Towards Generating Realistic Geosocial Networks

Abed Al Rhman Sarsour

Panagiotis Bouros

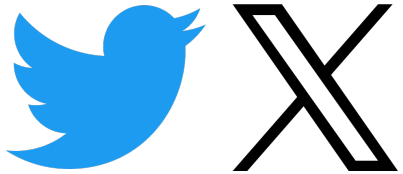
Theodoros Chondrogiannis

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Universität Konstanz

Geosocial networks

- Networks that model both
  - User social connections or interactions
  - Geo-referenced actions



- In academia, research on
  - Modeling
  - Indexing and query processing
  - Analysis
    - Influence maximization, community detection etc.

Dude, where are my datasets?

- Very few geosocial networks publicly available

- Use an official API
  - Limitations on queries or downloaded data per day
  - Fees for unlimited access

- Use synthetic geosocial networks
  - Realistic
  - Potentially large

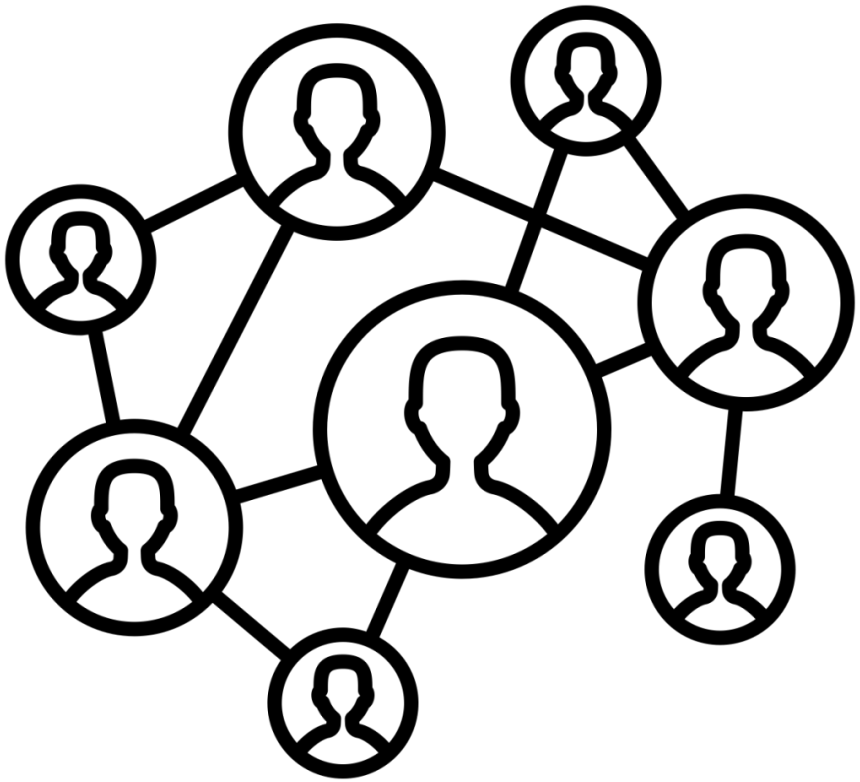
Background

- Social network generation
  - Power-law vertex-degree distribution
  - Small diameter
  - Progressively constructed using preferential attachment
    - Rich gets richer approach
- Spatial data generation
  - Multidimensional data generation
  - Variety of distributions in space
    - Uniform, clustered, diagonal
- Geosocial network generation
  - [Alizadeh et al. 2017] and [Gallagher et al. 2023]
    - Both spatial and social dimensions evolve at the same time

Contributions

- ✓Generation of realistic geosocial networks
  - Mimic the characteristics of real networks
- ✓Three types of synthetic networks
  - Different characteristics
  - Cover different scenarios and applications
- ✓Generator prototype
  - Modular architecture
  - Decouple graph generation from spatial data generation
  - Build upon existing generators
  - Reuse existing datasets

Types of synthetic networks (1/3)



- Characteristics
  - One type of vertices
    - Users of the network
  - One type of edges
    - Relationships between users, LIKE, FRIEND_OF, FOLLOW

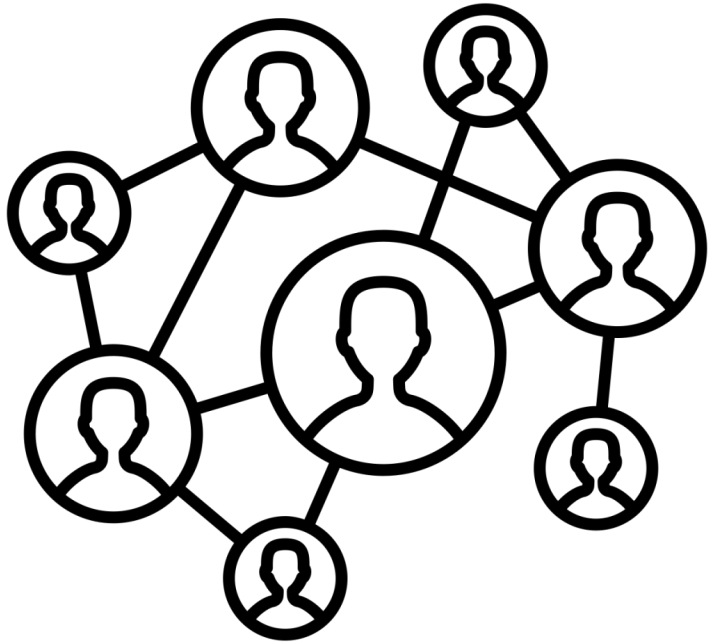
Types of synthetic networks (1/3)

- Characteristics
  - One type of vertices
    - Users of the network
  - One type of edges
    - Relationships between users, LIKE, FRIEND_OF, FOLLOW
  - Subset of vertices spatially annonated
    - Workplace, residence etc.

Types of synthetic networks (1/3)

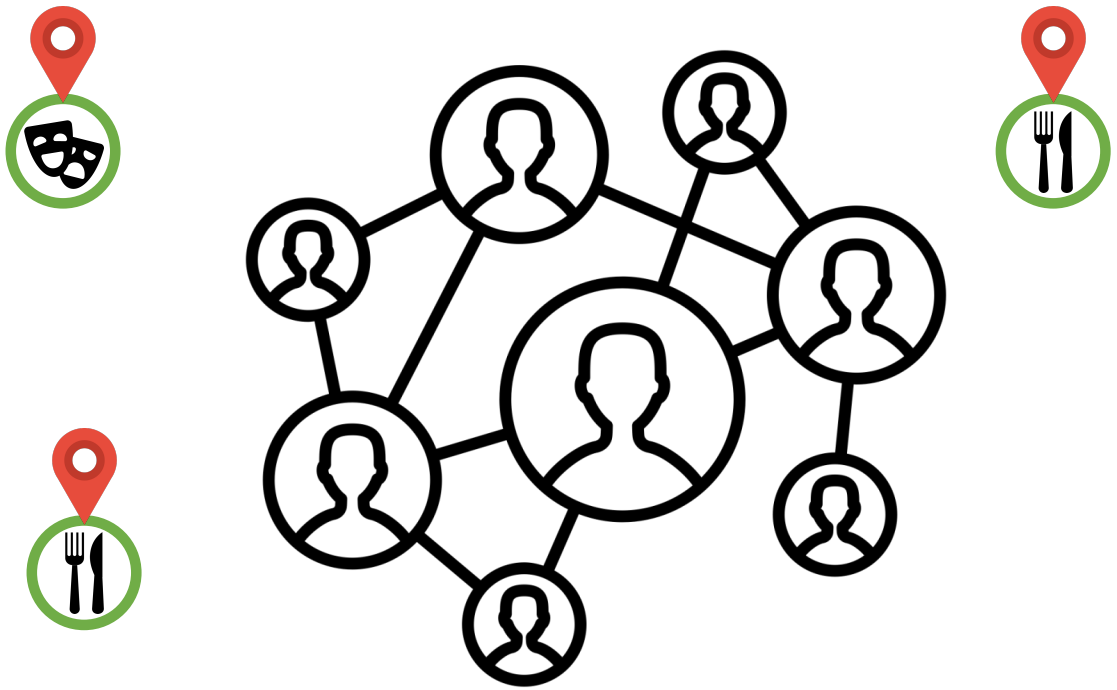
- Characteristics
  - One type of vertices
    - Users of the network
  - One type of edges
    - Relationships between users, LIKE, FRIEND_OF, FOLLOW
  - Subset of vertices spatially annonated
    - Workplace, residence etc.
- Example
  - Academic geosocial network
    - Co-authorship graph
    - Location of affiliation

Types of synthetic networks (2/3)



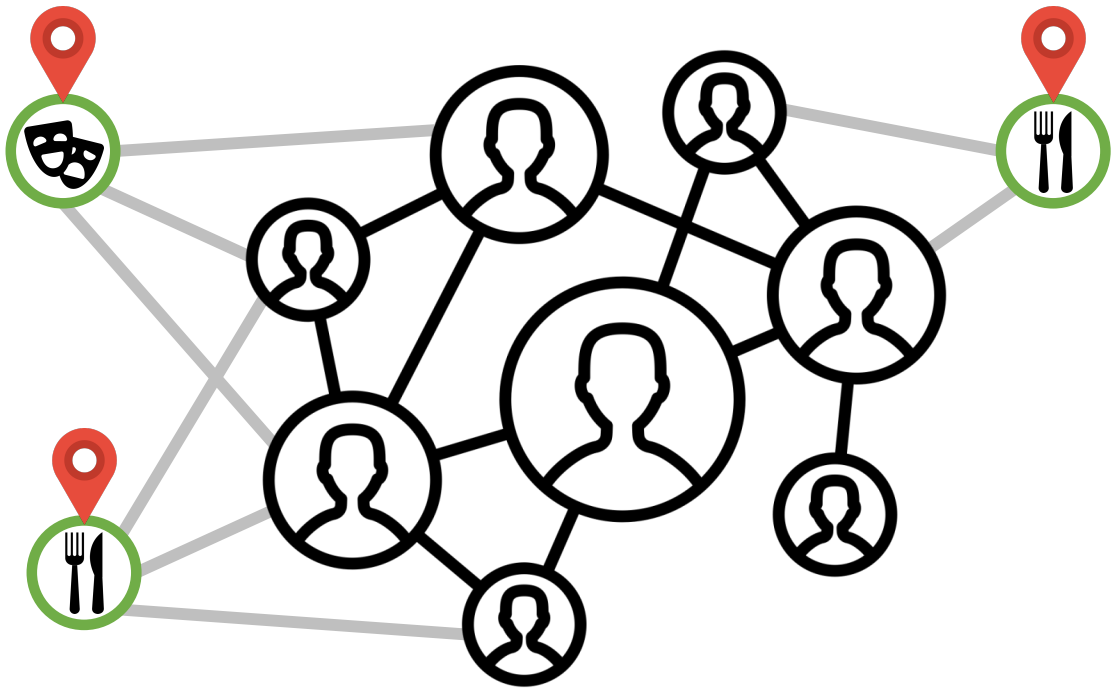
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users

Types of synthetic networks (2/3)



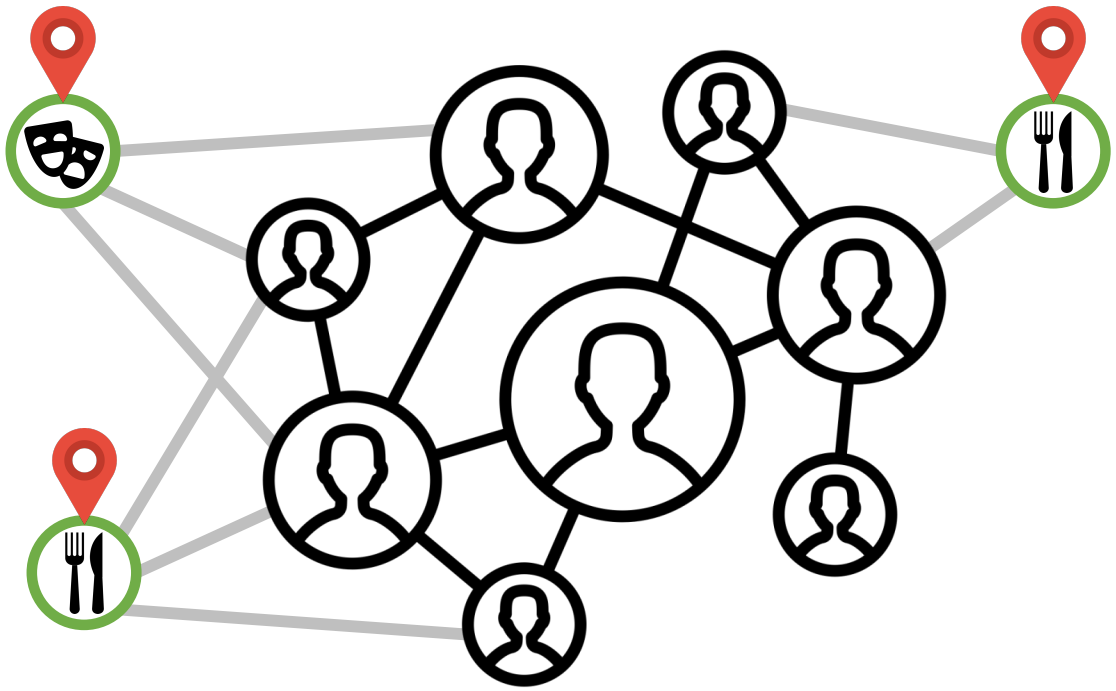
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users
  - Spatially annonated vertices
    - Venues, Points of Interest etc.

Types of synthetic networks (2/3)



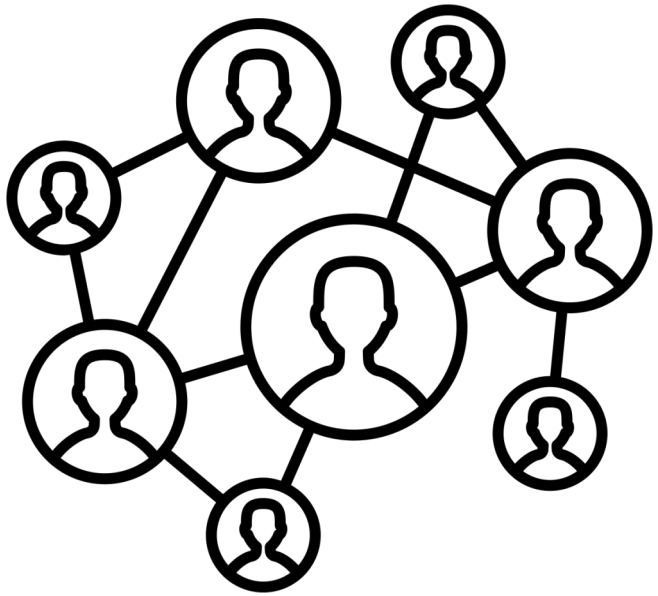
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users
  - Spatially annonated vertices
    - Venues, Points of Interest etc.
  - Spatial-to-social edges
    - One-to-many

Types of synthetic networks (2/3)



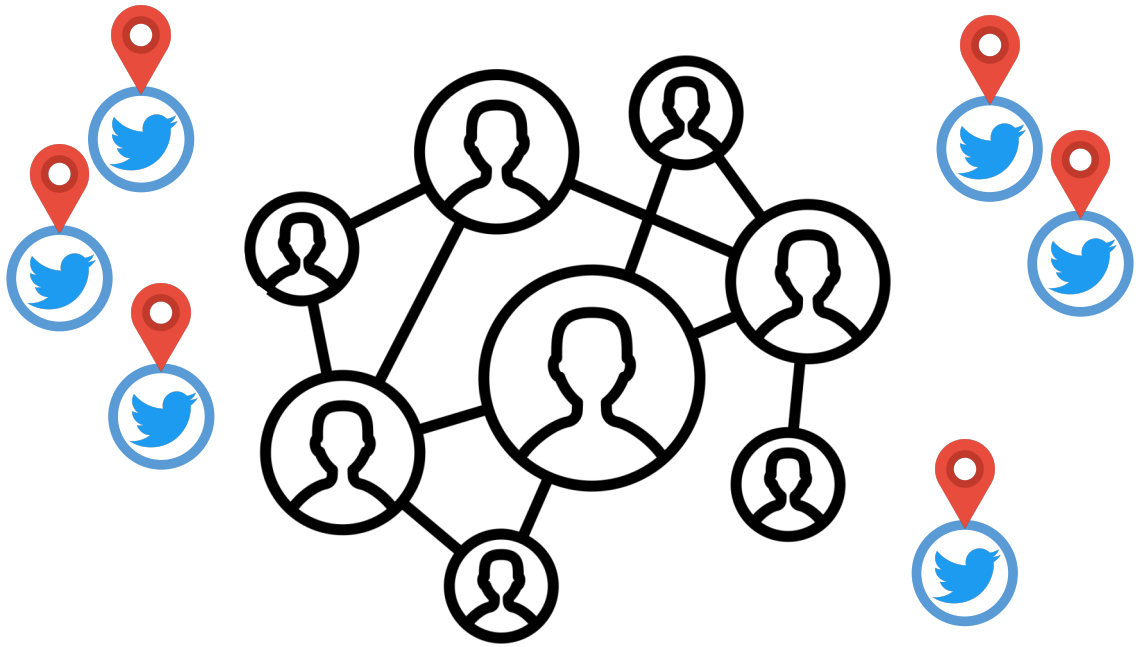
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users
  - Spatially annonated vertices
    - Venues, Points of Interest etc.
  - Spatial-to-social edges
    - One-to-many
- Example
  - Foursquare geosocial network
    - Users CHECK_IN in venues

Types of synthetic networks (3/3)



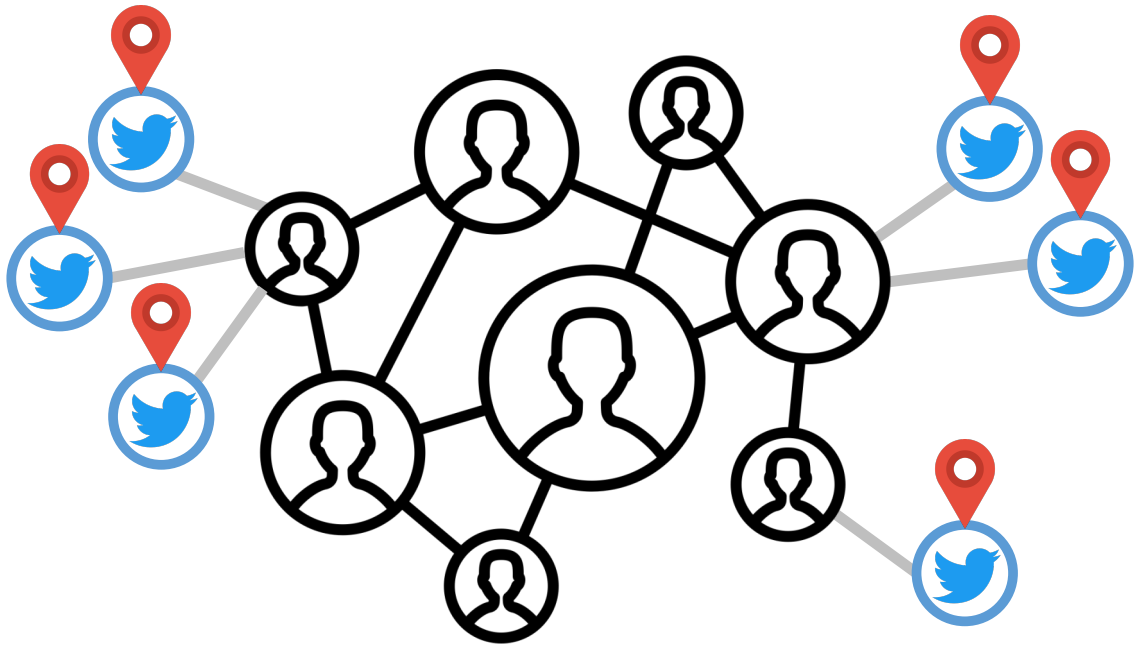
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users

Types of synthetic networks (3/3)



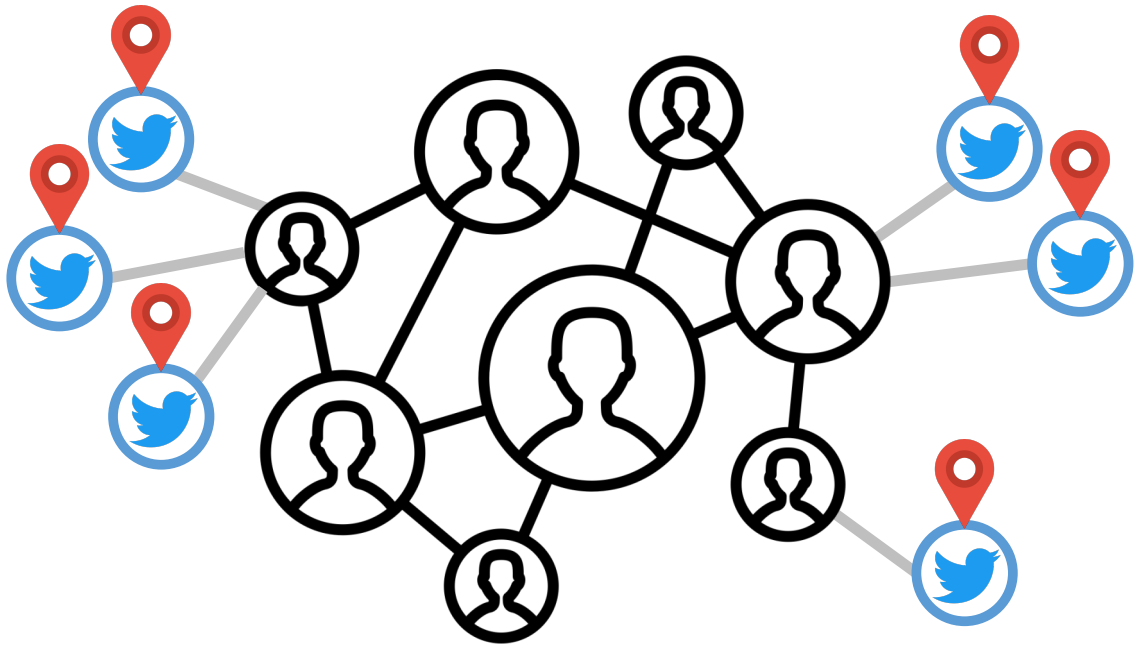
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users
  - Spatially annonated vertices

Types of synthetic networks (3/3)



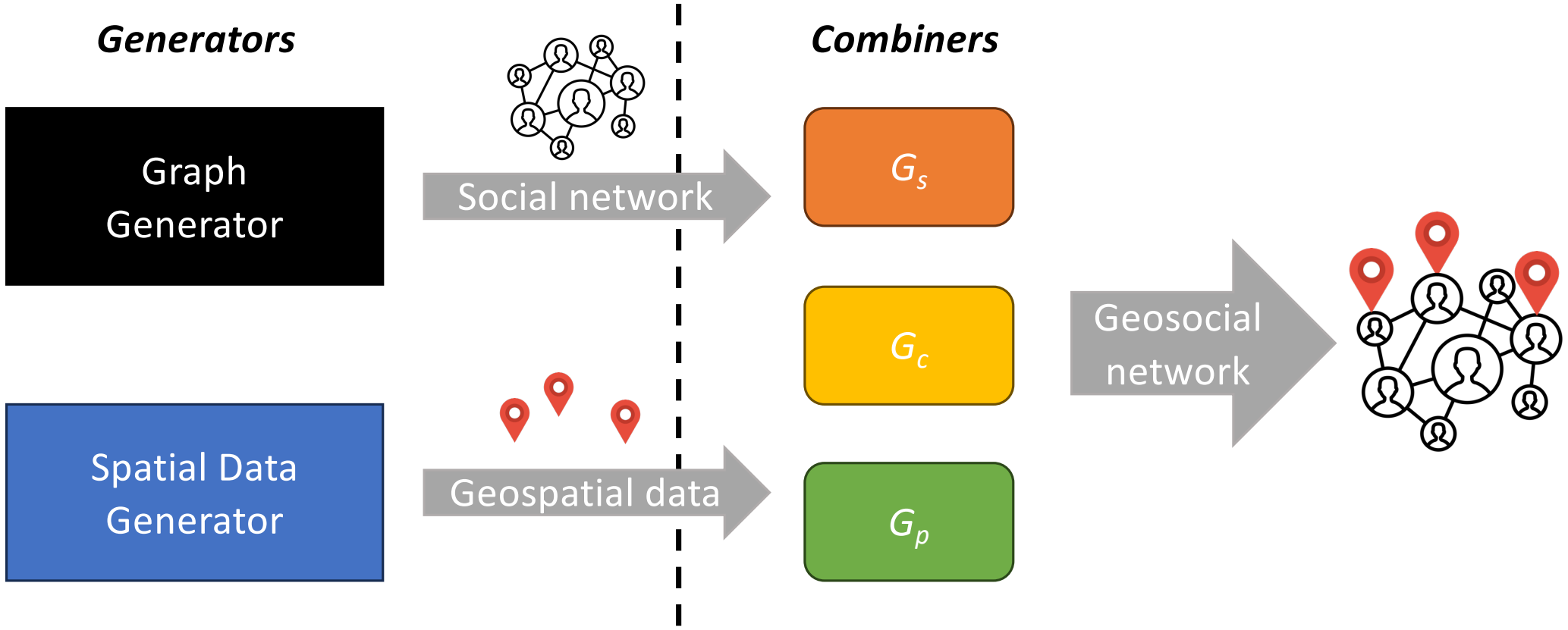
- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users
  - Spatially annonated vertices
  - Spatial-to-social edges
    - One-to-one

Types of synthetic networks (3/3)

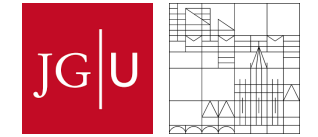


- Characteristics
  - Two types of vertices and edges
  - Social core of vertices and edges
    - Users of the network
    - Relationships between users
  - Spatially annonated vertices
  - Spatial-to-social edges
    - One-to-one
- Example
  - GeoTweets geosocial network
    - Users make geo-annotated posts

Generation process



Prototype



Graph generation
- Outputs a .gr file
- Barabasi albert [Albert and Barabasi 1999]
- Scale-free [Bollobás et al. 2003]
- Powerlaw cluster [Holme and Kim 2002]

Spatial data generation
- Outputs a .co file
- [Katiyat et al. 2020]
- Point or rectangles
- Uniform, clustered, diagonal space dsitributions

G_s 1st type: Randomly select a subset of vertices from .gr to assign a geometry from .co

G_c 2nd type: Create spatial vertices from .co, connect each to one or more social vertices from .gr

G_p 3rd type: Create spatial vertices from .co, connect each to one social vertex from .gr

Future work

- Study how realistic the generated networks are
  - Compare against available real networks
- Investigate new types of geosocial network or generation approaches
  - [Gallagher et al. 2023]
- Consider vertex and edge labels
- Develop an interactive UI for generation and visualization

Thank you!

Questions ?

https://github.com/pbour/geosocialgenerator