

Network Science Project

US Flight Market

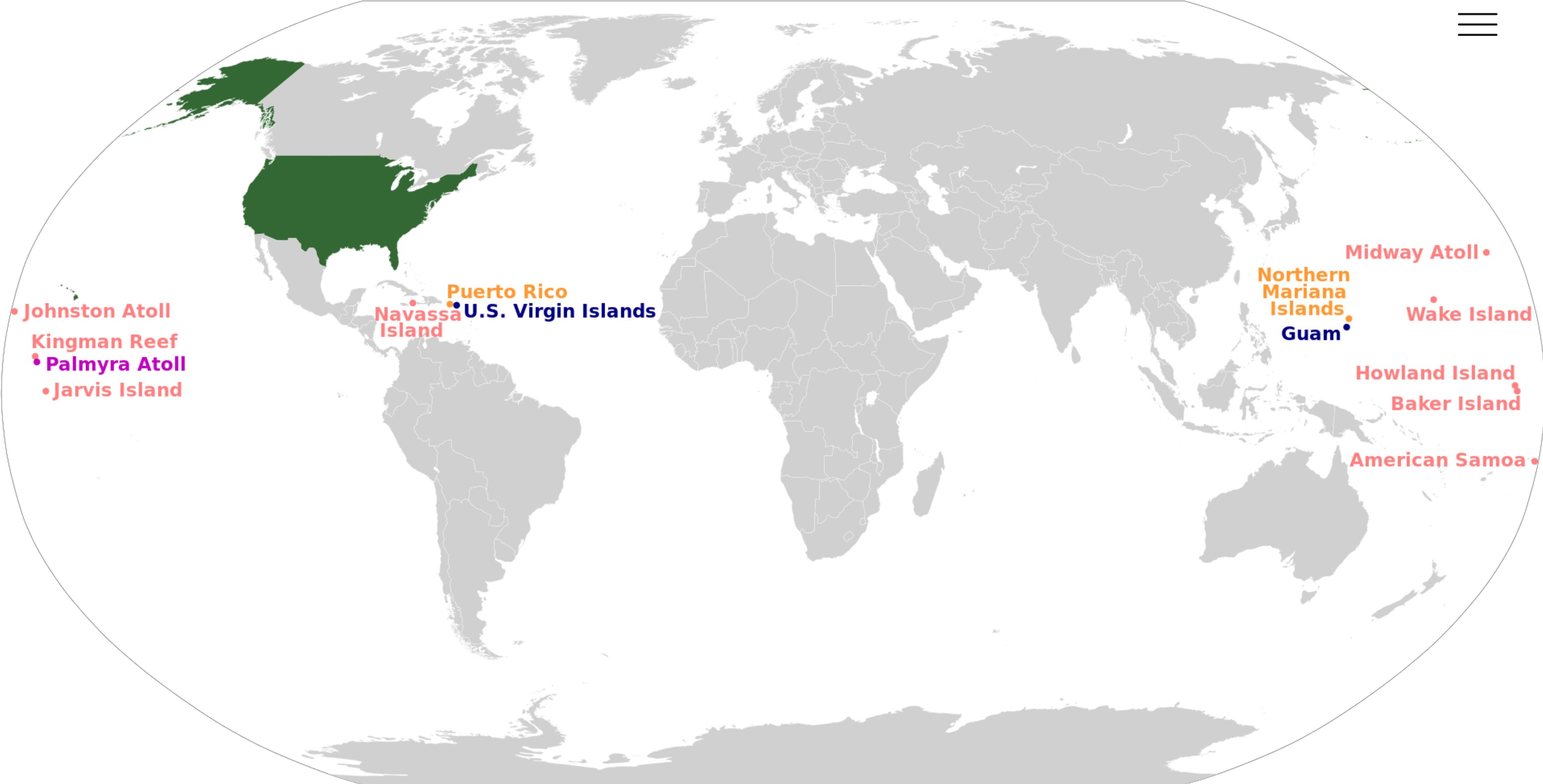
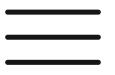
by Jan Philip Richter



DATASET

- Flight Data obtained from the US Bureau of Transportation Statistics (part of the Department of Transportation)
- Flights of 15 major US carriers in January 2023
- Domestic Flights only
- Information on origin, destination and delay





GRAPH REPRESENTATION

Vertices: Every city is a vertex
(cities with multiple airports have only one vertex)

Edges: An edge exists between two vertices, if a direct connection exists
between the two cities

Weights: The edge weight is the average delay of all flights on that connection

The final graph contains 333 vertices and 2584 edges (undirected)

For one part of the analysis we are going to consider the directed version of the graph



RESEARCH GOALS

- Investigating the general properties of the US flight network
- Exploring the most important cities in the US flight network
- Predicting future flight connections not yet in existence

GRAPH CHARACTERISTICS

Degree:

- Average Degree: 15.52
- Median Degree: 5
- Maximum Degree: 175
- Minimum Degree: 1
- Degree Standard Deviation: 26.69

Density: 0.0467

Diameter: 5

Graph Similarity:

- Degree Assortativity: -0.50
- Global Clustering Coefficient: 0.32
- Average Local Clustering Coefficient: 0.58

Connectivity:

- The directed version of the graph is strongly connected
- Number of bridges: 62

DELAY INFORMATION

Worst Connection: Boston, MA -> Valparaiso, FL (1,496min delay)

Best Connection: Peoria, IL -> Denver, CO (-31min delay)

Worst Airport to fly to: Dallas/Fort Worth, TX (2,345 weighted in-degree)

Worst Airport to fly from: Denver, CO (2,669 weighted out-degree)

Best Airport to fly to: Seattle, WA (-158 weighted in-degree)

Best Airport to fly from: Allentown/Bethlehem/Easton, PA (-37 weighted out-degree)

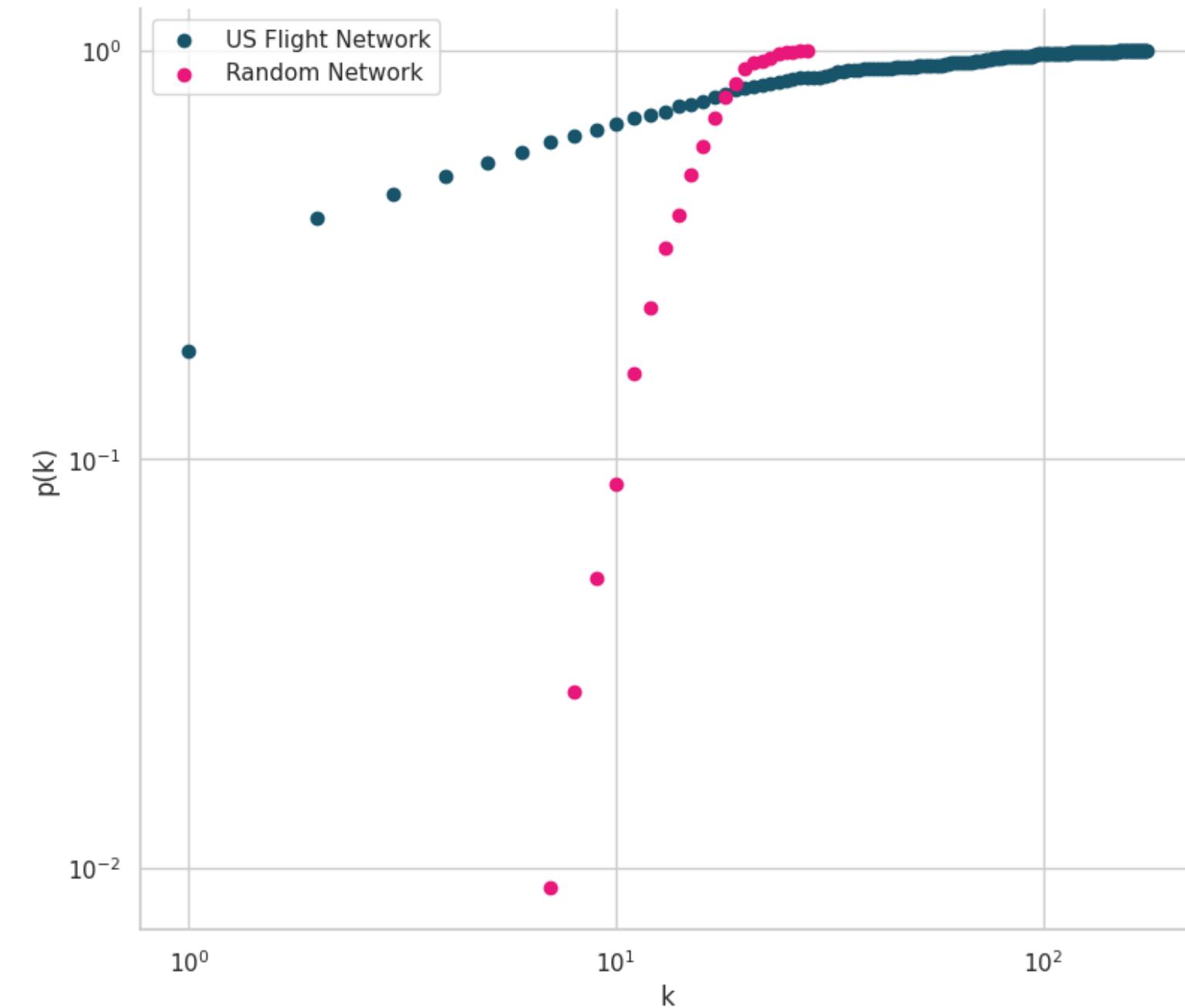
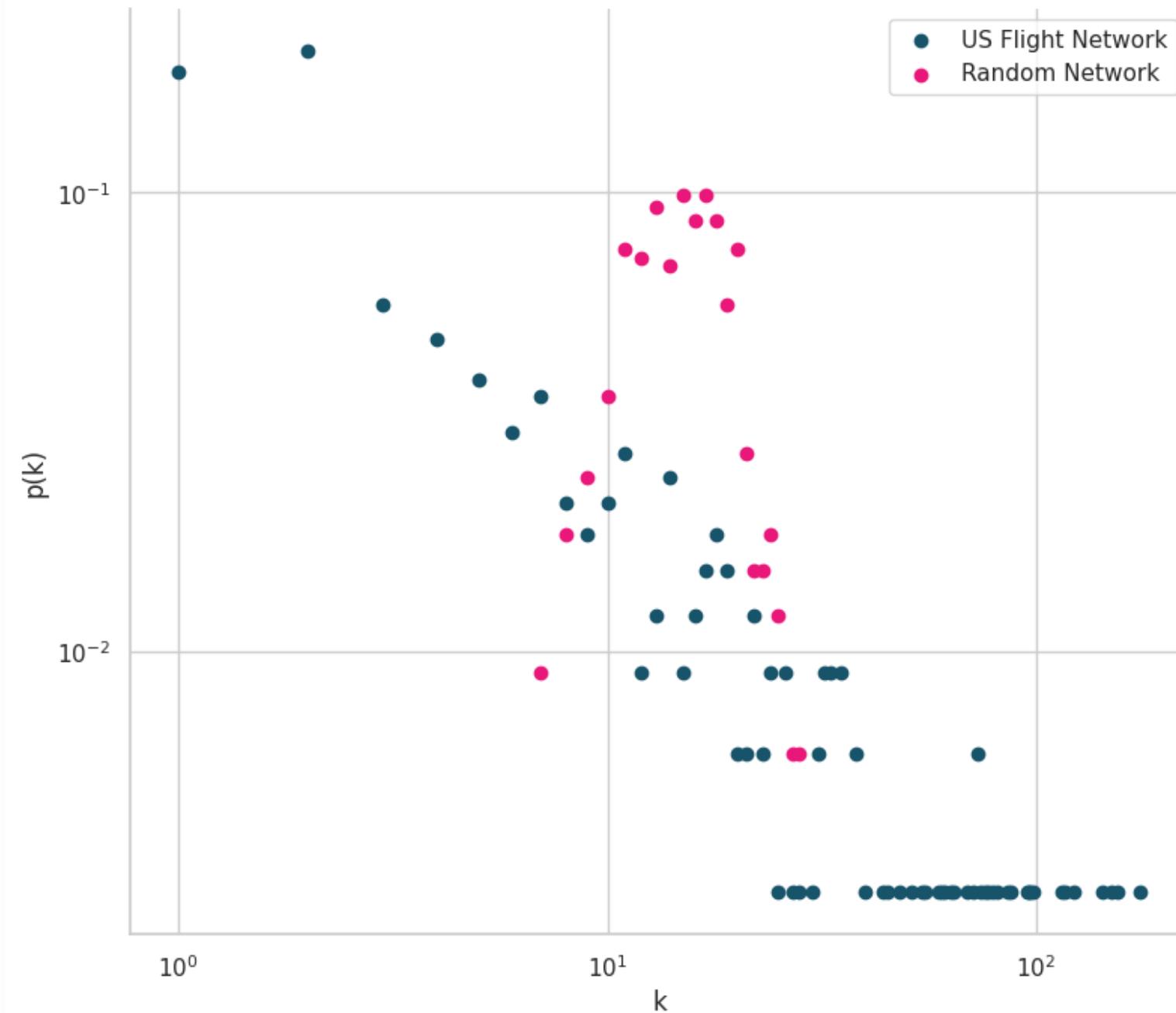
HIGH DEGREE NODES

- Dallas/Fort Worth, TX: 175
- Denver, CO: 154
- Chicago, IL: 150
- Atlanta, GA: 143
- Phoenix, AZ: 122

62 airports with only 1 connection



DEGREE DISTRIBUTION



CENTRALITIES

Degree Centrality:

Dallas/Fort Worth, TX: 0.53
Denver, CO: 0.46
Chicago, IL: 0.45
Atlanta, GA: 0.43
Phoenix, AZ: 0.37

Closeness Centrality:

Dallas/Fort Worth, TX: 0.66
Denver, CO: 0.64
Chicago, IL: 0.64
Atlanta, GA: 0.61
Phoenix, AZ: 0.60

Betweenness Centrality:

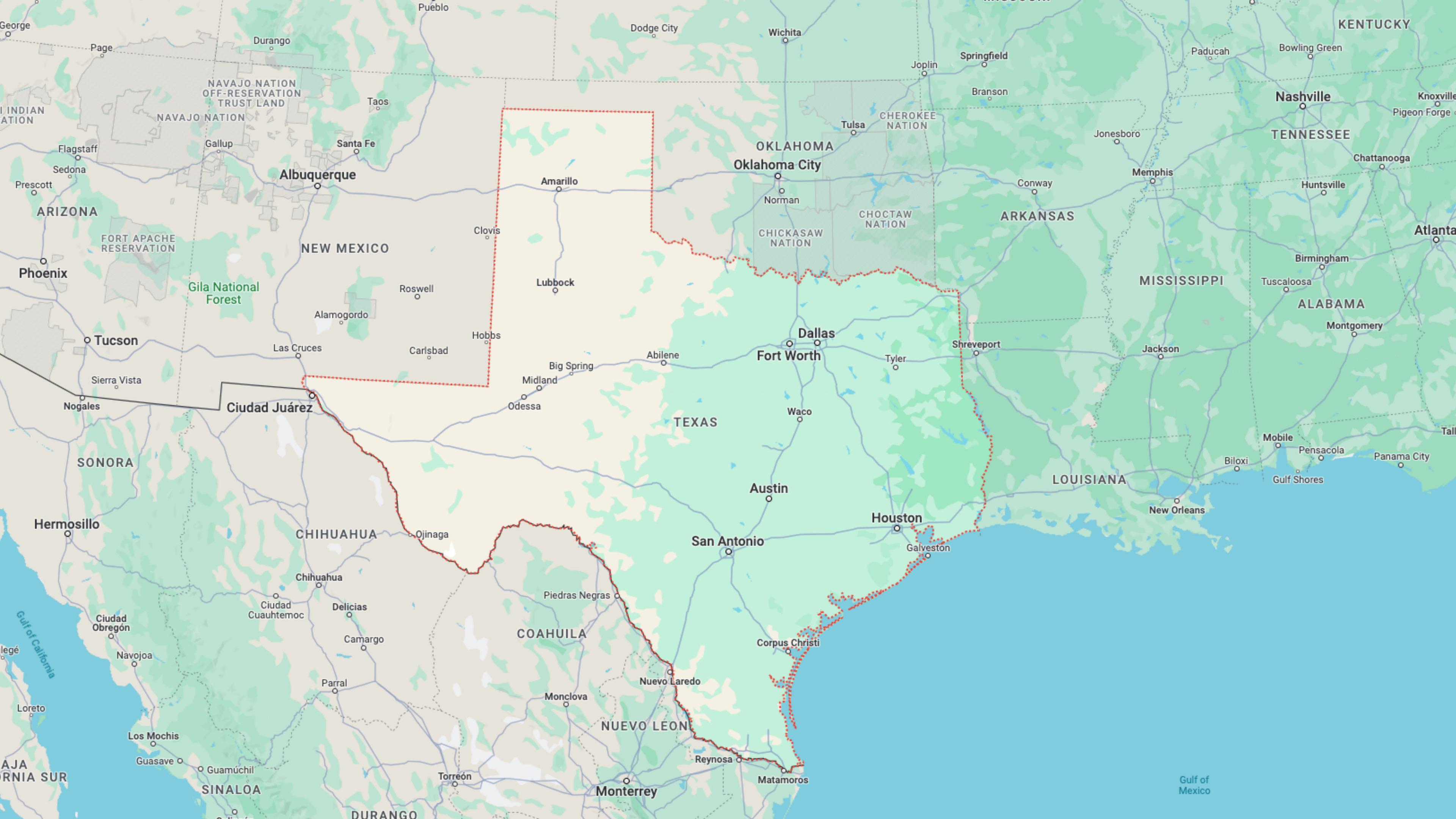
Dallas/Fort Worth, TX: 0.21
Denver, CO: 0.17
Chicago, IL: 0.13
Atlanta, GA: 0.09
Minneapolis, MN: 0.07

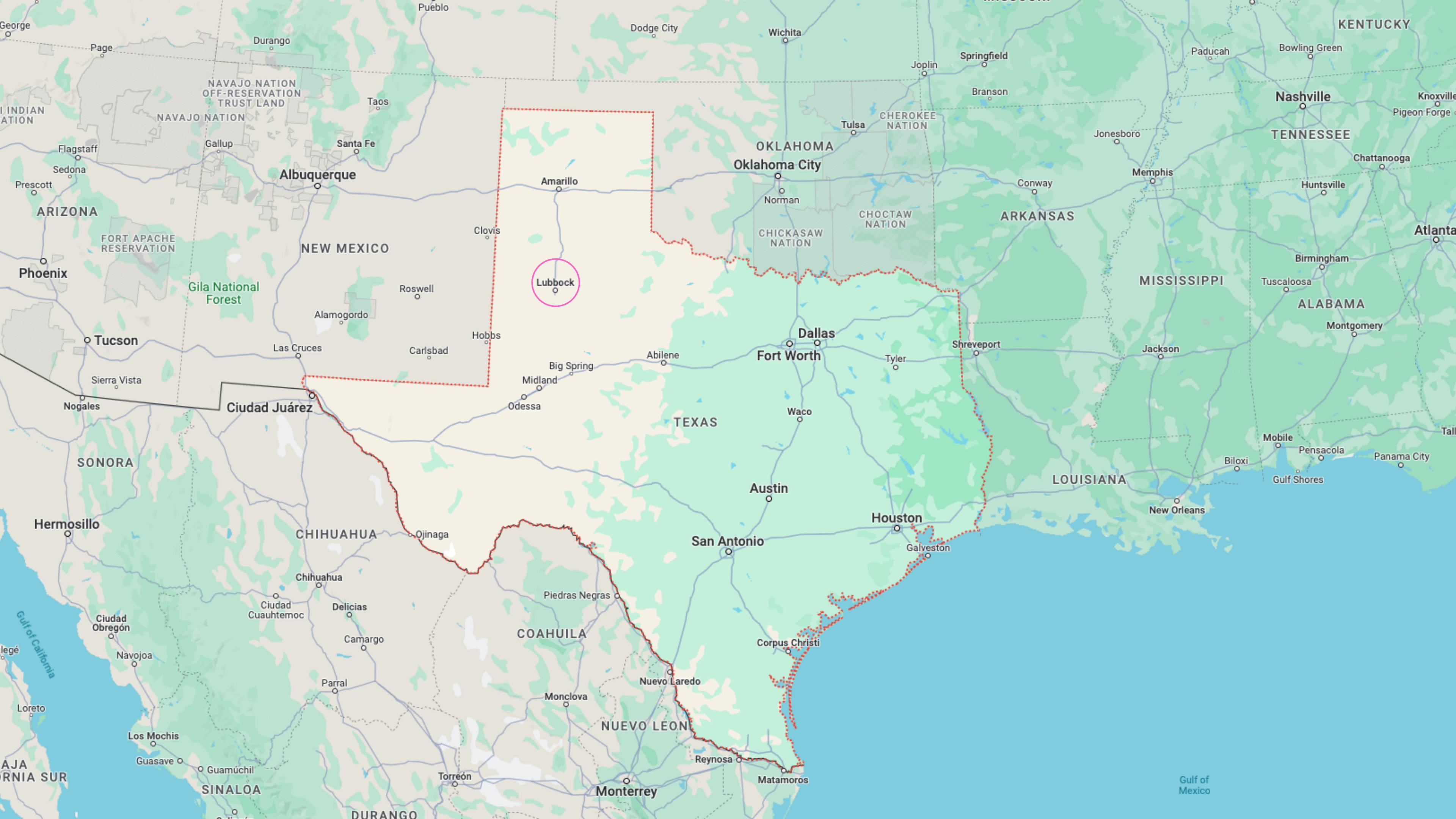
Eigenvector Centrality:

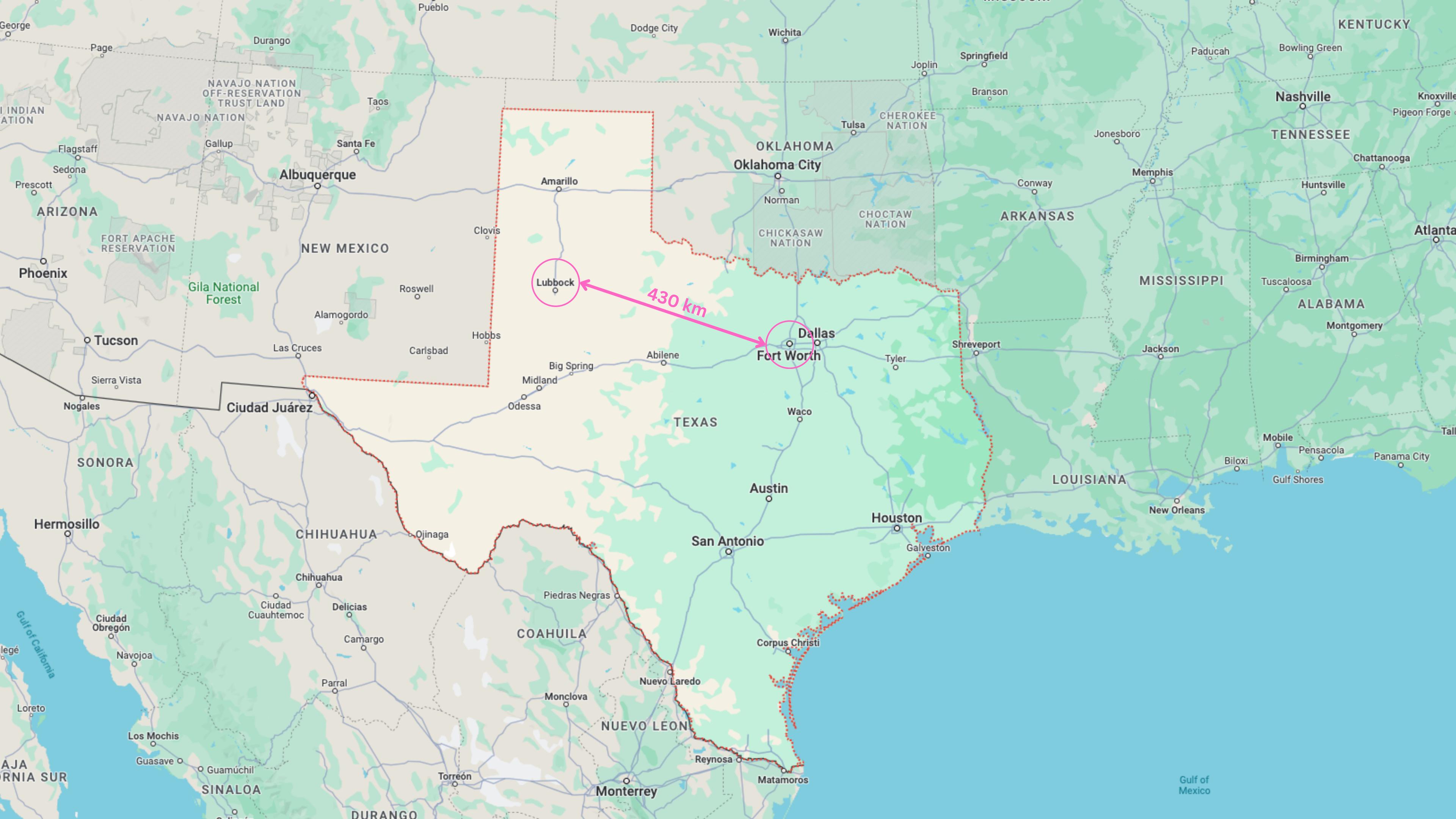
Dallas/Fort Worth, TX: 0.20
Chicago, IL: 0.19
Atlanta, GA: 0.19
Denver, CO: 0.19
Charlotte, NC: 0.17

CENTRALITIES CORRELATION

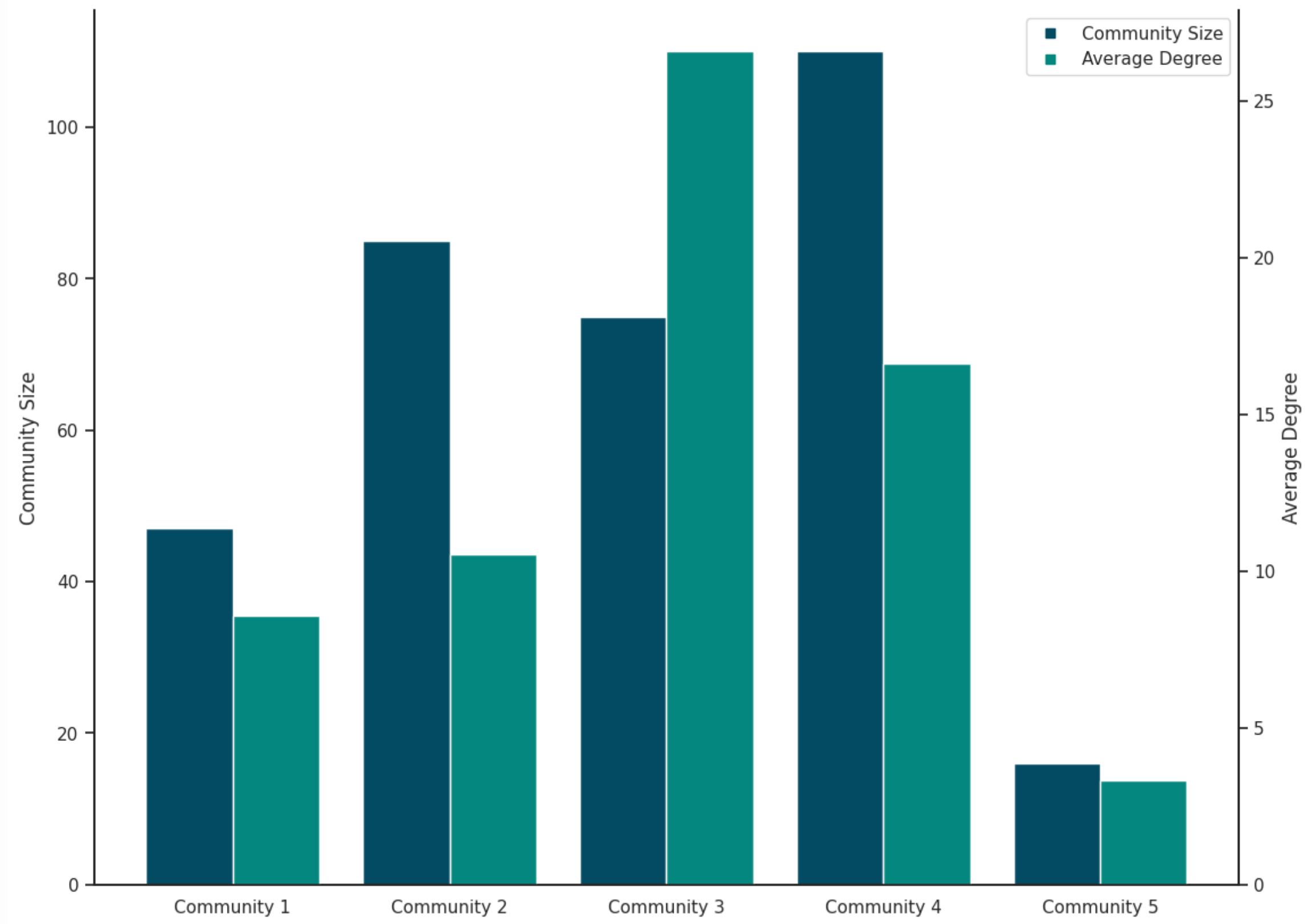








COMMUNITY DETECTION



COMMUNITY DETECTION

Community 1:

- 47 cities
- Mostly southern states (TX, AZ, LA, AL...)
- Fairly low average degree
- Highest degree cities:
 - Dallas/Fort Worth, TX: 175 connections
 - Atlanta, GA: 143 connections
 - Baton Rouge, LA: 5 connections

Community 2:

- 85 cities
- Eastern states
- Highest degree cities:
 - Chicago, IL: 150 connections
 - Minneapolis, MN: 95 connections
 - Sanford, FL: 63 connections

Community 3:

- 75 cities
- Mostly north-eastern states (NY, OH, MD, PA...)
- Very high average degree
- Highest degree cities:
 - Charlotte, NC: 115 connections
 - Washington, DC: 98 connections
 - New York, NY: 96 connections

Community 4:

- 10 cities
- Mostly western states (CA, UT, OR, NV...)
- Highest degree cities:
 - Denver, CO: 154 connections
 - Phoenix, AZ: 122 connections
 - Las Vegas, NV: 116 connections

Community 5:

- 16 cities
- Only Alaska
- Highest degree cities:
 - Anchorage, AK: 22 connections
 - Juneau, AK: 6 connections
 - Ketchikan, AK: 4 connections

LINK PREDICTION

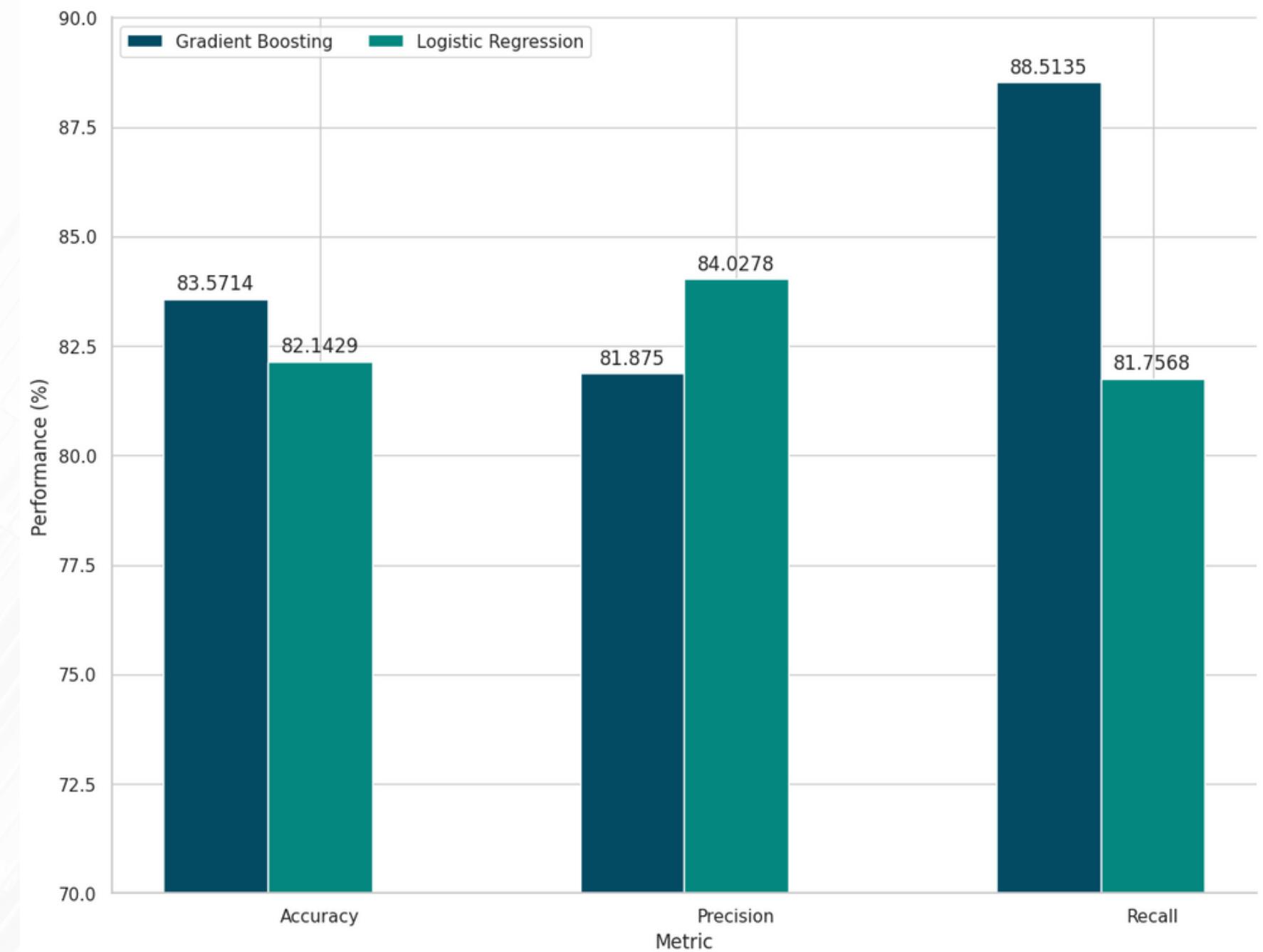
Time Span: January 2008 - January 2023

New Connections: 698

Predictors:

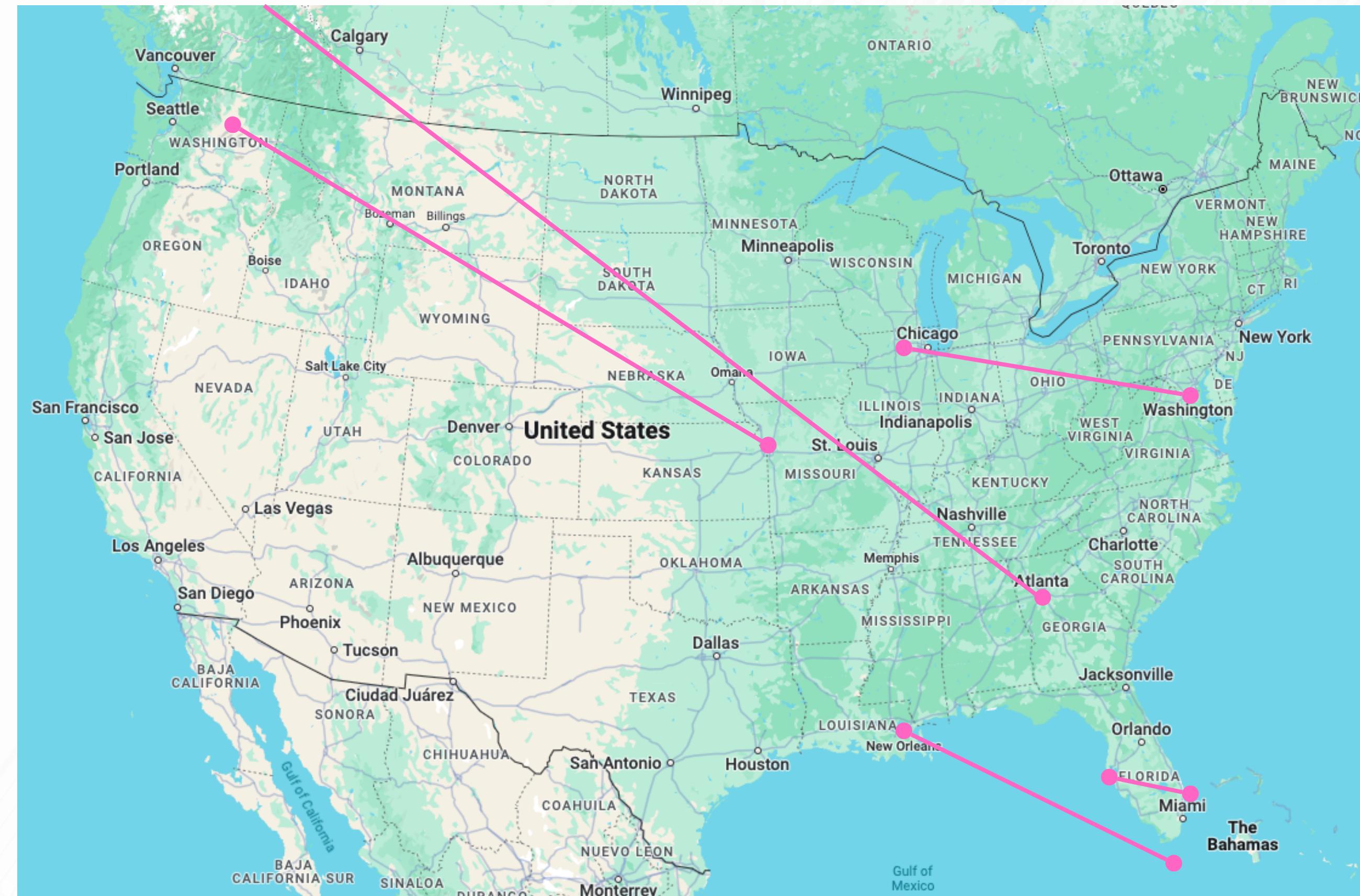
- Jaccard Coefficient
- Resource Allocation Index
- Adamic-Adar Index
- Preferential Attachment Score
- CCPA Score

Models: Logistic Regression & Gradient Boosting



MOST LIKELY FUTURE CONNECTIONS

- Washington, DC -> Rockford, IL (90.24%)
- Key West, FL -> New Orleans, LA (90.83%)
- Spokane, WA -> Kansas City, MO (90.84%)
- Palm Beach, FL -> Bradenton, FL (95.40%)
- Anchorage, AK -> Atlanta, GA (96.18%)



A black and white photograph showing the wing of an airplane in the upper left corner, flying above a dense layer of white, cumulus-like clouds against a dark sky.

THANK YOU FOR YOUR ATTENTION

Jan Philip Richter - Network Science