



Why the Heck is my Plane Late?

By Logan Eades, Tim McDonald, and Tom Zwiller

Background

Per the Bureau of Transportation² in 2024,
78% of flights were on time

- 7.51% Aircraft Arriving Late
- 6.44 % Air Carrier Delay
- 5.52% National Aviation System Delay

Image Source: <https://x.com/WindhamPridgen/status/1882551722977140751>



Objective: To understand how storm delays
in one area of the country can impact other flights



1,044,764,461

Passengers flew in the United States in 2024³



Network Structure



Ego The airport a flight departs from

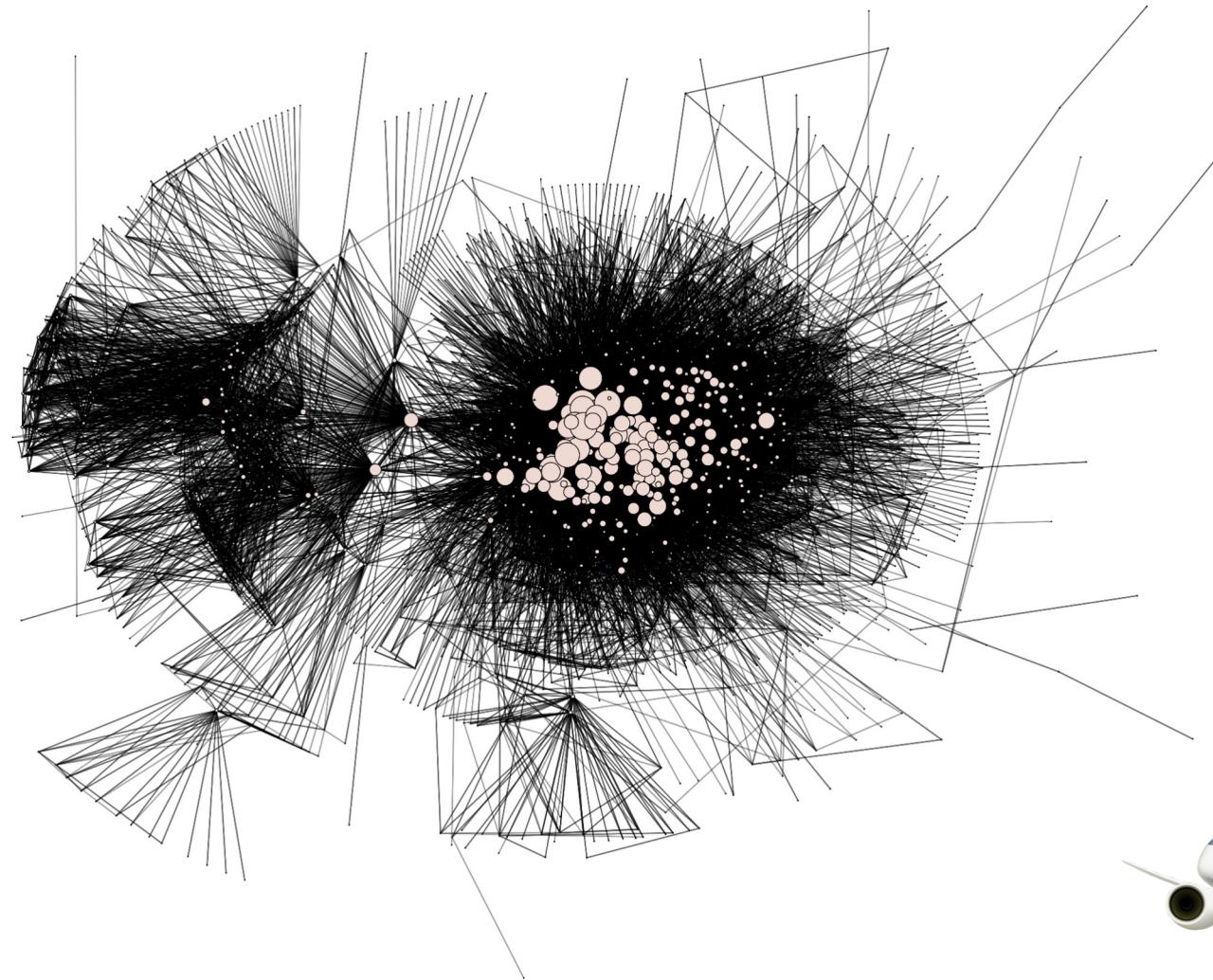
Alter The airport a flight arrives at

Edge The flight itself, weighted by the number
of passengers for the year 2010

Top Degree Counts

Airport	Node Count	Airport	Node Count
Hartsfield Jackson Atlanta	596	Middlebury State (VT)	1
O'Hare International	549	Cinnabar (Alaska)	1
Dulles International	529	Fort Bidwell (CA)	1
JFK International	526	Lee Airport (MD)	1
LA International	522	Sikorsky Airport (CT)	1

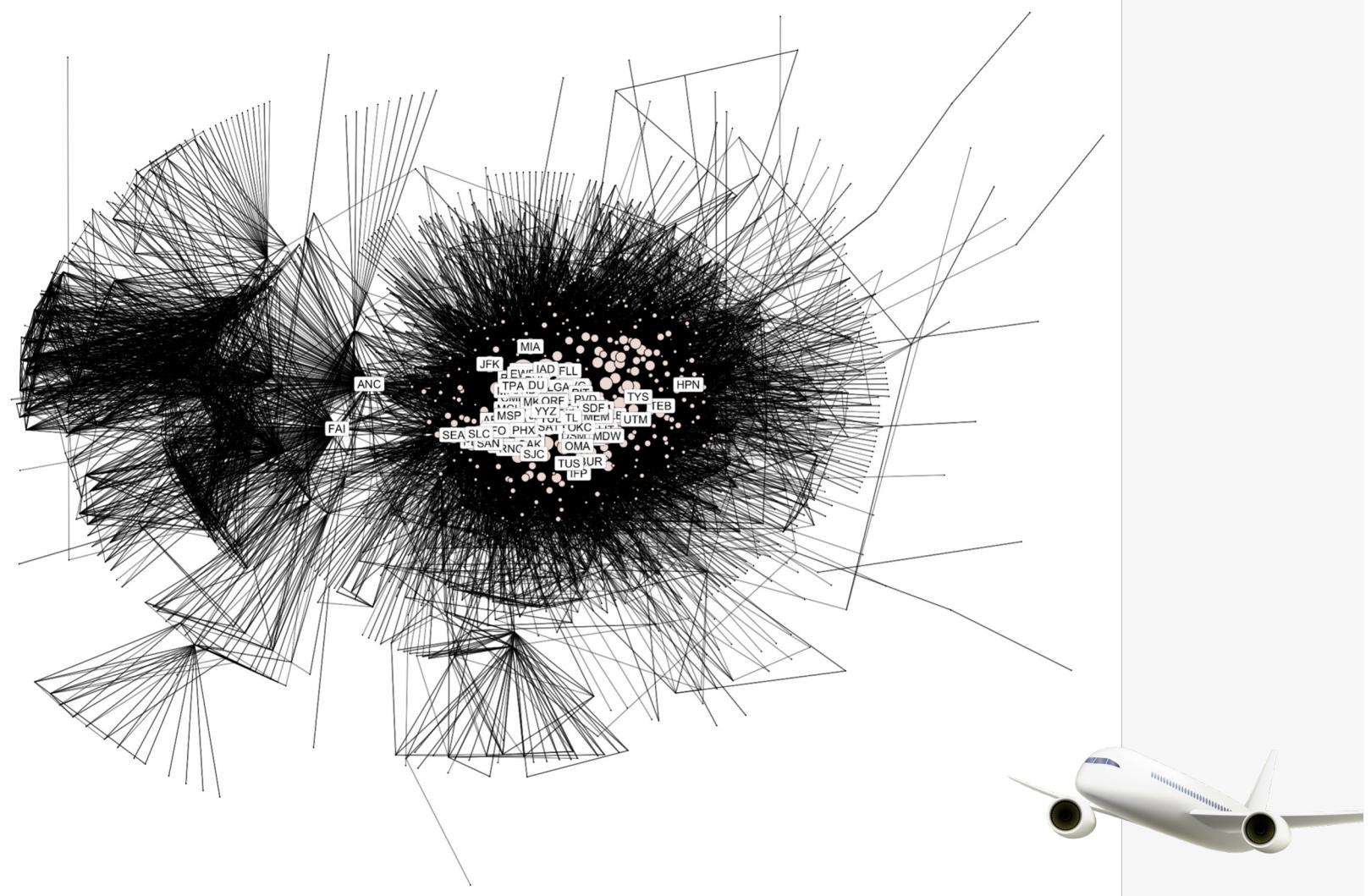




Eigenvector

Airport	Eigenvector	Airport	Eigenvector
O'Hare International	1.000	Hogan Airport (NY)	X > 0.00000001
Hartsfield Jackson Atlanta	0.997	Laconia Municipal (NH)	X > 0.00000001
Detroit Metro	0.981	Westerly State (RI)	0.00000004
Minneapolis-Saint Paul	0.966	St. Thomas Seaplane (VI)	0.00000007
Dallas Fort-Worth	0.958	Patuxent River (MD)	0.0000002





Top Flights



Flight	Number of Passengers	Distance Traveled	Flight Time	Flight Cost (2025)
SFO to LAX	1,489,618	337.52 miles	1 hr 30 min	\$214 (SW)
LAX to SFO	1,485,008	337.52 miles	1 hr 30 min	\$234 (SW)
LAX to JFK	1,466,962	2,469.45 miles	5 hr 40 min	\$799 (Delta)
JFK to LAX	1,441,376	2,469.45 miles	5 hr 40 min	\$799 (Delta)
MCO to ATL	1,310,880	403.60 miles	1 hr 30 min	\$479 (SW)
ATL to MCO	1,295,182	403.60 miles	1 hr 30 min	\$479 (SW)

Flight pricing info from Southwest and Delta

Triad Census

Triad Type	Description	Count
003	No ties, 3 Null	620,858,679
102	1 Mutual, 2 Null	15,166,971
012	1 Asymmetric, 2 Null	8,765,143
111U	Mutual, Asymmetric	277,823
111D	Mutual, Asymmetric	215,419
300	3 Mutual	116,256



Network Metrics

Average Transitivity: 0.223

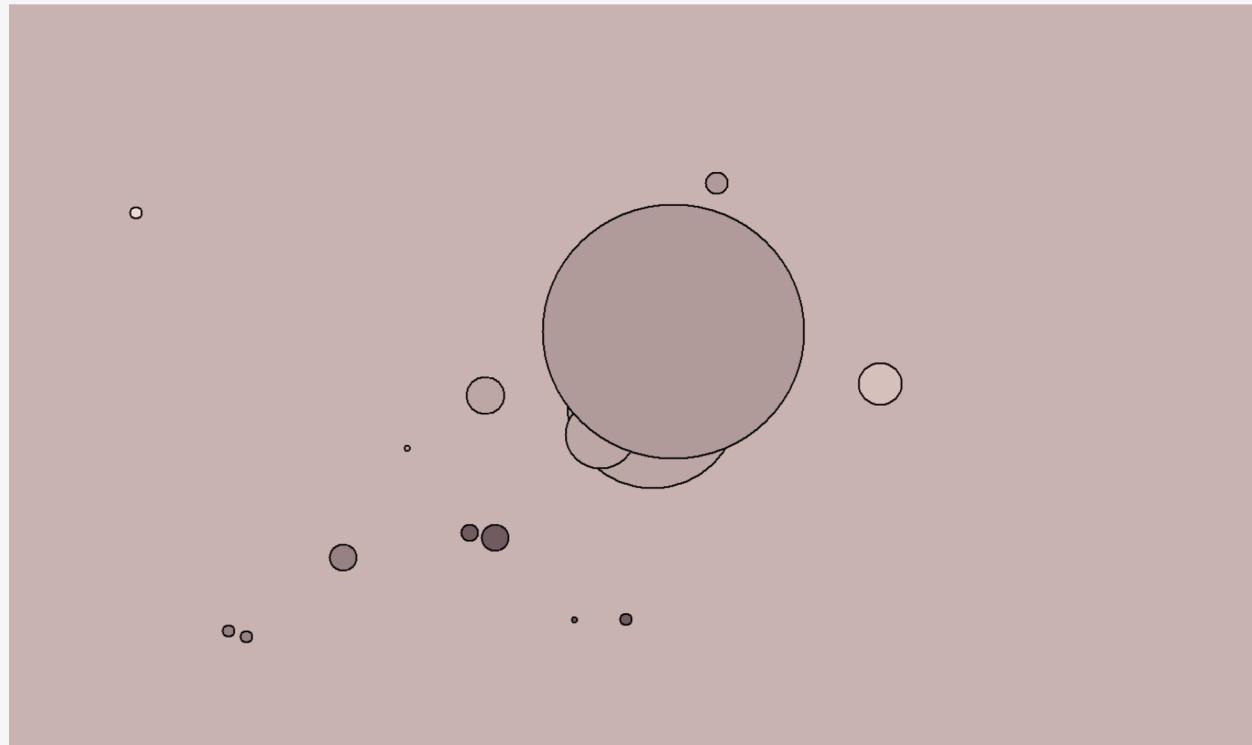
Average Local Efficiency: 0.614

Diameter: 8

Density: 0.011

Global Efficiency: 0.306

Clusters and Communities



Clusters Breakdown



Cluster 1	Very small-town USA/Canada airports
Cluster 2	Heavy military bases cluster
Cluster 3	Larger domestic commercial airports
Cluster 4	International travel hubs
Cluster 5/6/7	Specialized and remote operations
Cluster 10	Small support airports for larger metro areas

Multilevel Modeling: Random Intercept Model

- Estimated a random intercept model predicting relationship strength from Airport with random effects for Ego



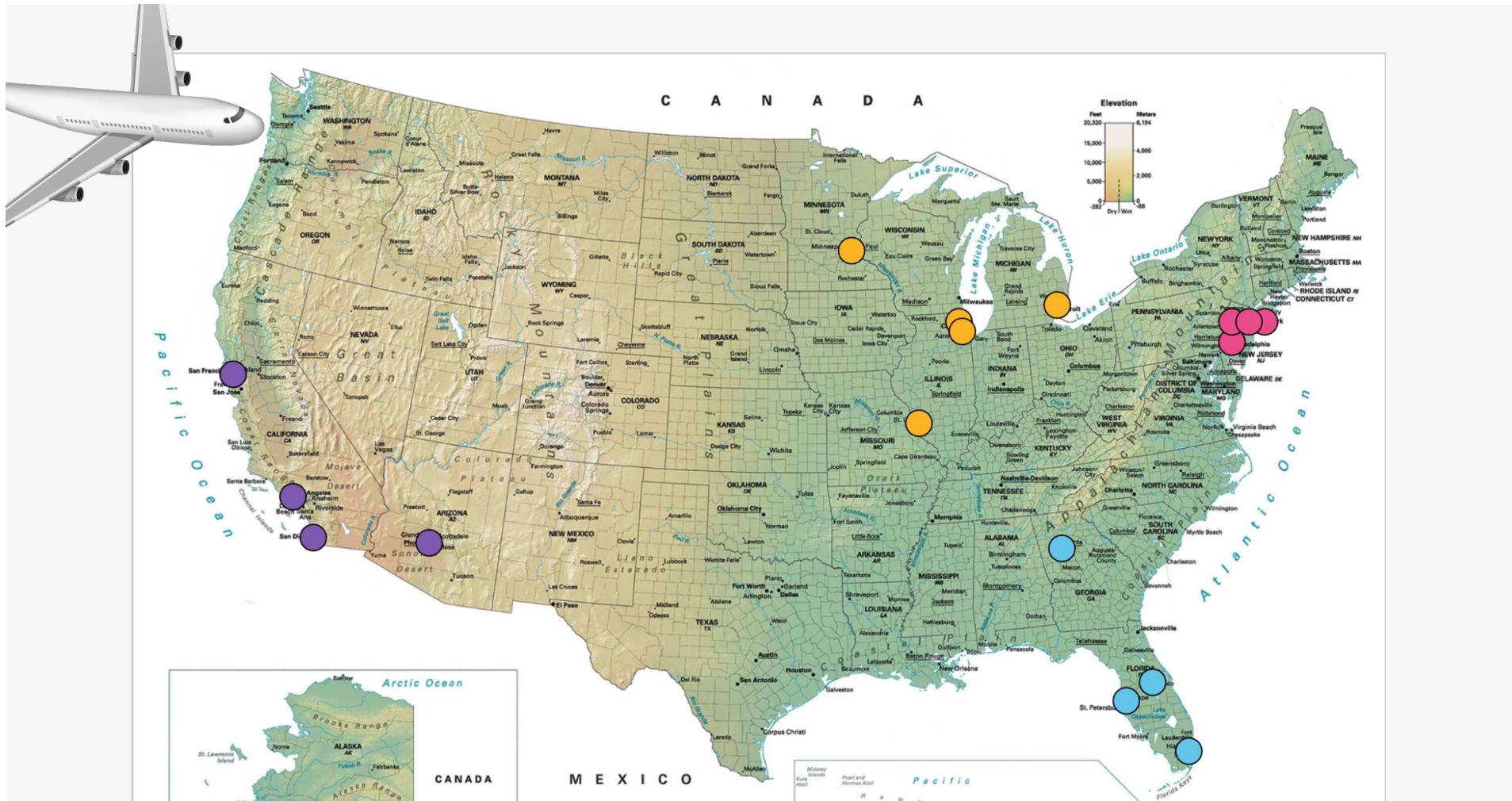
Intraclass Correlation Coefficient

Adjusted ICC	0.150
Unadjusted ICC	0.131



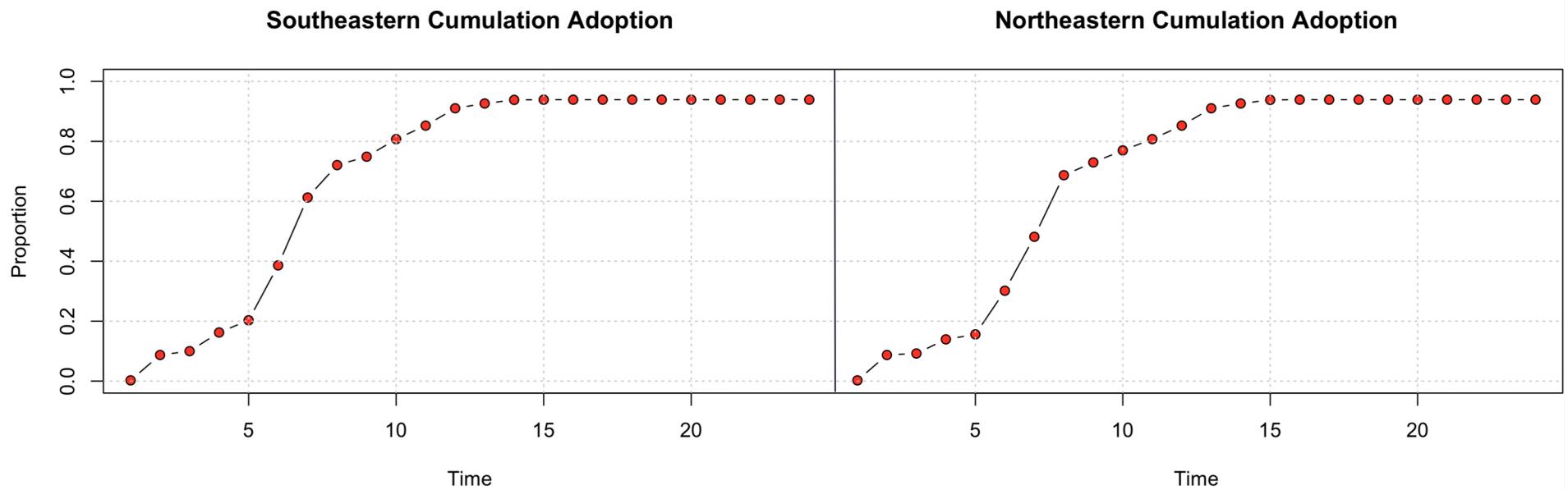


Airport Simulations

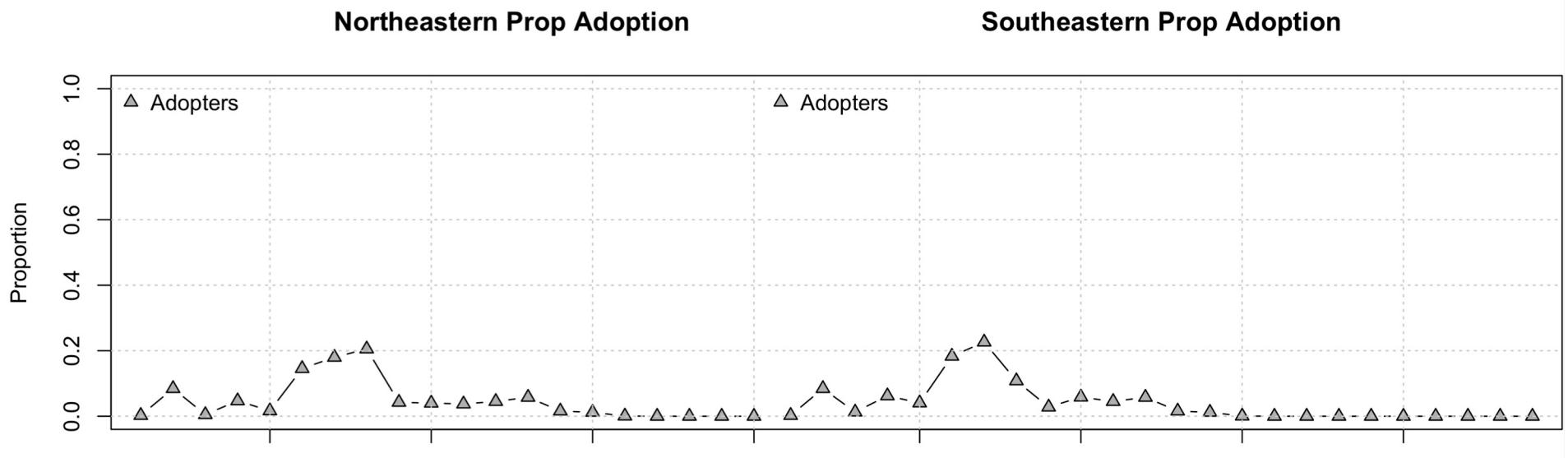


Map source: <https://gisgeography.com/map-of-usa/>

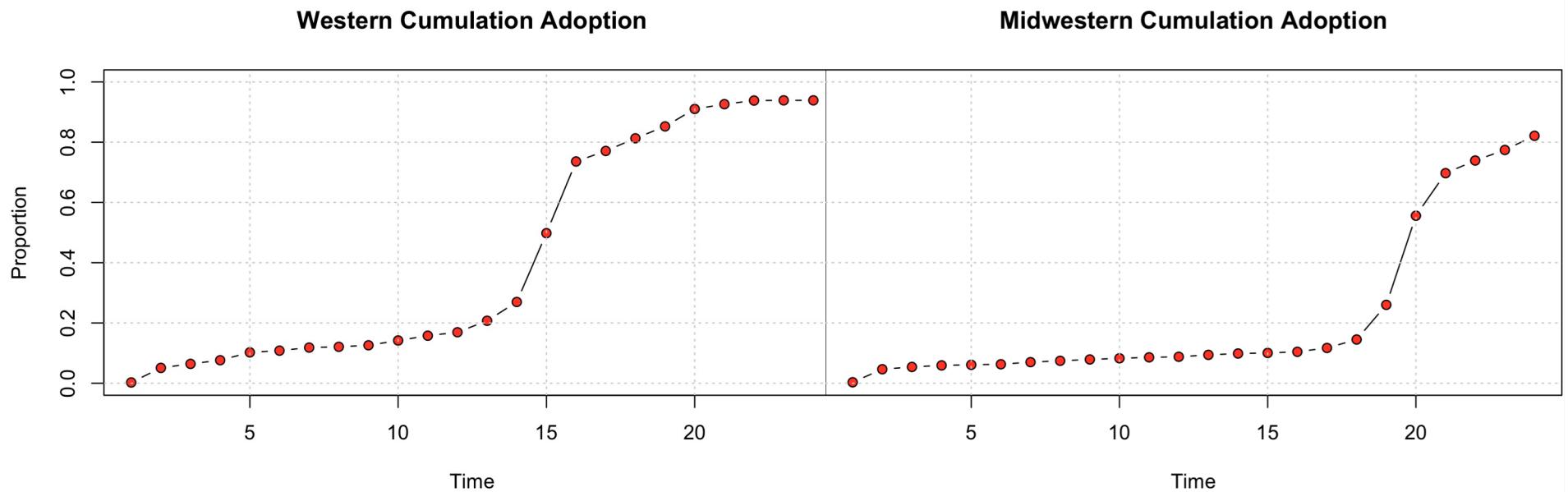
SE and NE Simulation



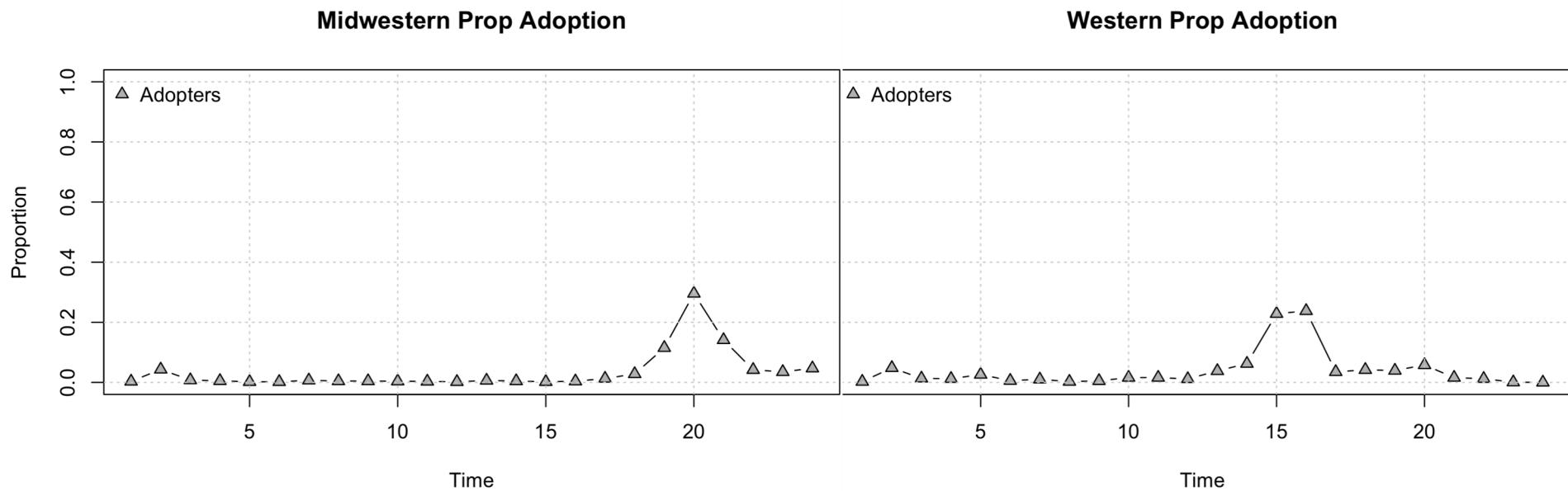
SE and NE Simulation Cont.



MW and WE Simulation



MW and WE Simulation Cont.



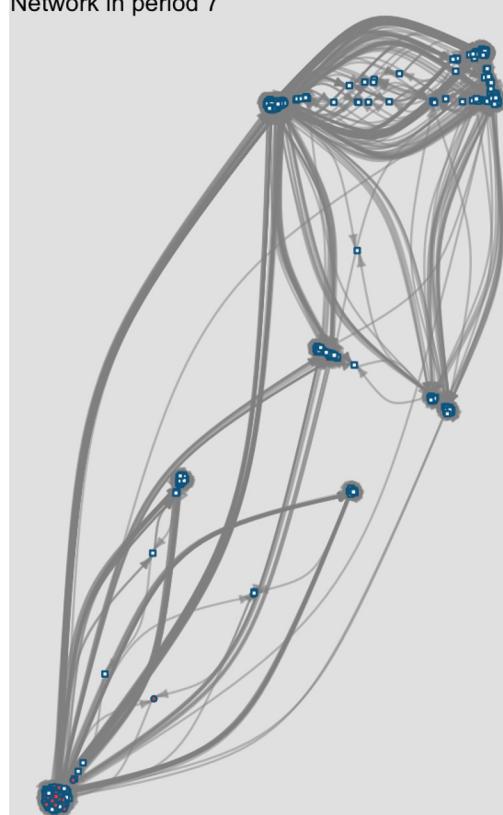
SE Simulation Cont.

Diffusion Network

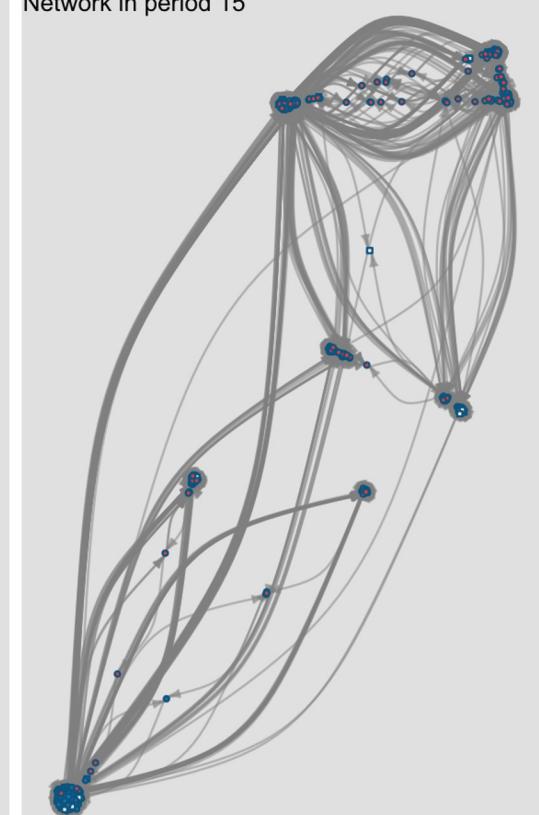
Network in period 1



Network in period 7



Network in period 15

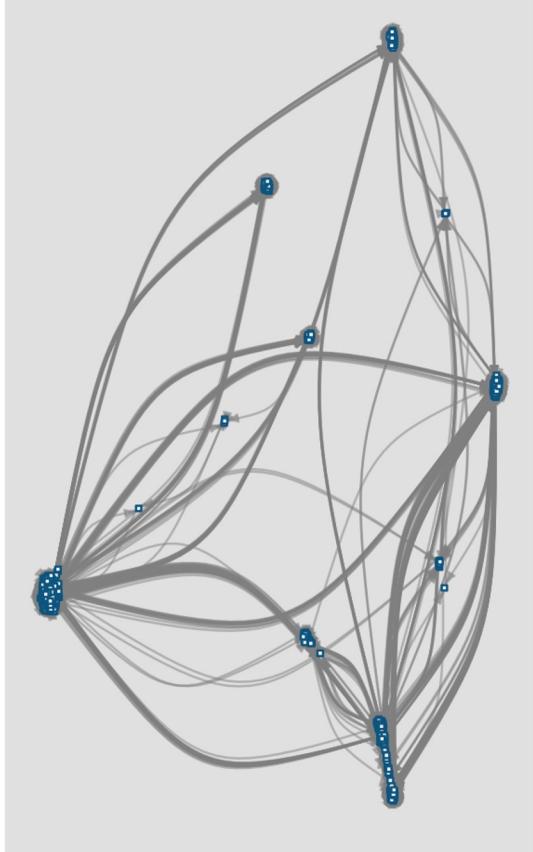


□ Non adopters ● New adopters ● Adopters

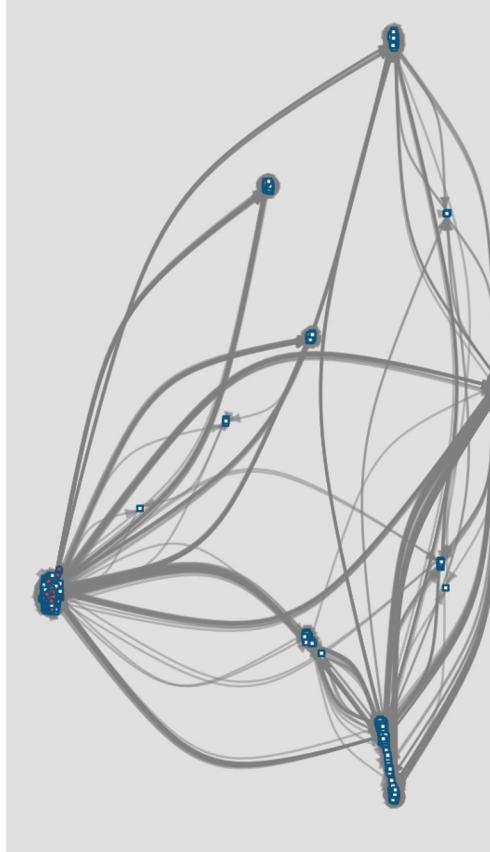
NE Simulation Cont.

Diffusion Network

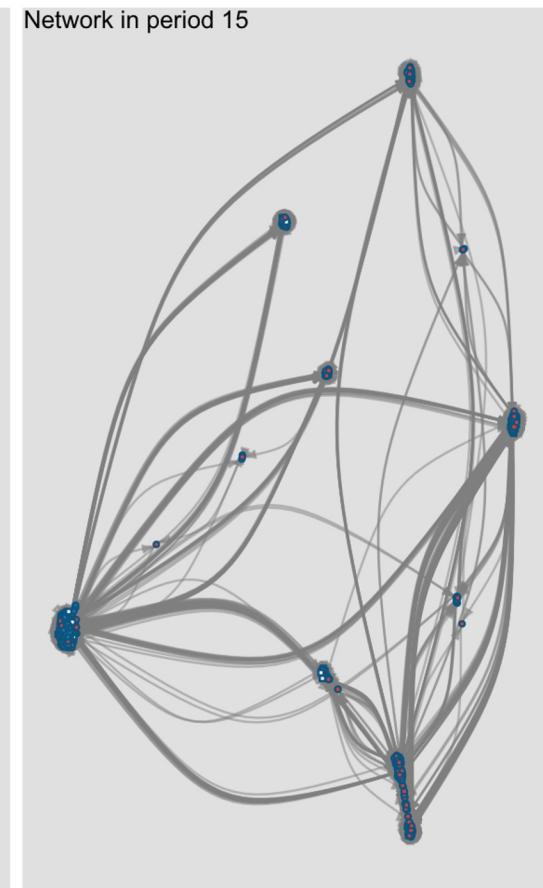
Network in period 1



Network in period 7



Network in period 15

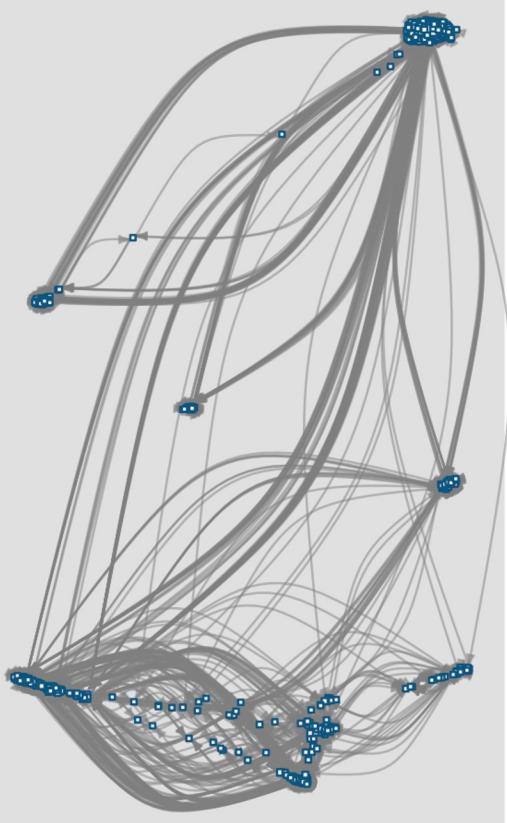


□ Non adopters ● New adopters ● Adopters

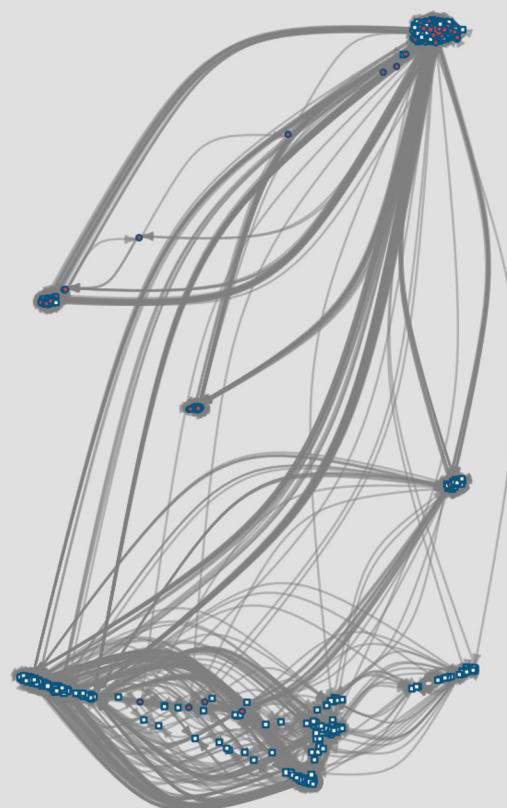
MW Simulation Cont.

Diffusion Network

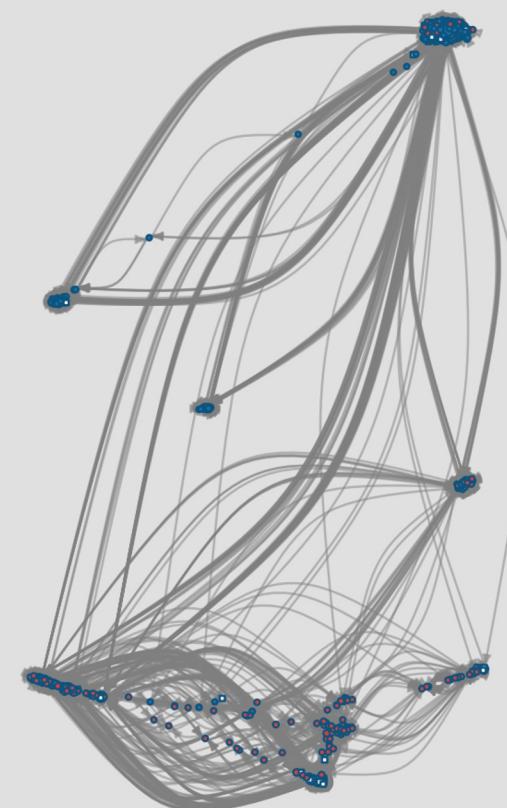
Network in period 1



Network in period 15



Network in period 20



□ Non adopters ● New adopters ● Adopters

Findings

- Low density but incredibly complex, efficient network
- Infections tended to be more impactful when starting in the east
 - Hitting key clusters rapidly spreads delays
- Limitations
 - The network didn't have any characteristics for airports
 - Each edge was weighted to the number of passengers to take that flight
 - Network did not factor in flight distance or frequency





Questions?



Degree
Centrality

Eigenvector
Centrality



Sources

- 1: <https://x.com/WindhamPridgen/status/1882551722977140751>
- 2: https://www.transtats.bts.gov/OT_Delay/OT_DelayCause1.asp?20=E
- 3: https://www.faa.gov/air_traffic/by_the_numbers/media/Air_Traffic_by_the_Numbers_2024.pdf
- 4: <https://www.southwest.com/?src=SRCH>
- 5: <https://www.delta.com/flightsearch/book-a-flight?cacheKeySuffix=a69cf598-8e17-491c-9c3d-190014551393>
- 6: <https://gisgeography.com/map-of-usa/>

Credits: This presentation template was created by **Slidesgo**, including icons by **Flaticon**, infographics & images by **Freepik**

