Mathematical Humanists: Graph Theory and Networks Self-Guided Workshop

Exercise #2: Conference Travel Network

Pick your favorite professional society or other group that holds an annual meeting. We are going to construct a network of all the travel you (and your friends, if you want to build a larger network) would have undertaken if you'd attended every annual meeting for the past 10 years.

Step 1: Look up the locations of their annual meetings for the past 10 years. Also make note of the places you have lived (long-term or short-term) during that same time period.

Step 2: For each meeting, determine the method you would have travelled from the place you were living at the time to the place the meeting was held. Would you have flown? Would you have taken a train? A metro? A ferry? Would you have driven?

Step 3: For each trip, make a list of any intermediate places you would have stopped along the way. E.g. if you flew from Washington, D.C. (IAD) to Vancouver, Canada (YVR) and had a layover in San Francisco, CA, (SFO) your trip would have been IAD to SFO to YVR. Be as detailed as you want.

Step 4: Write down any additional information about your travel that you consider important.

Step 5: Now that you've gathered the basic information you'll need, ask yourself: what will count as nodes? What will count as edges? Is there any additional data you would like to "attach" to your nodes and/or edges?

Step 6: Draw your network! Make each node a circle, connected by lines for edges. "Attach" data to nodes or edges by writing it by its respective node or edge.

Step 7: Looking at your network, think about what questions this network will allow you to ask and answer.

Step 8: Let's get feisty and *invert* our network. Let's take the things you counted as edges and now consider them to be nodes. That means your former nodes are now the edges.

Step 9: Draw your network! Make each node a circle, connected by lines for edges. "Attach" data to nodes or edges by writing it by its respective node or edge.

Step 10: Look at your inverted network. How do the questions we can ask and answer differ when we re-create the network this way?

Optional: Look at the Exercise #2 Sample Network. How do your networks differ? How are they similar? What kinds of questions interested you that can't be answered by the Sample Network? What kinds of questions can be answered using the Sample Network that can't be answered in your example?

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Exercise #2 Sample Network

Steps 1 & 2

American Historical Association Annual Meetings 2016-2025

2025: New York City – *train*
2024: San Francisco – *plane*
2023: Philadelphia – *train*
2022: New Orleans – *plane*
2021: Seattle [cancelled but we'll pretend it wasn't] – *plane*
2020: New York City – *train*
2019: Chicago – *plane*
2018: Washington, D.C. – *car then train*
2017: Denver – *plane*
2016: Atlanta – *plane*

lived in Washington, D.C. metro area and Pittsburgh

Steps 3 & 4

2025: Fairfax to WAS to NYP to New York Hilton (Amtrak)
2024: Fairfax to IAD to SFO to Hilton San Francisco Union Square (United Airlines)
2023: Fairfax to WAS to PHL to Philadelphia Marriott Downtown (Amtrak)
2022: Fairfax to IAD to MSY to New Orleans Marriott (United Airlines)
2021: Fairfax to IAD to SEA to Sheraton Seattle (United Airlines)
2020: Fairfax to WAS to NYP to New York Hilton (Amtrak)
2019: Fairfax to IAD to ORD to Hilton Chicago (United Airlines)
2018: Pittsburgh to Fairfax to Vienna/Fairfax-GMU Metro Station to Metro Center Metro Station to Woodley Park-Zoo/Adams Morgan Metro Station to Marriott Wardman Park (WMATA)
2017: Pittsburgh to PIT to DEN to Hyatt Regency Denver (United Airlines)
2016: Pittsburgh to PIT to ATL to Hilton Atlanta (Delta Airlines)

Step 5

nodes = places (*place name)*
edges = traveling from place to place (*type of transport, carrier, year of travel)*

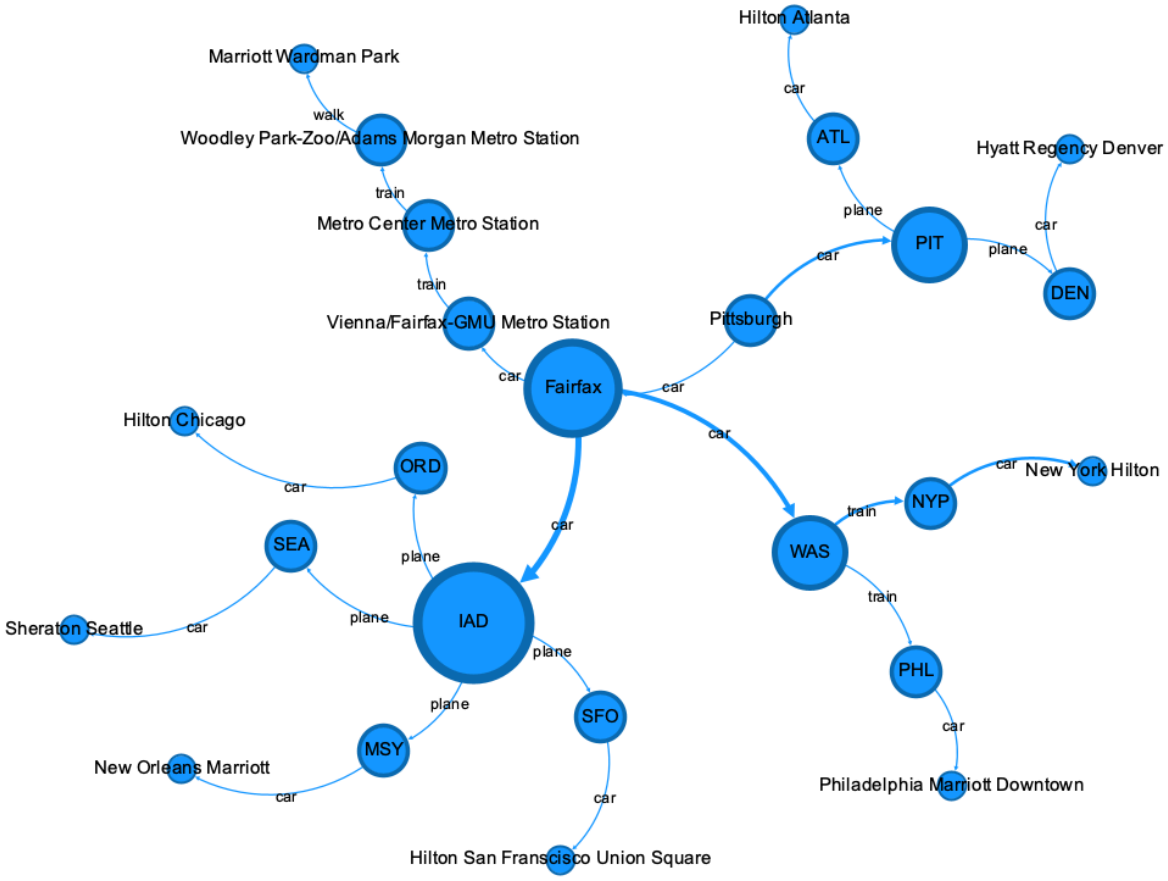
Steps 6 & 7, version 1 (more concise):

See how the edge lengths don't correspond to distance: San Francisco is a lot further away from Washington, D.C. than Philadelphia is, but it doesn't look that way in the network diagram!

Questions that immediate arise from looking at this include things like:

1. where does the conference happen most often? *(New York City, but only 2x)*
2. how many stages of travel do I usually have, going to a conference? *(just one)*
3. what kind of transportation do I usually take? *(plane, but train a close second)*
4. are there any obvious relationships between transportation type and destination city? *(plane for any trip that would require more than 4-5 hours of ground travel, train is preferred ground transportation for up/down the Eastern seaboard, car otherwise)*

Steps 6 & 7, version 2 (more complex):



Notice how this more complex format gives us more detailed travel information and changes the answers to the questions we asked above.

The role of cars (mine and taxis) as originating/terminating forms of ground transportation becomes more apparent. We can see the structural role the airport IAD and the train station WAS play in separating out plane and train travel. We can also see the complex trip on Washington, D.C.'s Metro (WMATA), which was previously obscured by only looking at city-level data.

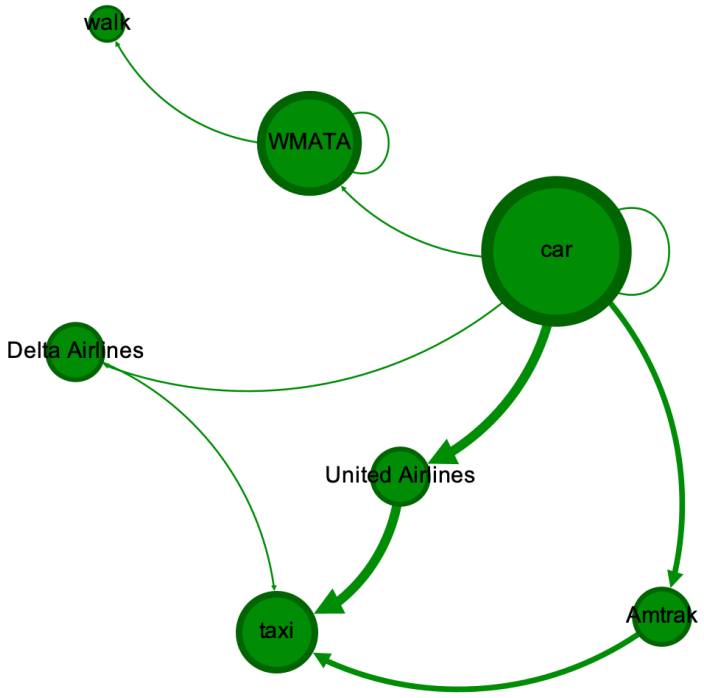
Neither of these networks is inherently better than the other. If you are interested in how the choice of conference location impacts travel, the first, more concise version network will help

you study that more easily. If you are interested in the carbon impact of conference travel, the second, more complex network will help you study that at every stage of travel.

Steps 8 & 9:

To invert our network, we'll need to rethink our data a little.

2025: car to Amtrak train to taxi
2024: car to United Airlines plane to taxi
2023: car to Amtrak train to taxi
2022: car to United Airlines plane to taxi
2021: car to United Airlines plane to taxi
2020: car to Amtrak train to taxi
2019: car to United Airlines plane to taxi
2018: car to car to WMATA train to WMATA train to walk
2017: car to United Airlines plane to taxi
2016: car to Delta Airlines plane to taxi



Questions that immediate arise from looking at this include the relationship between different types of transportation. You can see the central role of my personal car in getting to both the airport and train stations, my preference for United Airlines over Delta Airlines, the role of the taxi in getting me from long-distance public transportation to conference hotels, and the way the Washington, D.C. Metro system got me close enough to my final destination that I walked rather than relying on another vehicle to get me that last distance.

One thing this network obscures is the geographical distance I'm traveling. So if you're more interested in space than transportation methods, our first network is the better way to go.