ArcGIS Network Analyst: Automating Workflows with Geoprocessing

Melinda Morang
Patrick Stevens
• **Who are we?**
  - Network Analyst Product Engineers

• **Who are you?**
  - Current Network Analyst users?
  - Current geoprocessing users?
  - Have made geoprocessing models?
  - Have made geoprocessing Python scripts?
• ArcGIS Network Analyst extension concepts
• Geoprocessing framework for network analysis
• ModelBuilder: Models and model tools
• Python: Scripts and script tools
• Ready-to-Use services
• Support and resources
ArcGIS Network Analyst extension concepts

ArcGIS Help:
What is the ArcGIS Network Analyst extension
Topics to be covered

- ArcGIS Network Analyst extension concepts
- Geoprocessing framework for network analysis
- ModelBuilder: Models and model tools
- Python: Scripts and script tools
- Ready-to-Use services
- Support and resources
ArcGIS Network Analyst Extension does transportation analysis

Coverage
- Service Area

Optimization
- Location-Allocation
- Vehicle Routing Problem

Point-to-point routing
- Route
- Closest Facility
- Origin-Destination Cost Matrix

ArcGIS Network Analyst: Automating Workflows with Geoprocessing
Network Dataset
• Data within your organization

• Free data
  - Data and maps media (prior to 10.3)
  - TIGER (Census data)
  - OpenStreetMap
    - OSM to NDS tools
    - ArcGIS Editor for OpenStreetMap

• Pay for data
  - HERE or TomTom
  - Vendor street data processing tools
  - StreetMap Premium for ArcGIS

• Pay for analysis
  - ArcGIS.com Map Viewer
  - ArcGIS.com Network Services
• Composite layer
• One layer type for each solver
• Analysis properties
• Inputs
• Outputs
Performing an analysis manually
Steps for network analysis:

- **Make Layer**
- **Add Locations**
- **Solve**
- **Work with results**
What is Geoprocessing?

ArcGIS Help: The geoprocessing framework
• ArcGIS Network Analyst extension concepts
• Geoprocessing framework for network analysis
• ModelBuilder: Models and model tools
• Python: Scripts and script tools
• Ready-to-Use services
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What is Geoprocessing?

- Computation
- Visualization
- Storage & Management
What is Geoprocessing?

- Automating workflows
- Modeling & Analysis
• Performing Network Analysis
• Building networks
• Publishing services
• Managing turns
Using Geoprocessing

Single tool

Tool dialog

Python window

Chain tools

Model

Script
Using Geoprocessing

Model tools

Script tools

System tools

ArcGIS Network Analyst: Automating Workflows with Geoprocessing
1. Make or Edit Network Analysis Layer
2. Add locations to one or more Network Analysis Classes
3. Solve
4. Use the results
Building Geoprocessing Models

ArcGIS Help: What is ModelBuilder?
Topics to be covered

- ArcGIS Network Analyst extension concepts
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Geoprocessing Models

- Author using Model Builder
- Chain tools to perform a workflow
- Use models like ArcToolbox tools
- Use models within other models
- Apply all Model Builder techniques to network analysis models
Example: Service Area Model
Performing a network analysis in Model Builder

Sharing a model as a tool
• **Automate workflows** with Model Builder

• **Share** your model as a tool

  - Make inputs and outputs **model parameters**
    - Inputs can be selected by the tool’s user
    - Outputs will be added to the ArcMap Table of Contents
When running models as tools...
- The output network analysis layer should be a model parameter
- This will add the layer to the ArcMap Table of Contents
Automating workflows with geoprocessing models

Working with inputs and outputs

Make a toolbar button
Takeaways

Demo: Automating Workflows with Geoprocessing Models

- Run a model as a **button** on a toolbar
- Use the **Select Data** tool to access NA sublayers
- Work with **external data** like CSV files
Post-processing your analysis

- Use your analysis result as an input to another tool
  - The **Select Data** tool accesses individual sublayers
Writing Python Scripts

ArcGIS Help: What is Python?
Topics to be covered

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Python Scripts

- Conditional logic
- Loops
- Cursors, creating geometry
- Built-in and third party modules
- Cross-platform
- ArcPy site package
  - Network Analyst module
  - Other geoprocessing tools
  - Other useful functions and classes
    - Describe

ArcGIS Network Analyst: Automating Workflows with Geoprocessing
Simplify access to Network Analyst functionality from Python

Edit the analysis properties of network analysis layers
- No need to re-create layers
- Speed up execution
- Simplify script logic
Python Script: Basic Building Blocks

```
#Import system modules
import arcpy
```

Import the arcpy module
Python Script: Basic Building Blocks

Check out the Network Analyst extension license

```python
# Check out the Network Analyst extension license
arcpy.CheckOutExtension("Network")
```

Check out the Network Analyst Extension
Python Script: Network Analyst Workflow

Make/edit a network analysis layer

```python
# Name: Solve_WorkFlow.py
# Description: Solve a closest facility analysis to:
#   - the store locations and save the
#     result to disk.
# Requirements: Network Analyst Extension

# Import system modules
import sys
from arcpy import env

# Import arcpy
from arcpy import env

resultObject = arcpy.na.MakeClosestFacilityLayer(inNetworkDataset, outNALayerName,
                                                  impedanceAttribute, "TRAVERSE_TO",
                                                  "", 1, accumulateAttributeName,
                                                  "NO_UTURNS")

outNALayer = resultObject.getOutput(0)
```

ArcGIS Network Analyst: Automating Workflows with Geoprocessing
Add locations to network analysis classes

```python
subLayerNames = arcpy.na.GetNAClassNames(outNALayer)
# Stores the layer names that we will use later
facilitiesLayerName = subLayerNames["Facilities"]
arcpy.na.AddLocations(outNALayer, facilitiesLayerName, inFacilities, ",", ",")
```
Python Script: Network Analyst Workflow

Solve the network analysis layer

```
# Name: Solve_WorkFlow.py
# Description: Solve a closest facility analysis to find the closest warehouse from the store locations and save the results to a layer file on disk.
# Requirements: Network Analyst Extension

# Import system modules
import arcpy
from arcpy import env

try:
    # Check out the Network Analyst extension license
    arcpy.CheckOutExtension("Network")

    # Set environment settings
    env.workspace = "C:/data/Fairia.gdb"
    env.overwriteOutput = True

    # Set local variables
    inNetworkDataset = "Transportation/FairiaMultimodal Net"
    outdistancelayer = "ClosestFacilityAnalysis" 

    # Solve the network analysis layer
    arcpy.na.Solve(outNALayer)
```
Python Script: Network Analyst Workflow

```python
# Name: Solve_Workflow.py
# Description: Solve a closest facility analysis to find the closest warehouse
# from the store locations and save the results to a layer file on
# disk.
# Requirements: Network Analyst Extension

import arcpy
from arcpy import env

try:
    # Check out the Network Analyst extension license
    arcpy.CheckOutExtension("Network")

    # Set environment settings
    env.workspace = "C:/data/Paris.gdb"
    env.overwriteOutput = True
    # Set local variables
    inNetworkDataset = "Transportation/ParisMultiTime"
    outNALayerName = "ClosestWarehouse"
    impedanceAttributeName = "Drivetime"
    accumulateAttributeName = ["NetCost"]
    inFacilities = "Analysis/Warehouses"

    # Solve closest facility analysis
    arcpy.gp.ClosestFacilities_sa(inNetworkDataset, outNALayerName, impedanceAttributeName, accumulateAttributeName, inFacilities)

    # Save results to layer file
    arcpy.management.SaveToLayerFile(outNALayerName, outLayerFile, "RELATIVE")
```

Use the results
The network layer is retrieved as a layer object from the result object returned by `Make<solver>Layer`.

```python
resultObject = arcpy.na.MakeClosestFacilityLayer(inNetworkDataset, outNALayerName, impedanceAttribute, "TRAVEL_TO", ",", 1, accumulateAttributeName, "NO_UTURNS")

# Get the layer object from the result object. The closest facility layer can now be referenced using the layer object.
outNALayer = resultObject.getoutput(0)
```
• Edit the solver properties of an existing layer object

```python
# Get the service area layer as an input parameter
salayer = arcpy.GetParameter(0)

# Get the solver properties object from the service area layer
solverProps = arcpy.na.GetSolverProperties(salayer)

# Update the properties for the service area layer using the solver properties
solverProps.defaultBreaks = [5, 10, 15]
solverProps.useHierarchy = "USE_HIERARCHY"
```
The Select Data tool is not meant for python scripting

`arcpy.na.GetNAClassNames` should be used
- Renamed or localized sublayer names will work in the script

```python
#Get the names of all the sublayers within the closest facility layer.
subLayerNames = arcpy.na.GetNAClassNames(outNALayer)

#Store the layer names that we will use later
facilitiesLayerName = subLayerNames["Facilities"]

#Load the warehouses as Facilities using the default field mappings and search tolerance
arcpy.na.AddLocations(outNALayer, facilitiesLayerName, inFacilities, "", ",")
```
• Access individual sublayers using **ListLayers** on the NA layer.

```python
# Get the output Routes sublayer and save it to a feature class
routesSubLayer = arcpy.mapping.ListLayers(outNALayer, sublayerNames["Routes"])[0]
arcpy.management.CopyFeatures(routesSubLayer, outRoutesFC)
```

• Use sublayers as input to other tools (CopyFeatures, Join, Buffer, etc.).

• Use a SearchCursor to access the rows within a sublayer.
• Easily specify field mappings in Add Locations with `arcpy.na.NAClassFieldMappings`
The in-memory network analysis layer can be persisted using the `SaveToLayerFile` tool in the management module.

```python
arcpy.management.SaveToLayerFile(outNALayer, outLayerFile, "RELATIVE")
```

Layer files can be dragged from disk into ArcMap.
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Performing a network analysis with a python script
• Run simple python commands in ArcMap’s **python window**

• **Export models** to python scripts

• Persist the in-memory network analysis layer with **SaveToLayerFile**

• Run scripts from a command prompt **outside of ArcMap**
Building Script Tools

ArcGIS Help: What is a script tool?
• Work with your scripts through a user interface

• Use Script tools like any other tool within ArcToolbox
  - Use script tools in models and vice versa
If a network analysis layer is the output...
- Make an additional derived output parameter of type Network Analyst Layer
- Use `arcpy.SetParameterAsText(...)`

```python
# Do your analysis workflow
outNALayer = arcpy.na.MakeClosestFacilityLayer(inNetworkDataset, outNALayerName)

# Set your analysis layer as an output parameter for the script tool
arcpy.SetParameterAsText(1, outNALayerName)
```
Create a script tool

Create a script tool to provide a UI for a Python script

Use tool validation to customize the UI.

Write a script tool to extend the capabilities of ArcGIS.
• Provide a user interface for python scripts by making a **script tool**

• Use derived output and `arcpy.SetParameterAsText()` to add results to the map

• Use **tool validation** to customize your script tool’s UI

• Use python modules to **extend** the capabilities of ArcGIS
Topics to be covered

- ArcGIS Network Analyst extension concepts
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• Published by Esri

• Managed by Esri
  - No user maintenance of servers, services, or data
  - Excellent uptime and reliability
• Global data
• Live traffic
• No Network Analyst specific software required
• Create Layer, Add Locations, and Solve all in one tool
Anywhere geoprocessing tools can be used
- Model builder
- Python scripts
- ArcMap

Like any other service that uses credits

Supported from 10.0 SP5 and up
• ArcGIS Online subscription with credits

• Your own analysis inputs
- Check [credit page](#)
- Varies per type of analysis

<table>
<thead>
<tr>
<th>Network Analysis</th>
<th>Service Credits Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Routes</td>
<td>0.04 credits per route</td>
</tr>
<tr>
<td>Optimized Routes</td>
<td>0.5 credits per optimized route</td>
</tr>
<tr>
<td>Drive Time (Service Areas)</td>
<td>0.5 credits per drive time</td>
</tr>
<tr>
<td>Closest Facilities</td>
<td>0.5 credits per closest facility route</td>
</tr>
<tr>
<td>Multi-Vehicle Routes( VRP)</td>
<td>1 credits per route</td>
</tr>
<tr>
<td>Traffic</td>
<td>0 credits</td>
</tr>
</tbody>
</table>
Ready-To-Use services

Connecting to Ready-To-Use services

Using a Ready-To-Use service in a model
• Use **Ready-To-Use services** like other geoprocessing tools

• Access high-quality **street data**
More details about authoring, publishing and using on-premise network analysis services are available in technical workshop titled *Performing Network Analysis with ArcGIS for Server* from a previous user conference.

- Workshop presentation
- Workshop video
Summary
Summary

• Use the geoprocessing framework for network analyses
  - Network Analyst Tools
  - Models and Model tools
  - Script and Script tools

• Automate workflows

• Incorporate network analysis in larger process
Topics to be covered

- ArcGIS Network Analyst extension concepts
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Resources
Support and resources

- Tutorials
  - Network Analyst tutorial
  - Network Analyst geoprocessing service examples

- Code samples in Network Analyst tools toolbox

- ArcGIS Network Analyst Extension Discussion Forum

- ArcGIS for Transportation Analytics Group on arcgis.com
Support and resources

• Python for ArcGIS resource center

• Books
  - GIS Tutorial for Python Scripting
  - Python Scripting for ArcGIS
  - Getting to Know ArcGIS ModelBuilder
Network Analyst at the Esri User Conference
<table>
<thead>
<tr>
<th>Time</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
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<tr>
<td>8:30 am</td>
<td>Network Analyst: An Introduction</td>
<td>Network Analyst: An Introduction</td>
<td>Network Analyst: An Introduction</td>
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<td>9 am</td>
<td>Routing in Buildings with 3D Networks in ArcGIS Pro</td>
<td>Network Analyst: Automating Workflows with Geoprocessing</td>
<td>Using GTFS Public Transit Data in ArcGIS</td>
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<td>Network Analyst: Automating Workflows with Geoprocessing</td>
<td>Network Analysis with Python</td>
<td>Network Analyst: An Introduction</td>
</tr>
<tr>
<td>11 am</td>
<td>Using Navigator for ArcGIS</td>
<td>Using GTFS Public Transit Data in ArcGIS</td>
<td>Network Analyst: Network Analysis with ArcGIS Online</td>
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<td>Network Analyst: Creating Network Datasets</td>
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<td>Navigator for ArcGIS: Technical Preview</td>
<td>Navigator for ArcGIS: Technical Preview</td>
<td>Network Analyst: Creating Network Datasets</td>
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<td>3 pm</td>
<td>Performing Network Analysis</td>
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<td>Network Analyst: Creating Network Datasets</td>
</tr>
<tr>
<td>4 pm</td>
<td>Network Analysis with ArcGIS Online</td>
<td>Network Analysis with ArcGIS Online</td>
<td>Network Analyst: Creating Network Datasets</td>
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Room assignments:
- Room 15 A
- Room 16 B
- Demo Theater 10 Apps
- Demo Theater 13 Spatial Analysis
- Tech Theater 15 Exhibit Hall A
- Tech Theater 17 Exhibit Hall A
Understanding our world.