GEOG 4140/6140 – Winter 2021
Lab 11: Network Analyst
Due Thursday, April 15th by 11:59 PM

Overview
This lab explores functions and applications of the Network Analyst toolbox. This toolbox contains toolsets for the development, management, and analysis of network datasets, including simple and complex routing problems. The Network Analyst toolbox is based on a transportation network data model that allows users to accurately represent their unique requirements of the network they need to establish. Among other things, the network analyst allows users to create routes for a single vehicle or an entire fleet, calculate drive times and customize the network based on real-time impediments. In this lab, we will learn how to create routes, create the most efficient routes, build barriers, analyze service areas, and perform location-allocation analyses.

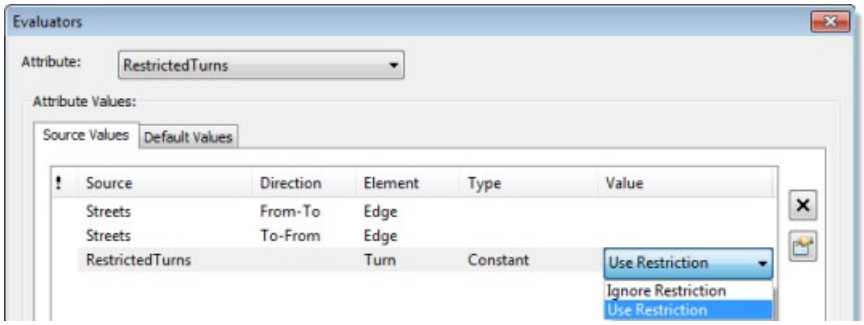
The following resource may be of use in completing this assignment:
Network Analyst, Network Dataset, Route, Service Area, Route, Barriers, Stops
Copy feature datasets, feature classes, and tables to a geodatabase
What is the ArcGIS Network Analyst extension?
An overview of the Network Dataset toolset
What is a network dataset?
Make Network Dataset Layer
An overview of the Network Analyst toolbox

Required Data (*Source*)
1. *Analysis* feature dataset (*Lab GDB on Canvas*)
    a. *CandidateStores* point feature class
    b. *CompetitorStores* point feature class
    c. *ExistingStore* point feature class
    d. *FireStations* point feature class
    e. *TractCentroids* point feature class
2. *Transportation* feature dataset (*Lab GDB on Canvas*)
    a. *RestrictedTurns* line feature class
    b. *Signposts* line feature class
    c. *Streets* line feature class
3. Tables (*Lab GDB on Canvas*)
    a. DailyProfiles
    b. Signposts_Streets
    c. Streets_DailyProfiles

Workflow

Part 1: Create a Network Dataset

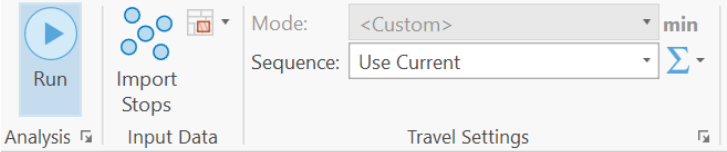
1. Creation of a Network Dataset is not yet implemented in ArcGIS Pro; thus, open ArcCatalog to create your network dataset.
    a. If the extension is not already enabled, enable Network Analyst via the Customize -> Extension drop down menu.
2. While still in ArcCatalog, connect to the folder ( ) on your N drive where the geodatabase from Canvas is stored.
3. To create the Transportation network dataset, right click on the Transportation feature dataset contained in the Lab 11 Geodatabase and click New -> Network Dataset.
4. Follow along the New Network Dataset Wizard, use default options unless otherwise specified:
    a. Name the new dataset "Streets_ND".
    b. Keep attributes for the network dataset as default, Network Analyst analyzes the source feature class to look for common fields and import them as done here.
        i. Add a new attribute to restrict the movement over the turn elements created earlier.
            1. Click Add; input "RestrictedTurns" in the Name field.
            2. Usage Type is *Restriction* and Restriction Usage is *Prohibited*.
            3. Keep Use by Default checked and click OK.
        ii. With this new Restricted Turns attribute highlighted, click Evaluators.
            1. For the RestrictTurns row, click under the Type column and choose Constant.
            2. Click the Value column and choose Use Restriction. Click OK to Close



        iii. Finally turn off the "Use by Default" option for Hierarchy by right clicking it in the list.
    c. Check the box next to "Build Service Area Index".
    d. Click Next and then Finish. When prompted, click yes to build the new network dataset. This will take a few minutes, if longer be sure the output is going to your N drive using the correct path.
    e. Check that your Network Dataset was created and covers the study area by selecting "Streets_ND" and then Preview. Close ArcCatalog when finished.

Part 2: Create a Route

1. Open ArcGIS Pro and create a new project titled *Lab11YourLastName* in your working directory for this lab.
2. Add the "Streets_ND" network dataset you just created to your map.
3. Create a **Route** (Analysis tab > Network Analysis > Route).
    a. A validation should be performed and then a 'Route' layer added to the contents pane in your map document.
4. In the contents pane, click your Route and then in the top ribbon in the Network Analyst: Route tab, you are now able to see all of the associated options and analyses available.
5. Now, create stops along your route. Think of stops as places you need to go on the way to your final destination. Use the **Create Features** option in the Edit tab with the Route: Stops template, be sure to save your edits when finished. Create 5 stops in the area covered by the Network Dataset.
6. Edit the attributes by renaming each of the five stops "Stop1" through "Stop5".
    a. Additionally, add a number 1-5 to the sequence field to correspond to the name.
    b. Save your edits.
7. In the Network Analyst: Route tab, run the route analysis with your new sequence, selecting "Use Current" as your sequence option.



8. Now, find the most efficient way to visit all of the stops while preserving your initial starting location.
    a. Change "Use Current" as your sequence option to "Preserve First Stop". This will show the best route based on driving time to visit all five of your stops, while starting at Stop1.
    b. (If your initial sequencing matches the fastest route it is possible you won't notice a change between the two runs!)
9. Now that we know the best sequence to visit all stops, create a barrier and see how that alters the results of our previous analysis. A barrier may be a closed road, construction, etc.
    a. Add a polygon barrier using the **Create Features** option in the Edit Tab, similar to adding the stops before.
    b. Make sure your barrier overlaps a large portion of your existing route.
    c. Rerun the analysis.
10. Finally, create step-by-step directions along the most efficient route with the barrier that you created.
    a. In the Network Analyst: Route tab, click 'Show Directions' in the Directions section.
11. Save a PDF of the directions ("Print" but select Adobe PDF rather than a physical printer). Also, create a layout map of your best route and the five stops. (Deliverable 1)
    a. Follow good cartographic practice/principles adding required map elements.
    b. Export the map when finished.

Part 3: Create a Service Area

A service area layer provides the structure and properties needed to set up and solve service area problems. It also contains the results after solving.

1. Add a new map and add the 'Streets_ND' network dataset, as well as the *FireStations* point feature class.
2. Create a Service Area (Analysis tab > Network Analysis > Service Area).
3. In the contents pane, click your Service Area and then in the top ribbon in the Network Analyst: Service Area tab, you are now able to see all of the associated options and analyses available.
4. Add facilities to the analysis (a facility is the starting location of a vehicle).
    a. The service area solver simulates all possible paths that a vehicle can travel to from a defined starting point within a set amount of time.
    b. In the Service Area ribbon, import the Fire Stations point feature as your facilities.
    c. Keep all values as default.
5. Now that the 'FireStations' have been added to the Service Area, we need to set a cutoff time that defines the service area of each station. This is the maximum allowable amount of time it would take for a fire station to respond to a fire within its service area.
    a. Set your cutoff time for the service area to 4 minutes and run the analysis.
    b. The results should show overlapping polygons, meaning that more than one fire station can respond to a certain incident within the specified four minutes.
6. Now, change the output geometry for your Service Area to 'Split' (the default is set to Overlap) and create a service area for each fire station without overlapping polygons.
    a. The polygon boundaries show where the response time of two fire stations are equivalent.
7. Finally, create a map that shows which areas are reached within 2 and 4 minutes from a fire station, dissolving the output geometry together.
8. Create a layout map of the two and four minute cutoff polygons with the dissolved geometry setting. (Deliverable 2)

Part 4: Location-Allocation

Location-allocation refers to analyses used to determine an optimal location for one or more facilities. These locations will service some type of demand from a given set of points. The goal of this analysis is to determine where in the study area there is demand that is not met, and then to find good locations for a candidate store.

1. Add a new map and add the network dataset "Streets_ND" as well as the "CandidateStores" feature class to your map.
2. Also, add the feature classes that represent consumer demand to the map: ExistingStores, TractCentroids, CompetitorStores.
3. Create a location-allocation layer (Analysis tab > Network Analysis > Location-Allocation).
4. Import the CandidateStores to the Location-Allocation analysis as the Facilities.
5. For the stores to best serve the nearby populations, we need to add demand points.
    a. Import the TractCentroids as the Demand Points and use the POP2000 field as the Weight property. Other values can be default.
6. Finally, set up location-allocation properties.

    a. In the location-allocation tab, in the Problem Type section, choose “Maximize Attendance”.
    b. Maximize attendance is a good problem type to choose when trying to site retail store locations. This method assumes that all retail stores are equally attractive and that shoppers generally shop at nearby stores.
7. Also under the location-allocation tab, change facilities to 3, and the cutoff as 5 minutes.
    a. These changes mean that the analysis will choose 3 locations and assume that people will not travel more than 5 minutes to get there.
    b. Now run the analysis and note the chosen locations.
8. Load the ExistingStore into the facilities, changing the Facility Type property to Required.
    a. This will force the analysis to use the existing store as one of the chosen locations.
    b. Rerun the process and notice the difference in the stores now selected when using the existing store location.
9. Finally, we want to add competing stores to take into account existing locations that customers may already utilize.
    a. Load the CompetitorStores feature as a Competitor Facility Type.
10. With competitor stores loaded, change your Problem Type to Maximize Market Share, your Cost Transformation Function Type to Power, and your Cost Transformation Function Parameter to 2.
    a. These settings affect the way that the program solves the location-allocation problem.
11. Solve this final set of inputs and create a layout map of your Location Allocation Analysis with the existing store, the competitive stores, the two additional chosen candidate stores, and the facility service areas, all using easily identified symbology. (Deliverable 3)

Deliverables

1. Route Map and Directions pdf. (7 points)
2. Two and Four minute Service Area map. (7 points)
3. Location-Allocation map. (7 points)