Combining Geographic and Network Analysis:

The GoMore Rideshare Network

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Outline

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3. The project objective
4. The GoMore network
5. The results
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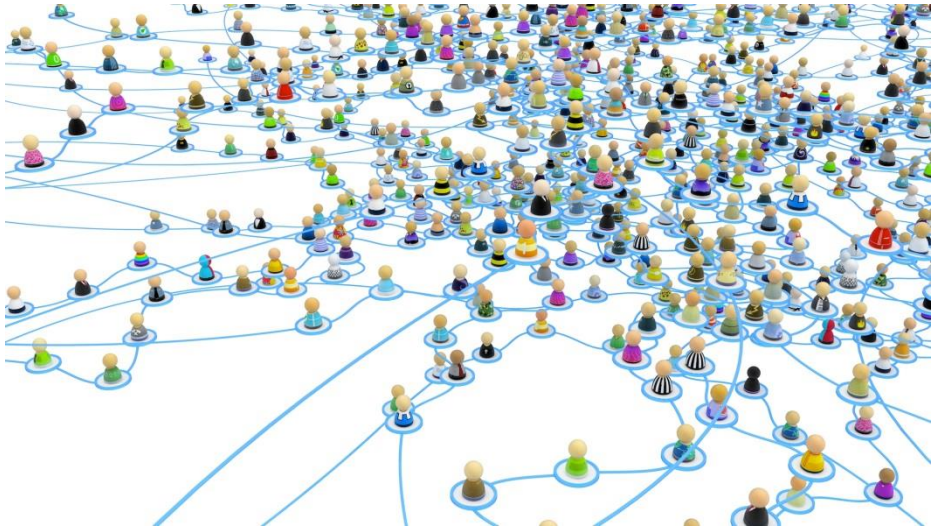
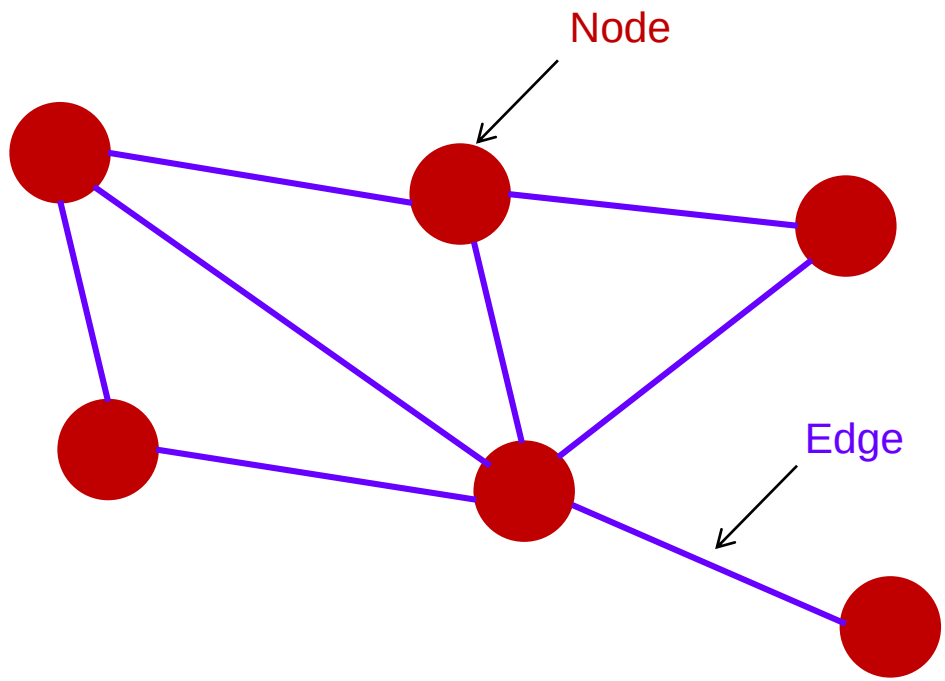
Motivation

Are there elements of geospatial theory which complement social network theoretic approaches to examining context and relationships in networks, and vice versa?



What is complex network analysis?

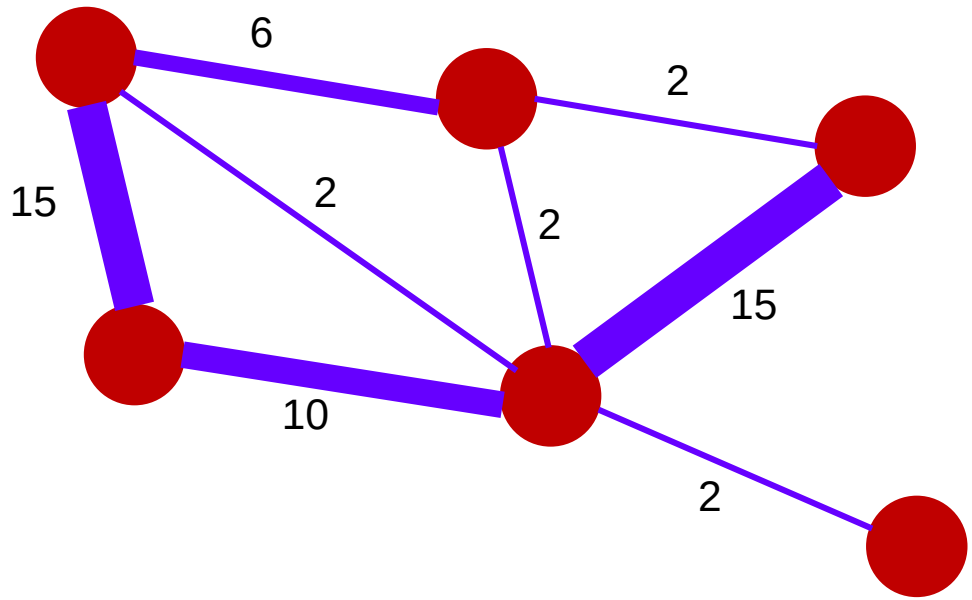
A network represents data as a series of ‘nodes’ and ‘edges’.



Weighted Networks

Not all networks are represented by edges sharing equal values.

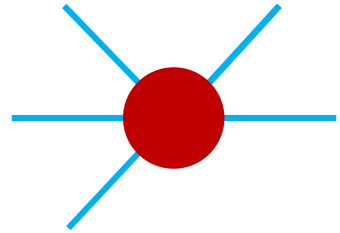
Weighted networks attribute additional data to every edge.



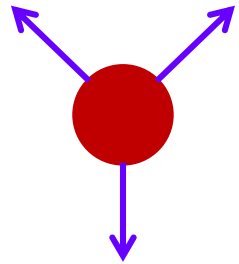
Topological Properties: Degree

Centrality measures such as ‘degree’ measure the relative importance of a node within a network.

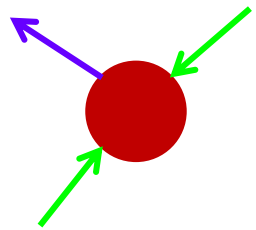
Degree = 5



Out degree = 3



In degree = 2
Out degree = 1



The Project Objective

Research paper:

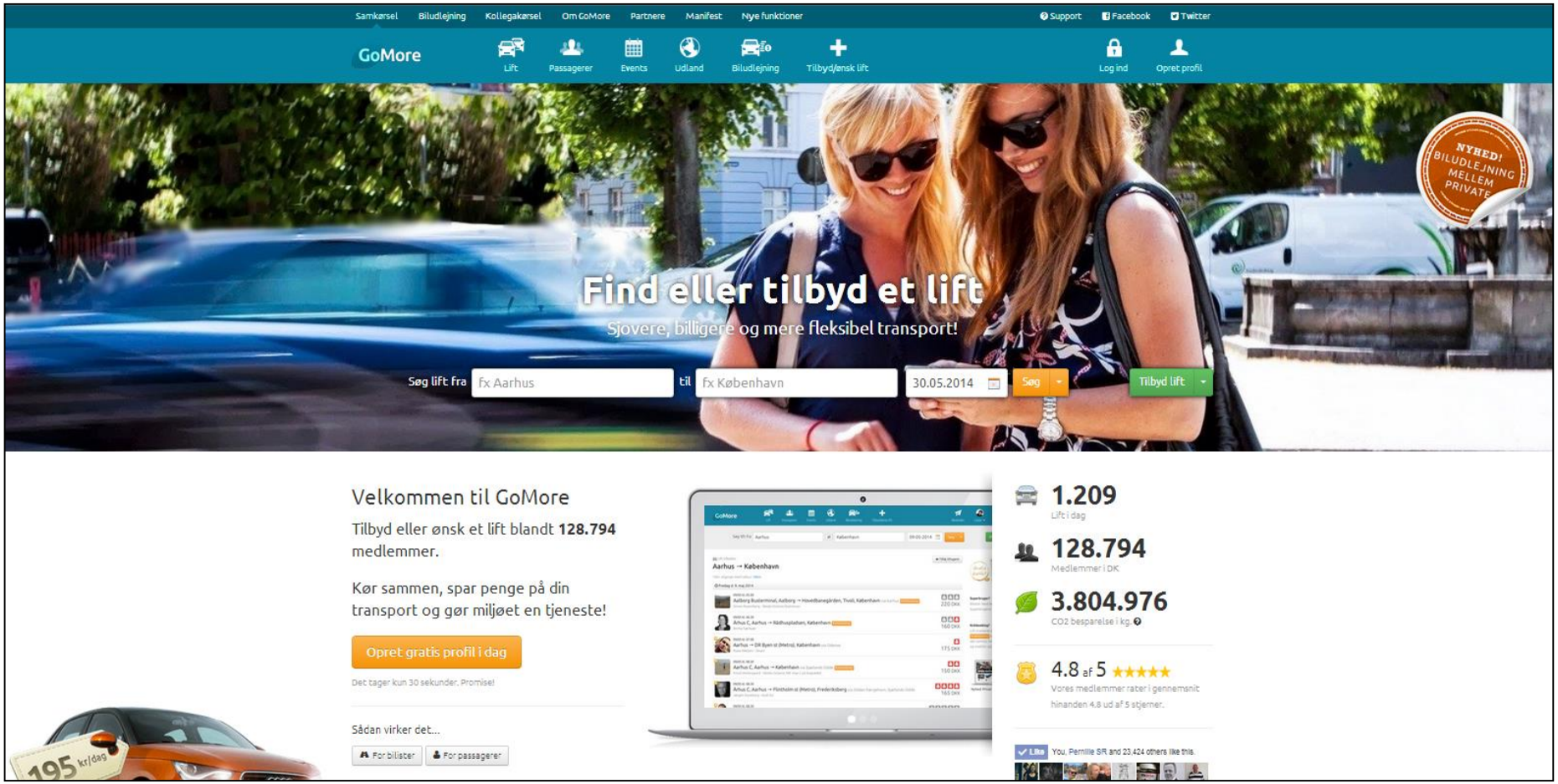
Combining Spatial and Network Analysis:
A Case Study of the GoMore Network

Purpose:

- To assess the complementarity of the integration of spatial analysis and complex network analysis
- To analyze topological and weighted network properties of Northern Europe's leading, online ride-share network
- To examine the geographic distribution of travel within the network and to identify underserved areas utilizing a gravity model

GoMore, Denmark

Case Study



Source: gomore.dk

The GoMore Network

Creating the Network Graph

- **PostgreSQL**: Advanced SQL queries to structure data
- **Gephi**: Generate .GML (graph file), visualization, analyses
- **igraph as R package**: Implement network analysis algorithms
- **R**: Implement statistical methods, visualization
- **ArcGIS for Desktop**: Spatial analyses, visualization, feature attribution, processing of demographic data
- **Python**: Script to generate origin/destination matrix (Google Distance Matrix API)

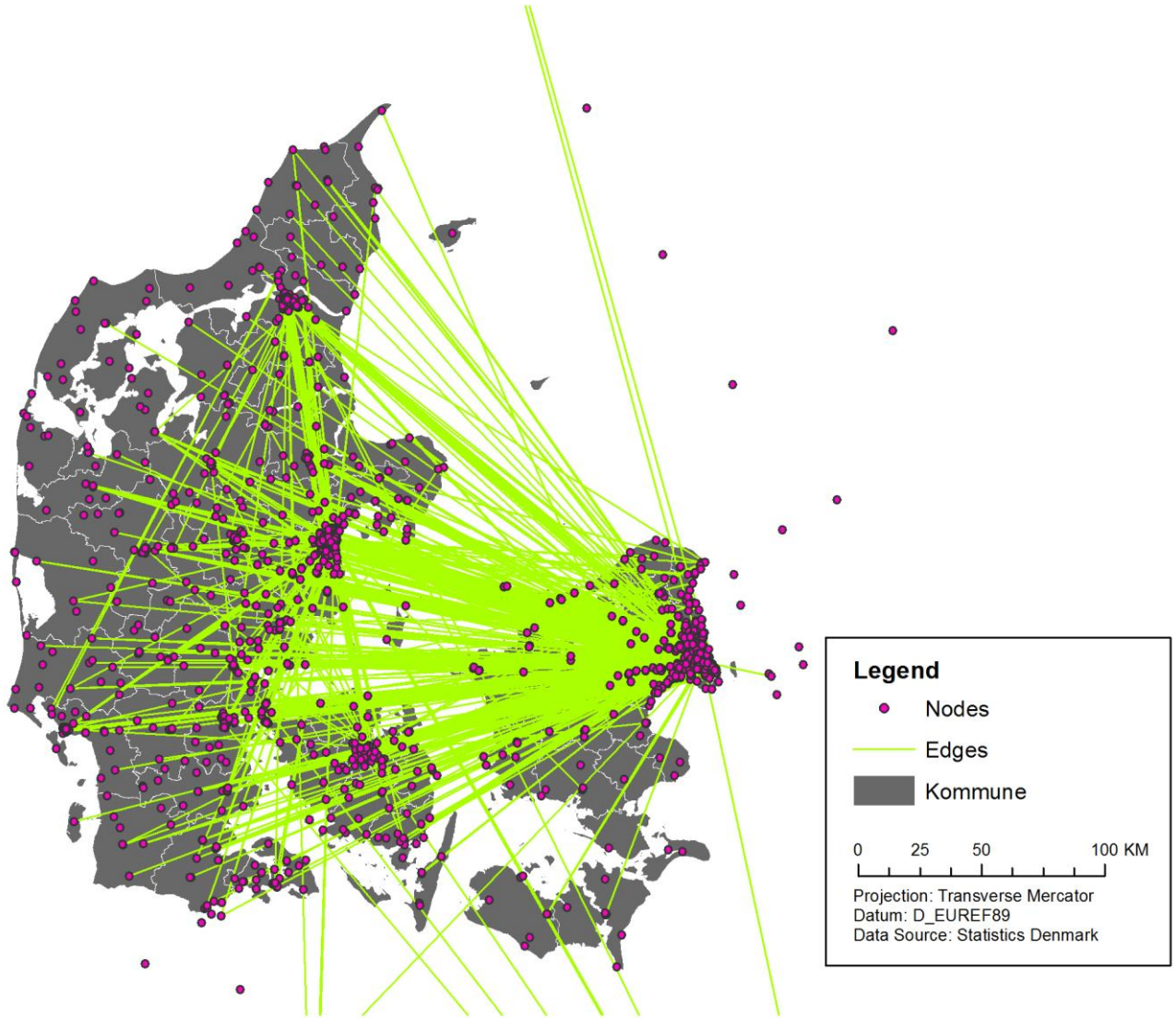
The GoMore Network

	Nodes N	Edges E	Maximum in degree k_{max}^{in}	Maximum out degree k_{max}^{out}	Average Directed degree k_{in}, k_{out}	Average Local Clustering Coefficient C_i	Average Path Length $\langle d \rangle$
GoMore Graph	2302	7004	283	288	3.043	0.079	3.385

Table 1: GoMore topological properties

The GoMore Ride Share Network

Denmark



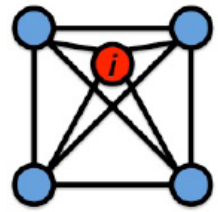
* Edges filtered to display trips with greater than 6 travelers

Source: Statistics Denmark, Gomore.dk (Feb. 2013 – Oct. 2013) ride data

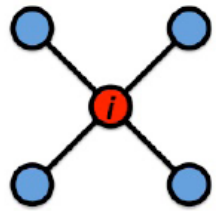
Topological and Weighted Analysis

Results

Metric	Interpretation
• Hubs in the network	• These nodes posses an above average number of inbound and outbound connections
• Clustering coefficient values	• Low degree nodes possess higher values than high degree nodes • Nodes peripheral to hubs are not well interconnected with other, peripheral nodes
• Centrality measures	• In degree, out degree and betweenness values were highly correlated • Nodes with high betweenness values are optimally located to provide services to end users, serve as pick-up points or as stops on multi-destination trips
• Weighted clustering coefficient values	• Triangle density is influenced by edges having large weights, signaling that locations which support large volumes of traffic are interconnected



$C_i = 1$



$C_i = 0$

Image Source: Barabási, A.L.: Network Science. Forthcoming, pp. 41

Spatial Analysis

Results

Approach	Interpretation
• Centrality within areal units	• Node degree and node strength summed by kommune • Most populated kommunes support the largest number of GoMore travelers • Most densely populated kommunes (those surrounding Copenhagen) do not support large volumes of traffic
• Gravity Model	• Total flow constrained gravity model utilized • Predictive values compared against observed travel to identify underperforming areas • Found rather than distance acting as a deterrent, ride-share users utilize the service for long distance trips • Areas for future study include the further specification of distance decay parameters

Conclusion

- Unique opportunity to examine the structural properties of an online/offline network from a geographic perspective, contextualized by demographic variables.
- Nodes with high betweenness values are optimally located to provide services to end users, serve as pick-up points or as stops on multi-destination trips.
- The examination of degree centrality within areal units, in this case the administrative boundaries of Danish kommunes, showed that the most populated kommunes supported the largest number of GoMore travelers. The most densely populated kommunes did not support large volumes of traffic, however this may be explained by user-generated location descriptions within the greater Copenhagen region.

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