Title: Networking Analysis

Critical Resources: an internet connected computer, ArcGIS Pro, lab 4 datasets.

Purpose: The purpose of this lab will be for you gain experience and knowledge with generating service areas and routes related to a disaster recovery event using networking analysis tools. The lab is based on a real-life flood disaster recovery case study from St.Louis, MO USA.

The purpose of this lab will be for you gain experience and knowledge with.

Learning Objectives – After completing the lab, you will know:

- How to filter datasets using SQL to conduct focused analysis
- How to generate service areas using network analysis tools.
- How to generate routes using network analysis tools.
- How to generate barriers using network analysis tools.

Deliverables:

Maps created via response to the instruction questions. Upload your write-up to the lab 4 drop box on myCourses.

Steps:

Task 1 – Download data sets

Step 1: Down the lab_4_datasets.zip from myCourses

Step 2: Unzip the datasets

Unzip the datasets to a location where you can find them easily, like the C:\temp folder.

Before proceeding with the next tasks, open ArcGIS Pro. Add a basemap, like OSM, to ArcGIS Pro to provide context. Move you map to 90.375230W 38.564830N to center over St. Louis, Missouri, USA.

Task 2 – Add and filter dataset

Data from the United States Environmental Protection Agency (US EPA) Disaster Debris Recovery Tool will be used in this exercise. The entire data set has been included for possible follow-up exercises related to using GIS for debris recovery. However, for this exercise, you will filter this data set so as to be relevant to the St. Louis Missouri 2015 flooding case study. Filtering the dataset will also giving you a reinforcement of using basic SQL WHERE, OR, and AND clauses as well as order of query interpretation that you learned earlier in the semester.

Step 1: Add EPA Recovery Centers shapefile to your map

In this step, you will add a shapefile of recovery centers to your map.

ArcGIS Pro Quick Steps Reference: Map Tab > Add Data > Data > Browse for EPA_Recovery_Centers.shp

Step 2: Filter data so only Recovery Centers from the city of St. Louis are displayed

As you will see when adding the recovery centers shapefile to your map, there are numerous recovery centers from all over EPA Region 5 and surrounding states like Missouri where St. Louis is located. The attribute table of the recovery centers shapefile contains an attribute field 'city' whose values we will use to filter the dataset display so we are only looking at recovery centers within our study area of St. Louis County. Also, the EPA dataset has inconsistent ways in which St. Louis is documented in the 'city' attribute column. In some records, it is spelled 'St Louis', in other records, it is spelled 'Saint Louis'. You will create an OR query so both values are used in the filters.

To filter so only Recovery Centers from the city of St. Louis are displayed:

ArcGIS Pro Quick Steps Reference:

Right click EPA_Recovery_Centers in Contents pane > Properties > Definition Query > New definition query > Where 'City' is equal to 'Saint Louis'

After creating this query, click the + Add Clause button and below the cause you just entered, enter:

'Or' 'City' is equal to 'St Louis'

Click the Apply button. It should show Query 1 as

City = 'Saint Louis' Or City = 'St Louis'

Click the OK button to apply the query (filter) to the dataset. If the definition query was entered successfully, the display of 48 recovery center points should only be around the St. Louis area now.

Step 3: Add Disasters shape file to your map

In this step, you will add a shapefile of disaster spots to your map.

ArcGIS Pro Quick Steps Reference: Map Tab > Add Data > Data > Browse for disaster_spots.shp

Step 4: Add Routes Shapefile (QGIS) or Network dataset (ArcGIS Pro) to your map
In this step, you will a data layer that will be used as the basis for the actual routing done later in the exercise. In ArcGIS Pro, you will add a network dataset that is an Esri-proprietary data format used with the Network Analyst tool.

For ArcGIS Pro, follow these steps:

Map Tab > Add Data > Data > Browse for Street_Centerlines_Subset_ND.nd (Shapefile Network)

In future steps, ArcGIS Pro will create analysis layers using Street_Centerlines_Subset_ND.nd as the Network Data Source

Task 3 – Defining Service Area for Sustainable Recovery – Electronic Debris Recycling

Future disaster debris recovery efforts will focus more on sustainable debris recovery, such as separating e-waste from other debris streams for recycling instead of sending all disaster debris to landfills.

In this task, you will generate service areas that show where electronic recycling services are offered. These service areas will be the basis for creating routes in Task 4 where stops will be made between the two disaster locations and one of recovery centers that offers electronic recycling services.

Step 1: Additional Filtering for Electronic Recycling Centers

Before generating the service area, you will add one more filter to the recovery centers. This filter will only display recovery centers that offer electronic recycling.

To update your filter so only Recovery Centers from the city of St. Louis AND offering electronic recycling services are displayed, follow these steps which assume that the filter that was added in Task 2, Step 2 for St/Saint Louis is still active.

ArcGIS Pro Quick Steps Reference:

Right click EPA_Recovery_Centers in Contents pane > Properties > Definition Query

The Definition Query should show Query 1 as

City = 'Saint Louis' Or City = 'St Louis'

Click the Edit button under Query 1

click the + Add Clause button and below the existing clause, enter:

‘And’ ‘Electronic’ is equal to ‘1’

Click the Apply button.

Using these steps, by default, ArcGIS Pro will group the query statements so that values of City = 'Saint Louis' are all selected and then only values where City = 'St Louis' AND ‘Electronic’ is equal to ‘1’ are selected.

If this query is run, 20 records are returned.

This is what the default query would like in an SQL view within the Definition Query window:

City = 'Saint Louis' Or (City = 'St Louis' And Electronic = 1).

However, tis query is not accurate for the needs of this exercise.

Specifically, SQL uses parenthesis to determine order of operation.

This means that

(City = 'St Louis' And Electronic = 1)

would be evaluated first, and then

City = 'Saint Louis’

Which would result in the incorrect number of records returned by the query.

To fix the query so it displays the data correctly, follow these instructions:

Assuming the query that was constructed using the previous steps is the same and the Definition Query window is still open, click the Edit button under Query 1.

Click the SQL slider button so SQL code for Query 1 is displayed.

Modify Query 1 so it looks like the following:

(City = 'Saint Louis' Or City = 'St Louis') And Electronic = 1

Modifying the parenthesis will change the query order operation so that records with the values of City = 'Saint Louis' Or 'St Louis' are first returned and then from those records, only records with the values of Electronic = 1.

Click the Apply button under the SQL view and then click the OK button in the Definition Query window.

If this updated filter was applied correctly, your map should show 5 recovery center points within St.Louis.

Step 2: Load EPA Recovery Centers as Service Areas Facilities

In this step, you will load the filtered recovery centers as facilities into a service area network analysis layer. This step is a prelude to generating the actual service area polygons like you saw in this week's video. In this specific step, you will add the filtered recovery centers as facilities to a service area network analysis.

For ArcGIS Pro, follow these steps:

Analysis Tab > Network Analysis > Service Area

This will generate a service area network analysis layer that is automatically added to your map.

The service area tab will also appear in the Network Analyst tab above the other main menus of ArcGIS Pro.

On the Service area tab, click Import Facilities in the Input Data group.

Enter the following into the Add locations tool that appears:

Input Network Analysis Layer: Service Areas (the default name of what was just created)
Sub Layer: Facilities (another default name based on what was just created)

Input Locations: EPA_Recovery_Centers (the filtered datasets from previous tasks and steps)

You can leave the default parameters for the rest of the tool parameters.

Click the Run button.

Your map will be updated where the 5 EPA recovery centers are added to the Facilities sub layer of the Service Areas Input Network Analysis Layer.

Step 3: Generate Service Area Polygons for e-waste Disaster Debris Recycling Recovery

With the filtered EPA recovery centers now loaded as facilities, in this step, you will generate service area polygons from those facilities for determining where you might route e-waste from the disaster locations.

Follow these steps:

If not already done so, click on the Service Area Network Analysis layer created in Task 3, Step 2. This will bring up the Network Analyst tab.

Network Analyst Tab > Service Area

Generating Service area polygons is relatively easy. For this task, we will use many of the default settings.

Make the following modifications to Service Area settings:

Output Geometry Tab:
Select Polygons as the Geometry

Polygon Detail Level: Standard Precision

Boundary Type: Dissolve

Polygon Rings or Disks: Rings

Travel Settings:
Direction: Away from Facilities
Cutoffs: 1000, 2000, 5000 (default values in meters)

Click Run on the Analysis tab to generate the service area polygons.

You Service Area network analysis layer Polygons sub-layer should populated with service area polygons that are also automatically added to the map.

Task 4 – Routing for Sustainable Recovery

In this task, you will generate a route that makes stops at the two disaster locations and ends at one of recovery centers that offers electronic recycling services. As discussed previously, future disaster debris recovery efforts will focus more on sustainable debris recovery such as, in this exercise, separating e-waste for recycling instead of sending it to a landfill.

You will determine your routes based on visual inspection of the service areas that you generated in Task 3.

To start building the routes, first, observe where the two disaster spots are located. Note how two of the disaster spots are located within the 5000 meter service area of the "Pro Computers and Consulting" electronic recycling recovery center (FID 3276). Given this close proximity to the two disaster spots, you will thus create a route that makes stops at the two disaster spots and ends at the "Pro Computers and Consulting" electronic recycling recovery center (FID 3276).

Step 1: Load Disaster Spots and an EPA Recovery Center as Stops

In this step, you will load the two disaster spots and the "Pro Computers and Consulting" electronic recycling recovery center (FID 3276) as stops into a route network analysis sub-layer.

For ArcGIS Pro, follow these steps:

Analysis Tab > Network Analysis > Route

This will generate a route network analysis layer that is automatically added to your map.

The Route tab will also appear in the Network Analyst tab above the other main menus of ArcGIS Pro.

On the Route tab, click Import Stops in the Input Data group.

Enter the following into the Add locations tool that appears:

Input Network Analysis Layer: Route (the default name of what was just created)

Sub Layer: Stops (another default name based on what was just created)

Input Locations: disaster_spots

You can leave the default parameters for the rest of the tool parameters.

Click the Run button.

Your map will be updated where the two disaster spots are added to the Stops sub layer of the Route Network Analysis Layer.

Next, you will manually enter the "Pro Computers and Consulting" electronic recycling recovery center (FID 3276) as a stop into a route network analysis sub-layer. To do so, follow these steps:

Edit Menu > Create

This will bring up the Create Features list. Under Route: Stops, click Stops

This will bring up a create features sub-menu, click Point (create a feature).

Move the mouse cursor over the map and hover it (or snap it) over the point for "Pro Computers and Consulting" electronic recycling recovery center (FID 3276) (remember, this was the recycling center that was closest to the two disaster points as per the service areas that were generated in Task 3, Step 3)

Once over the point, click to create the stop feature.

Once you have created the new stop feature, you can update its attribute table to determine the order of stops in the route.

To update the order of stops in the route, follow these steps:

Right click on the Stops sub-layer within the Route Network Analysis Group Layer and select Attribute Table.

With the Stops sub-layer Attribute Table open, select the row of the new stop that you just created. The new stop should be the third row or ObjectID 3. Under the field 'Sequence' for the new stop, click on the empty cell and type 3. This will make the newly created stop the third stop in the route (after the two disaster spots which respectively have 'Sequence' values of 1 and 2.)

After updating the sequence value, you will now have all of your route stops created.

To save this new stop feature:

Edit Menu > Save > Save all edits > Yes

Step 2: Generate Route Lines for e-waste Disaster Debris Recycling Recovery

In this step, you will run the ArcGIS Pro routing algorithm. The route will stop at the two disaster spots and end at the e-waste disaster debris recycling recovery that you filtered out from the broader recovery centers data layer in Task 3, Step 1.

For ArcGIS Pro, follow these steps:

With the route stops already entered as per the steps taken in Task 4, Step 1, generating route lines is relatively easy. If not already done so, click on the Route Network Analysis layer created in Task 4, Step 1. This will bring up the Network Analyst and the Route sub-tab below it.

To create the route, click the Run button on the Analysis tab.

The route will be calculated and automatically added to the map. A line feature will also be added under the Routes sub-layer of Route Network Analysis Group Layer.

Task 5: Create a Map

Figure 1 shows a map of the exercise results to this point. Create a map layout similar to Figure 1 showing the results of your analysis based on the previous four tasks.

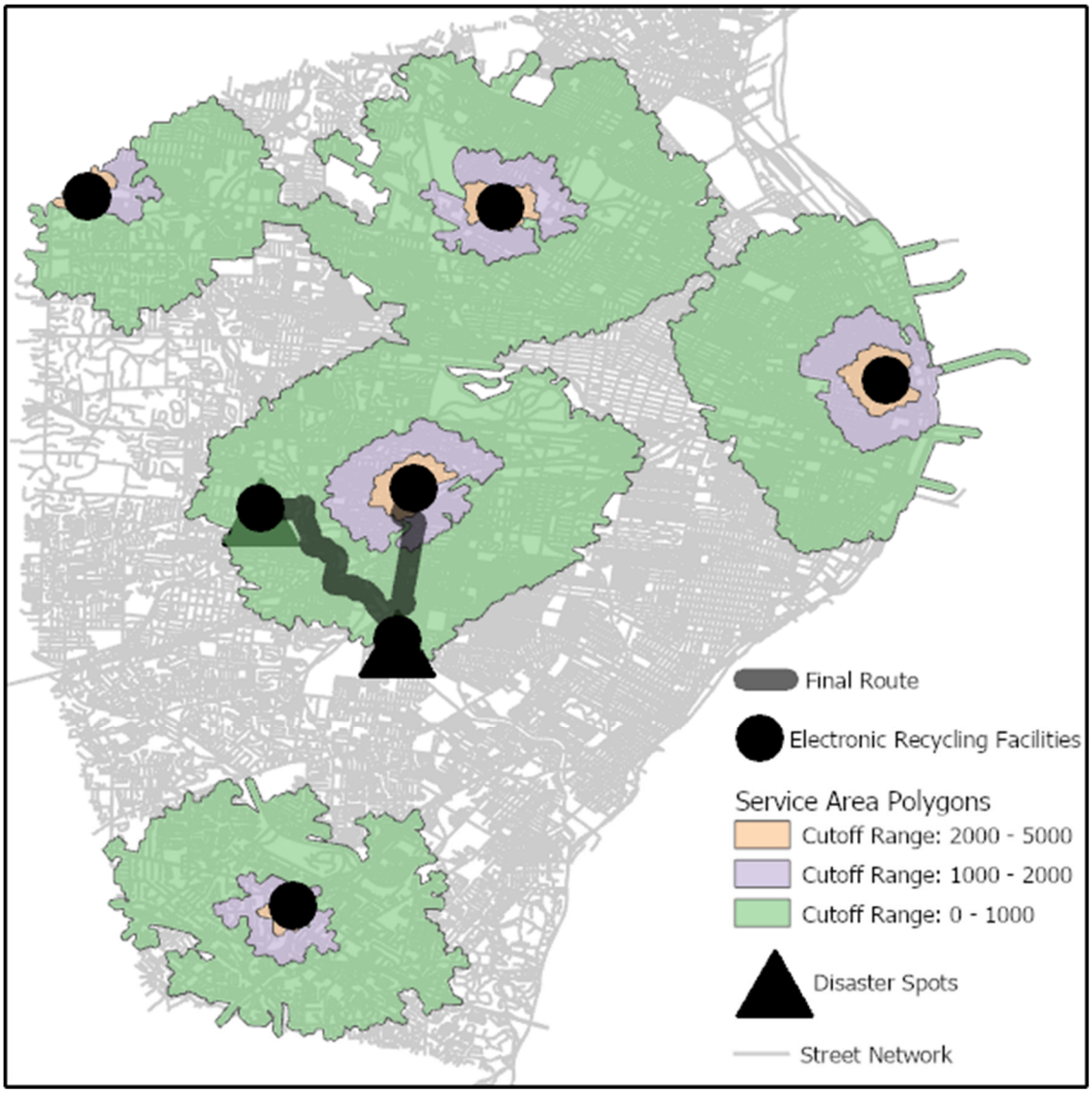

Figure 1: Exercise results. The map reflect outputs from the exercise directions such as the filtered electronic recycling facilities from Task 2, Step 2 and Task 3, Step 1, the service area polygons from Task 3, Step 3, and the final route created in Task 4, Step 2.

Task 6: Barriers

As you saw in this week's video, an important feature of the ArcGIS Pro Network Analysis Tool set is the ability to add barriers when planning a route. Review the documentation on how to create point, line, and polygon barriers in Network Analysis layers:

https://pro.arcgis.com/en/pro-app/help/analysis/networks/barriers.htm

Redo the scenario of routing to e-waste facilities, or other types of recovery centers, by adding hypothetical barriers that could potentially impact the routing. For example, this

would be a common scenario in the immediate aftermath of a disaster when street network may not be open for optimal routing due to barriers such as flooded areas or downed power lines occurred.

Create a second map layout showing how your previous route is impacted by barriers.

Deliverable:

Submit to the lab 4 drop a single MS Word (no PDFs or individual image files) that contains:

1. The two the maps (Task 5 and Task 6) you created following the assignment instructions.
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