

NYC Multimodal Network

(Walking, Subway, and Ferry)

SAVI 805 – Final Project

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Introduction

- ArcGIS Network Analyst is a powerful set of tools that can run various analyses on transportation and other networks.
 - However, networks must be well built in order to work properly
 - Lines must properly connect
 - Points must reside at vertices or endpoints of lines
- NYC Open Data provides various shapefiles that map transportation networks
 - Maps of roads, railways, subways, waterways

Introduction

- NYC Open Data shapefiles may be difficult to use
 - LION
 - Contains properly-connected road-, rail-, and water-ways
 - Does not contain points (stations, terminals, etc.)
 - Subway lines not simple to use
 - Does not contain all waterway routes
 - Subway Shapefiles
 - Separate shapefiles for subway lines, stations, and entrances
 - Not formatted for network analysis
 - Works well for simple visualizations
 - Line segments often not connected
 - Stations do not sit on lines
 - Entrances not at line endpoints on LION file
- Project was split into sections to simplify tackling these issues

Procedure (Subway)

- Messiest dataset for network analysis
- Subway lines do not interconnect
 - Needed to find common connection points within system
 - Subway Entrances chosen as connection points
 - One entrance may connect to several stations on different networks
- Shapefiles needed cleanup for network use
 - arcpy scripts written to split shapefiles by line

Procedure (Subway)

- Tools used
 - Select (arcpy)
 - Split shapefiles by line
 - Add XY Coordinates (arcpy)
 - Add coordinates to entrances
 - Integrate (batch)
 - Connect disconnected line segments in each subway line
 - Snap (batch)
 - Snap stations to lines
 - Near (arcpy)
 - Find entrances closest to stations for each line (and transfer stations)
 - Save station location coordinates
 - XY to Line (arcpy)
 - Create line segments connecting entrances to stations (and transfers)

Procedure (Subway)

- Tools used (cont.)
 - Merge
 - Combine multiple shapefiles into individual files per network segment
 - Lines, Stations, Entrances, Entrance Paths, Transfers
 - Find Identical
 - To determine whether there are overlapping lines or points
 - Delete Identical
 - Delete overlapping features
 - Split Line at Point
 - Split subway line segments at each station to ensure an endpoint
 - MUST SET SEARCH RADIUS!
 - Although this is an optional parameter, not setting it only splits the line segment at a single (nearest) point
 - Many line segments in data have multiple points on them
 - Setting search radius splits at all points within the radius

Procedure (Subway)

- Staten Island Railway
 - Entrances are in the Subway shapefile
 - Route is in LION
 - Selected and exported “FeatureTyp” = ‘1’ (Railroad)
 - Selected individual route and exported
 - Manually created feature set for stations
 - Placed points at station locations
 - Near entrances
 - Snapped to line segment endpoints
 - Add XY Coordinates, Near, and XY to Line
 - Connected entrances to stations

Procedure (Subway)

- Five merged shapefiles used to create subway network
 - Network was tested to connect internally



Procedure (Walking)

- LION Database
 - Walking routes extracted
 - Selected “FeatureTyp” fields ‘0’, ‘6’, and ‘W’
 - ‘0’ = Street other than vehicle only street
 - ‘6’ = Private Street (physically existing)
 - ‘W’ = Path, Non-Vehicular, Addressable
 - Exported selected features to new shapefile
 - Snap
 - Snapped copy of entrances layer to walking routes
 - Shapefile of nearest points on routes to entrances
 - Split Line at Point
 - Split walking routes at points nearest to entrances
 - Add XY Coordinates, Join by FID, and XY to Line
 - Connected near points to entrances with lines

Procedure (Walking)

- Edited walking paths shapefile used in network



Procedure (Ferry)

- Most sparse dataset
 - A lot of manual reconstruction
- Sources: LION and GTFS Data
 - LION maps various ferry routes
 - However, several new routes have been added recently
 - Only looked at NYC Ferry and Staten Island Ferry routes
 - Manually selected and exported applicable routes
 - General Transit Feed Specifications
 - Exported position data for ferries on various routes
 - Used Points to Line tool to reconstruct routes
 - Manually adjusted issues
 - Manually snapped endpoints at terminals to walking paths
 - Manually created terminal (points) feature set
 - Snapped to endpoints of routes at terminal locations

Procedure (Ferry)

- Ferry routes were checked versus the 2017 NYC Ferry map

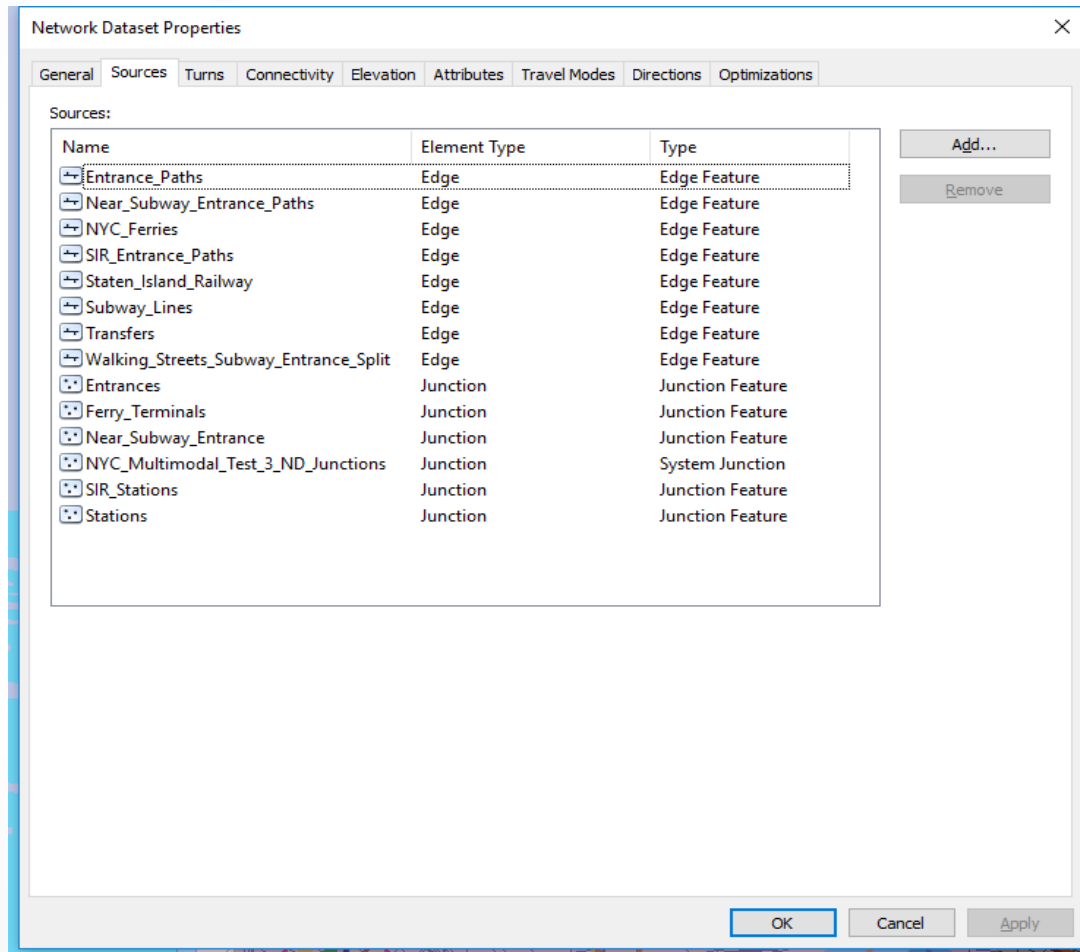


Completed Network

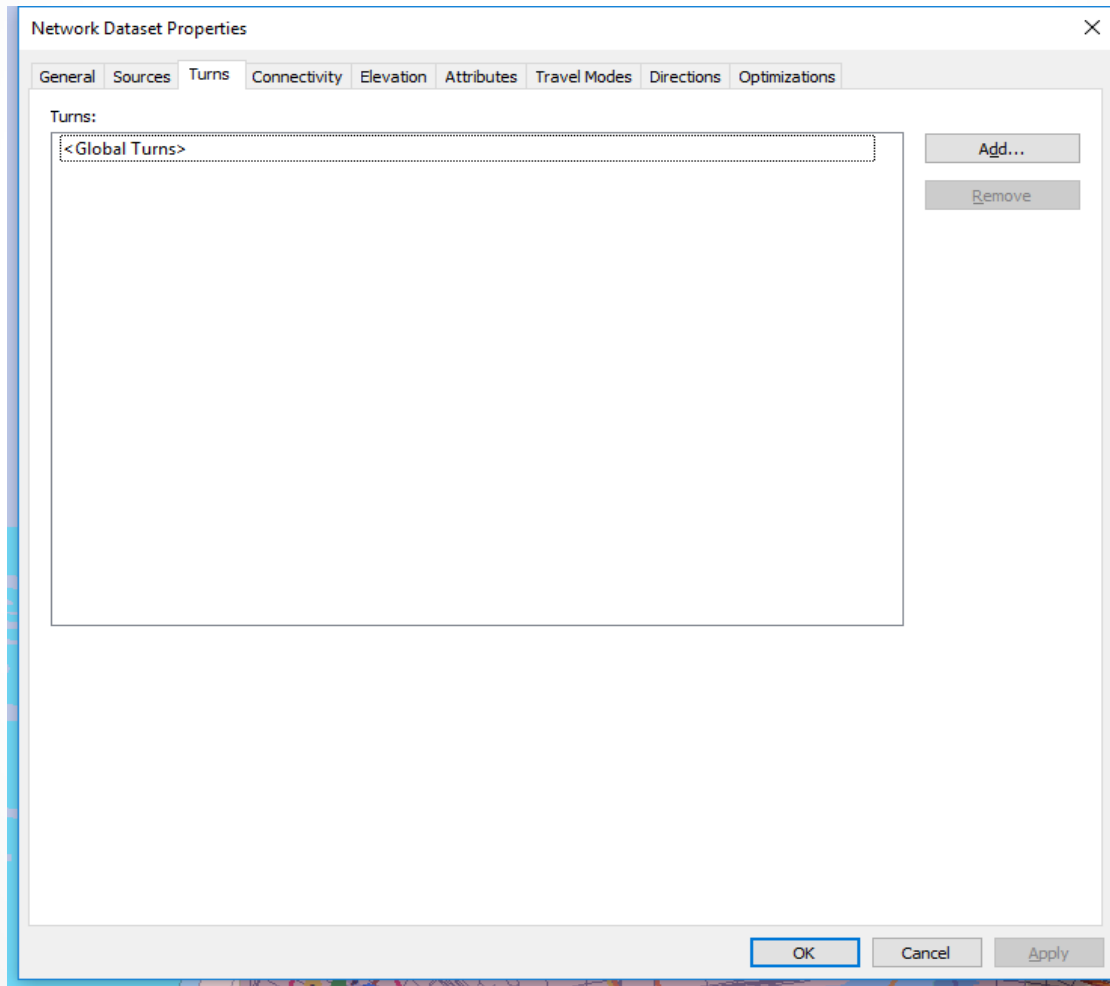
- Close-up of completed and stacked network layers



Creating Network Dataset



Creating Network Dataset



Creating Network Dataset

Network Dataset Properties

General Sources Turns **Connectivity** Elevation Attributes Travel Modes Directions Optimizations

Connectivity Groups:

Source	Connectivity Policy	1	2
Entrance_Paths	End Point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Near_Subway_Entrance_Paths	End Point	<input type="checkbox"/>	<input checked="" type="checkbox"/>
NYC_Ferries	End Point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
SIR_Entrance_Paths	End Point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Staten_Island_Railway	End Point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Subway_Lines	End Point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Transfers	End Point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Walking_Streets_Subway_Entrance_Split	End Point	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Entrances	Override	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Ferry_Terminals	Override	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Near_Subway_Entrance	Override	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SIR_Stations	Override	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Stations	Override	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Group Columns:

OK Cancel Apply

Creating Network Dataset

Network Dataset Properties

General Sources Turns Connectivity **Elevation** Attributes Travel Modes Directions Optimizations

Elevation Model:

None

Using Z Coordinate Values from Geometry

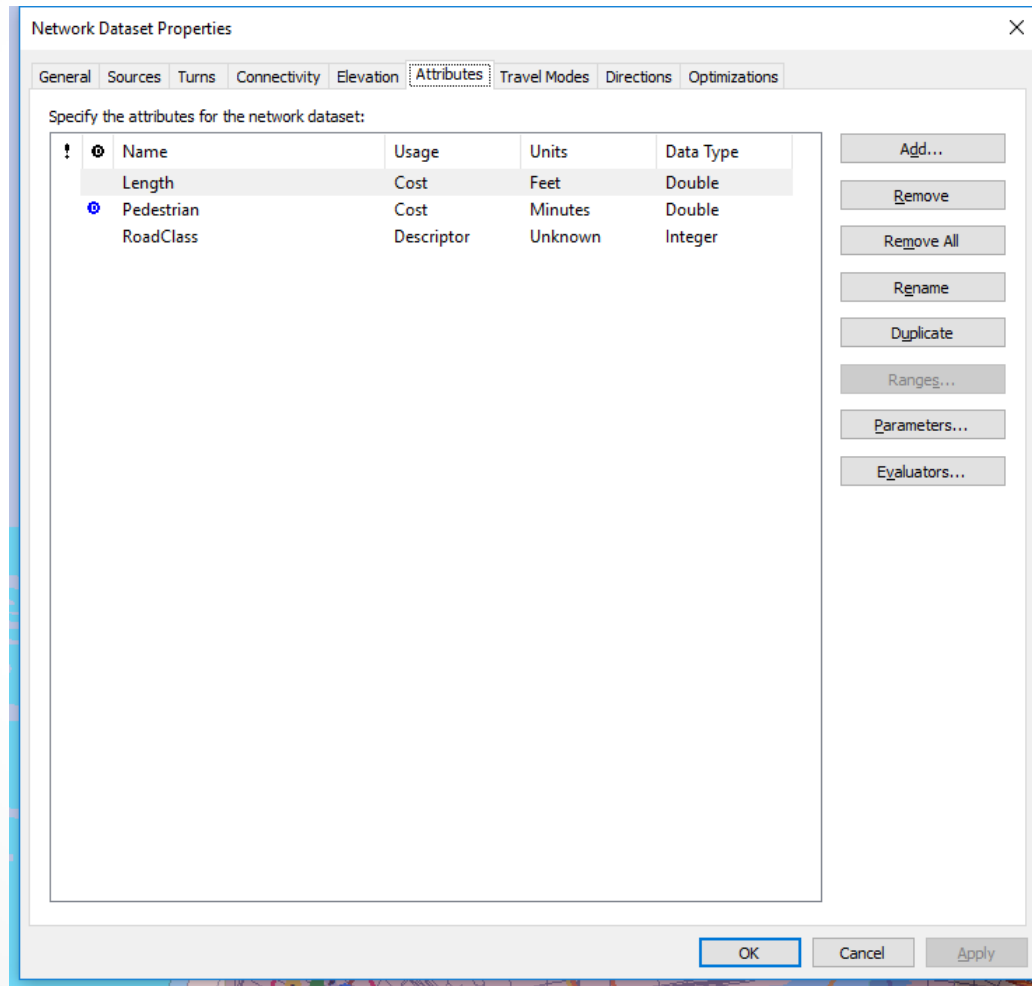
Using Elevation Fields

Source	End	Field
Entrance_Paths	From End	
Entrance_Paths	To End	
NYC_Ferries	From End	
NYC_Ferries	To End	
Near_Subway_Entrance_Paths	From End	
Near_Subway_Entrance_Paths	To End	
SIR_Entrance_Paths	From End	
SIR_Entrance_Paths	To End	
Staten_Island_Railway	From End	
Staten_Island_Railway	To End	
Subway_Lines	From End	
Subway_Lines	To End	

Click in the Field column to set elevation fields.

OK Cancel Apply

Creating Network Dataset



Creating Network Dataset

Evaluators ✕

Attribute:

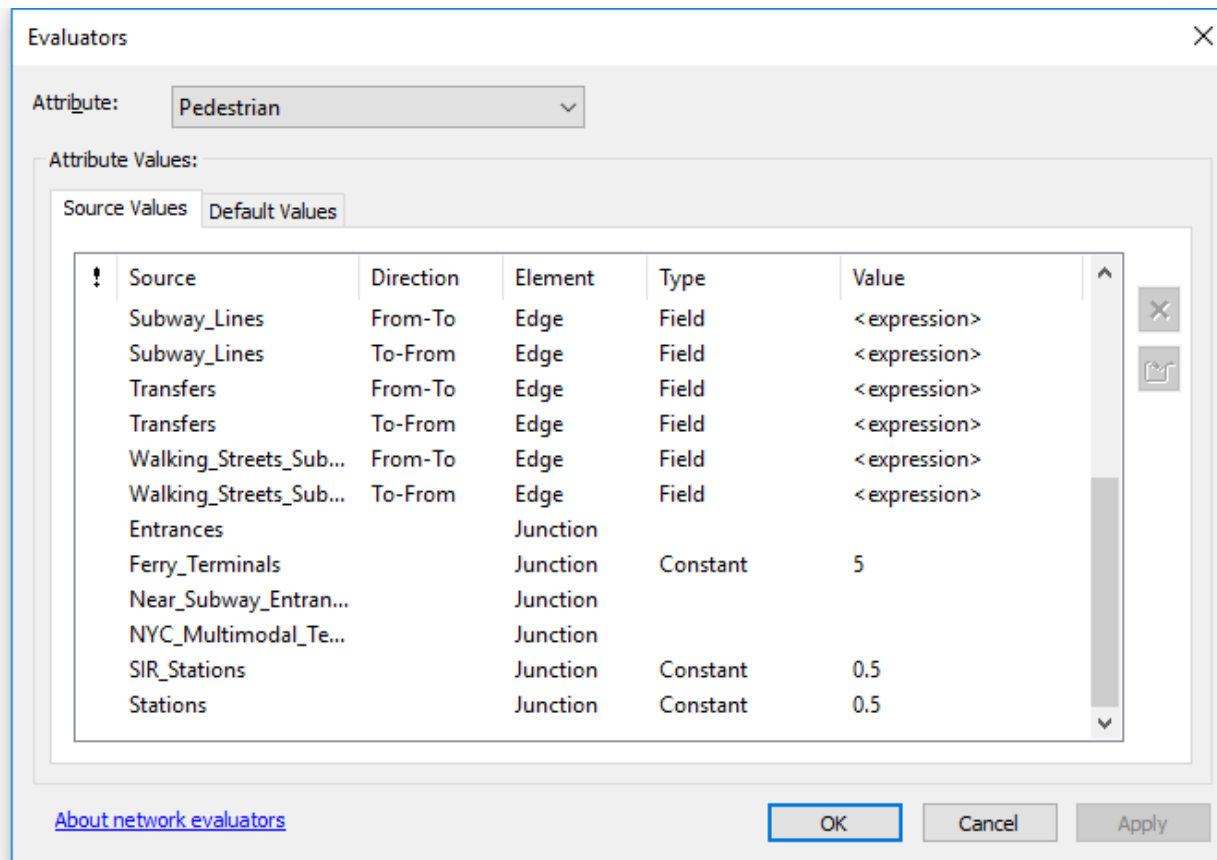
Attribute Values:

Source Values

!	Source	Direction	Element	Type	Value
	Entrance_Paths	From-To	Edge	Field	<expression>
	Entrance_Paths	To-From	Edge	Field	<expression>
	Near_Subway_Entran...	From-To	Edge	Field	<expression>
	Near_Subway_Entran...	To-From	Edge	Field	<expression>
	NYC_Ferries	From-To	Edge	Field	<expression>
	NYC_Ferries	To-From	Edge	Field	<expression>
	SIR_Entrance_Paths	From-To	Edge	Field	<expression>
	SIR_Entrance_Paths	To-From	Edge	Field	<expression>
	Staten_Island_Railway	From-To	Edge	Field	<expression>
	Staten_Island_Railway	To-From	Edge	Field	<expression>
	Subway_Lines	From-To	Edge	Field	<expression>
	Subway_Lines	To-From	Edge	Field	<expression>
	Transfer	From-To	Edge	Field	<expression>

[About network evaluators](#)

Creating Network Dataset



Creating Network Dataset

Field Evaluators

Parser
 VB Script Python

Fields:
LINE
OBJECTID
POINT_X
POINT_X_1
POINT_Y
POINT_Y_1
Shape
Shape_Length

Type:
 Number
 String
 Date

Functions:
Abs
Atn
Cos
Exp
Fix
Int
Log
Sin
Sqr
Tan

Pre-Logic Script Code:
* / & + - =

Value =
([Shape_Length] * 60 / 10560) + 2

Clear Load... Save... Verify
OK Cancel

Creating Network Dataset

Network Dataset Properties

General Sources Turns Connectivity Elevation Attributes Travel Modes Directions Optimizations

Travel Mode: + - Use By Default
Default Travel Mode: Pedestrian

Settings

Description:

Type:

Impedance:

Time Attribute:

Distance Attribute:

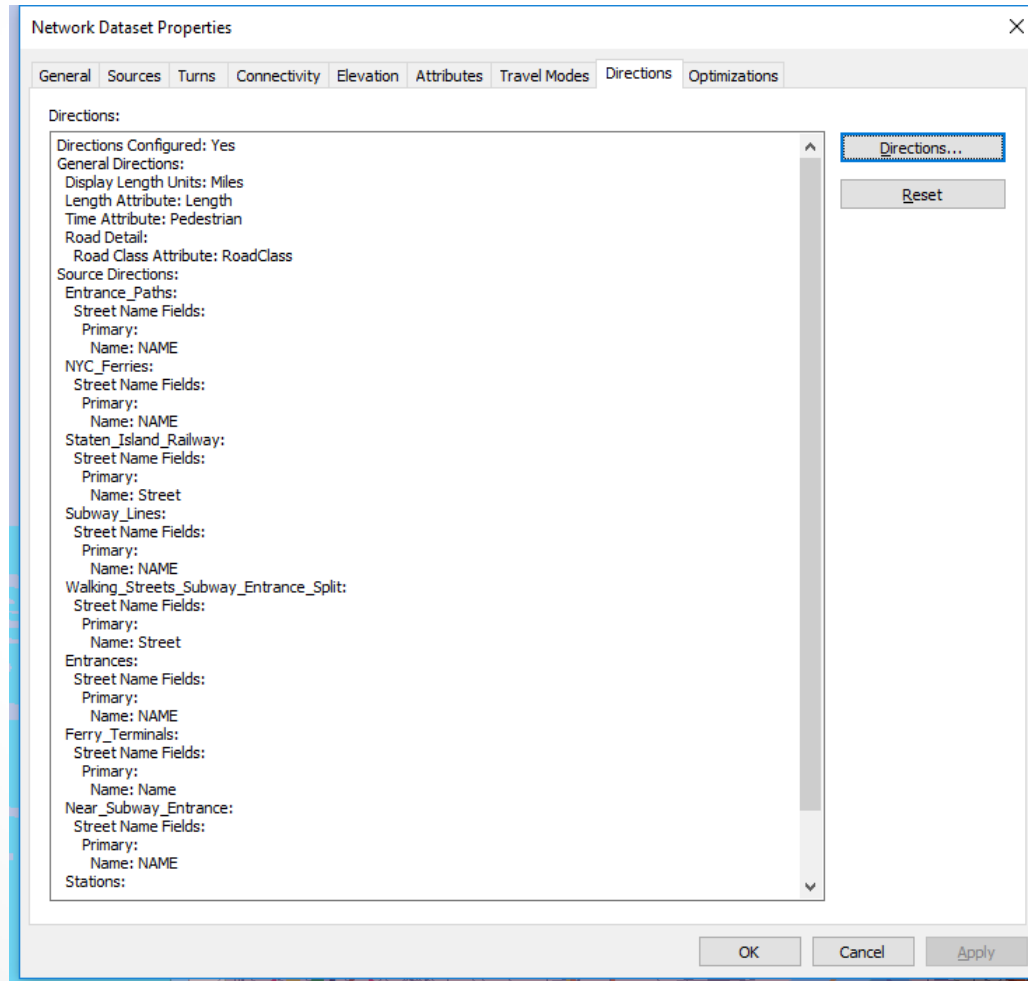
U-Turns at Junctions:

Simplification Tolerance:

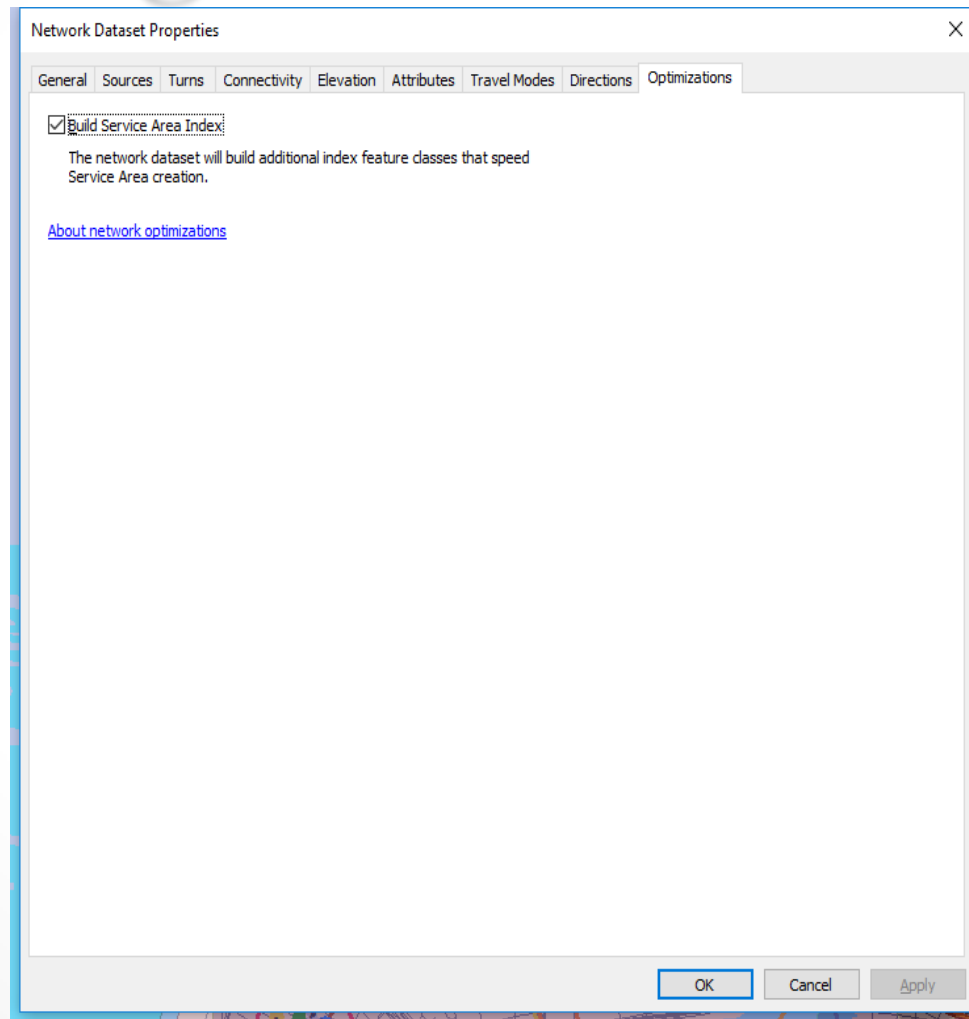
Use Hierarchy

Restrictions

Creating Network Dataset



Creating Network Dataset

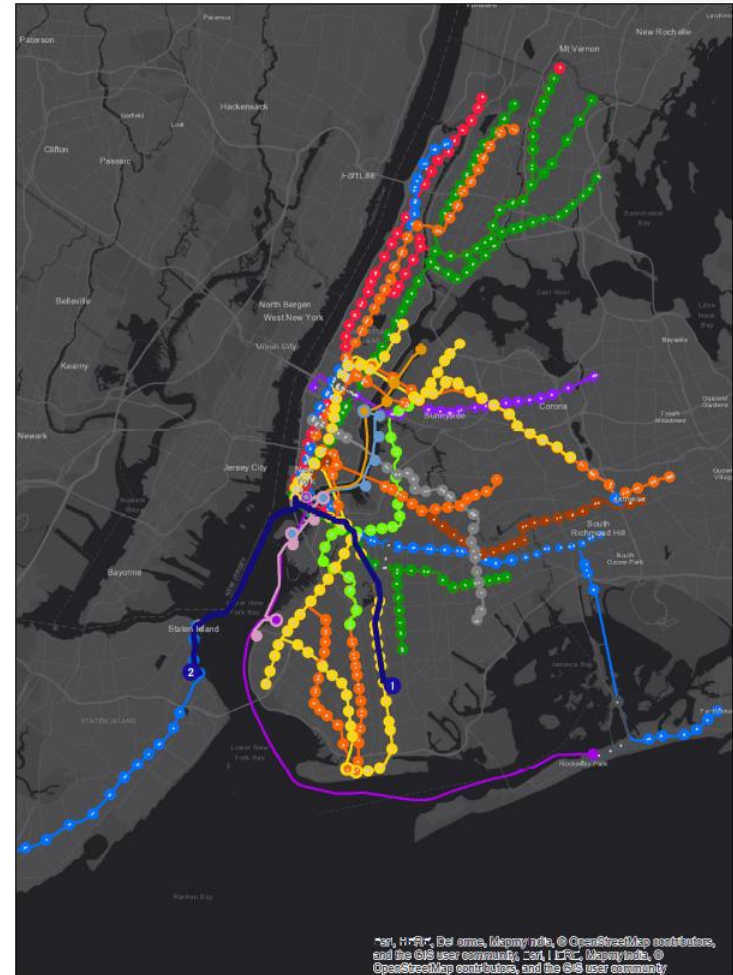


Creating Network Dataset

- Evaluator Assumptions
 - Walking Speed on Streets = 3mph
 - Walking Speed on Subway Paths = 2mph
 - For transfers, add additional 2 minutes
 - For entrance from street, add additional 2 minutes
 - Subways travel at 25 mph
 - Additional 30 seconds at each stop
 - Ferries travel at 30 mph
 - Additional 5 minutes per stop
- These evaluators gave time estimates similar to personal experience and Google Maps
 - Other sources may be used for more precision
 - Set specific routes for various times (express, rush-hour, etc.)
 - Used GTFS live data

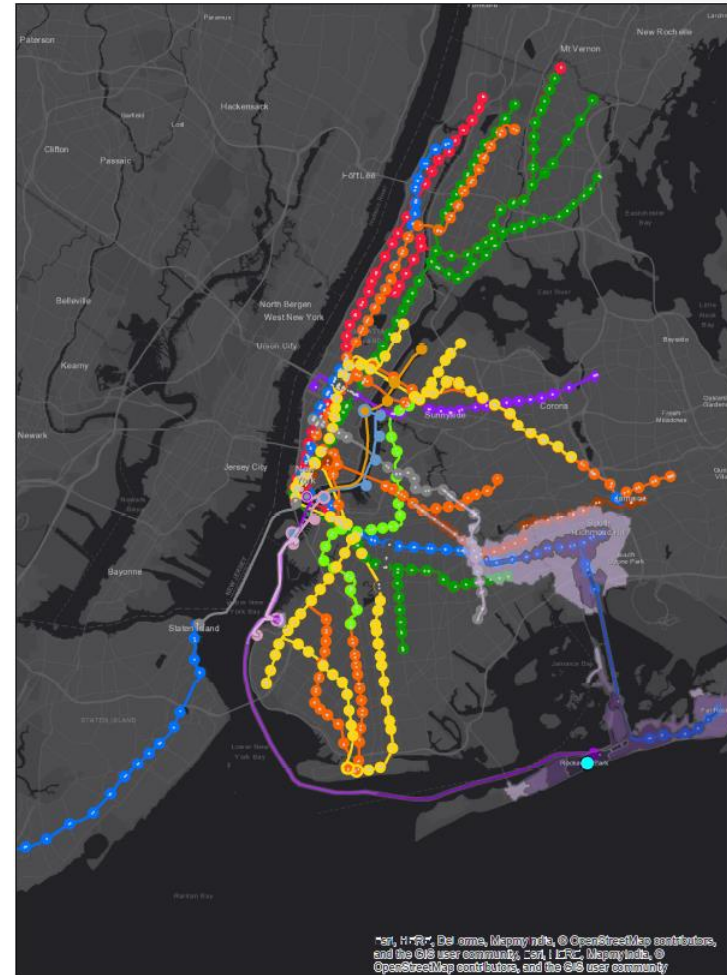
Using Network for Analysis

- Find most efficient route
 - Graphic Pick 1 - Graphic Pick 2
 - Total time: 1 hr 25 min
 - Total distance: 16 mi



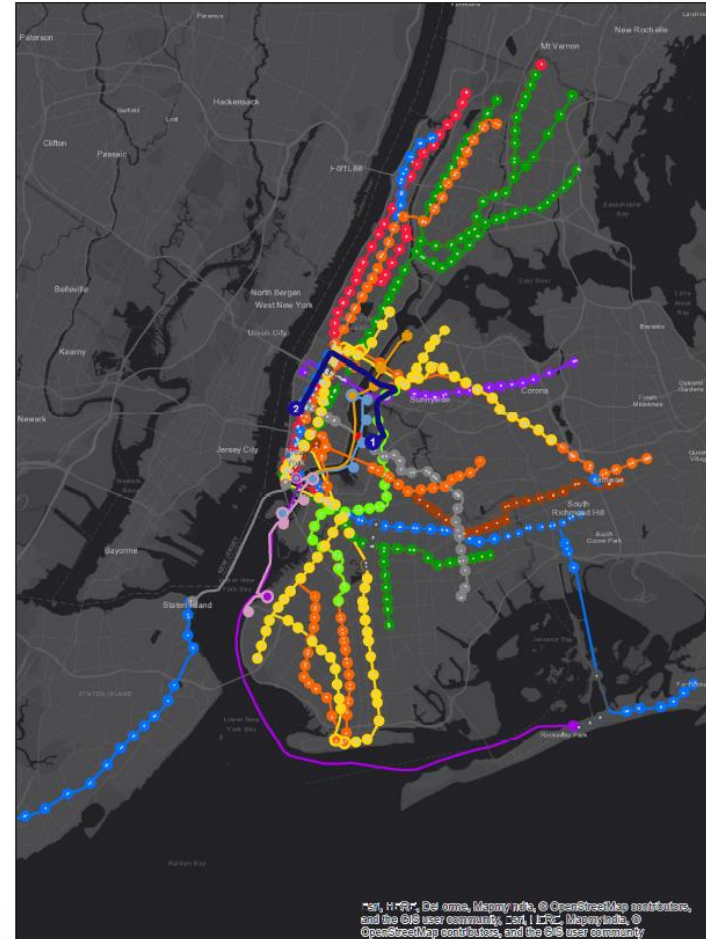
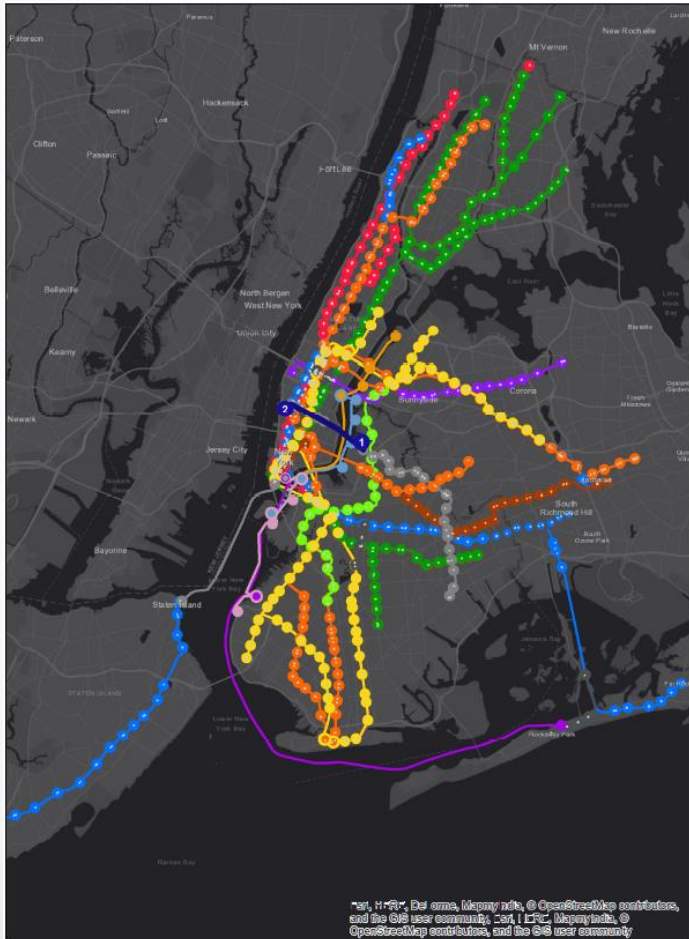
Using Network for Analysis

- Time of travel



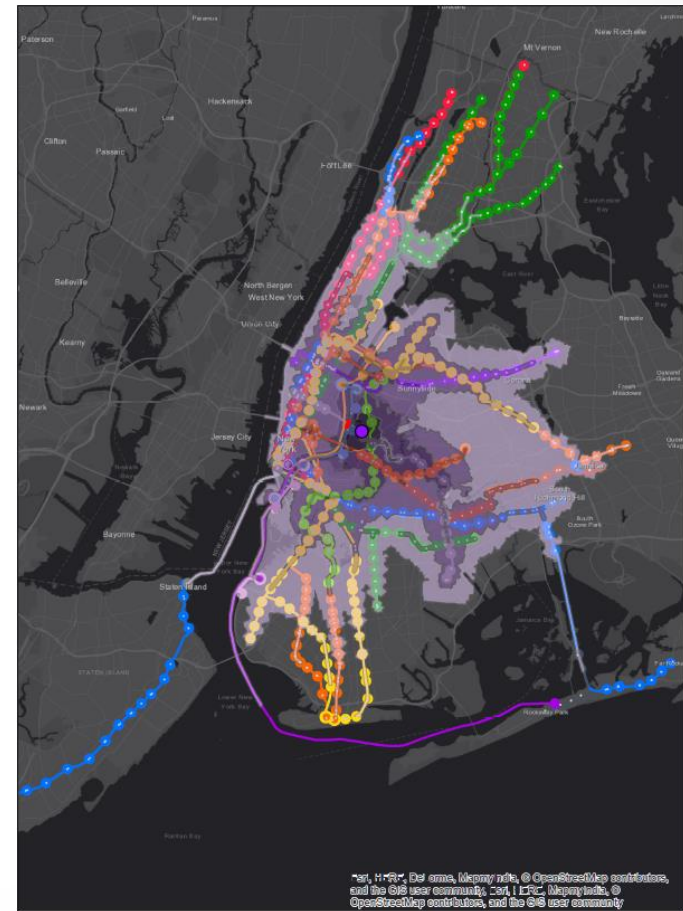
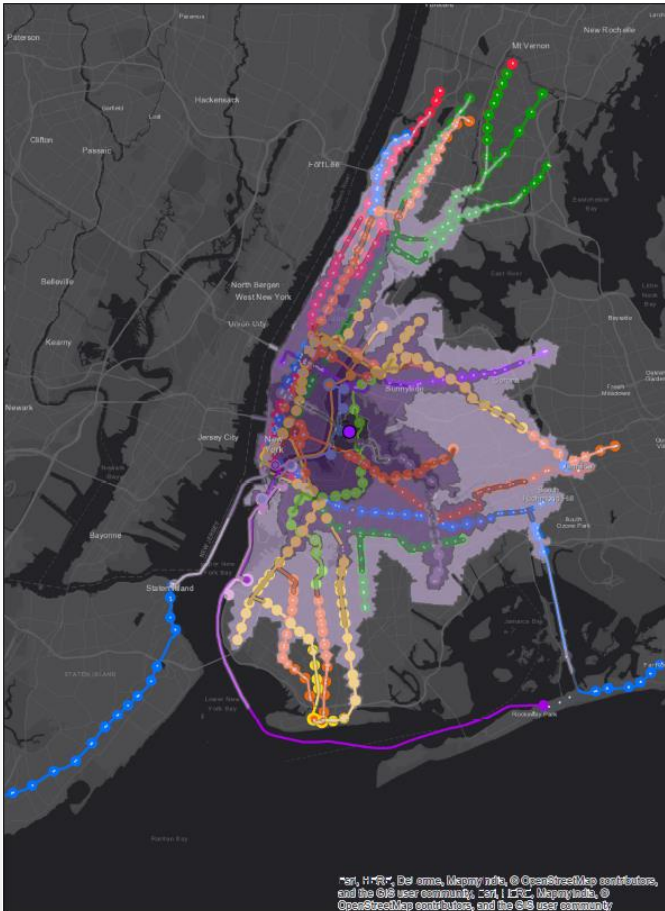
Using Network for Analysis

- Difference between routes (L-Train shutdown)



Using Network for Analysis

- Difference between time of travel (L-Train shutdown)



Thank You!

Questions?