Performing Network Analysis with Geoprocessing

Deelesh Mandloi
Jay Sandhu
Schedule

• 75 minute session
  – 60 – 65 minute lecture
  – 10 – 15 minutes Q & A following the lecture

• Cell phones and pagers

• Please complete the session survey – we take your feedback very seriously!

Please! Turn OFF cell phones and paging devices.
Introductions

• Who are we?
  – Network Analyst Product Engineers

• Who are you?
  – Current Network Analyst users?
  – Current Geoprocessing users?
  – Developers who wish to include network analyses in their applications?
  – Familiarity with Geoprocessing framework?
  – Experience with Python?
Topics

- ArcGIS Network Analyst Extension
- Terms used in network analysis
- Geoprocessing framework for network analysis
- Building geoprocessing models
- Building script tools
- Publishing network analysis services
- Support and Resources
- Questions
What is Network Analyst?

- Extension for analyzing transportation networks
  - Uses Network Datasets
  - Five network solvers

![Route](Route.png)
![Closest Facility](Closest_Facility.png)
![Vehicle Routing Problem](Vehicle_Routing_Problem.png)
![Origin-Destination (OD) Cost Matrix](Origin-Destination_OD_Cost_Matrix.png)
![Service Area](Service_Area.png)
Overview

Desktop GIS
- ArcGIS Desktop
  - ArcInfo
  - ArcEditor
  - ArcView
- ArcGIS Extensions
  - NA Extension
  - ArcMap
  - ArcCatalog
  - ArcReader

Embedded GIS
- ArcGIS Engine
  - NA Extension
    - Create custom GIS desktop applications

Server GIS
- ArcGIS Server
  - NA Extension
    - Comprehensive server-based GIS

ArcIMS
- Publish maps, data, metadata on the Web

Mobile GIS
- ArcGIS Mobile
  - ArcPad
  - GIS for field mapping applications

GP Framework
- Developer building blocks

Geodatabase
- File GDB
- PGDB
- DBMS

Shapefiles
- StreetMap

ArcSDE
- Advanced spatial data server

ArcGIS Extensions
- North American Extension

Developer building blocks
- GP Framework
Terms used in Network Analysis

- Network Dataset
- Network Analysis Layer (NA Layer)
- Network Analysis Classes (NA Classes or Sub-layers)
  - Network Analysis Locations (NA Locations)
- Network Analysis Objects (Features or Rows)
- GIS Dictionary

Geoprocessing Framework

- Development framework in ArcGIS
  - A way to create new software for the ArcGIS user community
  - High-level programming abstraction
  - Easier than writing ArcObjects code

- Development Toolkit
  - Built-in geoprocessing tools
  - Common UI to manage, execute, modify, and document tools
  - A visual programming language called Model Builder
  - Support for text based scripting languages

See: Geoprocessing Framework
Using Geoprocessing – How?

• Accessed through ArcToolbox

• Network Analyst Tools
  – Performing Network Analysis
  – Building networks
  – Managing turns
Using Geoprocessing – How? (continued)

- **Script - Textual programming language**
- **Tool dialog box**
- **Single tool execution**
- **Command line**
- **Model – Visual programming language**
- **Chain tools**

```
# Process: Make OD Cost Matrix Layer...
# Process: Add Locations...
gp.AddLocations_na(OD_Cost_Matrix, "Origins", Stores, "Name Name #:CurbApproach #:0");
```
Using Geoprocessing – Where?

ArcGIS Desktop

ArcGIS Engine

ArcGIS Server

Geoprocessing Tools

Model tools
- Allocation Problems
- Determine Optimum Allocation
- School Allocation Problem Model
- Transportation Problem Model

Closest Facilities Service
- Apply Style Sheet
- Find Closest Facilities to Incidents

Gravity Modeling Tools
- Determine Accessibility
- Determine Spatial Interaction
- Network Central Feature

Network Analyst Tools
- Analysis
- Network Dataset
- Turn Feature Class
- Service Area Tools
- Find Service Area

System (built-in) tools

Script tools
Network Analysis Workflow

1. Make Network Analysis Layer

2. Add locations to one or more Network Analysis Classes

3. Solve

4. Use the results
Geoprocessing Models

• A visual programming language
  – Chain geoprocessing tools to perform a workflow

• Authored using the Model Builder application

• Models behave like any other tools within ArcToolbox
  – Can use a model within another model

• All Model Builder techniques apply when authoring models for network analysis

• See: Automating your work with models
Example Model to perform Service Area Analysis

- Numbers refer to steps in Network Analysis workflow
Demo

• Authoring a model to determine multiple routes from a text file containing start and end X,Y coordinates
Points to Note

• Use the Select Data tool to access sub-layers of an NA layer

• NA layer is the derived output of most of the tools (Add Locations, Solve)

• If running models as tools, make the NA layer as Model Parameter so that its added to ArcMap TOC

• The output of the Solve tool is the same input NA layer containing results in memory

• If NA layer is intermediate data, delete it as a last step
Geoprocessing Scripts

• Used for
  – Conditional logic
  – Looping
  – Cursors, creating geometry
  – Accessing built-in and third party python modules

• Access any GP tool (including network analyst tools)

• Python scripts can be run cross platform

• See: Geoprocessor programming model

• See: Automating your work with scripts
Script Tools

• Add standalone geoprocessing scripts to ArcToolbox as script tools

• Script tools behave like any other tool within ArcToolbox
  – Can use script tools in models and vice versa

• Convenient method for providing a UI for scripts within ArcGIS desktop

• See: Creating Script Tools

Demo : School Allocation Script Tool

- Scripts can take advantage of all the capabilities provided by the python language

- Call third party applications that support python interface to have a “tightly coupled” approach
  - For example, calling GLPK using PuLP
    - PuLP is a public domain Python module for modeling LP problems
    - GLPK is a public domain package for solving LP problems

- Solve an allocation problem assigning students to schools with capacity constraints
Points to Note

• Custom validation logic can be programmed for the script tool UI by programming the Tool Validator class

• Use Describe() to determine the properties of the Network Dataset and the Network Analysis layer

• The NA layer can be referenced within the script using its name

• If the output is an NA layer, make it a derived output parameter and use SetParameterAsText()

• The output NA layer supports pre-defined symbology using layer files
Network Analysis on ArcGIS Server

• Network Analysis Service
  – Coarse-grained, stateless network analysis objects
  – No out-of-the-box clients

• Geoprocessing Service
  – Configured using models and scripts tools
  – Full use of the geoprocessing framework
  – Out-of-the-box clients
    • ArcGIS Explorer
    • ArcGIS Desktop
    • Web ADF
  – JavaScript clients
Geoprocessing Service

- Created by publishing models and scripts on ArcGIS Server
- Geoprocessing tasks accessible by web-enabled clients
- Author, Publish, and Serve workflow
- Accessed using
  - Out-of-the-box clients
    - ArcGIS Explorer
    - Web Mapping Applications
    - ArcGIS Desktop
  - JavaScript clients
- See: Geoprocessing with ArcGIS Server
  
Publishing Geoprocessing Services

1. **Geoprocessing service**
   Publishing a toolbox to create a geoprocessing service. Each tool in the toolbox becomes a task. *Outputs of tasks are drawn by the client.*

2. **Geoprocessing service with a source map document**
   Publishing a map document containing tool layers to create a geoprocessing service. Each tool layer becomes a task. Tasks can access layers in the source map document. *Outputs of tasks are drawn by the client.*

3. **Geoprocessing service with result map service**
   Publishing a map document containing tool layers to create a geoprocessing service. Each tool layer becomes a task. Tasks can access layers in the map document. *Outputs of tasks are drawn by the map service.*
Network Analysis Geoprocessing Services

- Publish services using tool layers in map document and not as toolbox
  - Can use other layers in the TOC as model variables
  - Services run faster since the network dataset can be already open
  - Can publish only some models as opposed to all models with in a toolbox

- Choose to have a result map service if you need advanced symbology (such as labels)
Geoprocessing Service Configuration

- No result map service
  - Works with asynchronous and synchronous services
  - Can keep outputs in memory
  - Define symbology for the outputs in tool sub layers
  - Can use dynamic values with unique value renderer
  - Useful for displaying service areas or multiple routes
  - Supports only symbology and layer transparency
Geoprocessing Service Configuration

- Using result map service
  - Results are drawn as an image and not features
  - Works only for asynchronous services
  - Can not use dynamic values with unique value renderer
  - Can not use in-memory workspace for outputs
  - Useful if symbology needs to include labeling or other advanced options
  - Useful for generating sequenced stop symbol using labels
Demo

• Publishing a service that finds service areas

• Publishing a service that finds closest facilities and consume the service in a Google Maps mashup
Points to Note

• Use “in_memory” to write outputs to the in-memory workspace
  – Improves performance

• NALayer is not valid output parameter data type for ArcGIS server
  – Must use Select Data and/or Copy Features after solve

• Keep a reference to the Network Dataset in the map
  – Increases performance since doesn’t load from disk every time

• For dynamic symbology, don’t use result map service
  – Uncheck <all other values> for the symbol value
Network Analysis Tips

• Use appropriate field mappings before using Add Locations tool

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<th>Default Value</th>
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• Use Calculate Locations tool to pre-compute network locations for faster loading
Summary

- Geoprocessing as a development framework for ArcGIS
  - Visual programming language (models)
  - Textual programming language (scripts)
- Easier than writing ArcObjects code
- Automate repetitive tasks
- Incorporate network analysis in larger process
- Can use out-of-the-box ArcGIS Server clients
- Can use JavaScript clients
Support and Resources

• ArcGIS Desktop Help on Geoprocessing

• Network Analyst Help

• Geoprocessing Center (coming soon)
  http://resources.esri.com/arcgisdesktop/index.cfm?fa=showgeo

• Slides and demos from this session

• ArcGIS Network Analyst discussion forum
  http://forums.esri.com/forums.asp?c=93&s=1944#1944
In Conclusion...

- Related sessions
  - Building and Optimizing Geoprocessing Services for ArcGIS Server
  - Developing Desktop Applications with the Geoprocessing Framework

- All sessions are recorded and will be available on EDN
  - Slides and code will also be available

- Please fill out session surveys!

- Questions

- Still have questions?
  - Tech talk (Lobby)