

NETWORK ANALYSIS

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NETWORK

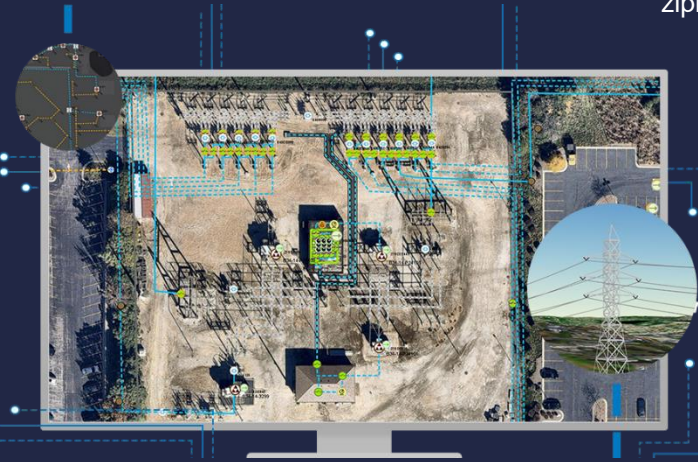
A system of interconnected elements

NETWORK

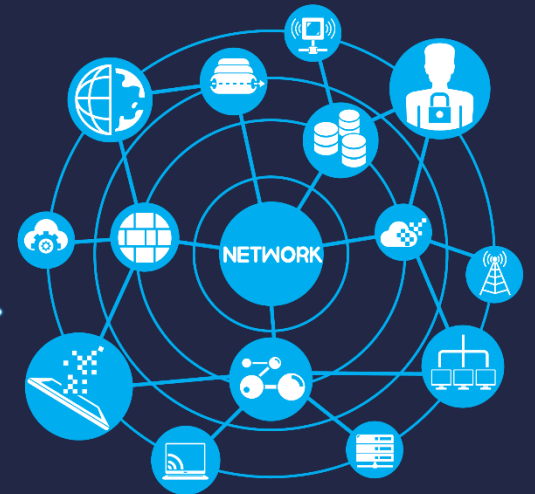
- A network is a system of interconnected elements
 - Edges (lines)
 - Connecting junctions (points)
 - Represent possible routes from one location to another
- Many types of network
 - Transportation network
 - Utility network
 - River network
 - Computer network
 - etc.
- ArcGIS groups network into two categories
 - Geometric networks (utility and river networks)
 - Network datasets (transportation network)



zipline logistics.com



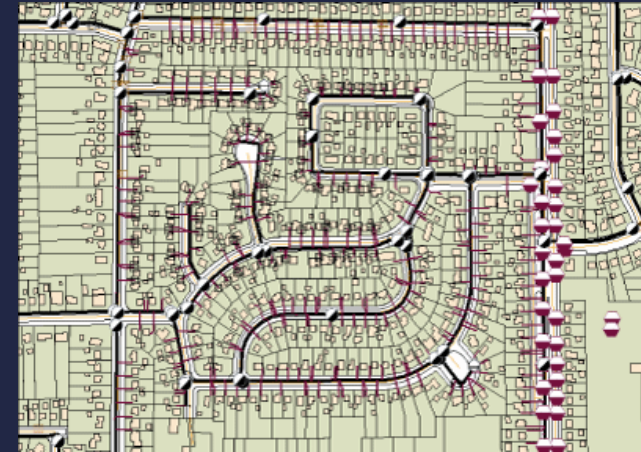
esri.com



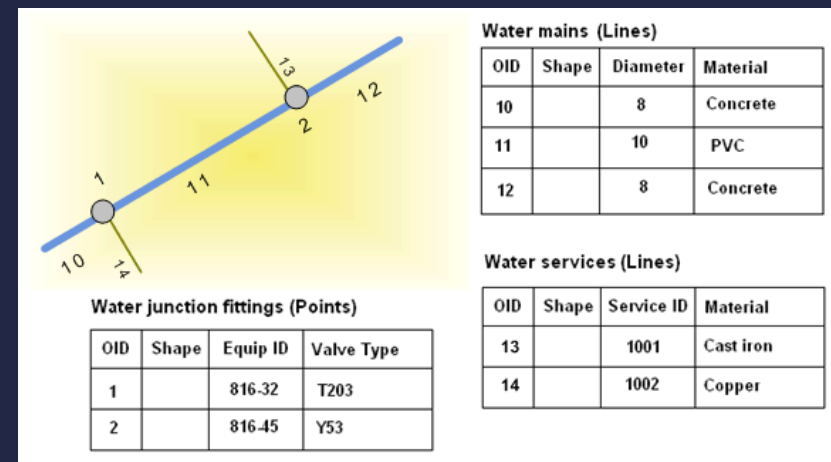
eaglecom.net

GEOMETRIC NETWORKS

- Geometric networks offer a way to model common networks and infrastructures found in the real world. Water distribution, electrical lines, gas pipelines, telephone services, and water flow in a stream are all examples of resource flows that can be modeled and analyzed using a geometric network
- Geometric networks can't choose direction to travel; rather, the path it takes is determined by external forces: gravity, electromagnetism, water pressure, and so on



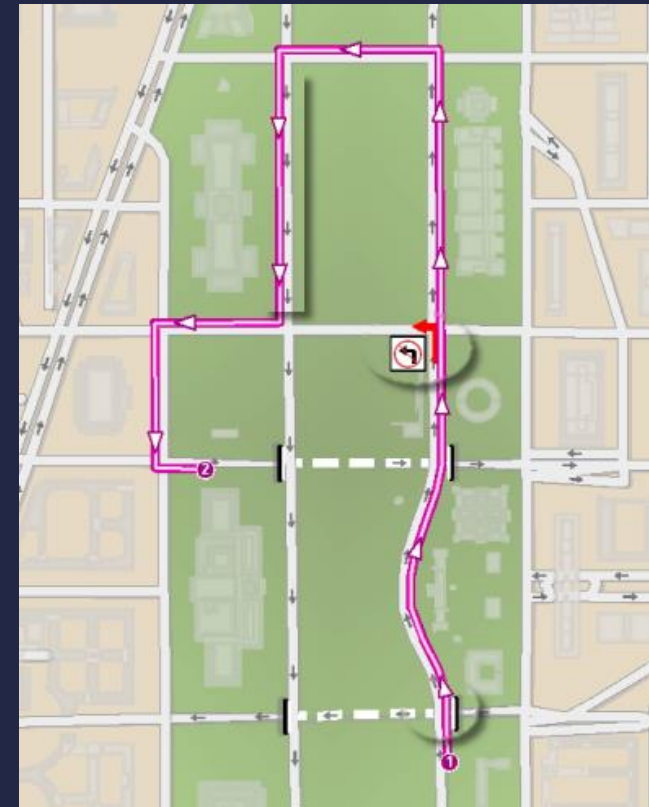
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NETWORK DATASETS

- Network datasets are well suited to model transportation networks
 - In ArcGIS, transportation networks are best modeled by network datasets
- Allows to travel on edges (lines) in both directions
 - Street, pedestrian, railroad, waterway, and airway networks
 - The agent on the network is generally free to decide the direction of traversal as well as destination
- Network datasets are created from source features
 - Simple features such as points and lines
 - Turns
 - Connectivity of the source features

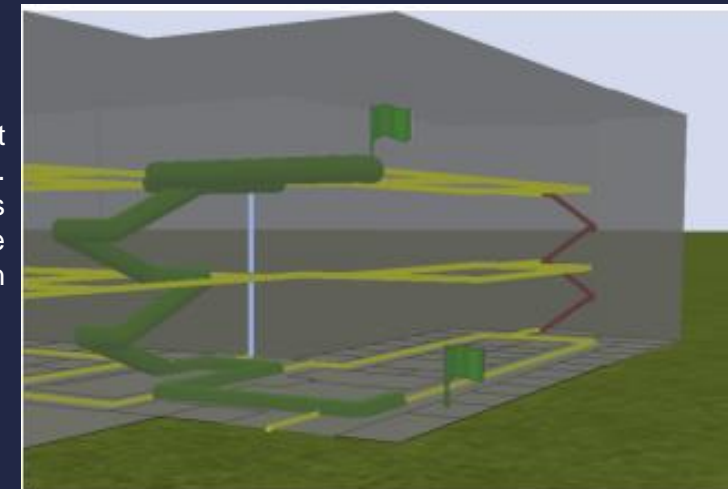


NETWORK DATASET

- Network datasets include
 - Multimodal network
 - More complex connectivity scenarios
 - Multimodal network datasets can handle several transportation modes like roads, railroads, airways, and waterways
 - 3D network
 - Enables modeling of interior pathways of buildings, subways, mines, caves, and so on
 - 3D pathways require z-coordinate values to create z-aware features for modeling
 - Examples
 - ❖ What is the best wheelchair-accessible route between rooms in different buildings?
 - ❖ What floors of a high-rise building can't be reached by a fire department within eight minutes?



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A quickest route connects a stop on the first floor of a building to one on the third floor. Using restrictions, you can perform analyses that avoid staircases for wheelchair-accessible routes or that avoid elevators for evacuation planning.

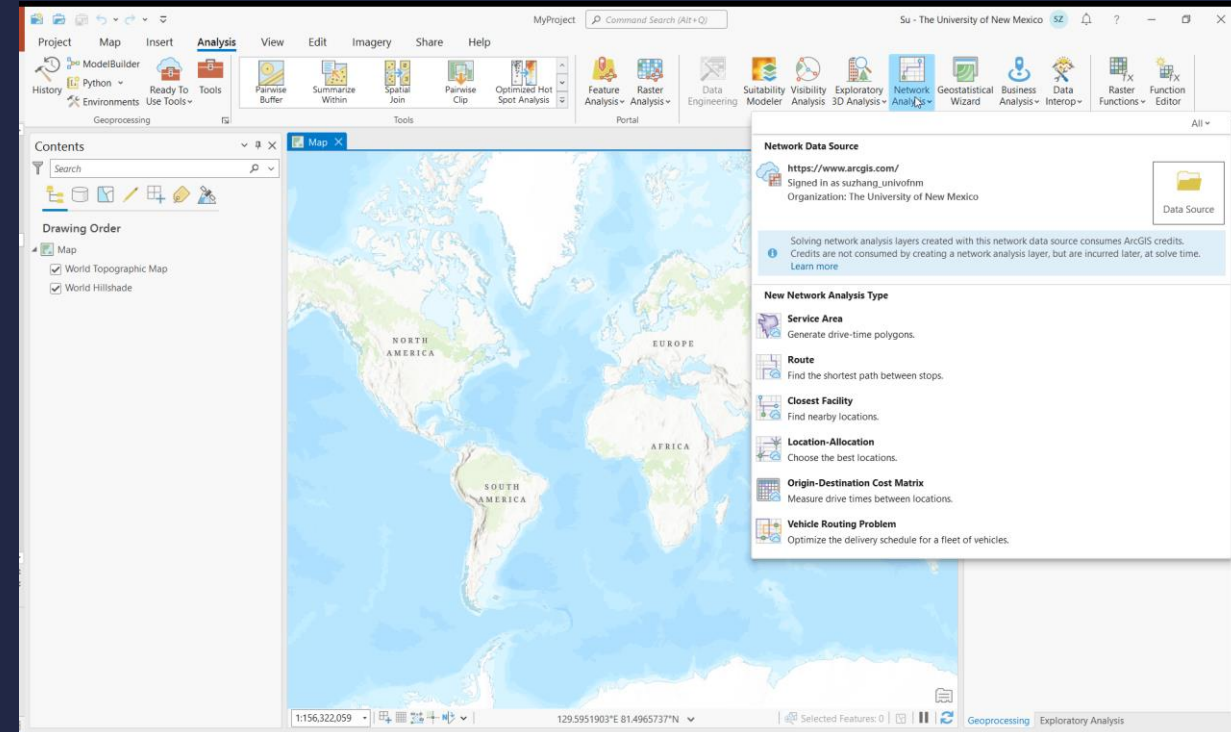
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NETWORK ANALYST EXTENSION

A toolset to analyze network datasets

NETWORK ANALYST EXTENSION

- Network Analyst Extension is toolset to answer questions such as what is the quickest way to get from point A to point B
- A collection of user interface components that allows users to access and execute ArcGIS Network Analyst Extension
- When conducting network analysis with ArcGIS Network Analyst Extension, the analysis always occurs on a network dataset
 - Available with Network Analyst License
 - Need to work with network dataset

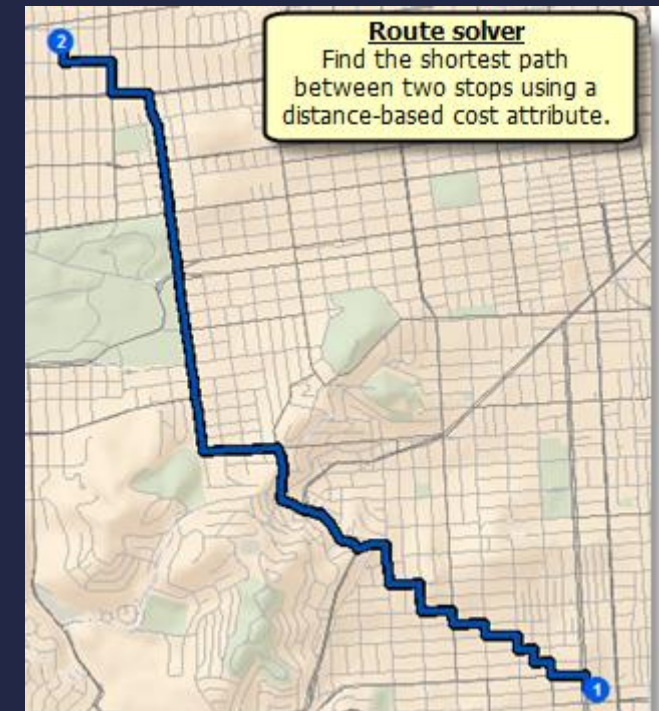
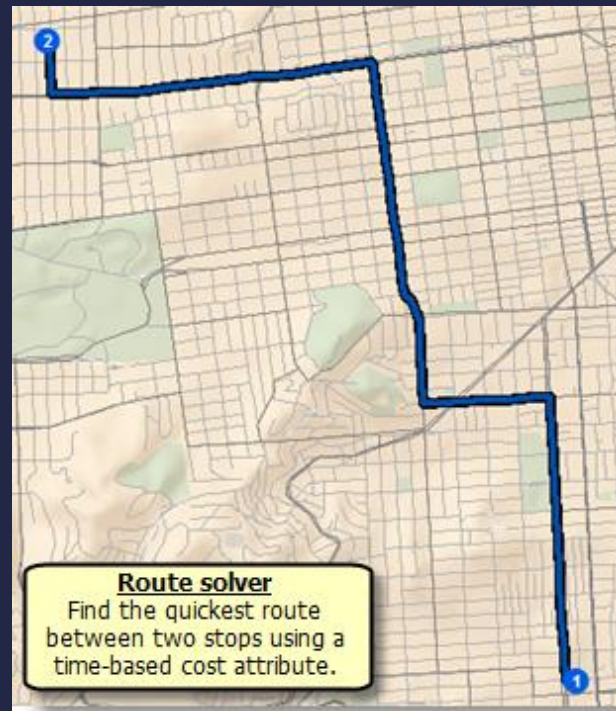


NETWORK ANALYST TOOLS

A toolset to analyze network datasets

ROUTE

- Solving a route analysis can identify the quickest, shortest, or even the most scenic route, depending on the impedance you choose to solve for
- If the impedance is time, then the best route is the quickest route
- If the impedance is a time attribute with live or historical traffic, then the best route is the quickest route for a given time of day and date
- The best route can be defined as the route that has the lowest impedance, or least cost, where the impedance is chosen by users; any cost attribute can be used as the impedance when determining the best route



ROUTE

The screenshot displays the ArcGIS Desktop interface with the 'Route Layer' ribbon active. The main map shows a world map with continents labeled: NORTH AMERICA, SOUTH AMERICA, AFRICA, EUROPE, ASIA, and AUSTRALIA.

Route Layer Ribbon:

- Mode: Driving Time (min)
- Sequence: Use Current
- Not Using Time: [Dropdown]
- Along Network: [Dropdown]
- Output on Solve: [Checked]
- Show Directions: [Checked]
- Route Layers: [Icon]
- Share As: [Icon]

Contents Pane (Left):

- Map
- Route
- Stops
- Routes
- Point Barriers
 - Restriction
 - Added Cost
- Line Barriers
 - Restriction
 - Scaled Cost
- Polygon Barriers
 - Restriction
 - Scaled Cost
- World Topographic Map
- World Hillshade

Geoprocessing Pane (Right):

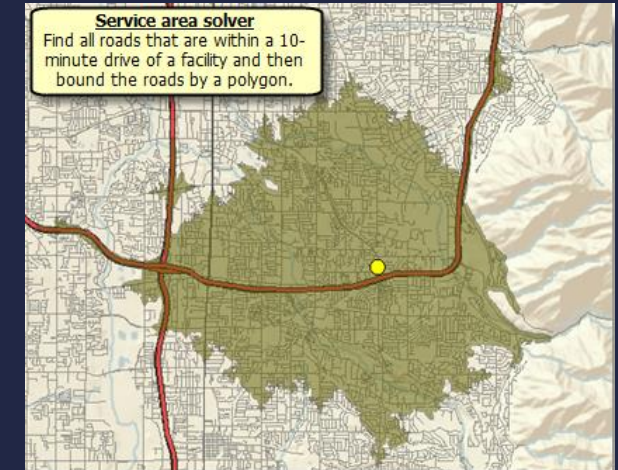
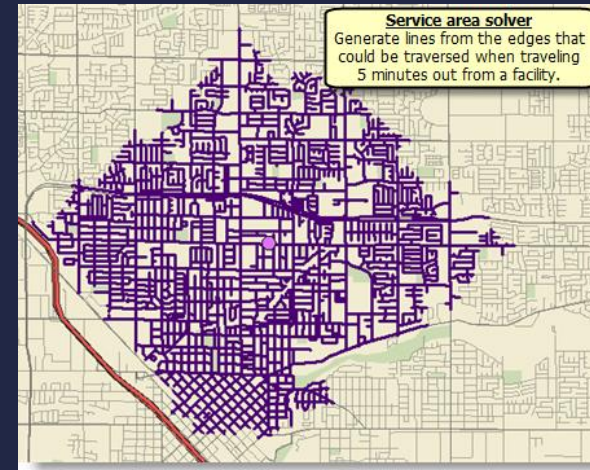
- Find Tools
- Favorites
- Toolboxes
- Portal
- Project Favorites
 - Calculate Field (Data Management Tools)
 - Painwise Buffer (Analysis Tools)
 - Near (Analysis Tools)
 - Pairwise Dissolve (Analysis Tools)
 - Spatial Join (Analysis Tools)
 - Pairwise Intersect (Analysis Tools)
- Recent
 - Make Route Analysis Layer (Network Analyst Tools) ✓

Status Bar (Bottom):

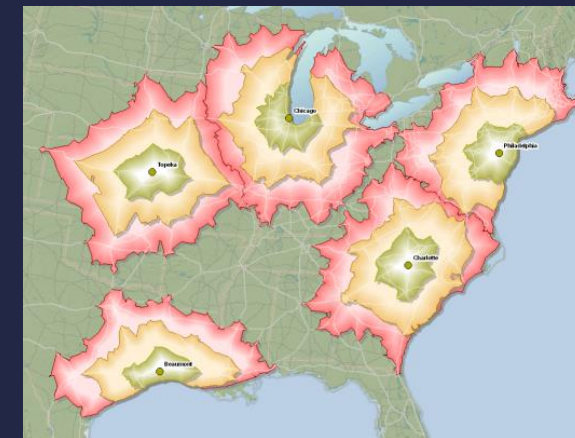
- Scale: 1:156,322,059
- Coordinates: 153.6713609°W 69.0093015°N
- Selected Features: 0
- Geoprocessing | Exploratory Analysis

SERVICE AREA

- A network service area is a region that encompasses all accessible streets (that is, streets that are within a specified impedance)
- For instance, the 5-minute service area for a point on a network includes all the streets that can be reached within five minutes from that point
- Service areas created by Network Analyst also help evaluate accessibility
- Identify how much land, how many people, or how much of anything else is within the neighborhood or region



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SERVICE AREA

The screenshot displays the ArcGIS Desktop interface with the **Service Area Layer** tool active. The tool's configuration is as follows:

- Mode:** Driving Time
- Direction:** Away from facilities
- Cutoffs:** 5, 10, 15
- Output Geometry:** Polygons
- Standard Precision:** Standard Precision
- Overlap:** Overlap
- Rings:** Rings

The **Contents** pane on the left shows the following layers in the drawing order:

- Map
- Service Area
- Facilities
- Polygons
- Lines
- Point Barriers
 - Restriction
 - Added Cost
- Line Barriers
 - Restriction
 - Scaled Cost
- Polygon Barriers
 - Restriction
 - Scaled Cost
- World Topographic Map
- World Hillshade

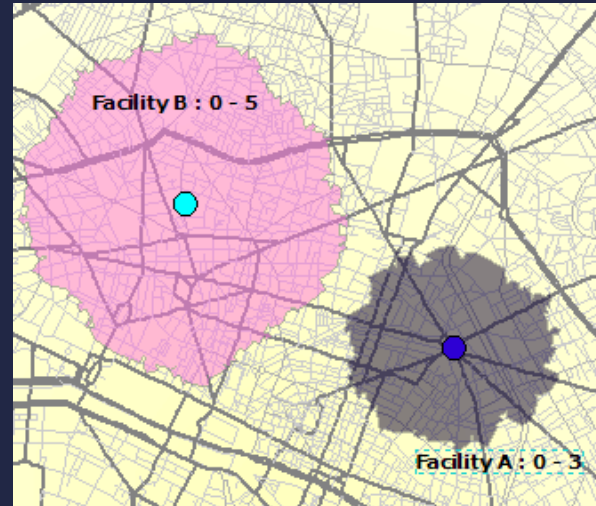
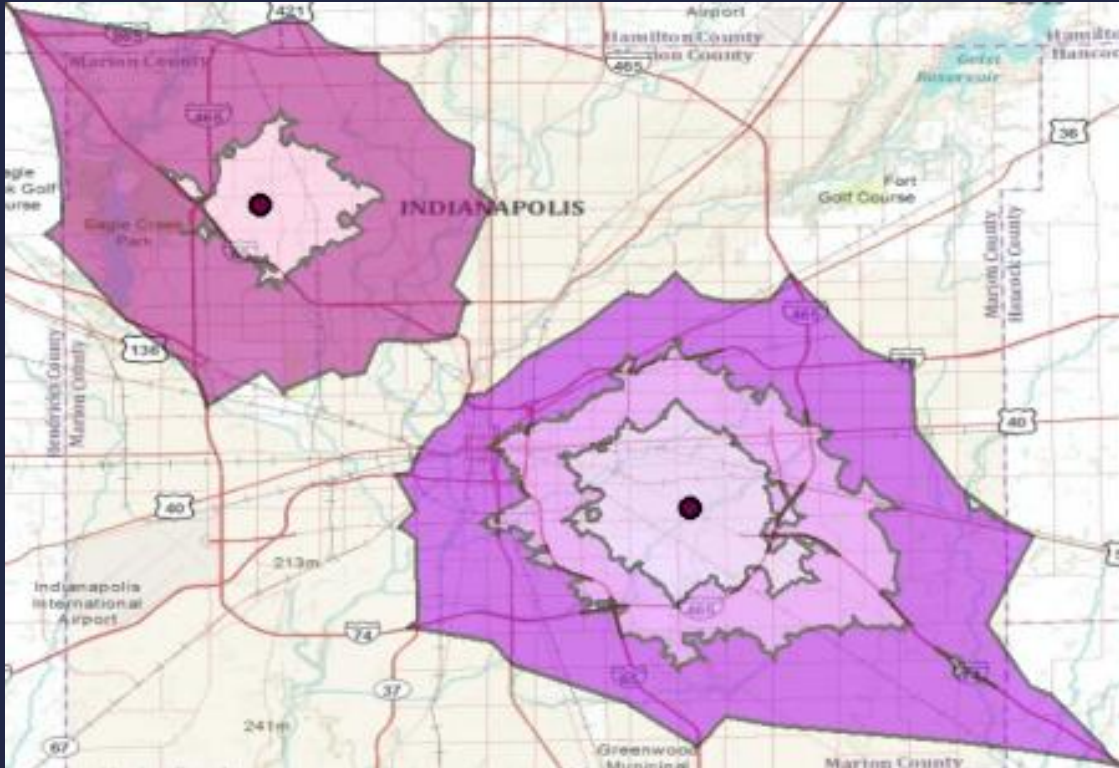
The **Geoprocessing** pane on the right shows the **Recent** list:

- Make Service Area Analysis Layer (Network Analyst Tools) ✓
- Delete Network Analysis Layer (Network Analyst Tools) ✓
- Make Route Analysis Layer (Network Analyst Tools) ✓

The main map window shows a world map with a service area analysis layer overlaid, primarily covering North America, Europe, and Asia. The status bar at the bottom indicates the scale is 1:156,322,059 and the coordinates are 123.9476934°E 81.4082172°N.

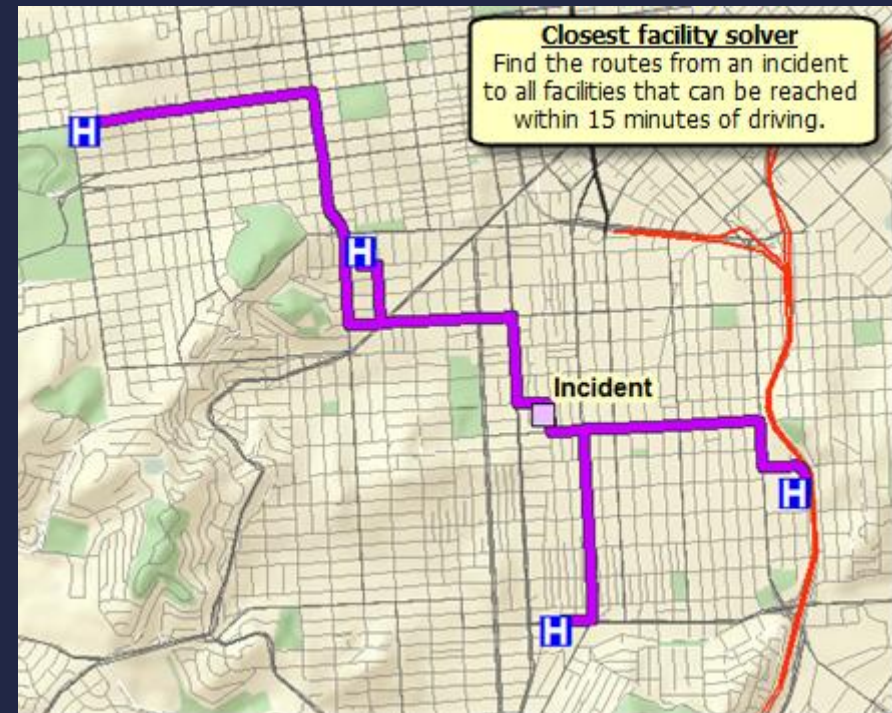
SERVICE AREA

Breaks (impedance, usually use time)

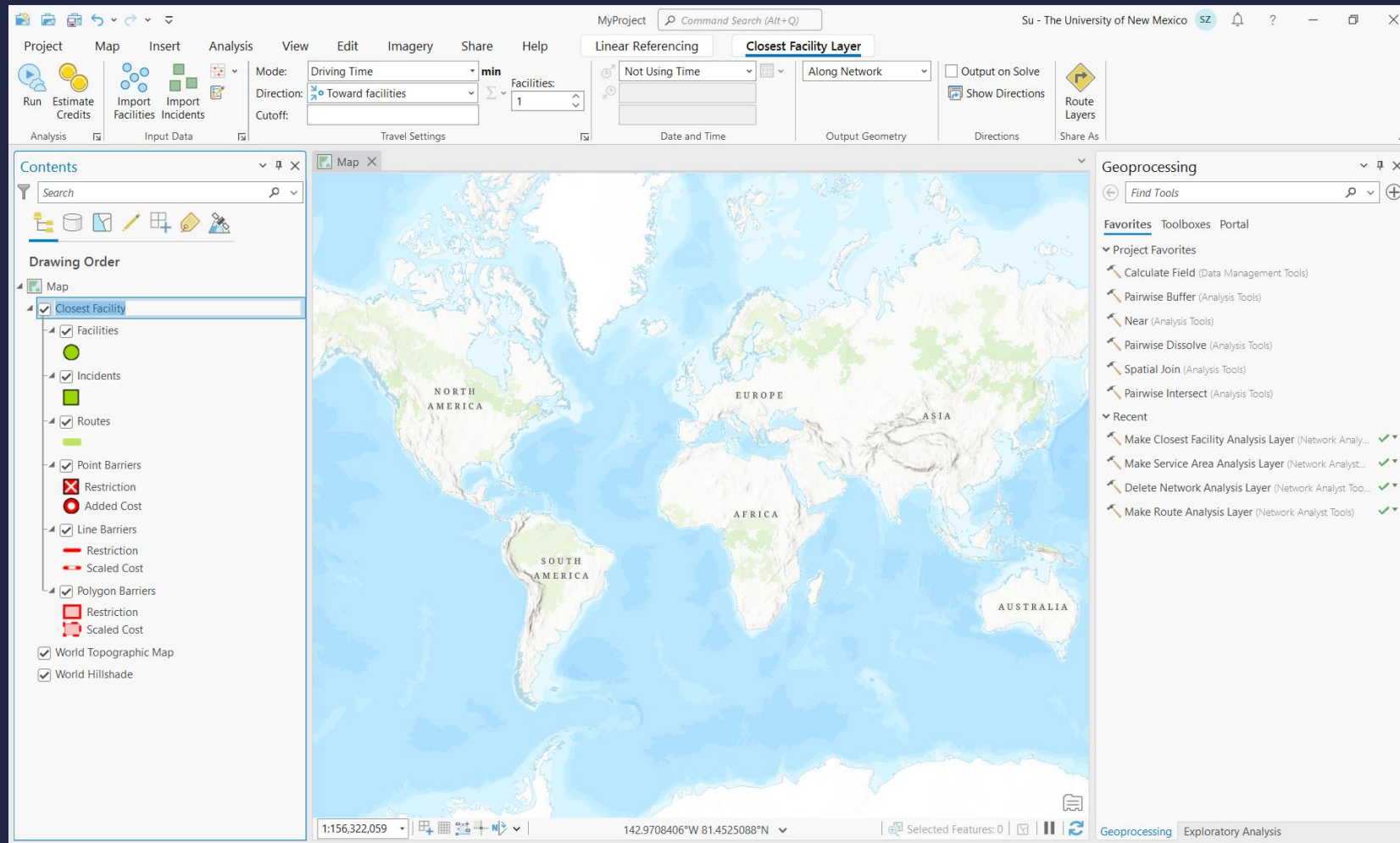


CLOSEST FACILITY

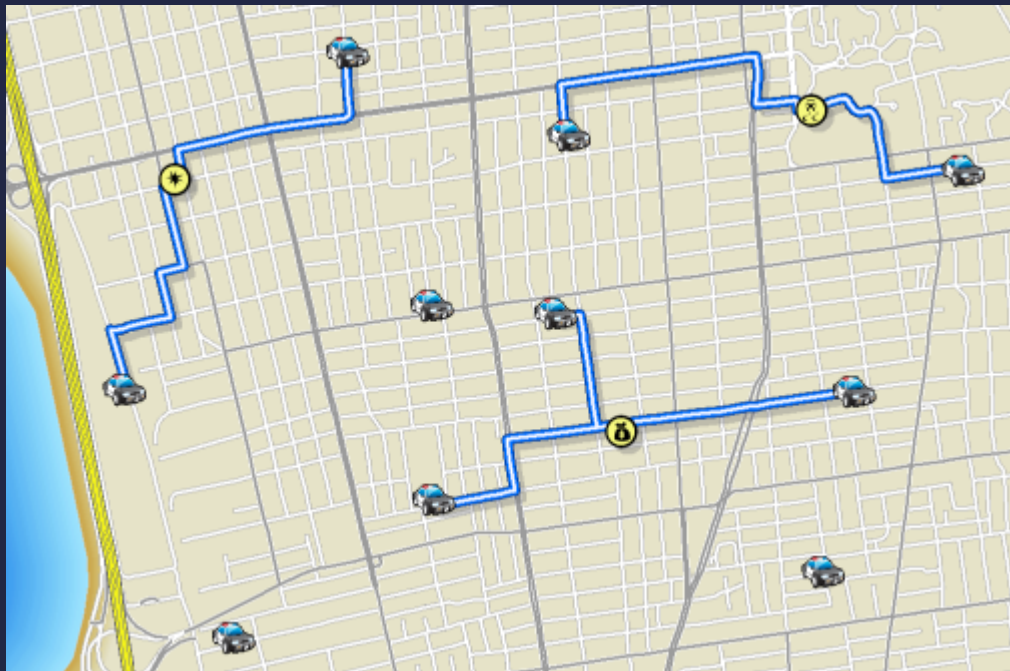
- Measures the cost of traveling between incidents and facilities and determines which are nearest to one other
- Users can specify how many to find and whether the direction of travel is toward or away from them
- The closest facility solver displays the best routes between incidents and facilities, reports their travel costs, and returns driving directions
- Users can specify constraints, like a cutoff cost beyond which Network Analyst will not search for facilities



CLOSEST FACILITY



CLOSEST FACILITY



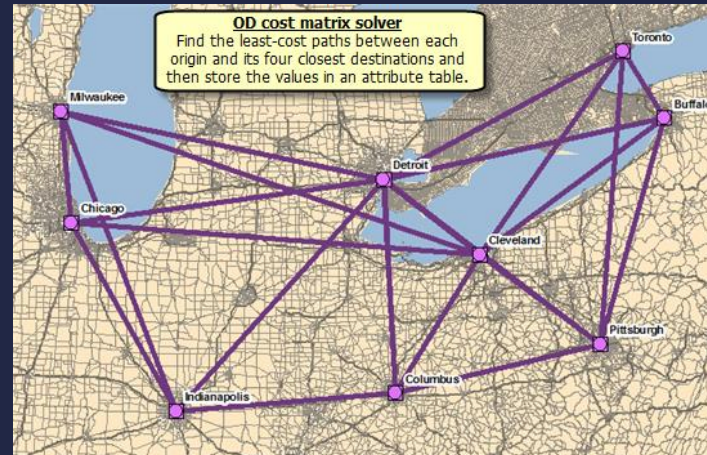
desktop.arcgis.com



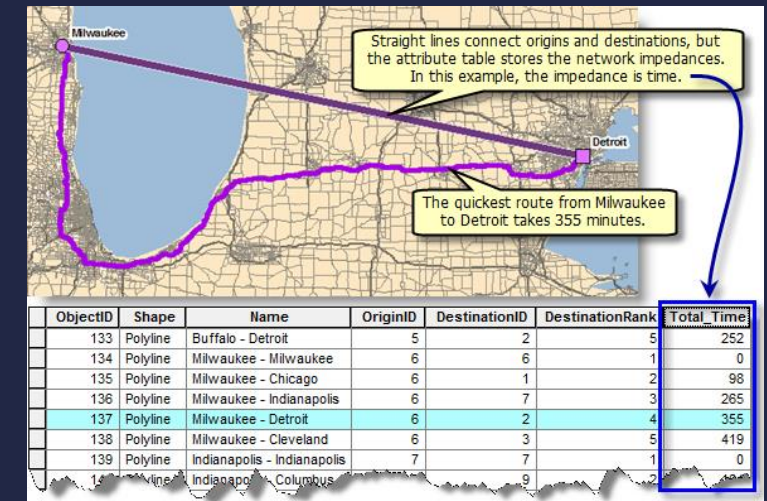
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OD COST MATRIX

- The OD cost matrix finds and measures the least-cost paths along the network from multiple origins to multiple destinations, or find the least cost path between each OD pair or the entire network
- Users can specify the number of destinations to find and a maximum distance to search
- The output shape type could be set to produce straight line
- The output shape type could also be set to reflect network distance, not straight line

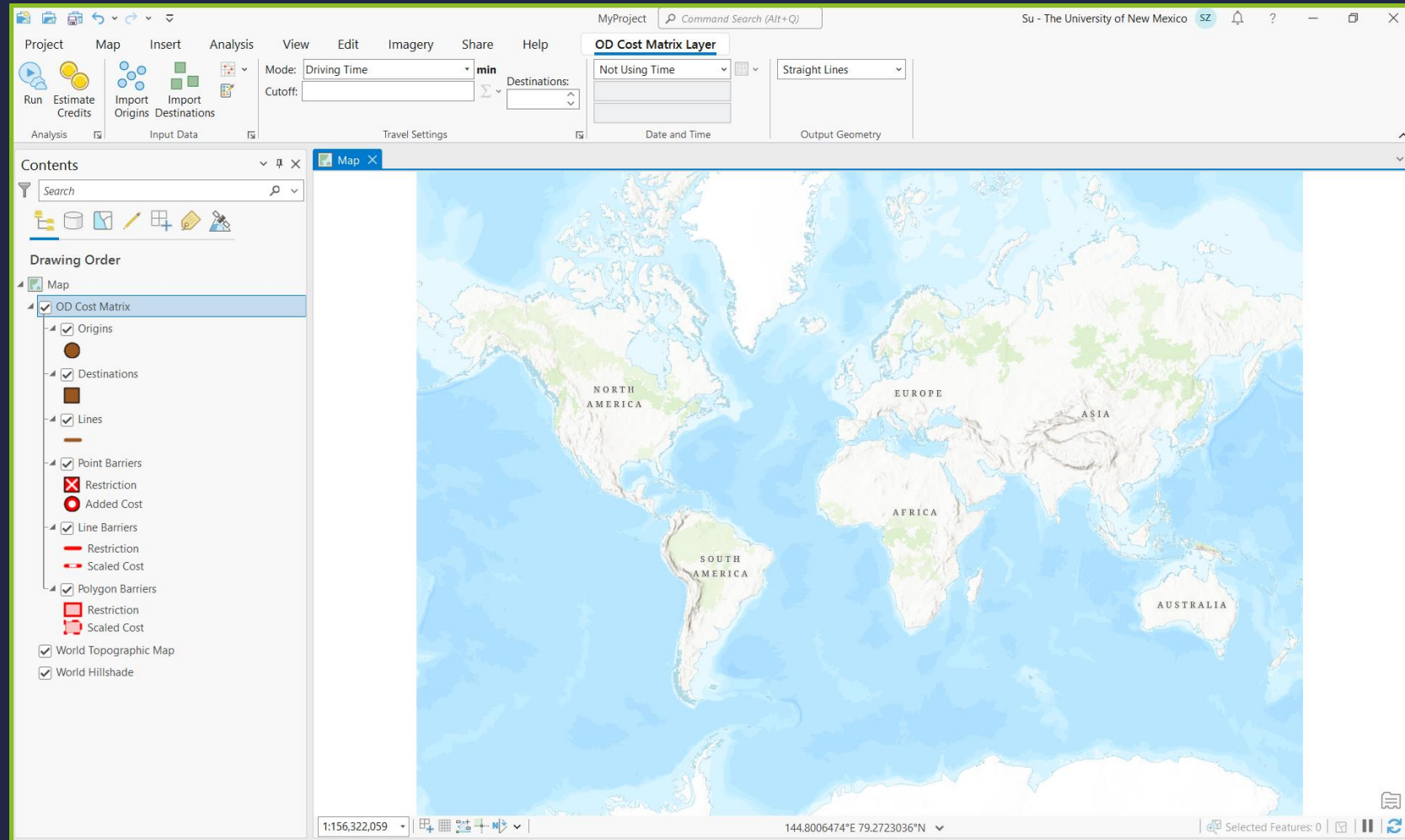


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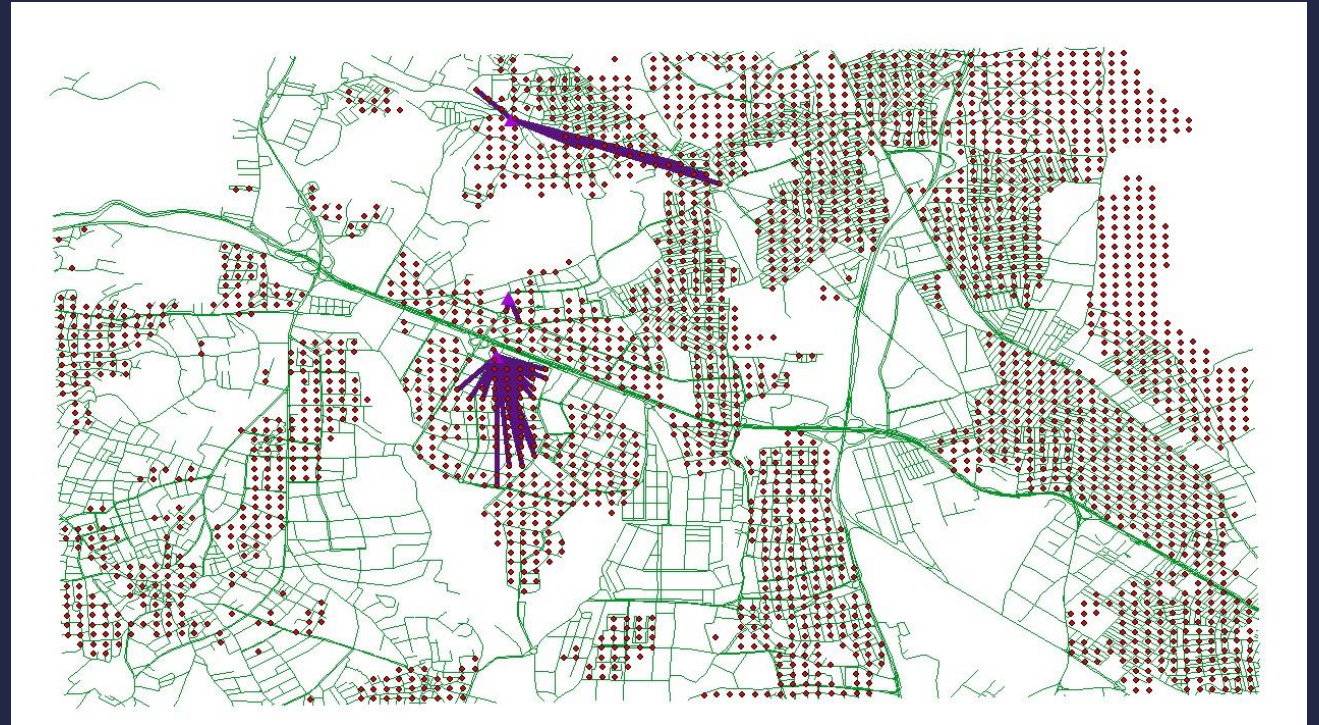
OD COST MATRIX



OD COST MATRIX



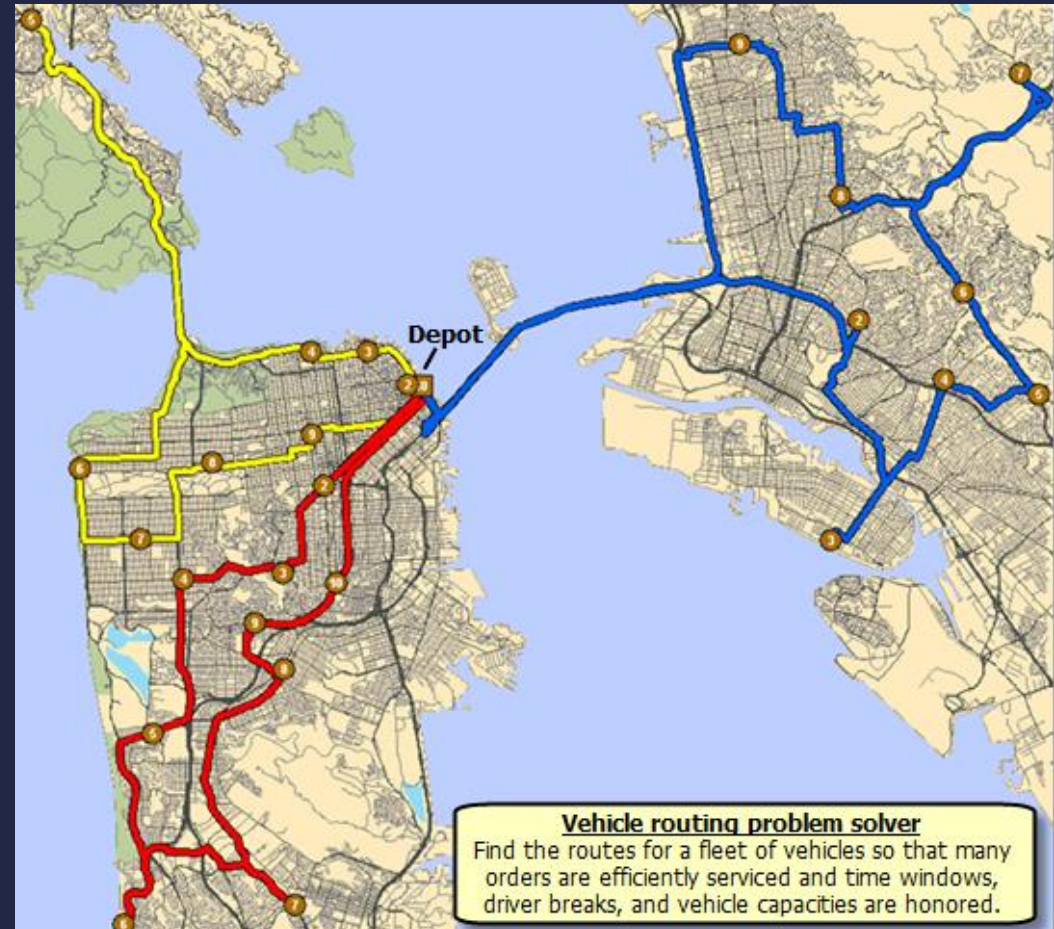
gisgeography.com



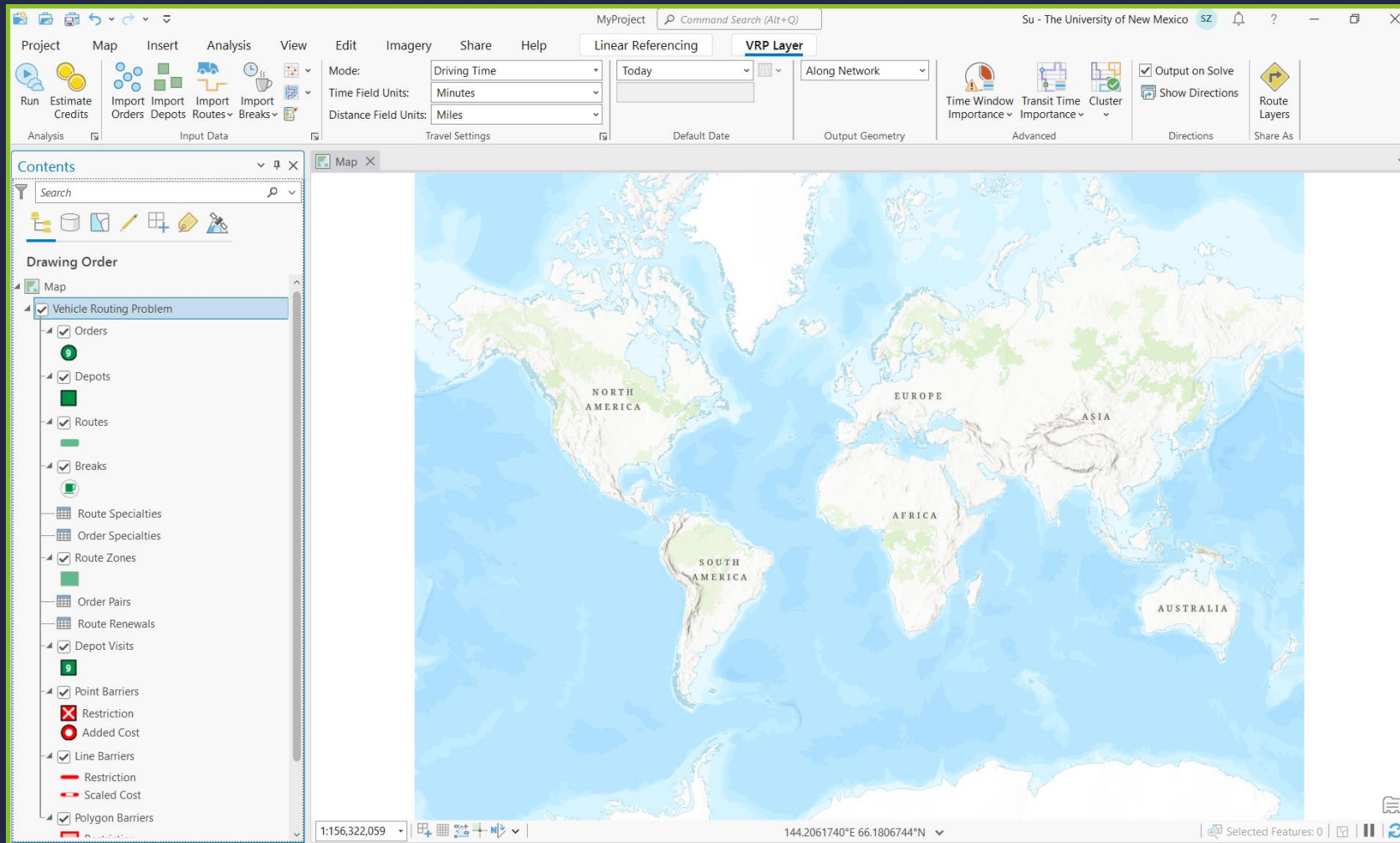
gis.stackexchange.com

VEHICLE ROUTING

- Various organizations service orders with a fleet of vehicles
- Each organization needs to determine which orders (homes, restaurants, or inspection sites) should be serviced by each route (truck or inspector) and in what sequence the orders should be visited
- The primary goal is to best service the orders and minimize the overall operating cost for the fleet of vehicles
- Can solve more specific problems because numerous options are available, such as matching vehicle capacities with order quantities, giving breaks to drivers, and pairing orders so they are serviced by the same route

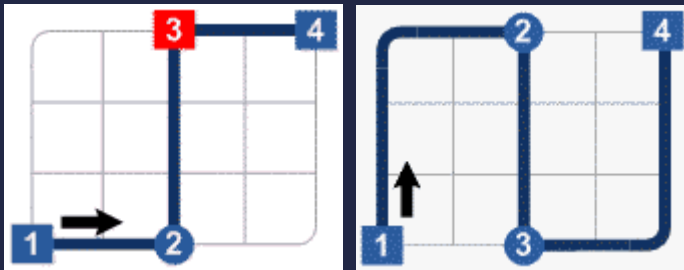
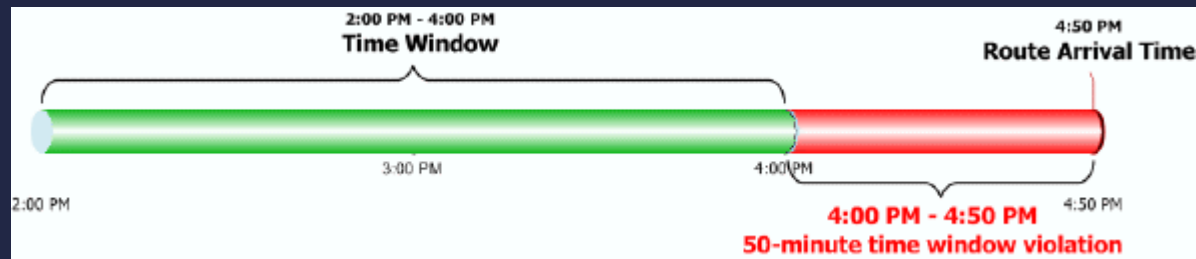


VEHICLE ROUTING



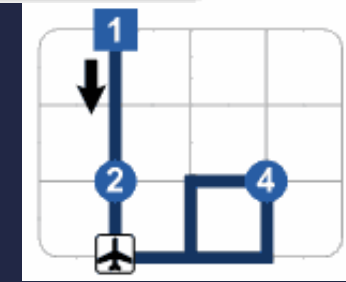
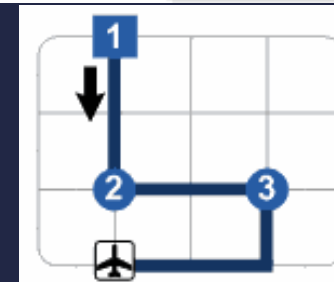
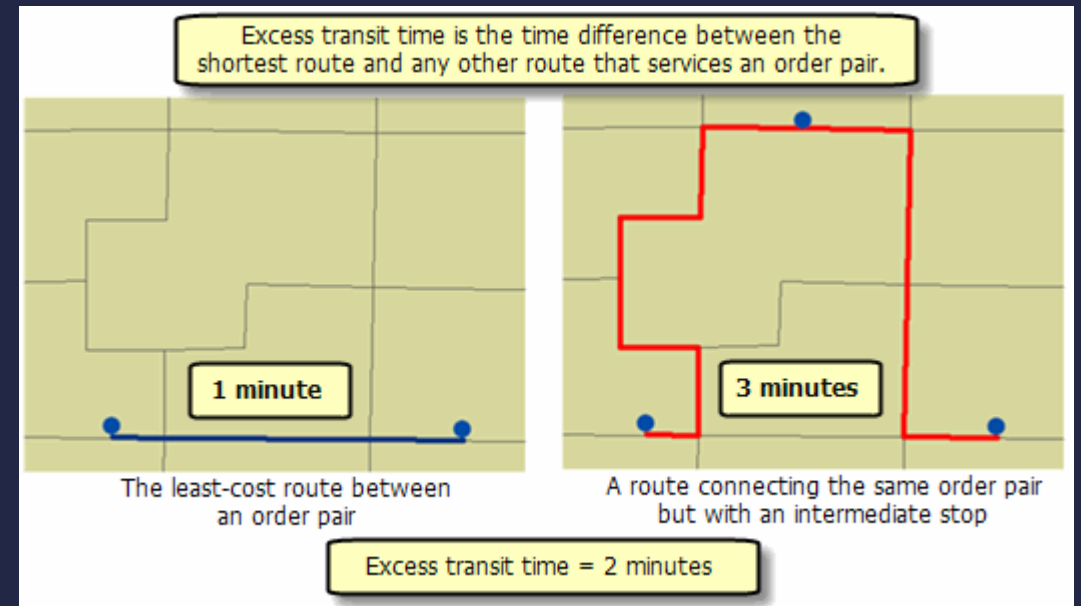
VEHICLE ROUTING

Time window violation



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Excess Transit Time



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LOCATION-ALLOCATION

- Location is often considered the most important factor leading to the success of a private- or public-sector organization
- Private-sector organizations can profit from a good location, whether a small coffee shop with a local clientele or a multinational network of factories with distribution centers and a worldwide chain of retail outlets
- Location can help keep fixed and overhead costs low and accessibility high
- Public-sector facilities, such as schools, hospitals, libraries, fire stations, and emergency response services (ERS) centers, can provide high-quality service to the community at a low cost when a good location is chosen
- Given facilities that provide goods and services and a set of demand points that consume them, the goal of location-allocation is to locate the facilities in a way that supplies the demand points most efficiently



LOCATION-ALLOCATION

The screenshot displays the ArcGIS Pro software interface with the Location-Allocation tool active. The main window shows a world map with a color-coded cost surface. The tool's configuration panel is visible at the top, and the Contents and Geoprocessing panes are open on the left and right sides, respectively.

Location-Allocation Layer Configuration:

- Mode: Driving Time
- Direction: Away from facilities
- Cutoff: [Empty]
- Facilities: 1
- Problem Type: $f(\text{cost}, \beta)$: Linear, β : 1
- Market: 10 %
- Capacity: 1
- Output Geometry: Straight Lines

Contents Pane:

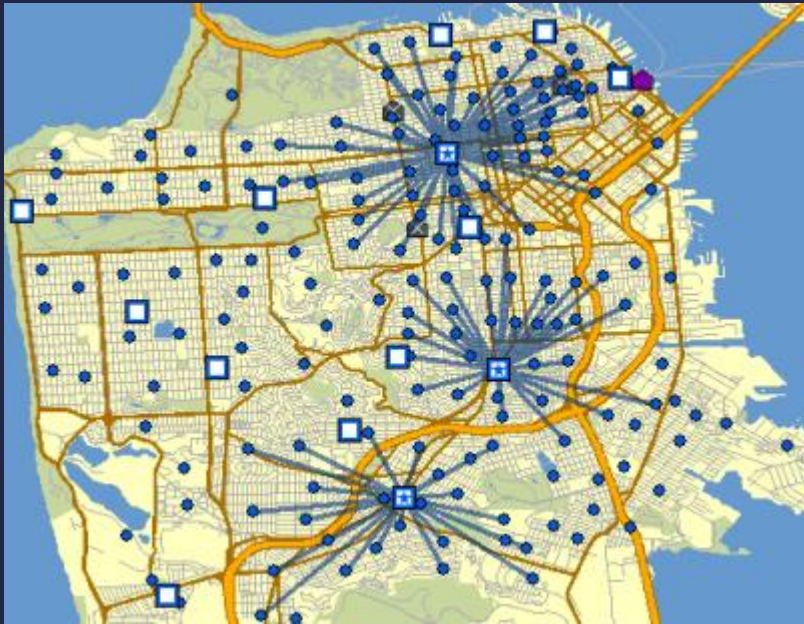
- Map
- Location-Allocation
 - Facilities
 - Chosen
 - Required
 - Competitor
 - Candidate
 - Demand Points
 - Lines
 - Point Barriers
 - Restriction
 - Added Cost
 - Line Barriers
 - Restriction
 - Scaled Cost
 - Polygon Barriers
 - Restriction
 - Scaled Cost
 - World Topographic Map
 - World Hillshade

Geoprocessing Pane:

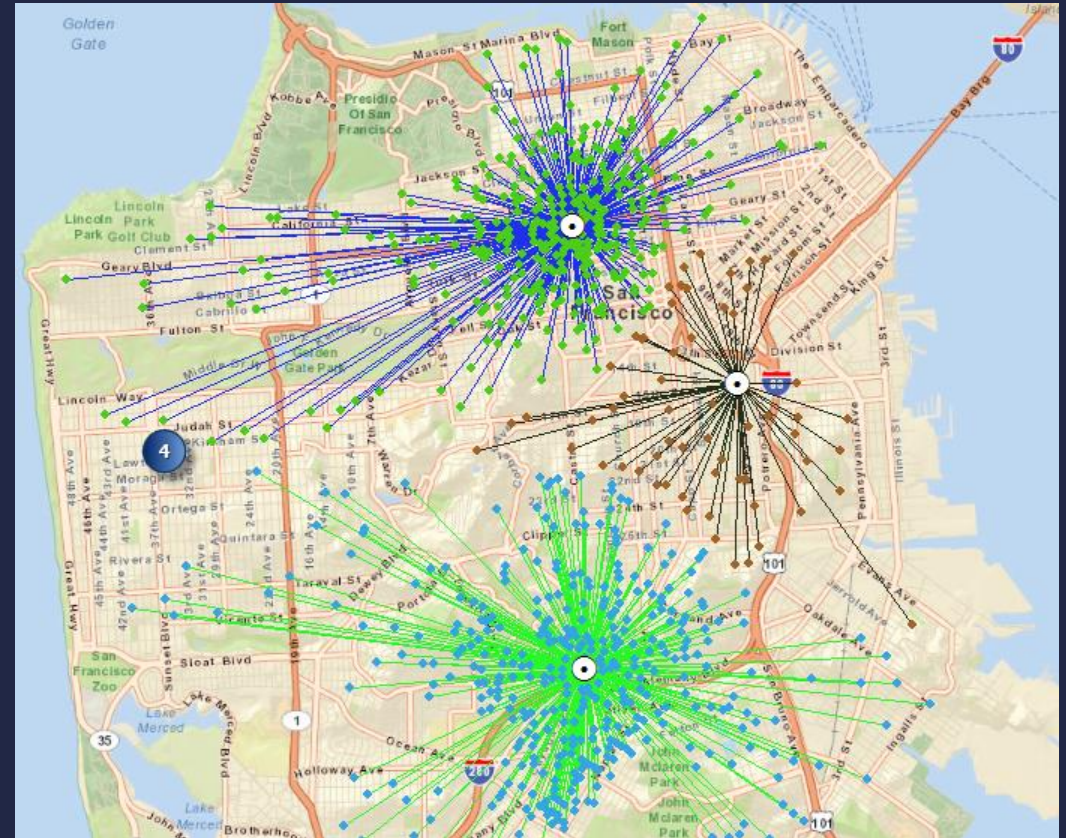
- Recent
 - Make Location-Allocation Analysis Layer (Network Analyst Tools) ✓
 - Make OD Cost Matrix Analysis Layer (Network Analyst Tools) ✓
 - Delete Network Analysis Layer (Network Analyst Tools) ✓
 - Make Closest Facility Analysis Layer (Network Analyst Tools) ✓
 - Make Service Area Analysis Layer (Network Analyst Tools) ✓
 - Make Route Analysis Layer (Network Analyst Tools) ✓

The map shows a world view with labels for NORTH AMERICA, SOUTH AMERICA, AFRICA, EUROPE, ASIA, and AUSTRALIA. The cost surface is color-coded, with green representing lower costs and yellow/orange representing higher costs. The status bar at the bottom indicates coordinates: 148.9155741°W 81.2287618°N.

LOCATION-ALLOCATION



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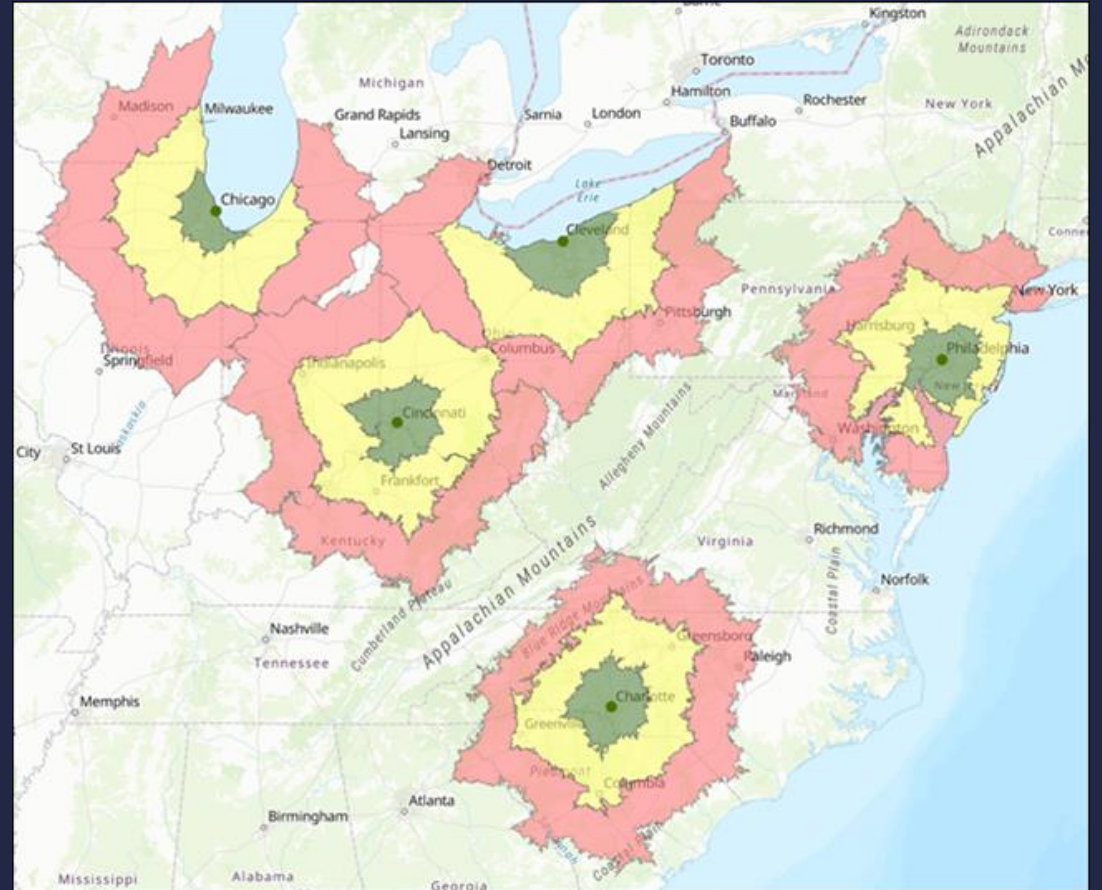


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SCENARIO / ALTERNATIVE ANALYSIS

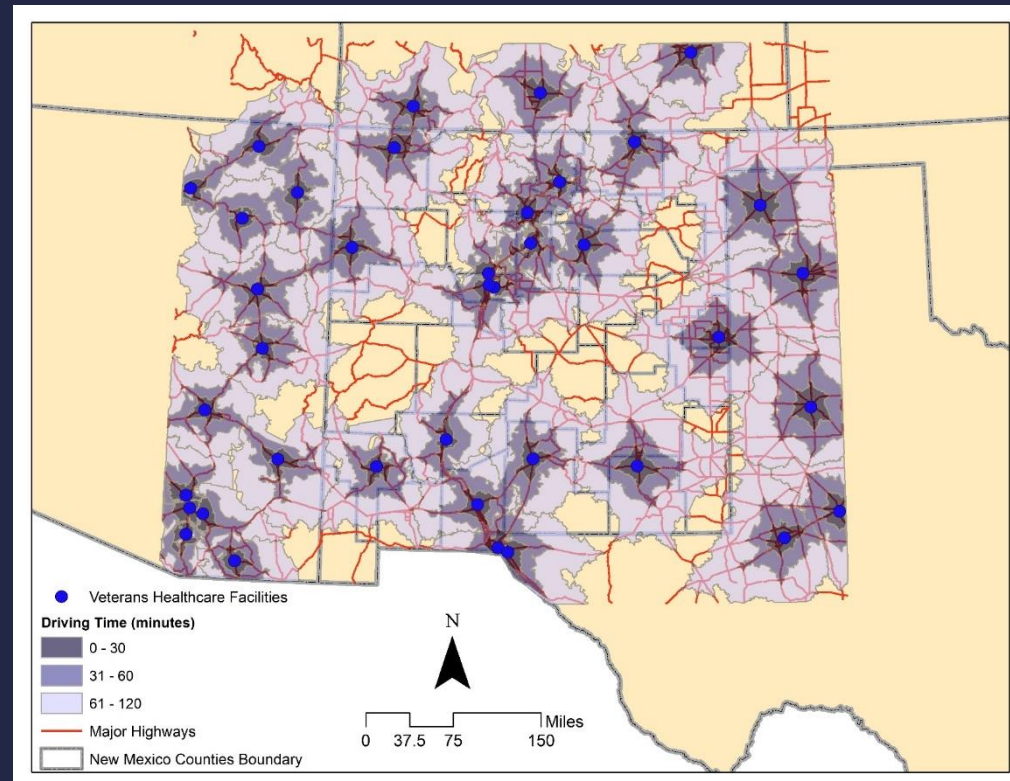


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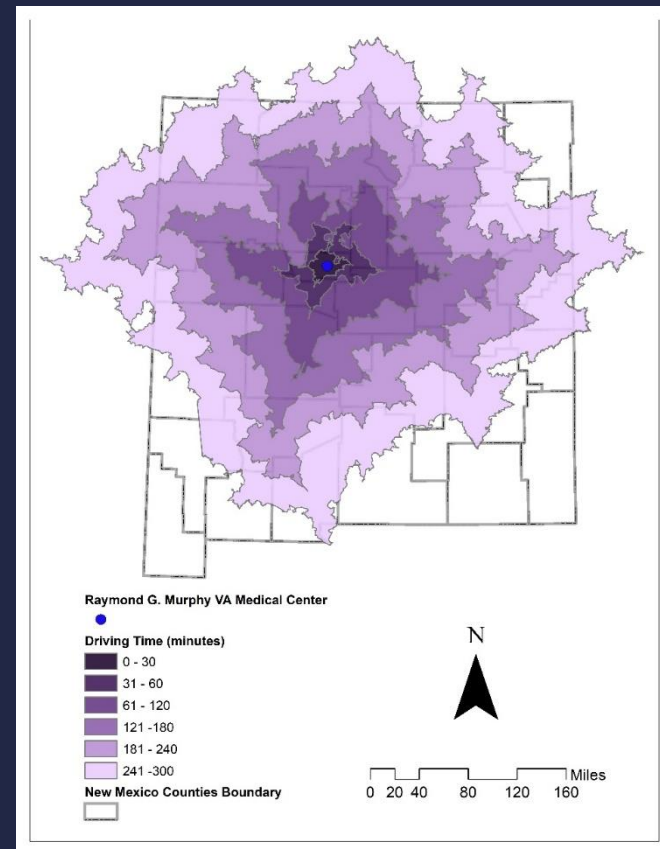


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EXAMPLES



EXAMPLES



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