Esri International User Conference | San Diego, CA

Technical Workshops | Analysis and Geoprocessing

Network Analyst – Automating Workflows with Geoprocessing

Deelesh Mandloi

Patrick Stevens

Introductions

- Who are we?
  - Network Analyst Product Engineers
- Who are you?
  - Current Network Analyst users?
  - Current geoprocessing users?
  - Have made geoprocessing models?
  - Experience with Python?
  - Have made geoprocessing python scripts?

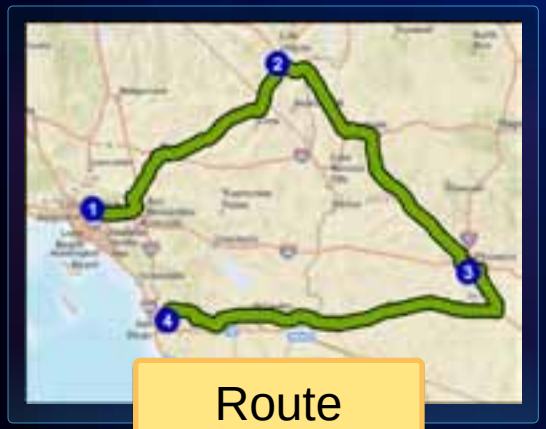
Topics

- ArcGIS Network Analyst extension concepts
- Geoprocessing framework for network analysis
- Building geoprocessing models
- Writing Python scripts and building script tools
- Support and resources
- Network Analyst at the User’s Conference
- Questions

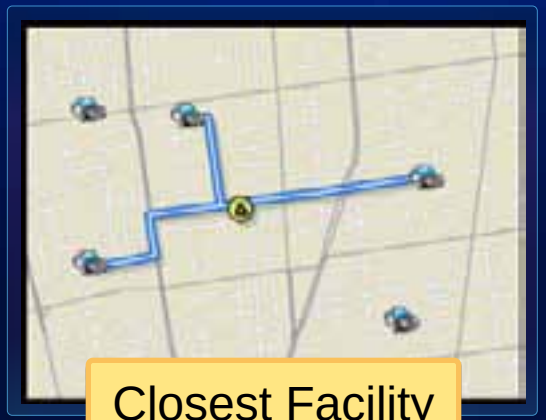
Network Analyst Extension Concepts

More Information:

What is Network Analyst in ArcGIS Desktop help



Route

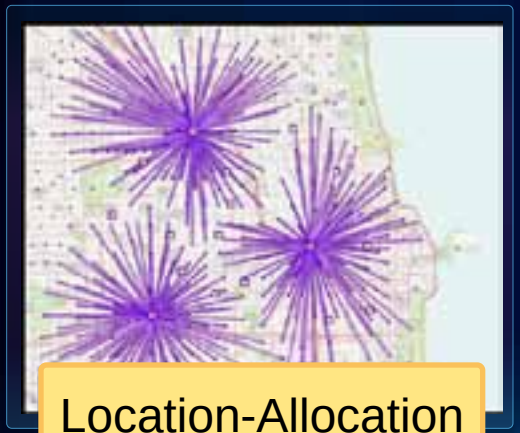


Closest Facility

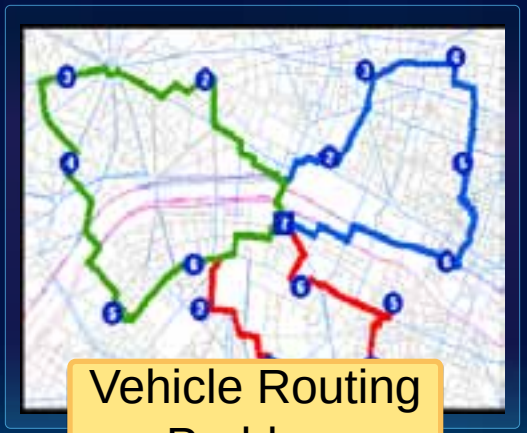
Service Area

ArcGIS Network Analyst Extension

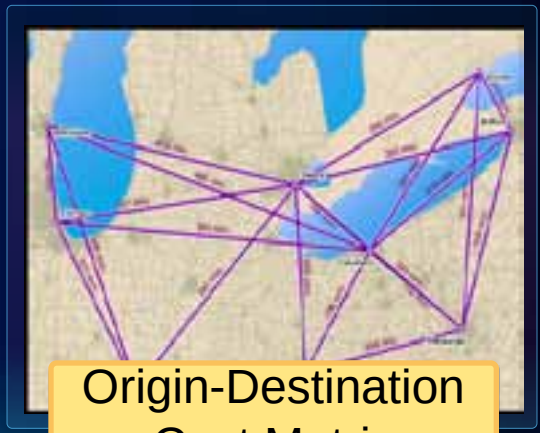
Solving transportation problems



Location-Allocation



Vehicle Routing Problem



Origin-Destination Cost Matrix

Network Dataset

Transportation Network

Network Dataset

Data Model

Geodatabase

Shapefile Streetmap

Where do you get street data?

- Free data
  - Data and Maps DVD
  - TIGER

- Community data
  - OpenStreetMap

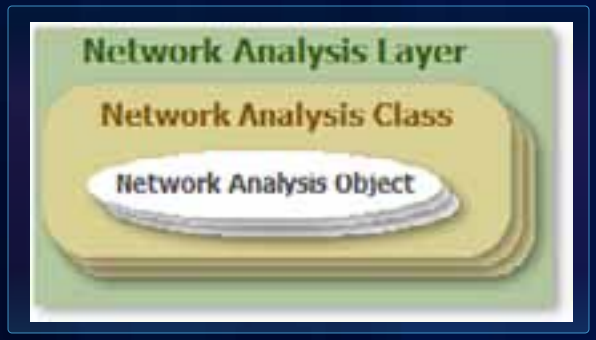
- Your data
- Vendor data

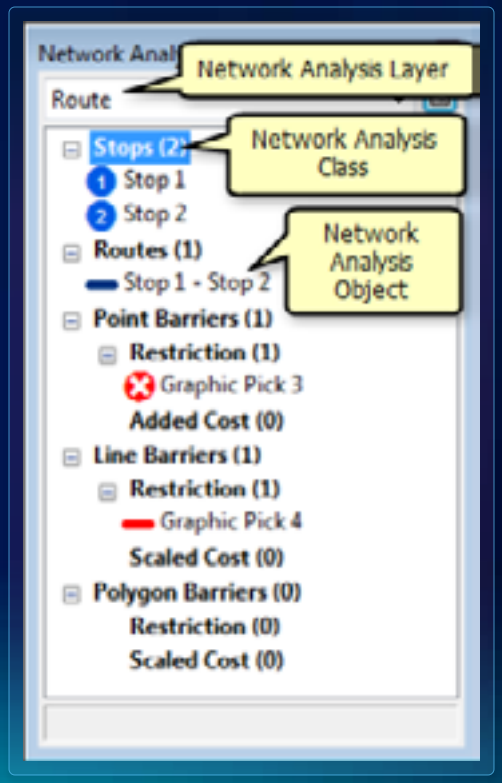
NAVTEQ

TOMTOM

Network Analysis Layer

- Composite layer configured for a specific solver.
- Stores analysis properties, inputs, and outputs from the solver
- Contains **Network Analysis Classes** that store **Network Analysis Objects**



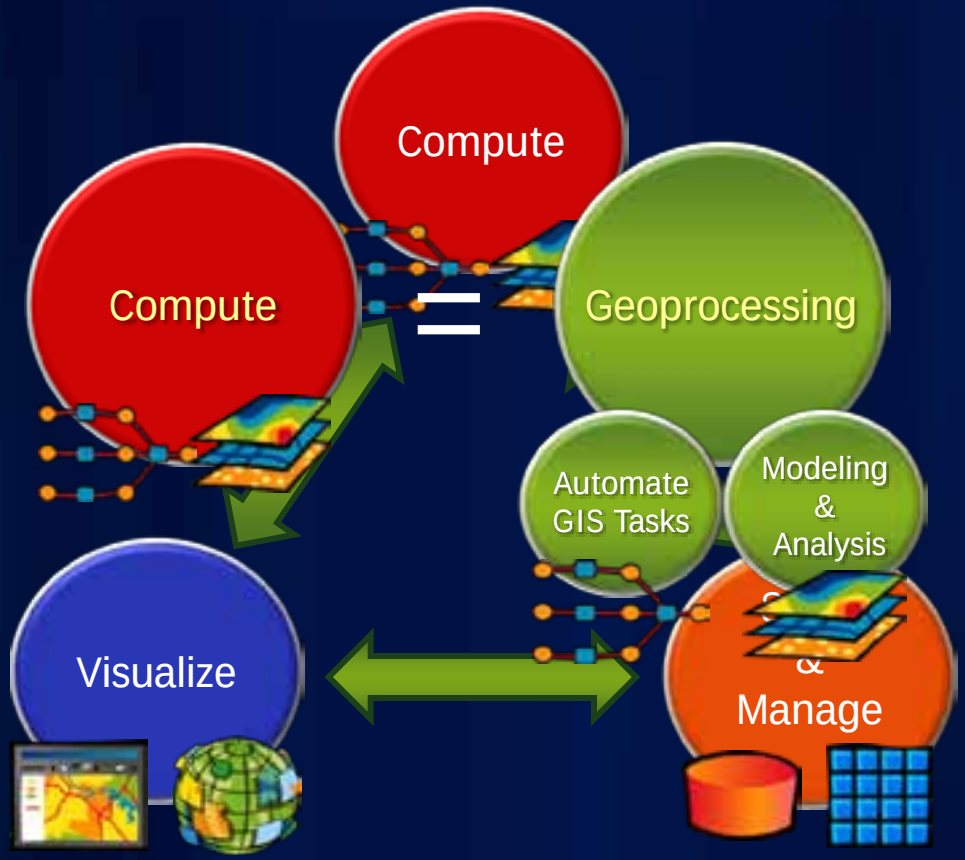


Geoprocessing Framework

More Information:

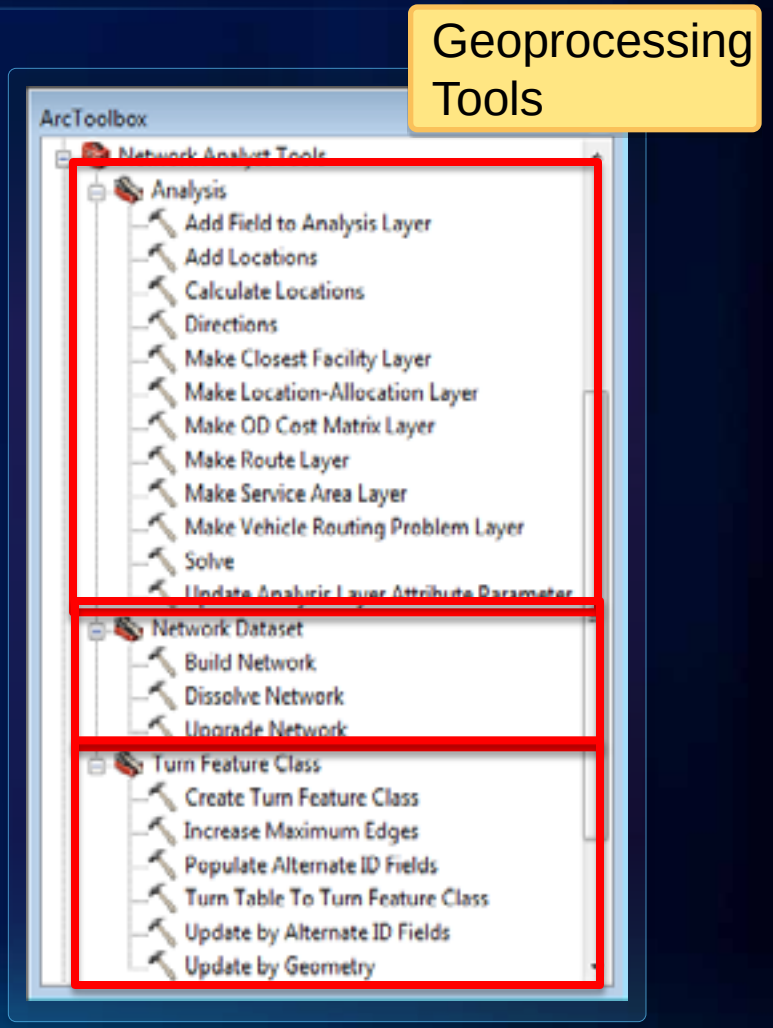
The geoprocessing framework in ArcGIS Desktop help

What is Geoprocessing?

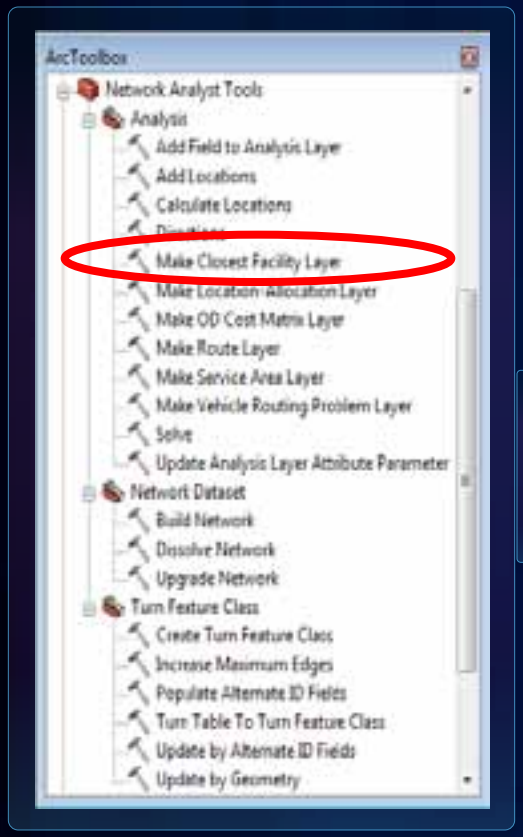


Using Geoprocessing – How?

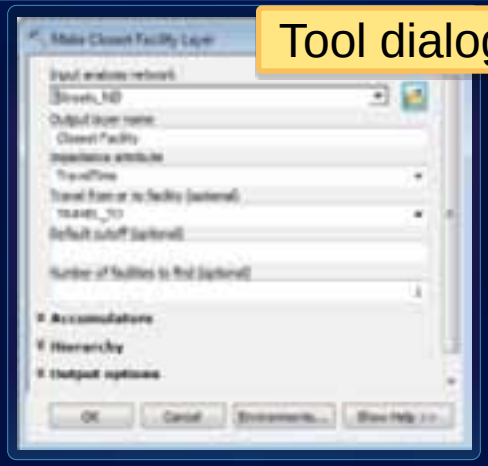
- Accessed through ArcToolbox
- Network Analyst Tools
  - Performing Network Analysis
  - Building networks
  - Managing turns



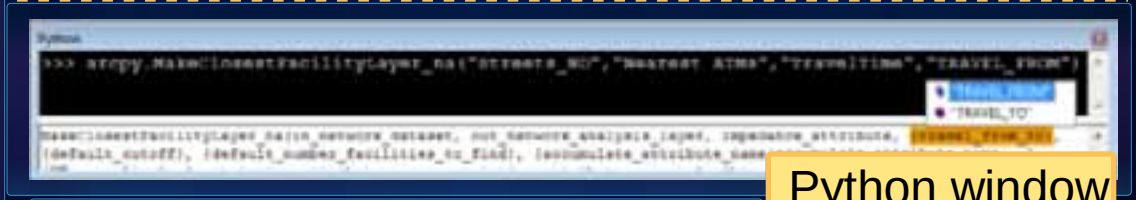
Using Geoprocessing – How?



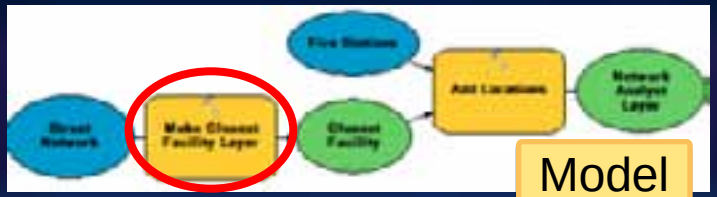
Tool dialog



Single tool execution



Python window



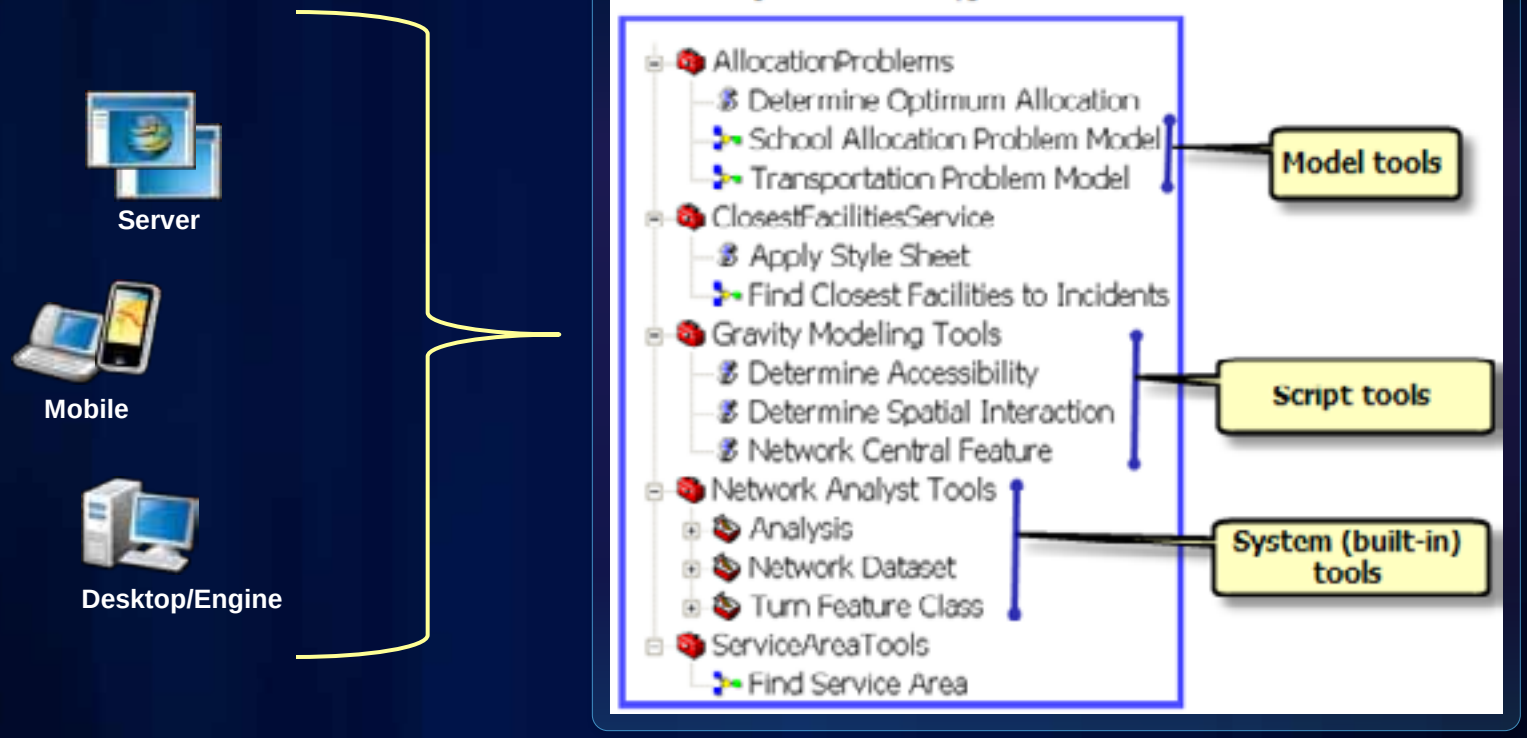
Model

Chain tools

```
# Process: Make Closest Facility Layer
arcpy.MakeClosestFacilityLayer_na(Street_Network, "Closest Facility", "TravelTim

# Process: Add Locations
arcpy.AddLocations_na(Closest_Facility, "Facilities", Fire_Sta
```

Script

Using Geoprocessing – Where?



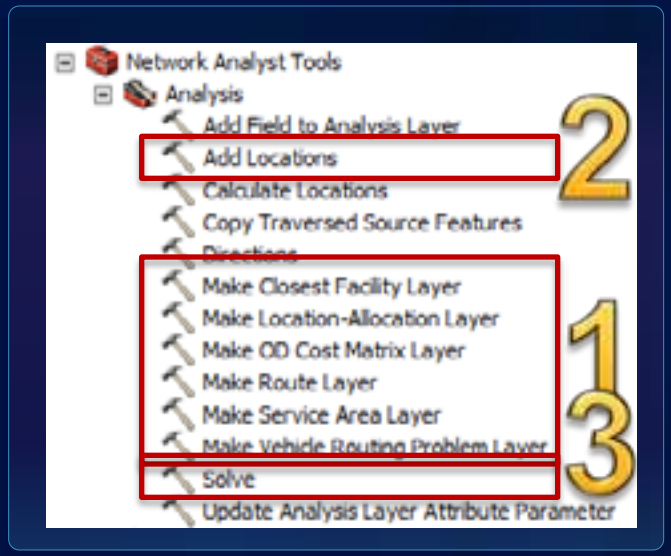
Building Geoprocessing Models

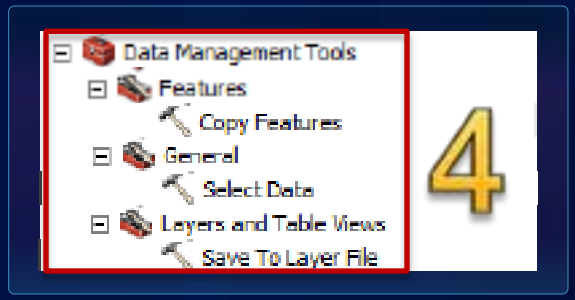
More Information:

Geoprocessing with Model Builder in ArcGIS Desktop help

Network Analysis Workflow

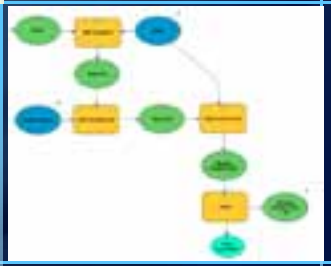
1. Make Network Analysis Layer
2. Add locations to one or more Network Analysis Classes
3. Solve
4. Use the results





Demo: Geoprocessing Models

Authoring a simple route model



Demo: Geoprocessing models - takeaways

- You can easily share models as tools
- If running models as tools, make the output network analysis layer as model parameter so that it is added to the ArcMap Table of contents
- Network analysis layer is the derived output from most of the tools (Add Locations, Solve)

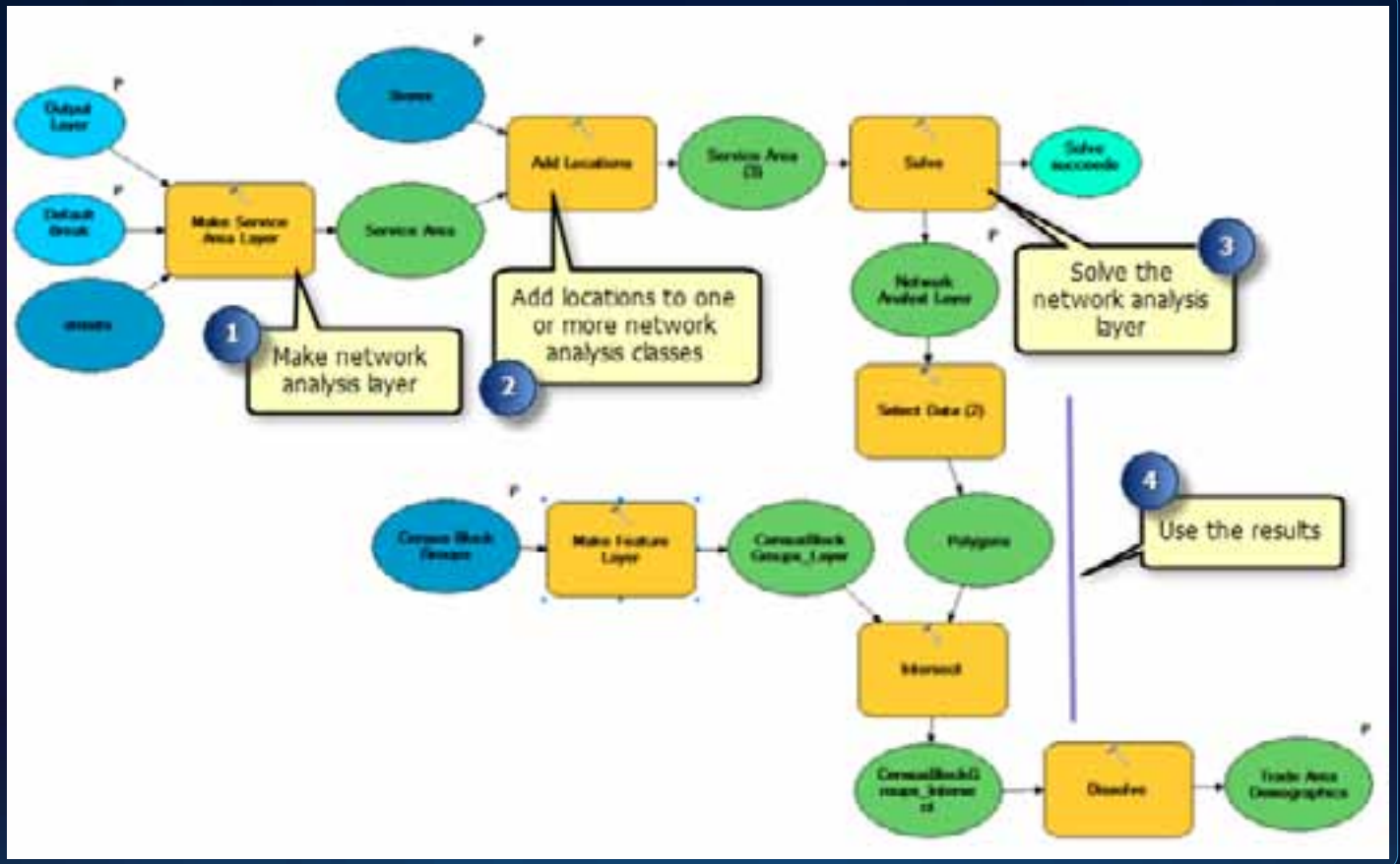
Geoprocessing Models

- 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

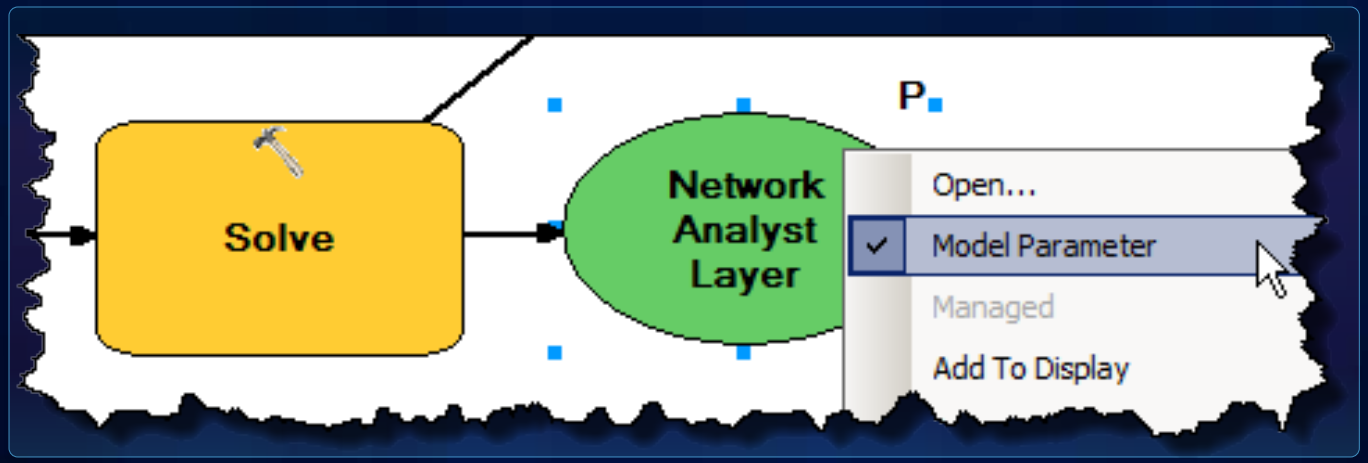
Example Model to perform Service Area Analysis

- **Numbers refer to steps in Network Analysis workflow**



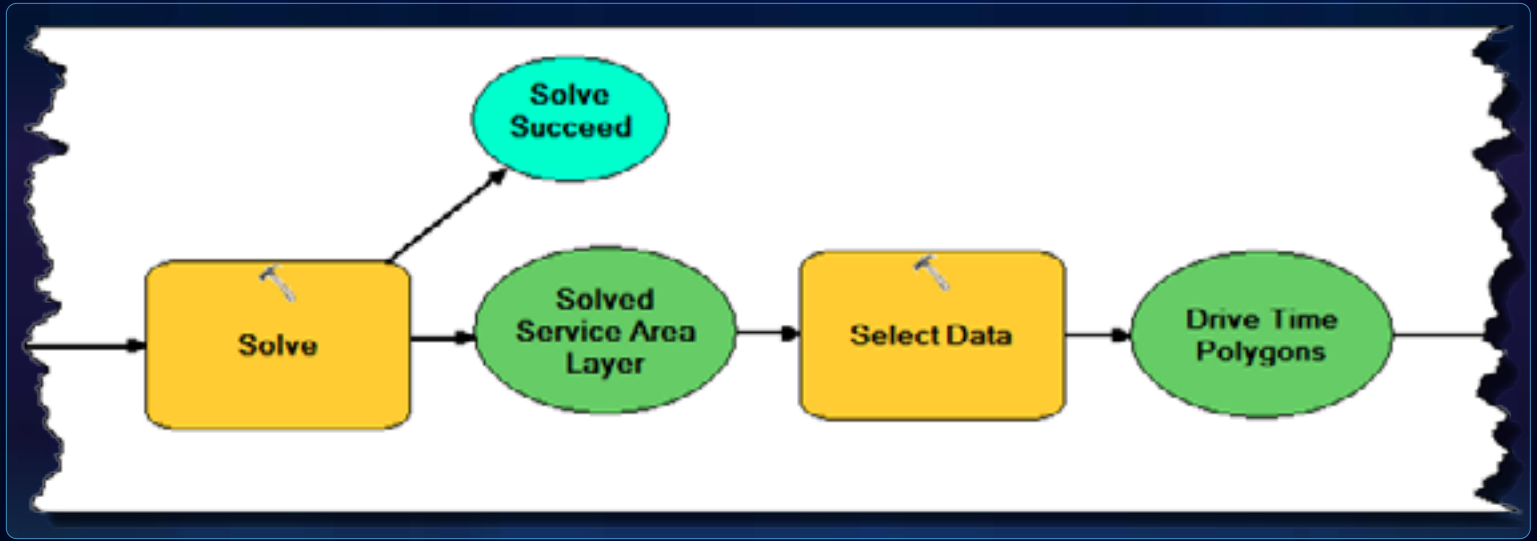
Adding analysis results to ArcMap

- If running models as tools, make the output network analysis layer a model parameter. This will add the layer to the ArcMap Table of Contents.



Post-processing your analysis

- Use **Select Data** tool to access individual sublayers from an analysis layer



Demo: Geoprocessing Models

Authoring a model to determine multiple routes from a text file containing start and end addresses

Demo: Geoprocessing models - takeaways

- Use the **Select Data** tool to access sublayers of a network analysis layer
- Incorporate external data (csv in this example) into your analysis
- Automate your workflows without code
- Model tools can be added as buttons on any toolbar
- If network analysis layer is intermediate data, explicitly delete it as a last step

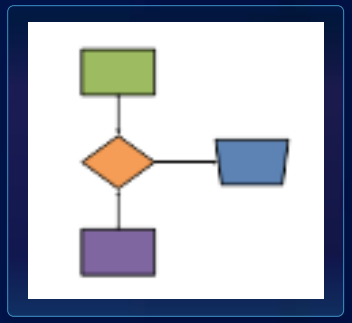
Writing Python Scripts

More Information:

Geoprocessing with Python in ArcGIS Desktop help

Python Scripts

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



- ArcPy site package
  - Access any geoprocessing tool (including network analyst tools)
  - Other useful functions and classes such as Describe

- Python scripts can be run cross platform

Python Script - Basic Building Blocks

```
#Import arcpy and other system modules
import arcpy
from arcpy import env
import traceback
import sys

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

#Set local variables
inNetworkDataset = "Transportation/Streets_ND"
outNALayer = "StoreRoute"
impedanceAttribute = "TravelTime"
startLocation = "Analysis/DistributionCenter"
storeLocations = "Analysis/Stores"
fieldMappings = "Name Name #; Attr_TravelTime ServiceTime #"
outLayerFile = "C:/data/output" + "/" + outNALayer + ".lyr"

#Create a new route layer. The route starts at the distribution center and
#takes the best sequence to visit the store locations.
arcpy.MakeRouteLayer_na(inNetworkDataset,outNALayer,impedanceAttribute,
                        "FIND_BEST_ORDER","PRESERVE_FIRST","",["Meters"],
                        "NO_UTURNS",start_date_time="8 AM")

#Load the distribution center as the start location using default field
#mappings and search tolerance
arcpy.AddLocations_na(outNALayer,"Stops",startLocation,"","")
```

Import arcpy module

Python Script - Basic Building Blocks

```
#Import arcpy and other system modules
import arcpy
from arcpy import env
import traceback
import sys

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

    #Set local variables
    inNetworkDataset = "Transportation/Streets_ND"
    outNALayer = "StoreRoute"
    impedanceAttribute = "TravelTime"
    startLocation = "Analysis/DistributionCenter"
    storeLocations = "Analysis/Stores"
    fieldMappings = "Name Name #; Attr_TravelTime ServiceTime #"
    outLayerFile = "C:/data/output" + "/" + outNALayer + ".lyr"

    #Create a new route layer. The route starts at the distribution center and
    #takes the best sequence to visit the store locations.
```

Check out the Network Analyst Extension

Python Script - Basic Building Blocks

```
#Import arcpy and other system modules
import arcpy
from arcpy import env
import traceback
import sys

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

Set inputs and outputs

```
#Set local variables
inNetworkDataset = "Transportation/Streets_ND"
outNALayer = "StoreRoute"
impedanceAttribute = "TravelTime"
startLocation = "Analysis/DistributionCenter"
storeLocations = "Analysis/Stores"
fieldMappings = "Name Name #; Attr_TravelTime ServiceTime #"
outLayerFile = "C:/data/output" + "/" + outNALayer + ".lyr"
```

```
    #takes the best sequence to visit the store locations.
    arcpy.MakeRouteLayer_na(inNetworkDataset,outNALayer,impedanceAttribute,
                            "FIND_BEST_ORDER","PRESERVE_FIRST","",['Meters'],
                            "NO_UTURNS",start_date_time="8 AM")
```

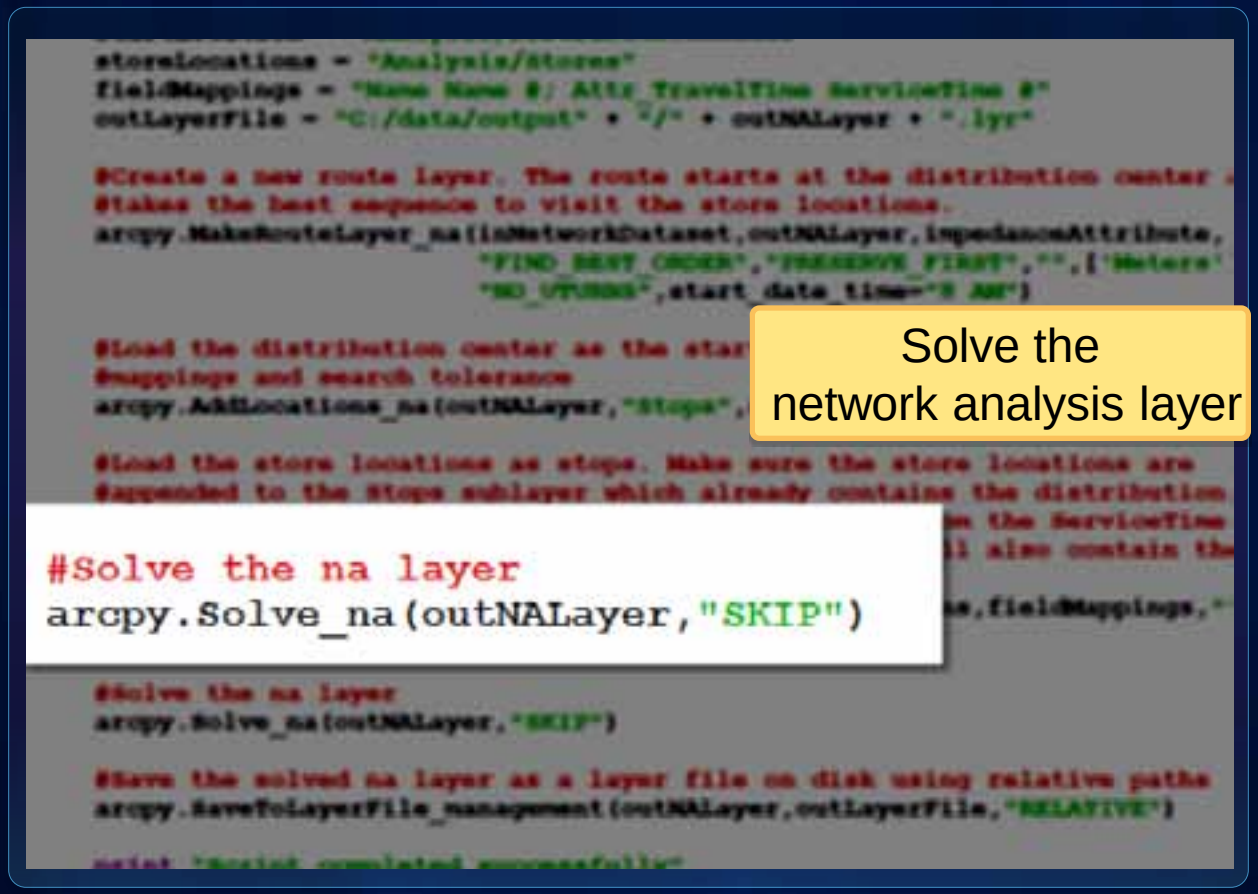
Python Script - Basic Building Blocks

Python Script - Basic Building Blocks

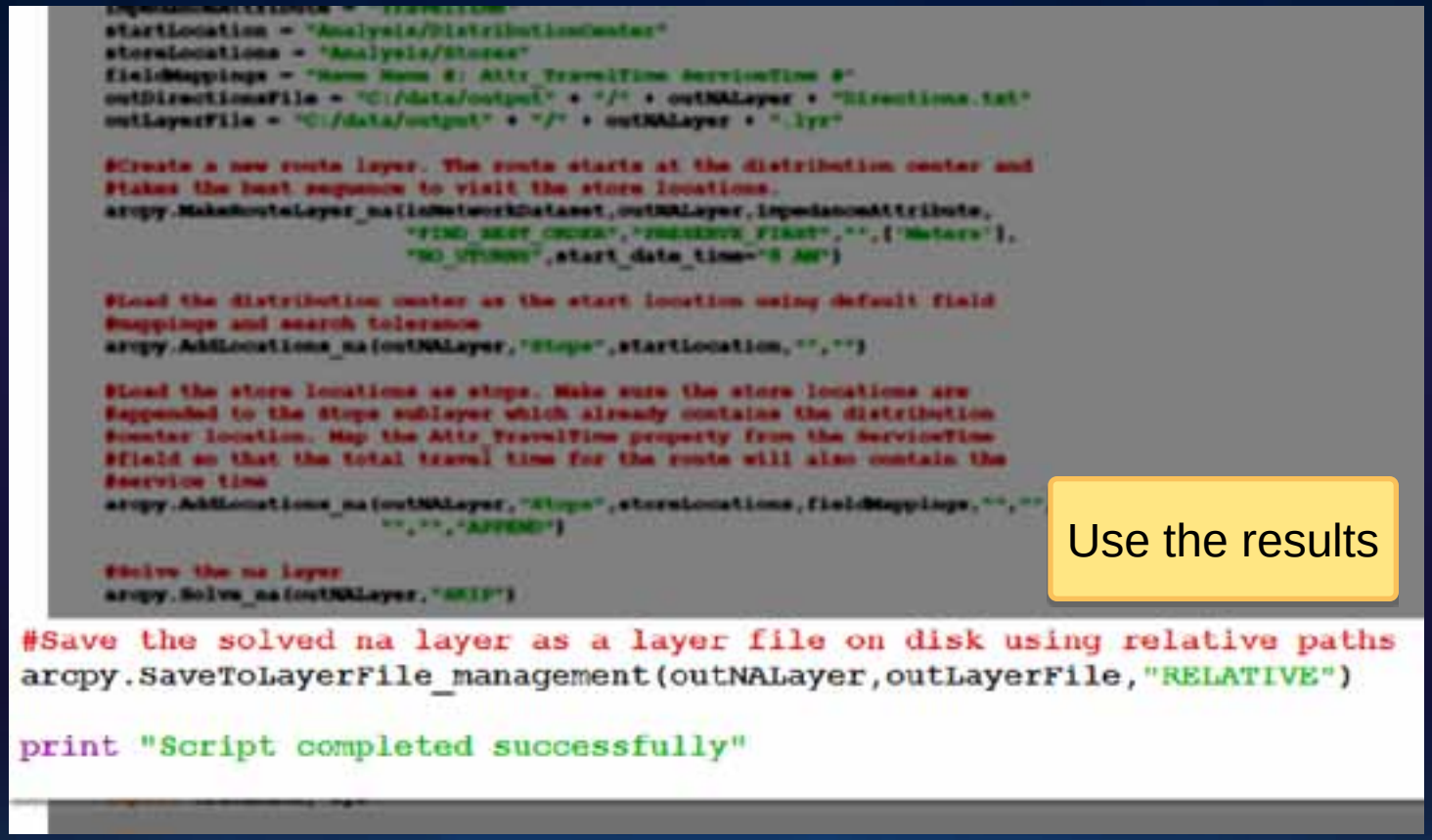
Add locations to network analysis classes

```
outNALayer = "StoreRoute"
impedanceAttribute = "TravelTime"
startLocation = "Analysis/DistributionCenter"
storeLocations = "Analysis/Stores"
fieldMappings = "Name Name #; Attr_TravelTime ServiceTime #"

#Load the distribution center as the start location using default field
#mappings and search tolerance
arcpy.AddLocations_na(outNALayer,"Stops",startLocation,"","")

#Load the store locations as stops. Make sure the store locations are
#appended to the Stops sublayer which already contains the distribution
#center location. Map the Attr_TravelTime property from the ServiceTime
#field so that the total travel time for the route will also contain the
#service time
arcpy.AddLocations_na(outNALayer,"Stops",storeLocations,fieldMappings,"","",
                      "","","APPEND")

#Solve the na layer
arcpy.Solve_na(outNALayer,"SKIP")

#Save the solved na layer as a layer file on disk using relative paths
arcpy.SaveToLayerFile_management(outNALayer,outLayerFile,"RELATIVE")
```

Python Script - Basic Building Blocks



Python Script - Basic Building Blocks




```
#Save the solved na layer as a layer file on disk using relative paths
arcpy.SaveToLayerFile_management(outNALayer,outLayerFile,"RELATIVE")

print "Script completed successfully"
```

Working with analysis layers within scripts

- The network analysis layer can be referenced within the script using its name (as a string)

```
# Create string variable to represent an analysis layer
myServiceAreaLayer = "Service Area"

# Use that variable to reference an analysis layer as a parameter
arcpy.MakeServiceAreaLayer_na(myNetworkDataset, myServiceAreaLayer, "T

arcpy.AddLocations_na(myServiceAreaLayer, "Facilities", storeLocations,

arcpy.Solve_na(myServiceAreaLayer, "SKIP")
```

Accessing sublayers in scripts

- The Select Data tool is not meant for python scripting. To access sublayers in python scripts, use the syntax:

  <Analysis Layer Name> + os.sep + <Sublayer Name>

```
polygonsSubLayer = myServiceAreaLayer + os.sep + "Polygons"

arcpy.CopyFeatures_management(polygonsSubLayer, outFeatureClass)
```

Saving analysis results

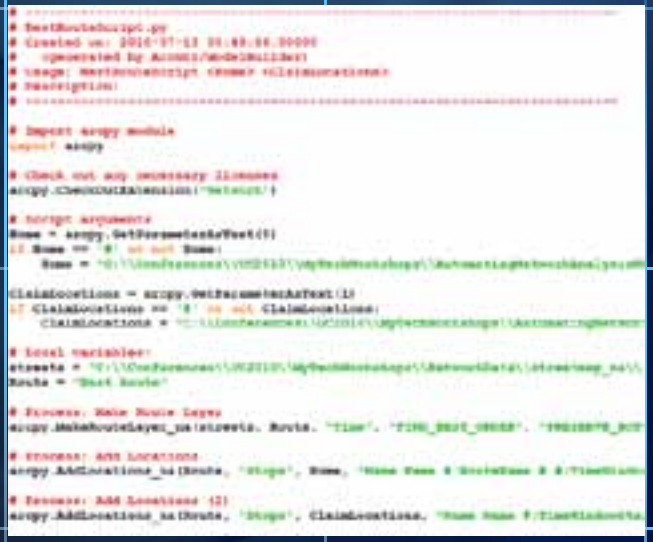
- The in-memory network analysis layer can be persisted using **SaveToLayerFile** geoprocessing tool.

```
arcpy.SaveToLayerFile_management(myServiceAreaLayer, "c:\MyPath\MyLayer.lyr", "RELAT
```

- Layer files can then be dragged into ArcMap manually

Demo: Python Script

Authoring a Python script that finds the best sequenced route for given stops



Demo: Python Script- takeaways

- The network analysis layer can be referenced within the script using its name
- The in-memory network analysis layer can be persisted using SaveToLayerFile geoprocessing tool.
- The sublayers within a network analysis layer are feature layers that can be used with many other tools
- Scripts can be created by exporting a model to a script
- Scripts can be run at the operating system command prompt

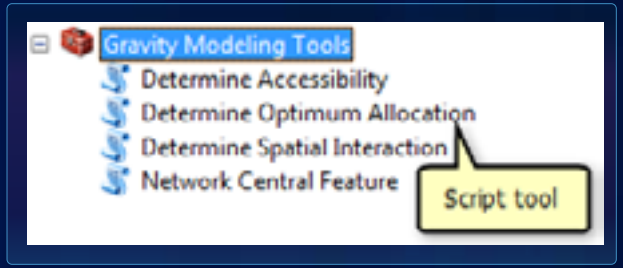
Building Script Tools

More Information:

Creating script tools with Python scripts in ArcGIS Desktop help

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 user interface for scripts within ArcGIS desktop**

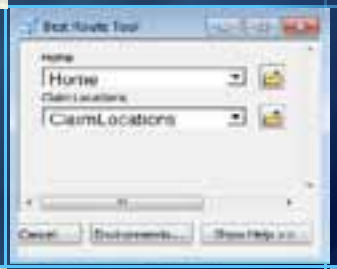
Add outputs from script tool to ArcMap

- If network analysis layer is the output, make an additional derived output parameter of type Network Analyst Layer and use **arcpy.SetParameterAsText(…)**

```
# Do your analysis workflow
myServiceAreaLayer = "Service Area"
arcpy.MakeServiceAreaLayer_na(myNetworkDataset, myServiceAreaLayer, "

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

Demo: Script Tool

1. Creating a script tool to provide a UI for a Python script
2. Solve an allocation problem assigning students to schools with capacity constraints



Determine Optimum 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 linear programming (LP) solvers using PuLP
  - PuLP is a public domain Python module for modeling LP problems
  - PuLP can work with a variety of LP solvers such as COIN-OR, GLPK, XPRESS, CPLEX.

Demo: Script Tool - takeaways

- If network analysis layer is the output, make an additional derived output parameter of type Network Analyst Layer and use arcpy.SetParameterAsText()
- Custom validation logic can be programmed for the script tool user interface by programming the Tool Validator class
- Use Describe() to determine the properties of the network dataset and the network analysis layer

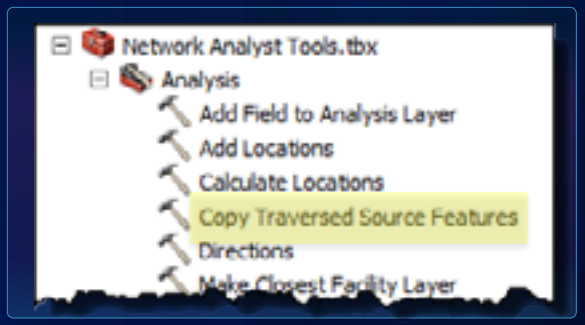
  Network Analyst Layer Describe Properties

  Network Dataset Describe Properties
- The output network analysis layer supports pre-defined symbology using layer files

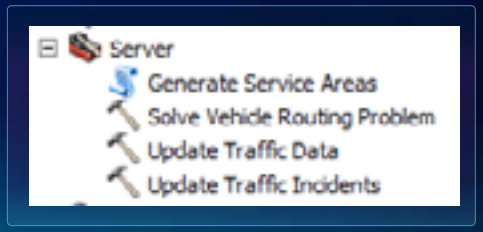
The road ahead (10.1)

- Network Analyst Python module (arcpy.na)
  - Easy access to Network Analyst functionality from Python, along with helper functions and classes
  - Ability to edit a Network Analysis layer without having to create a new one

- New tools
  - Working with traversal results



  - Easy publishing of GP Services



Summary

Summary

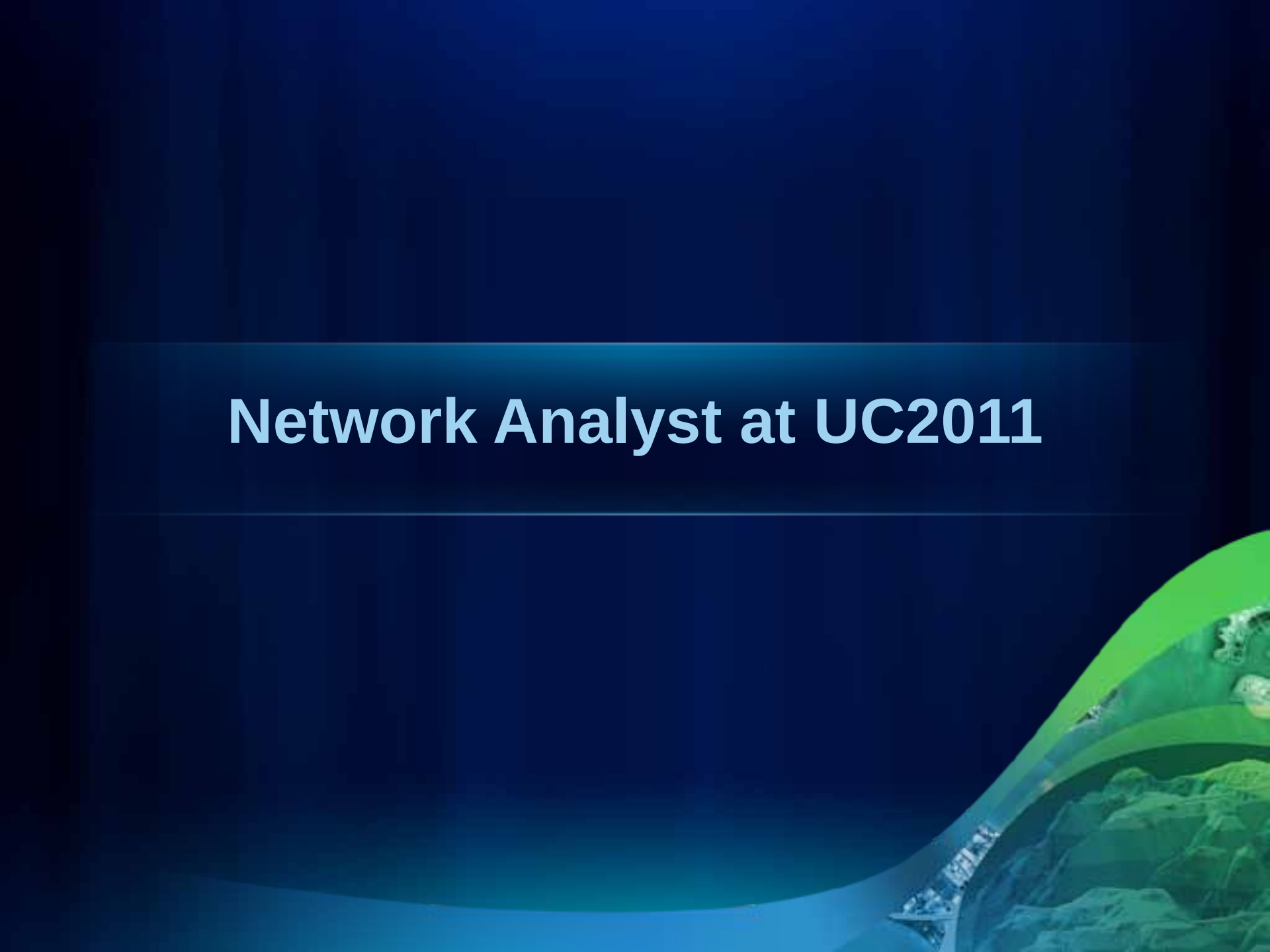
- Geoprocessing framework for network analyses
  - Network Analyst Tools (system tools)
  - Models and Model tools (no programming)
  - Script and Script tools (python code)
- Automate repetitive tasks
- Easier than writing ArcObjects code
- Incorporate network analysis in larger process

Resources

Support and Resources

- ArcGIS Desktop Help on Geoprocessing
- Network Analyst Help
- Geoprocessing Resource Center
- ArcGIS Network Analyst Extension Discussion Forum

Network Analyst at UC2011



Tech Workshops

- ArcGIS Network Analyst – An Introduction
- ArcGIS Network Analyst – Performing Network Analysis
- Performing Network Analysis with ArcGIS Server
- ArcGIS Network Analyst – Creating Network Datasets
- ArcGIS Network Analyst – Automating Workflows with Geoprocessing

Demo Theaters

- Patterns for Measuring and Mapping Access Using Network Analysis
- ArcGIS Network Analyst – Modeling Real-World Problems with the VRP Solver
- What is ArcGIS Network Analyst and Why Should I Use It?
- ArcGIS Network Analyst – Routing Inside Buildings with 3D Networks
- ArcGIS Network Analyst – Location-Allocation and Accounting for Competition in Site Selection

	Tuesday	Wednesday	Thursday
8 am			
9 am	ArcGIS Network Analyst - An Introduction	ArcGIS Network Analyst - Automating workflows with Geoprocessing	ArcGIS Network Analyst - Performing Network Analysis
10 am	ArcGIS Network Analyst - Performing Network Analysis	ArcGIS Network Analyst - Creating Network Datasets	
11 am			
12 pm	Patterns for Mapping Access		
1 pm	Modeling Real-World Problems with the VRP Solver		
2 pm		ArcGIS Network Analyst - An Introduction	ArcGIS Network Analyst - Creating Network Datasets
3 pm	Performing Network Analysis with ArcGIS Server	ArcGIS Network Analyst – Routing Inside Buildings With 3D Networks	Room 3 Room 9 Room 6B Spatial Analyst Island Demo Theater Mapping and Visualization Island Demo Theater
4 pm	What is Network Analyst?	ArcGIS Network Analyst – Location-Allocation in site selection	

Related Tech Workshops - Geoprocessing

- Geoprocessing Models
  - Building Tools with ModelBuilder
    - Wednesday 10:15 - Room 14B
    - Thursday 3:15 – Room 4
  - Getting Started with ModelBuilder
    - Wednesday 1:30 - Room 5A/B

- Python Scripts and Script Tools
  - Python – Getting Started
    - Thursday 8:30 – Room 2
  - Building Tools with Python
    - Thursday 10:15 – Room 9

In Conclusion…

- Please fill out session surveys!
- Questions
- Still have questions?
  - Spatial Analysis Island (Exhibit Hall C)