# RASTER ANALYSIS – 3

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Creating continuous surfaces

- Interpolation predicts values for cells in a raster from a limited number of sample data points
- Interpolation is the prediction of variables at unmeasured locations based on a sampling of the same variables at known locations
- Interpolation tools create a continuous surface from discrete point values (e.g., temperature)
- It can be used to predict unknown values for any spatially continuous data, such as elevation, rainfall, chemical concentrations, and noise levels, but not spatially discrete data
- Tools in ArcGIS
  - · IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Spline with Barriers
  - Topo to Raster
  - Topo to Raster by File
  - Trend



![](_page_3_Figure_1.jpeg)

artemavdeenko.weebly.com

- 🔺 💼 Spatial Analyst Tools
- 👂 🚋 Conditional
- 🕨 술 Density
- 👂 🛓 Distance
- 👂 술 Extraction
- 👂 🚋 Generalization
- 👂 🚋 Groundwater
- 🖻 🔄 Hydrology
- 🔺 술 Interpolation
  - 🔨 IDW
  - 🔨 Kriging
  - 🔨 Natural Neighbor
  - 🔨 Spline
  - Spline with Barriers
  - 🔨 Topo to Raster
  - 🔨 Topo to Raster by File
- Trend
   Local

Geoprocessing		~ ¤ ×
E ID	W	$\oplus$
Parameters Environments		?
* Input point features		
1 Z value field		
		-\$\$ <del>`</del>
* Output raster		
		🚞
Output cell size		
Power		2
Search radius	Variable	~
Number of points	5	12
Maximum distance	2	
Input barrier polyline feature	s	
		i / •

- 🔺 💼 Spatial Analyst Tools
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  - 🔨 Spline
  - Spline with Barriers
  - 🔨 Topo to Raster
  - 🔨 Topo to Raster by File
- Trend
   Local

Geo	processing		~ ‡ ×
$\bigcirc$	Krig	ing	$\oplus$
0	The Empirical Bayesian Kr enhanced functionality or	iging tool provides performance.	×
Para	meters Environments		?
* Inp	ut point features		
k Z v	alue field		
			<u> 105</u>
* Ou	tput surface raster		
Ser	mivariogram properties		
	Kriging method	Ordinary	~
	Semi-variogram model	Spherical	~
	Lag size		
	Major range		
	Partial sill		
	Nugget		
Ou	tput cell size		
Sea	arch radius	Variable	~
	Number of points		12
	Maximum distance		
Ou	tput variance of prediction	raster	

![](_page_6_Figure_1.jpeg)

![](_page_6_Figure_2.jpeg)

## **INTERPOLATION VS. PROXIMITY**

#### Proximity only considers nearness in space

![](_page_7_Figure_2.jpeg)

![](_page_7_Picture_3.jpeg)

## **INTERPOLATION VS. PROXIMITY**

Original

![](_page_8_Figure_2.jpeg)

#### Nearest Neighbor

![](_page_8_Figure_4.jpeg)

#### **Conditional Nearest Neighbor**

![](_page_8_Figure_6.jpeg)

## **INTERPOLATION AND PREDICTION**

Prediction also involves the estimation of variables at unsampled locations, but differs from interpolation in that estimates are based at least in part on other variables, and often on a total set of measurements

![](_page_9_Picture_2.jpeg)

#### Interpolating an elevation surface

![](_page_10_Figure_2.jpeg)

![](_page_10_Picture_3.jpeg)

![](_page_10_Picture_4.jpeg)

#### Interpolating a concentration surface

![](_page_10_Figure_6.jpeg)

## **INTERPOLATION METHODS**

- Deterministic
  - Create surfaces from measured points, based on either the extent of similarity or degree of smoothing
  - Global vs. local
  - Examples: IDW (inverse distance weighting), Natural Neighbor, Trend, and Spline

#### Geostatistical

- Based on geostatistical models that include autocorrelation (the statistical relationship among the measured points).
   Because of this, geostatistical techniques not only have the capability of producing a prediction surface but also provide some measure of the certainty or accuracy of the predictions
- Example: Kriging
- Topo to Raster and Topo to Raster by File, use an interpolation method specifically designed for creating continuous surfaces from contour lines, and the methods also contain properties favorable for creating surfaces for hydrologic analysis

![](_page_11_Figure_9.jpeg)

![](_page_11_Figure_10.jpeg)

gisgeography.com

Albrecht 2007

![](_page_11_Figure_13.jpeg)

Yan et al. 2018

## **INTERPOLATION METHODS**

- Exact Interpolation
  - Predict a value that is identical to the measured value at a sampled location
  - Examples: IDW and Spline and Kriging
- Inexact Interpolation
  - Predict a value that is different from the measured value at a sampled location
  - Example: Kriging

![](_page_12_Figure_7.jpeg)

![](_page_12_Figure_8.jpeg)

Martin and Dominguez 2019

### **INTERPOLATION METHODS**

#### IDW is usually better when

- You know that your sample data points represent the minimum and maximum values of your surface; because IDW is an averaging process, all interpolated values are within the sample range
- You have line data that you want to use to interrupt the interpolation process; for example, you would not want to interpolate elevation data across over a cliff, or animal habitat data across a river the animal could not cross; IDW lets you set interpolation barriers of this kind
- You are more interested in the spatial variation near your sample points than in the smoothness of the overall surface
- You have a large set of sample values

#### • Spline is usually better when

- The range of sample values may not include the extremes of the phenomenon being interpolated
- The number of sample values is relatively small; spline generally produces better surfaces than IDW with sparse sample datasets
- You want to see a surface with smooth distribution of values

Visualize and analyze a DEM

- To visualize and analyze a terrain landform represented by a DEM
- Slope shows the gradient and steepness of the terrain
- Aspect shows the compass direction of the slope
- Hillshade shows surface using an illumination source
- Viewshed determines what parts of surface can be seen from a specified point(s)
- Curvature calculates the curvature of a raster surface, optionally including profile and plan curvature
- Contour creates contour lines from a raster surface
- Cut Fill calculates the volume change between two surfaces

![](_page_16_Figure_1.jpeg)

- Starting with a digital elevation data (DEM) as input
- You can gain information by producing a new dataset that identifies a specific pattern within an original dataset
- You can derive patterns that were not readily apparent in the original surface, such as contours, angle of slope, steepest downslope direction (Aspect), shaded relief (Hillshade), and visibility

- Digital Surface Model (DSM)
- Digital Terrain Model (DTM)
- Digital Elevation Model (DEM)

![](_page_17_Picture_4.jpeg)

![](_page_17_Picture_5.jpeg)

Provided by USNA

Provided by 3DMetrica

## Slope shows the gradient degree of incline and steepness of the terrain

Geo	processing	~ Ŧ ×
	Slope	$\oplus$
0	The Surface Parameters tool provides enhanced functionality or performance.	×
Para	meters Environments	?
1 Inp	ut raster	
* Ou	tput raster	
Ou	tput measurement	
D	egree	~
Me	thod	
PI	anar	~
Zf	actor	1
Tar	get device for analysis	
G	PU then CPU	~

#### Output reported in degrees or percentages

- Degree: 0 (flat) 90 (vertical)
- Percentage: 0 (flat) infinite (vertical)

![](_page_18_Figure_6.jpeg)

#### Aspect shows the compass direction of the slope

![](_page_19_Picture_2.jpeg)

- Defines the direction of water flow, the amount • of sunlight a site may receive, line-of-sight
- Measured in degrees from 0 to 360
  - 0° is north-facing
  - 90° is east-facing
  - 180° is south-facing
  - 270° is west-facing

![](_page_19_Figure_9.jpeg)

Input elevation raster

![](_page_19_Picture_11.jpeg)

![](_page_19_Figure_12.jpeg)

Output aspect raster

desktop.arcgis.com

Contours are lines that connect locations of equal value in a raster dataset that represents continuous phenomena such as elevation, temperature, precipitation, pollution, or atmospheric pressure

![](_page_20_Picture_2.jpeg)

![](_page_20_Picture_3.jpeg)

pro.arcgis.com

![](_page_21_Picture_0.jpeg)

#### Curvature is the amount by which a curve deviates from being a straight line, or a surface deviates from being a plane

Geo	processing ×	д	$\times$
	Curvature	(	Ð
0	The Surface Parameters tool provides enhanced functionality or performance.		×
Para	meters Environments	(	?
* Inp 	ut raster tput curvature raster	]	2
	•	]	7
Zfa	actor		1
Ou	tput profile curve raster		
Ou	tput plan curve raster	1	_

![](_page_21_Figure_3.jpeg)

desktop.arcgis.com

![](_page_21_Picture_5.jpeg)

A DEM view of a surface.

The Curvature function surface.

desktop.arcgis.com

Cut Fill Calculates the volume change between two surfaces; this is typically used for cut and fill operations

![](_page_22_Picture_2.jpeg)

![](_page_22_Picture_3.jpeg)

gis.stackexchange.com

1	Attrit	oute t	able:		(no	ote: ce	ellsize o	ofinp	ut is 10)
	R	owid	VAL	UE *	COL	UNT	VOLU	ME	AREA
ĺ		0		1		13		0	1300
		1		2		1	-4	500	100
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	0	0	0	0		1300	1300	1300	1300
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	0	400	400	0		1300	200	200	1300
	0	0	0	0		1300	1300	1300	1300

#### desktop.arcgis.com

OLUME et Gain nchanged

Hillshade, also known as shaded relief, a technique to visualize terrain using an illuminated hypothetical light source

Used for visualization rather than analysis

Geoprocessing		~ † ×
Hil	Ishade	$\oplus$
Parameters Environments		?
* Input raster		
* Output raster		
Azimuth		315
Altitude		45
Model shadows		
Z factor		1

![](_page_23_Figure_4.jpeg)

pinterest.com

![](_page_23_Picture_6.jpeg)

![](_page_23_Picture_7.jpeg)

#### Visibility

Geo	processing	~	д	×
	Viewshed		(	Ð
0	The Geodesic Viewshed tool provides enhanced functionality or performance.	I		×
Para	meters Environments		(	?
* Inp	out raster out point or polyline observer features		]	•
* Ou	tput raster		1	_
Ou	tput above ground level raster		]	
Zf	actor			1

#### Input surface raster and **Output raster** observer features Not visible Observer 1 ▲ Observer 2 Visible Viewshed output displayed on a hillshaded elevation surface

pro.arcgis.com

Visualize and analyze a DEM

- Used to either clean up small erroneous data in the raster or generalize the data to get rid of unnecessary detail for a more general analysis
- Common sources for the erroneous data
  - Classified satellite imagery may contain many small areas of misclassified cells
  - Images that are scanned paper maps may contain unnecessary lines or text
  - Conversion issues from rasters in different format, resolutions, or projection may exist
- With generalization tools, you can identify such areas and automate the assignment of more reliable values to the cells that make up the area

![](_page_26_Picture_7.jpeg)

Kelly et al. 2011

![](_page_27_Figure_1.jpeg)

- 🖻 🚋 Density
- 👂 🚋 Distance
- 👂 🖆 Extraction
- 🔺 🚉 Generalization
  - 🔨 Aggregate
  - 🔨 Boundary Clean
  - 🔨 Expand
  - 🔨 Majority Filter
  - 🔨 Nibble
  - 🔨 Region Group
  - 🔨 Shrink
  - 🔨 Thin

# Editing Tools Conflation Densify Erase Point Extend Line Flip Line Generalize Simplify By Straight Lines And Circular Arcs Snap Trim Line Update COGO

- Cartography Tools
  - Annotation
  - 👂 🔄 Cartographic Refinement
  - 🔺 🚋 Generalization
    - 🔨 Aggregate Points
    - Aggregate Polygons
    - 🔨 Collapse Hydro Polygon
    - 🔨 Collapse Road Detail
    - 🔨 Create Cartographic Partitions
    - 🔨 Delineate Built-Up Areas
    - Merge Divided Roads
    - 🔨 Simplify Building
    - 🔨 Simplify Line
    - 🔨 Simplify Polygon
    - 🔨 Simplify Shared Edges
    - 🔨 Smooth Line
    - 🔨 Smooth Polygon
    - 🔨 Smooth Shared Edges
    - 🔨 Thin Road Network

![](_page_27_Picture_34.jpeg)

#### 🔺 💼 Data Management Tools

- Archiving
- 👂 <sub>ấ</sub> Attachments
- 👂 ഹ Attribute Rules
- 👂 🚋 Catalog Dataset
- Contingent Values
- 🕨 🌆 Data Comparison
- Distributed Geodatabase
- 🖻 🔄 Domains
- 👂 🚋 Feature Binning
- 🖻 🔤 Feature Class
- 👂 <sub> Eeatures</sub>
- 👂 🛓 Fields
- 👂 🚋 File Geodatabase
- 👂 술 General
- 4 🔄 Generalization
  - 🔨 Dissolve
  - 🔨 Eliminate
  - 🔨 Eliminate Polygon Part

![](_page_27_Picture_54.jpeg)

Geoprocessing ×				
(	Aggregate	$\oplus$		
Parameters Environme	ents	?		
<ol> <li>Input raster</li> </ol>				
* Output raster				
* Cell factor				
Aggregation technique				
Sum		~		
Expand extent if needed				
Ignore NoData in calculations				

Generates a reduced-resolution version of a raster. Each output cell contains the Sum, Minimum, Maximum, Mean, or Median of the input cells that are encompassed by the extent of that cell

![](_page_28_Figure_3.jpeg)

OutRas = Aggregate(InRas1, 3, Max, Expand, Data)

pro.arcgis.com

Smooths the boundary between zones by expanding and shrinking it

~ † ×
$\oplus$
?
~

![](_page_29_Figure_3.jpeg)

pro.arcgis.com

Geoprocessing		~ † ×
	Expand	$\oplus$
Parameters Environme	nts	?
* Input raster		
* Output raster		
* Number of cells		
* Zone values		
		+ Add another
Expand method		
Morphological		~

Expands specified zones of a raster by a specified number of cells.

![](_page_30_Figure_3.jpeg)

Geoprocessing		~ † ×
	Shrink	$\oplus$
Parameters Enviror	nments	?
* Input raster		
Output raster		
		Image: A start and a start
* Number of cells		
<ul> <li>Zone values</li> </ul>		
		+ Add another
Shrink method		
Morphological		~

Shrinks the selected zones by a specified number of cells by replacing them with the value of the cell that is most frequent in its neighborhood

![](_page_31_Figure_3.jpeg)

Geoproces	sing	~ 7 ×
	Majority Filter	$\oplus$
Parameters	Environments	?
* Input raster		
* Output raste	er	
Number of	neighbors to use	
Four		~
Replacemer	nt threshold	
Majority		~

Replaces cells in a raster based on the majority of their contiguous neighboring cells

![](_page_32_Figure_3.jpeg)

pro.arcgis.com

Geoproces	ssing ×	$^{\ddagger}$ $\times$
	Nibble	$\oplus$
Parameters	Environments	?
* Input raster		_
* Input raster	mask	_
* Output raste	er	_
🖌 Use Nol	Data values if they are the nearest neighbor	_
🗌 Nibble I	NoData cells	
Input zone i	raster	

Replaces cells of a raster corresponding to NoData cells of a mask with the values of the nearest neighbors

![](_page_33_Figure_3.jpeg)

pro.arcgis.com

Geoproces	ssing		~ 4 ×
	Region	Group	$\oplus$
Parameters	Environments		?
* Input raster			
* Output rast	er		
Number of	neighbors to use		
Four			~
Zone group	oing method		
Within			~
Add link	k field to output		
Excluded va	alue		

For each cell in the output, the identity of the connected region to which that cell belongs is recorded; a unique number is assigned to each region

![](_page_34_Figure_3.jpeg)

Geoprocessing	~ † ×	
E T	- hin	$\oplus$
Parameters Environments		?
1 Input raster		
* Output raster		
Background value		
Zero		~
Filter input first		
Shape for corners		
Round		~
Maximum thickness of input linear features	t	

Thins rasterized linear features by reducing the number of cells representing the width of the features

![](_page_35_Figure_3.jpeg)

![](_page_35_Picture_4.jpeg)

desktop.arcgis.com