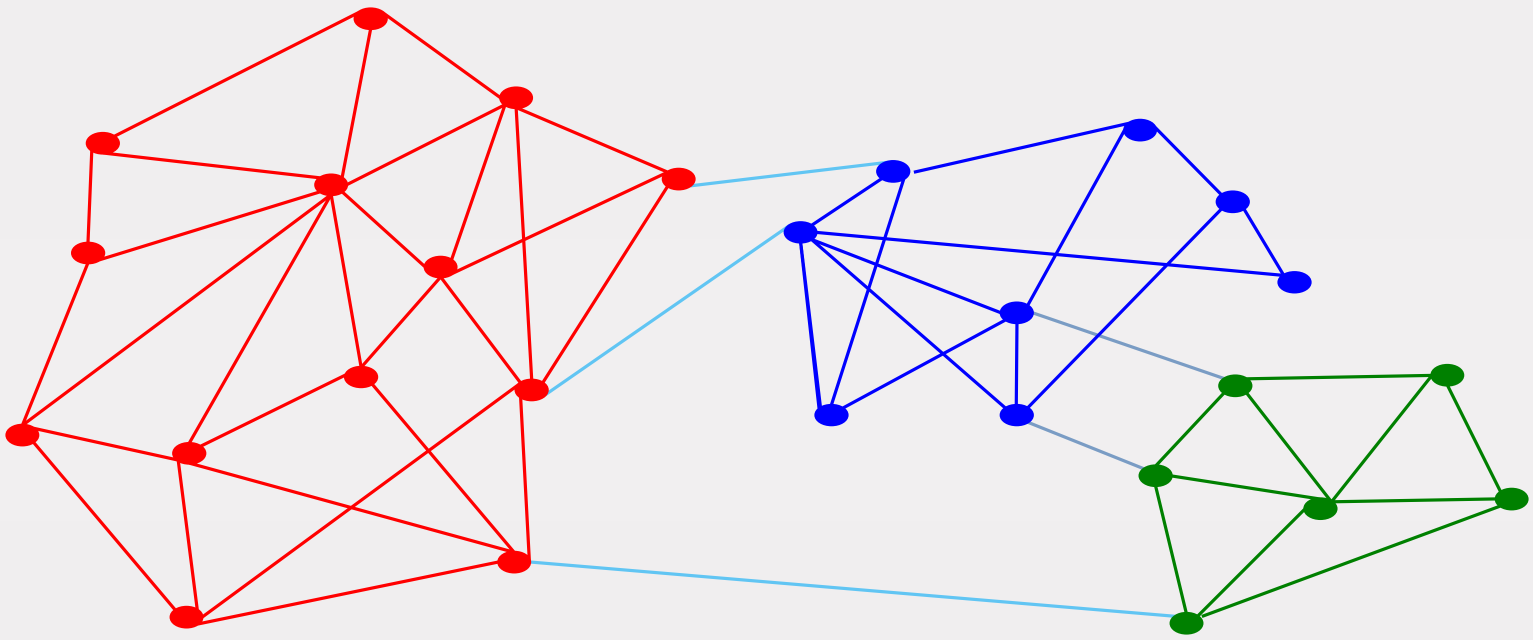
Stad: Performing Adaptive Diffusion for Community Detection



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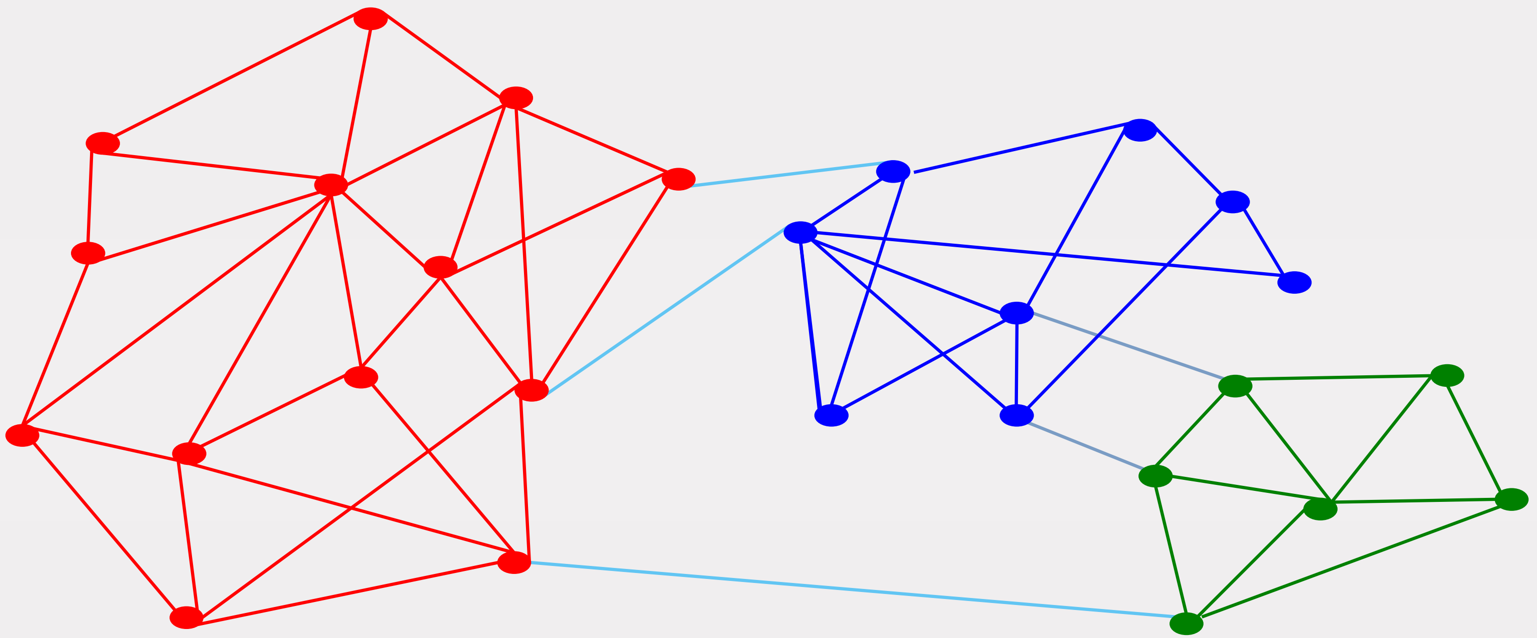
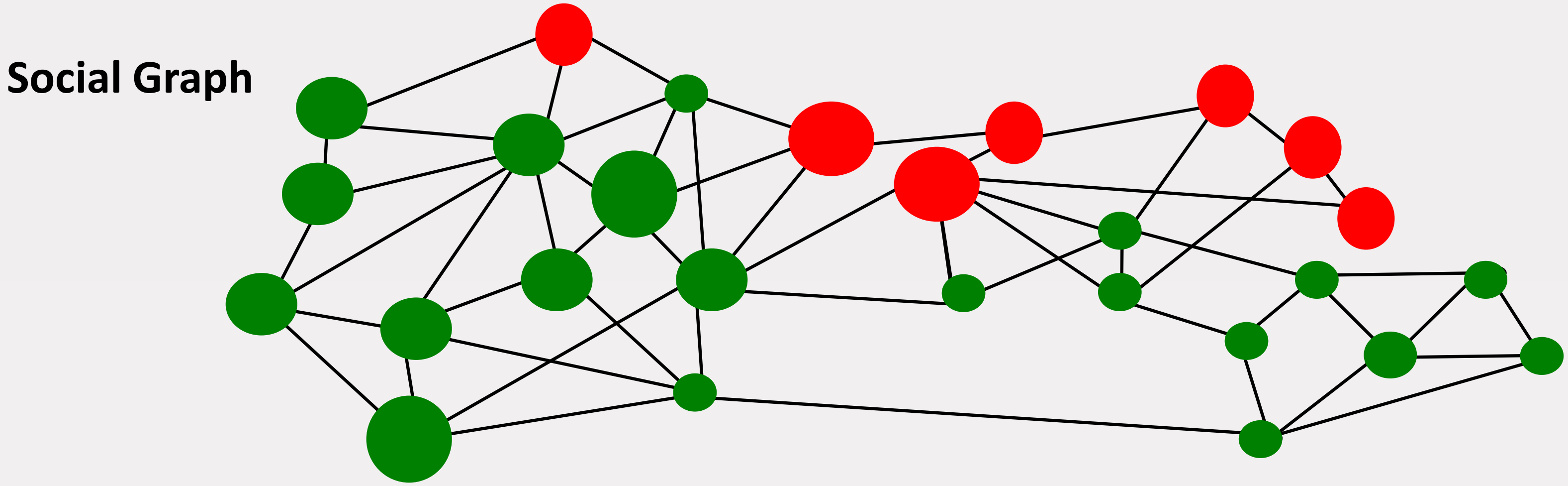


AdaGraph: Spam Detection using Graph Clustering



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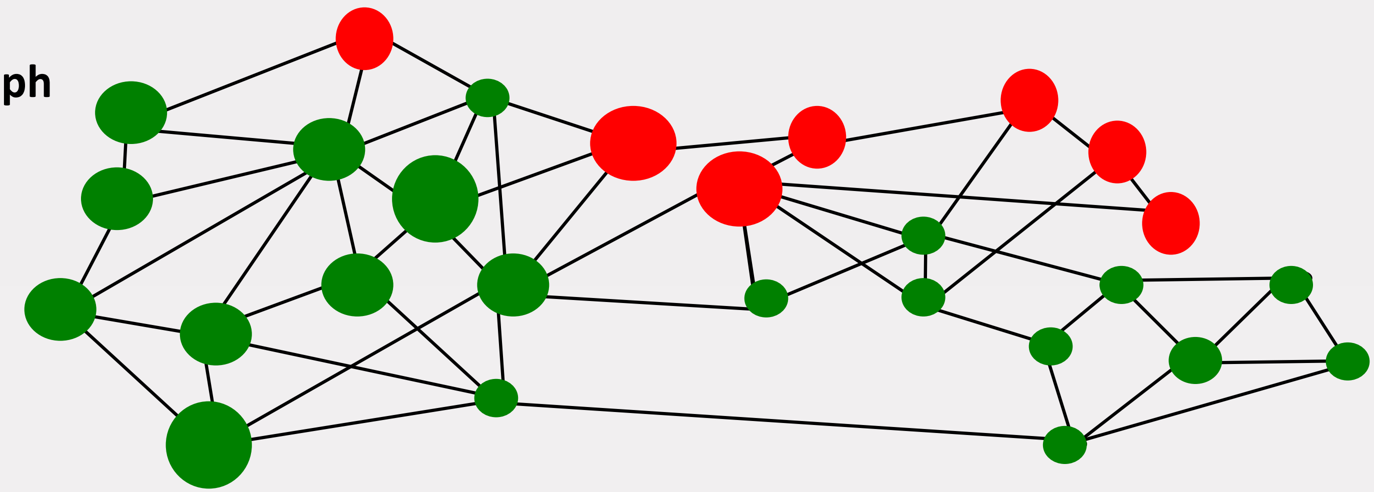
Social Graph



Similarity Graph

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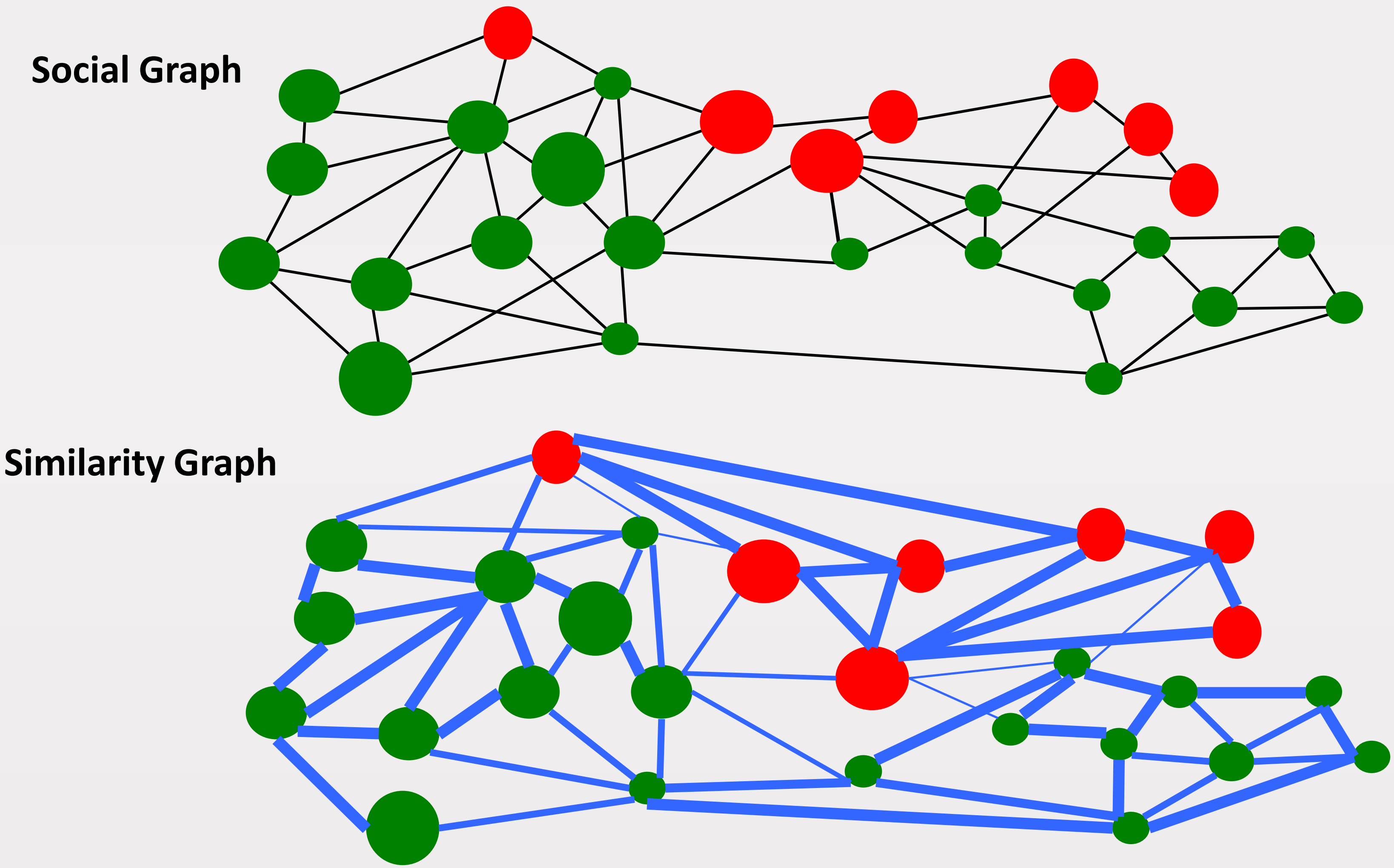

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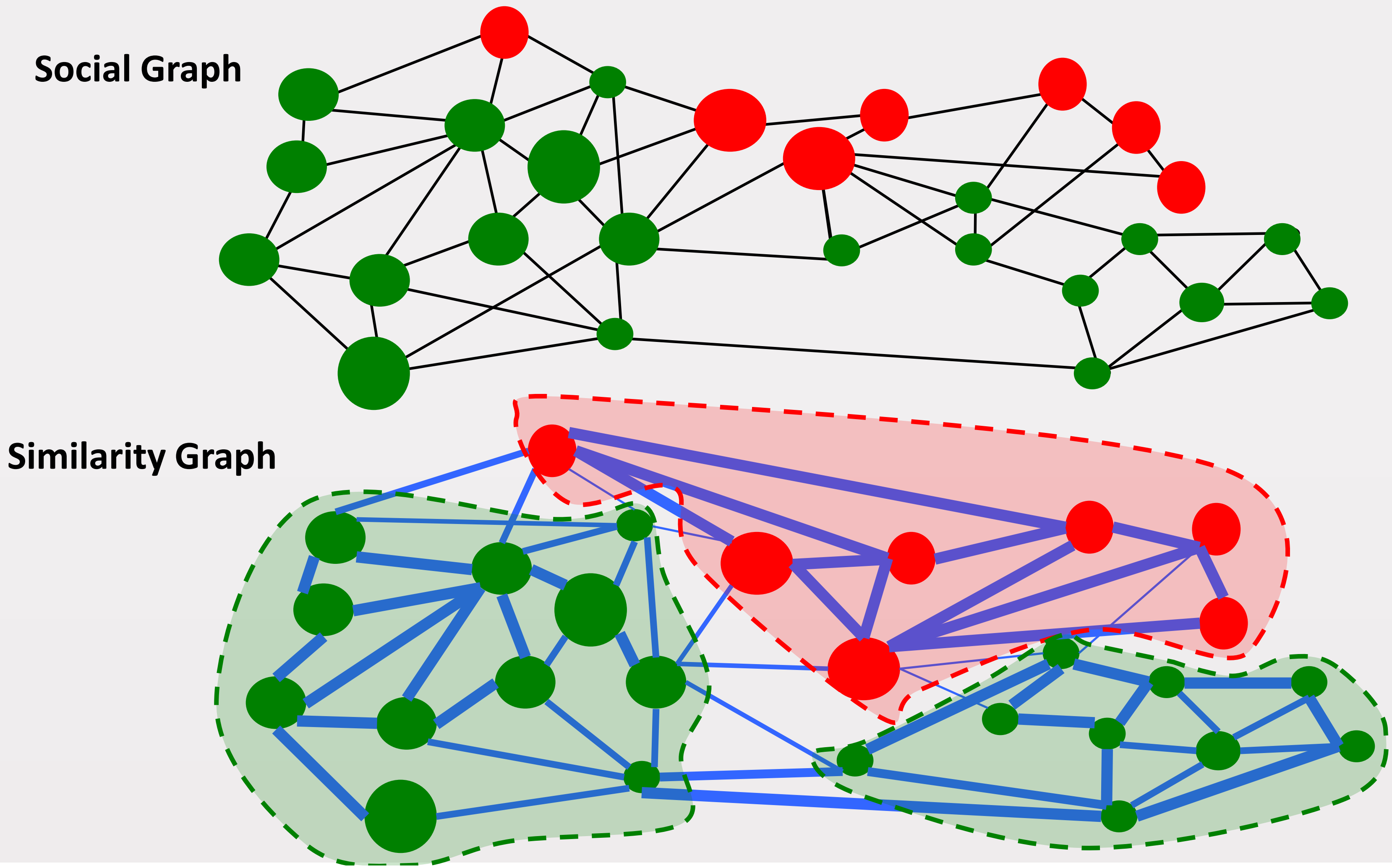
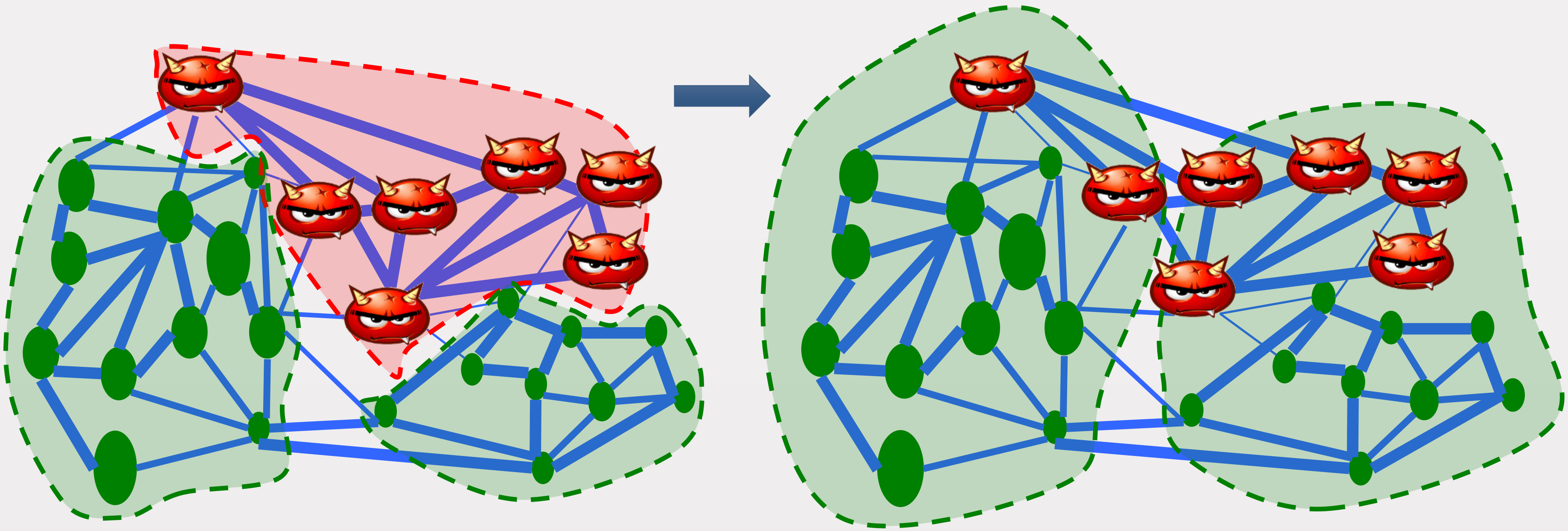


AdaGraph and Adversarial Manipulations

Malicious nodes collaborate with each other to falsify detected communities.



(a) Targeted detected communities

(b) Incorrect community memberships

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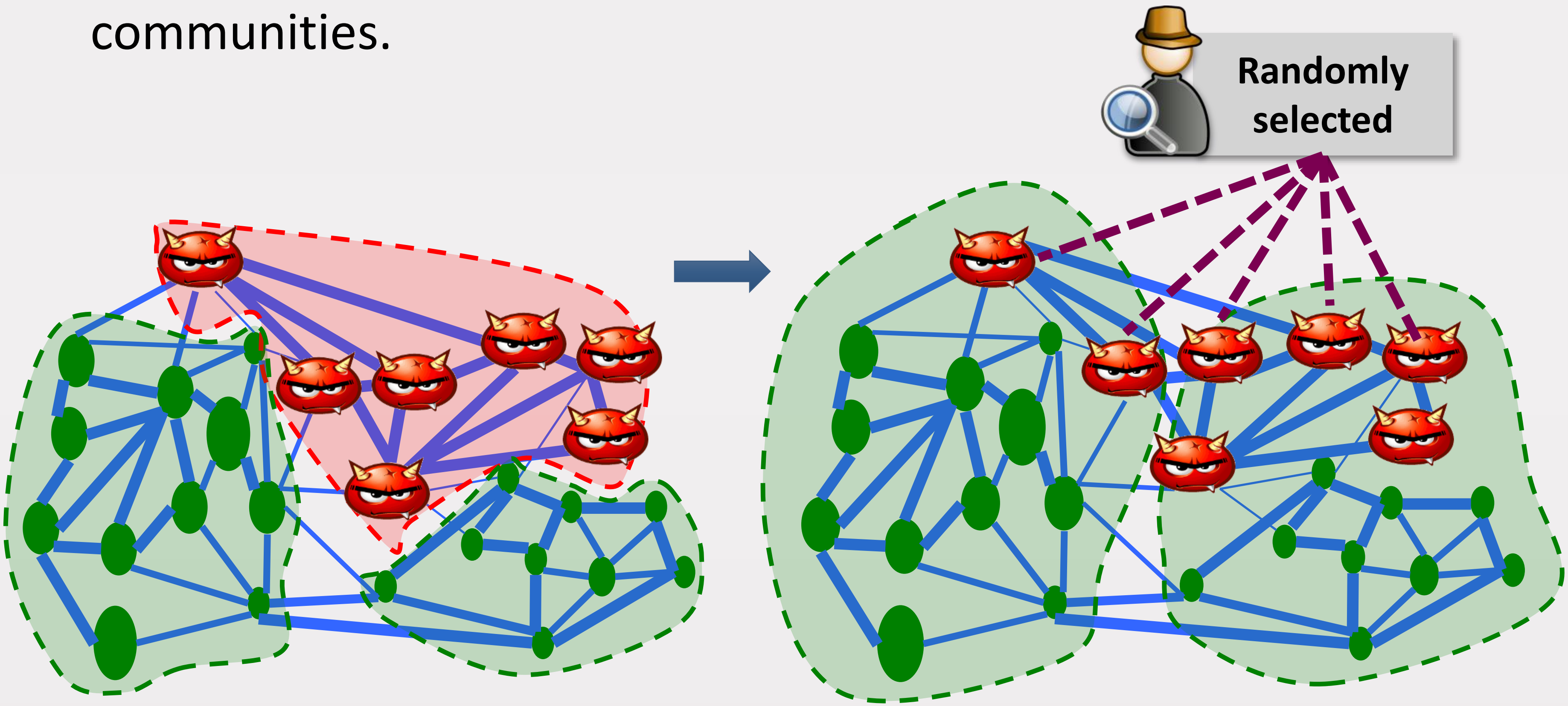

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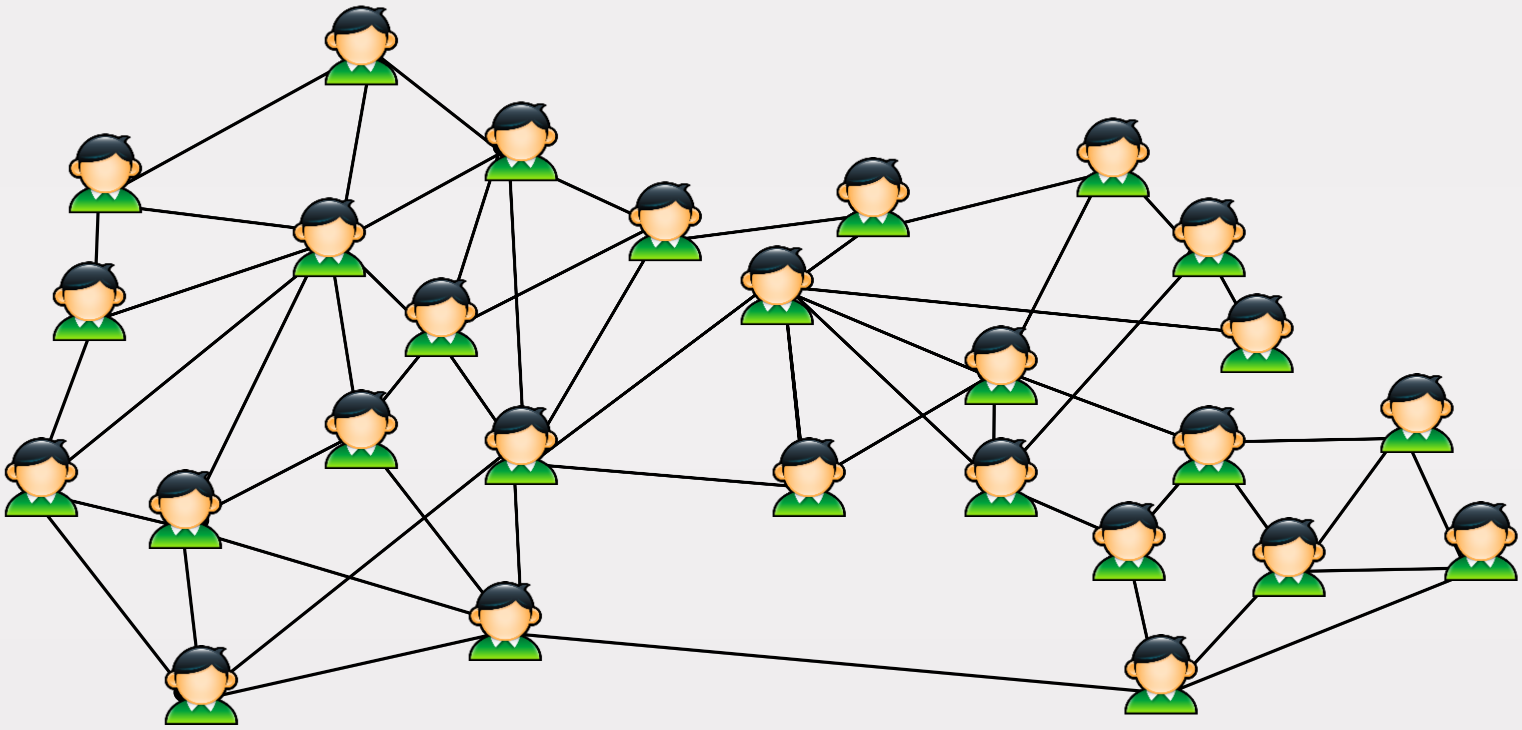
DIVa & CADIVa: How much trustworthy a profile is?



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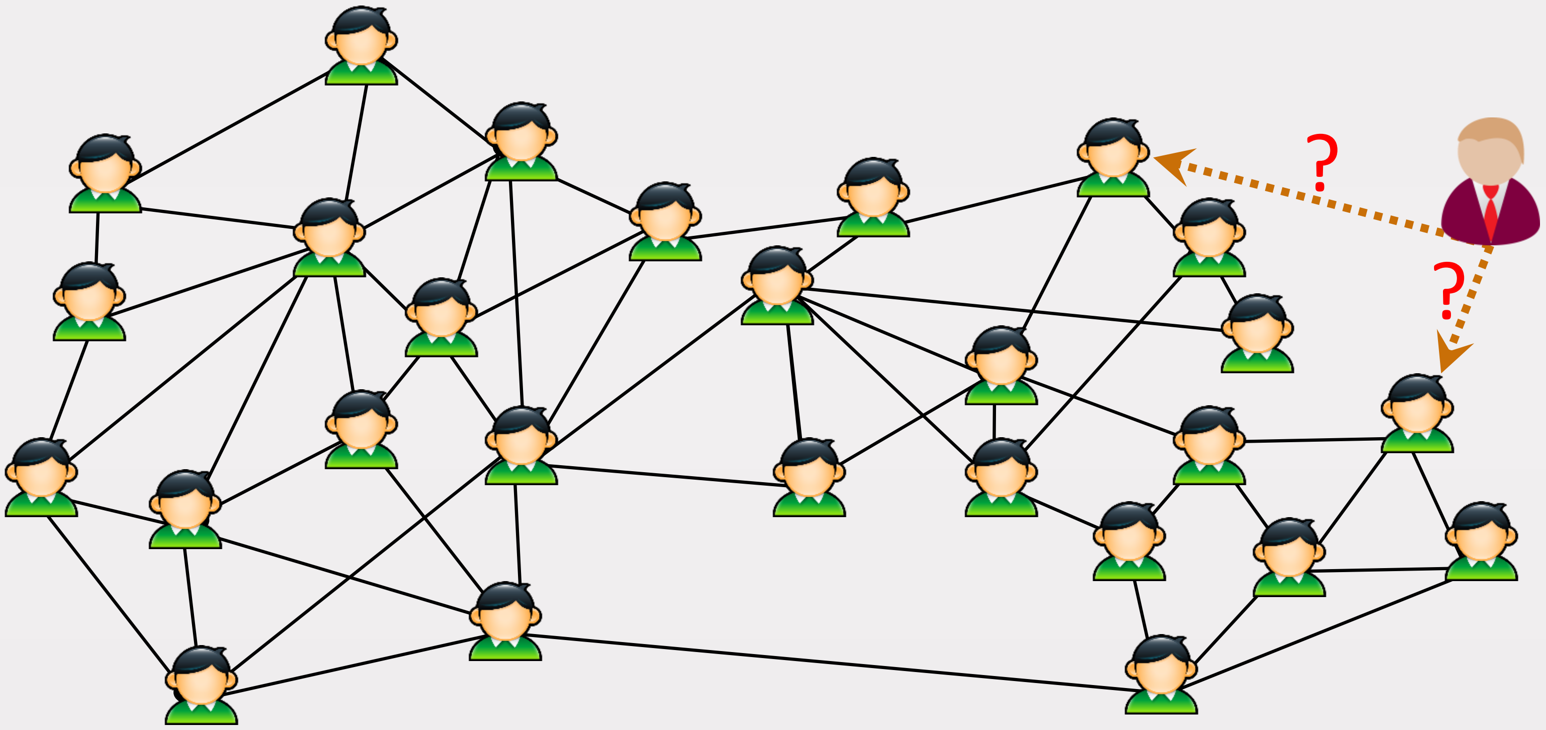

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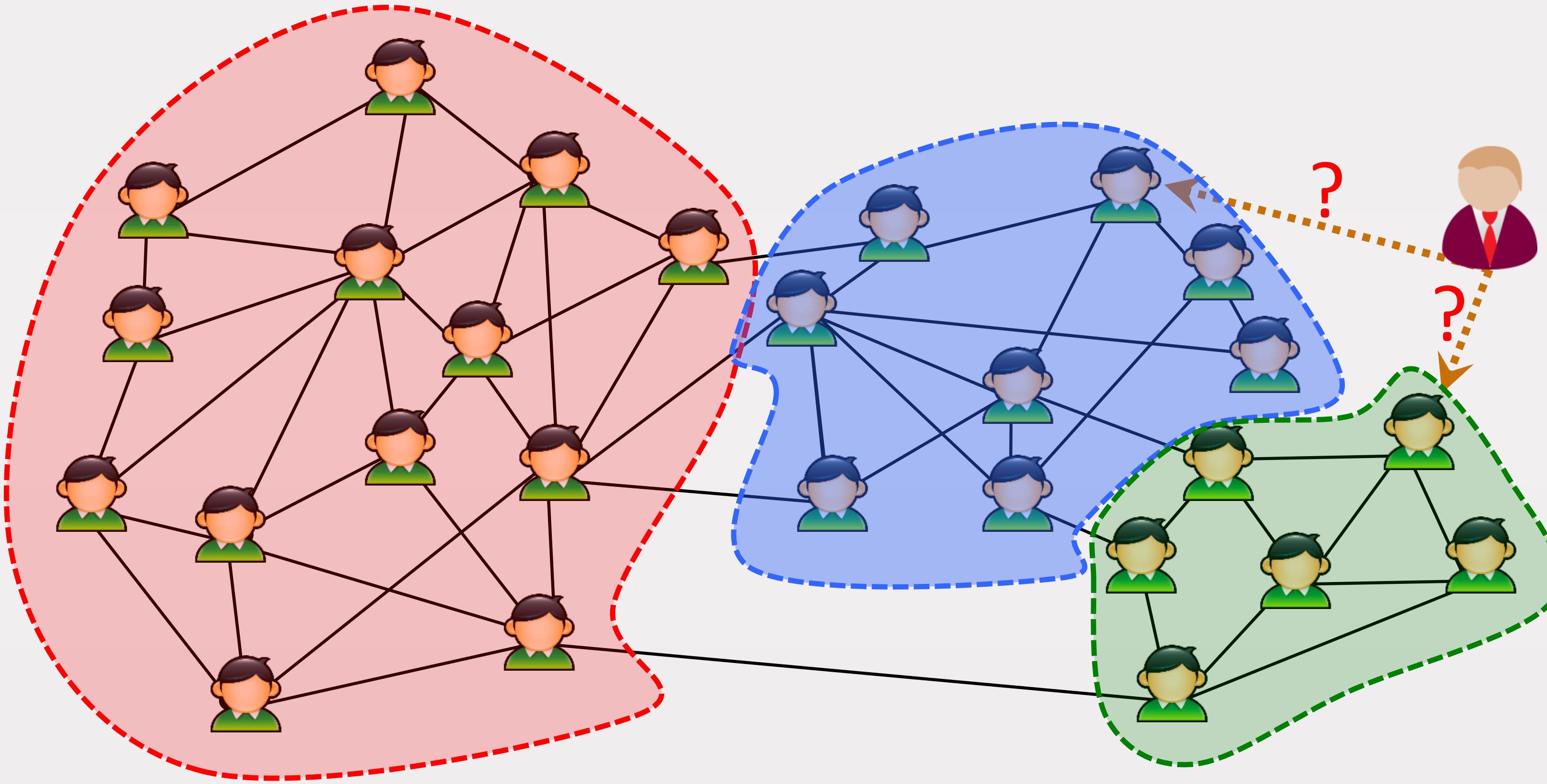

List of Publications

1. Soliman, A. , Rahimian, F., and Girdzijauskas, S. (2018). Stad: Stateful Diffusion for Linear Time Community Detection. 38th International Conference on Distributed Computing Systems (ICDCS), pp. 1074-1085. IEEE, 2018.
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