



Table of Contents

Student Manual – Extended Tools of Surface Analysis

Applications in Surface Analysis

Lesson 1 – Mapping Distance 1

Lesson Objectives:

- Identify terminology pertaining to surface analysis
- Identify different distance mapping techniques
- Calculate straight line distance to a feature or features in a source data layer
- Calculate cost weighted distance to a feature or features in a source data layer
- Assign allocation of cells on a grid to features in a source data layer
- Assign direction of cells on a grid to a feature or features in a source data layer

Lesson & Enrichment Exercises: Mapping Distance

- Load the Spatial Analyst extension program
- Compare regular distance measurements to distance analysis using Spatial Analyst
- Perform a straight line distance calculation
- Explore a direction grid created from a Spatial Analyst distance analysis calculation
- Create a cost raster to be used for a cost-weighted distance calculation
- Perform a cost-weighted distance calculation (multiple source features)
- Reclassify values in a grid data layer
- Explore an allocation grid created from a Spatial Analyst distance analysis calculation
- Perform a cost-weighted distance calculation (single source feature)
- Find the shortest path from one location to another costs represented in a surface grid

Lesson 2 – Mapping Density 59

Lesson Objectives:

- Identify terminology pertaining to surface analysis
- Identify different distance density calculation techniques
- Calculate density using kernel calculation technique

- Calculate density using simple calculation technique

Lesson & Enrichment Exercises: Mapping Density

- Explore different density calculation techniques
- Perform a simple density calculation on US cities using population values
- Perform a kernel density calculation on US cities using population values
- Perform a density calculation to show the density of features contained in a geographic area

Lesson 3 – Interpolating Surfaces 95

Lesson Objectives:

- Identify terminology pertaining to surface analysis
- Identify different surface interpolation methods
- Create a surface from a set of features using the **Inverse Distance Weighted** interpolation technique
- Create a surface from a set of features using the **Spline** interpolation technique
- Create a surface from a set of features using the **Kriging** interpolation technique

Lesson & Enrichment Exercises: Interpolation

- Perform an Inverse Distance Weighted (IDW) interpolation on elevation point data to create an elevation surface for an entire geographic area.
- Perform Spline interpolation on elevation point data to create an elevation surface for an entire geographic area.
- Perform Kriging interpolation on elevation point data to create an elevation surface for an entire geographic area.
- Compare interpolation methods based on analysis results

Lesson 4 – Surface Analysis Methods 119

Lesson Objectives:

- Identify terminology pertaining to surface analysis
- Identify different surface analysis methods
- Create elevation contour data from an elevation raster
- Calculate and display slope derived from an elevation raster
- Determine and display aspect derived from an elevation raster
- Create a hillshade surface from an elevation raster
- Calculate the viewshed of a surface to determine visible objects
- Calculate the cut/fill of a surface to estimate volume changes

Lesson & Enrichment Exercises: Surface Analysis

- Create elevation contours (vector data) from a raster elevation grid
- Perform a slope calculation using an elevation grid data layer
- Create an aspect surface data layer using an elevation grid data layer
- Create a three-dimensional effect to elevation data using the Hillshade technique

- Create a viewshed surface data layer to identify areas in a geographic area that can and can't be seen from an observation point
- Determine areas of increased and decreased surface volume using time-lapsed elevation grids

Lesson 5 – Raster Statistics..... 159

Lesson Objectives:

- Identify terminology pertaining to surface analysis
- Identify different statistical methods in raster analysis
- Calculate Cell Statistics using temporal raster grid data
- Calculate Neighborhood Statistics using raster grid data
- Calculate Zonal Statistics using raster grid data

Lesson & Enrichment Exercises: Raster Statistics

- Analyze precipitation changes using Cell Statistics methods in Spatial Analyst
- Analyze diversity of land use in a geographic area using Neighborhood Statistics methods in Spatial Analyst
- Analyze relationships that exist between slope and land use using Zonal Statistics methods in Spatial Analyst

Lesson 6 – Using the Map Calculator..... 187

Lesson Objectives:

- Identify terminology pertaining to surface analysis
- Use the Raster Calculator to build queries using local data
- Use analysis masks and analysis extents to clip data to an irregular boundary
- Use queries to analyze geographic data to explore environmental issues

Lesson & Enrichment Exercises: Using the Map Calculator

- Clip a county land use data layer to a city boundary to create a city land use data layer
- Identify areas of an elevation grid that represent areas of low elevation in the community
- Isolate areas of specific land use in the community that could be considered sensitive
- Perform a raster calculation to find all areas of low elevation or sensitive land use that exist in a community



Table of Contents

Student Manual – Extended Tools in 3D Visualization

3D Visualization of Geospatial Data

Lesson 1 – 3D Data Types, Display, and Visualization3-1

Lesson Objectives:

- Understand fundamental concepts of 3D Analysis
- Interpret different types of spatial data used in 3D visualization and analysis.
- Navigate different types of surfaces with ArcScene

Lesson & Enrichment Exercises: 3D Data Types, Display, and Visualization

- Launch ArcScene
- Add Data to ArcScene
- Change symbology of raster elevation grid in ArcScene
- Explore ArcScene navigation tools
- Assign base heights to an elevation surface
- Set the Observer View in ArcScene
- Vertically exaggerate surface elevation values in ArcScene
- Use lighting effects to increase contrast on the elevation surface in ArcScene
- Export an ArcScene scene
- Import a scene image into a word processing document
- Convert a Digital Elevation Model (DEM) to a TIN data layer
- Create a TIN from a shapefile containing elevation values

Lesson 2 – Data Acquisition and Processing3-33

Lesson Objectives:

- Discover where to obtain free data on the Internet
- Download and extract data
- Build 3D datasets to be used in ArcScene
- Navigate and process 3D data sets

Lesson & Enrichment Exercises: – Data Acquisition and Processing

- Access online sources of 3D data
- Convert downloaded data to a format compatible for use in ArcGIS
- Edit the the Spatial Properties of the converted raster data layer
- Download the USGS Quad Index

- Download a DEM from an online source
- Convert a DEM in SDTS format to grid
- Mosaic DEM grids to create a new grid

Lesson 3 – 2D and 3D Feature Data in a 3D Scene3-73

Lesson Objectives:

- Display 2D features onto a 3D surface.
- Create shapefiles to view in a 3D environment.
- Construct a 3D model of an urban environment.

Lesson & Enrichment Exercises: 2D and 3D Feature Data in a 3D Scene

- Extrude 2D feature data layers from a 3D elevation surface
- Create a new shapefile in ArcCatalog
- Add 3D features to a new shapefile
- Drape a image data layer on a 3D surface

Lesson 4 – Displaying Non-Elevation Data in 3D3-101

Lesson Objectives:

- Display georeferenced data measurements in 3D
- Apply Interpolation to show population distribution
- Understand how non-elevation georeferenced 2D data in a 3D environment can provide valuable statistical information
- Navigate different types of surfaces in ArcScene using new methods.

Lesson & Enrichment Exercises: Displaying Non-Elevation Data in 3D

- Convert non-elevation data to 3D
- Extrude features by calculating a Z value
- Interpolate a surface from a set of feature data

Lesson 5 – Surface Analysis.....3-119

Lesson Objectives:

- Create contour lines in a 3D environment
- Use the contour function to generate contour lines
- Discover the benefits of using the Steepest Path tool
- Calculate statistics using the Area and Volume statistical tool
- Use the Line of Sight tool to determine if obstructions between two points exist

Lesson & Enrichment Exercises: Surface Analysis

- Create elevation contours from a raster elevation grid
- Find the steepest path in an elevation surface
- Calculate the area of a surface
- Calculate the volume of a surface
- Evaluate visibility between two observation points using Line of Sight

Lesson 6 – Global Visualization and Analysis.....3-149

Lesson Objectives:

- Use ArcGlobe to learn how to build a 3D global mapping application
- Navigate an image in ArcGlobe

- Add Raster data to ArcGlobe
- Add Vector data to ArcGlobe

Lesson & Enrichment Exercises: Global Visualization and Analysis

- Launch ArcGlobe
- Experiment with ArcGlobe navigation tools
- Add a raster data layer to ArcGlobe
- Set caching properties for displaying data in ArcGlobe
- Display elevation data in ArcGlobe
- Vertically exaggerate elevation data in ArcGlobe
- Add image data to ArcGlobe
- Edit symbology properties of image data in ArcGlobe
- Adjust the transparency of a data layer in ArcGlobe
- Add vector data to ArcGlobe
- Edit symbology properties of vector data in ArcGlobe
- Extrude features in ArcGlobe

Lesson 7 – Animation and Exporting Projects3-175

Lesson Objectives:

- Create animations in ArcScene using manually recording techniques
- Create animations in ArcGlobe using virtual snapshots of views
- Export Animations so they may be viewed outside of ArcScene and ArcGlobe

Lesson & Enrichment Exercises: Animation and Exporting Projects

- Load the Animation toolbar in ArcScene
- Use animation tools to record a navigation scene in ArcScene
- Save an animation file
- Create an animation from perspective views
- Create an animation keyframe
- Manage transitions between keyframes using the Animation Manager
- Set distance ranges for animations in ArcScene
- View an animation
- Export an animation in VRML format



Table of Contents

Student Manual – Extended Tools in Routing Analysis

Applications in Geospatial Networks & Routing

Lesson 1 – Creating Network Data Sets..... 1

Lesson Objectives:

- Identify terminology dealing with geospatial networks and routing
- Activate the Network Analyst for ArcGIS 9.1 extension program
- Create a network dataset using an existing shapefile
- Create a network dataset using an existing geodatabase

Lesson & Enrichment Exercises: Creating Network Data Sets

- Exploring network datasets needed for routing analysis
- Create a network dataset from a shapefile to be used in analysis
- Preview the network dataset in ArcCatalog
- Create a network dataset from a geodatabase to be used in analysis
- Create a multimodal network dataset from a multiple networks in a geodatabase

Lesson 2 – Finding Best Route..... 55

Lesson Objectives:

- Identify terminology dealing with geospatial networks and routing
- Identify tools and techniques associated with the Network Analyst extension program
- Find the most efficient routes for numerous stops on a street network, given various conditions
- Generate directions from one location to another using a street network

Lesson & Enrichment Exercises: Finding Best Route

- Add a network dataset to ArcMap
- Load the Network Analyst extension program
- Add the Network Analyst toolbar to the ArcMap window
- Load locations to be used for routing analysis
- Set Analysis Properties for routing analysis
- View directions created from routing analysis
- Export route data layers created from routing analysis
- Relocated “unlocated” features in a routing analysis

- Move locations in the network interactively in the map display
- Set the search tolerance in Analysis Properties to locate “unlocated” features in the network
- Add locations to be used for routing analysis using the Find tool
- Create an Address Locator in ArcCatalog to find addresses in the local street network dataset to use for routing analysis
- Create a map layout

Lesson 3 – Finding Closest Facility 113

Lesson Objectives:

- Identify terminology dealing with geospatial networks and routing
- Identify tools and techniques associated with the Network Analyst extension program
- Find the closest facility from a location on a street network, given various conditions
- Generate directions from one location to another using a street network

Lesson & Enrichment Exercises: Finding Closest Facility

- Set Analysis Properties for closest facility analysis
- Find facility locations closest to an incident location based on travel time on the route from facility to incident.
- Find the closest emergency response facilities located within five minutes of an emergency location
- View directions created for multiple routes in the routing analysis
- Identify tools and techniques associated with the Network Analyst extension program

Lesson 4 – Determining Service Areas 143

Lesson Objectives:

- Identify terminology dealing with geospatial networks and routing
- Identify tools and techniques associated with the Network Analyst extension program
- Define service areas using a street network based on travel time
- Create a Origin-Destination Cost Matrix to communicate costs associated with travel from facilities to destinations in a geospatial network

Lesson & Enrichment Exercises: Determining Service Areas

- Add new cost attribute fields to a street shapefile
- Calculate travel costs for each segment of a street shapefile
- Join a table containing speed limit data to a street shapefile to allow for travel time cost attributes to be used in analysis
- Determine service areas for numerous facility locations in a geographic area
- Set Analysis Properties for service area analysis
- Edit symbology of service area polygons to reflect each polygon’s facility affiliation

- Determine areas of the network dataset not included in any service area
- Move a facility location to address key locations not included in a service area
- Use single and multiple break values to establish service areas
- Edit symbology of service area polygons to show multiple break service areas
- Create an Origin-Destination Cost Matrix to display travel costs from each facility origin to destination locations inside the network dataset
- Edit symbology of the Origin-Destination Cost Matrix to reflect the cost associated with the travel facility origins to destinations

Lesson 5 – Modeling Real World Networks 205**Lesson Objectives:**

- Identify terminology dealing with geospatial networks and routing
- Identify tools and techniques associated with the Network Analyst extension program
- Model real-life traffic flow including one-way streets and closed streets

Lesson & Enrichment Exercises: Determining Service Areas

- Prepare street shapefile data so that one-way streets can be modeled in a map display
- Edit a shapefile field to designate street segments that are included in one-way streets
- Create a network dataset that includes a restriction attribute
- Perform a Closest Facility analysis to experiment with one-way restrictions in a street network
- Add barriers to an analysis scenario to examine how routes change due to restrictions caused by closed streets in a network
- Add barriers to a network scenario by loading the locations and by placing