RASTER ANALYSIS – 2

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MAP ALGEBRA

A simple and powerful algebra with which users can execute all Spatial Analyst tools, operators, and functions

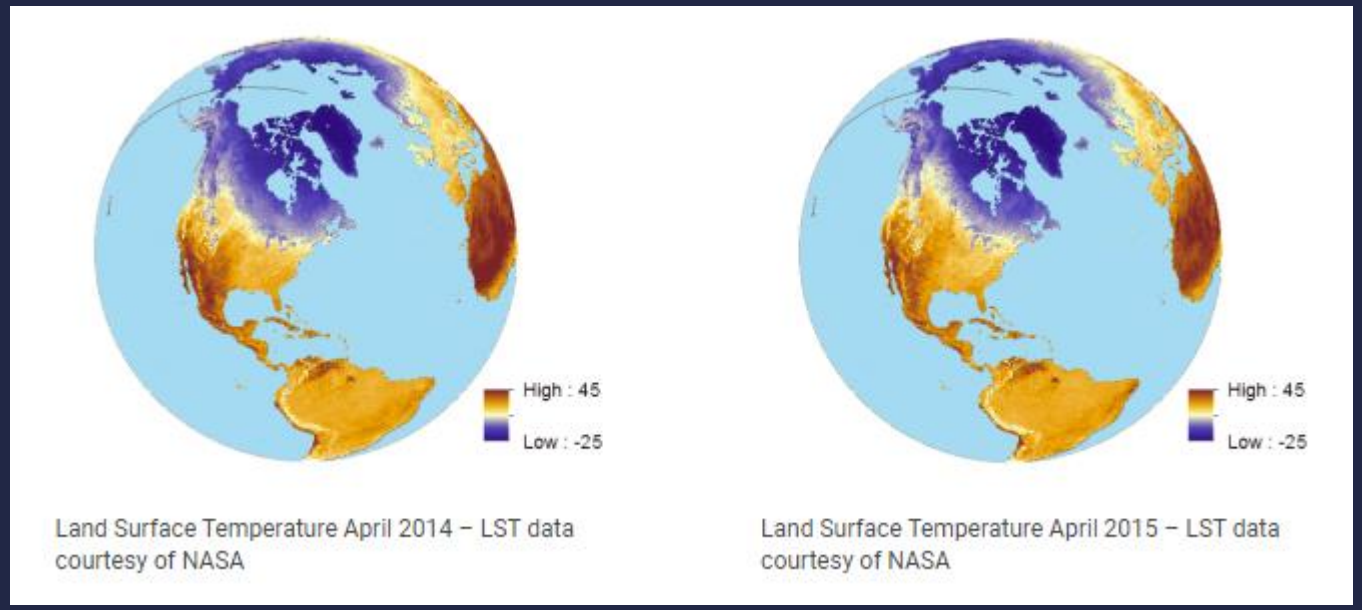
MAP ALGEBRA

- Allows for access to spatial analyst tools, operators, and functions
- Can be categorized as local, focal, zonal, and global operations
- Requires Raster Calculator to execute Map Algebra expressions

1	4	5		5	1	3		6	5	8
5	3	2	+	1	2	1	=	6	5	3
2	5	2		1	4	2		3	9	4

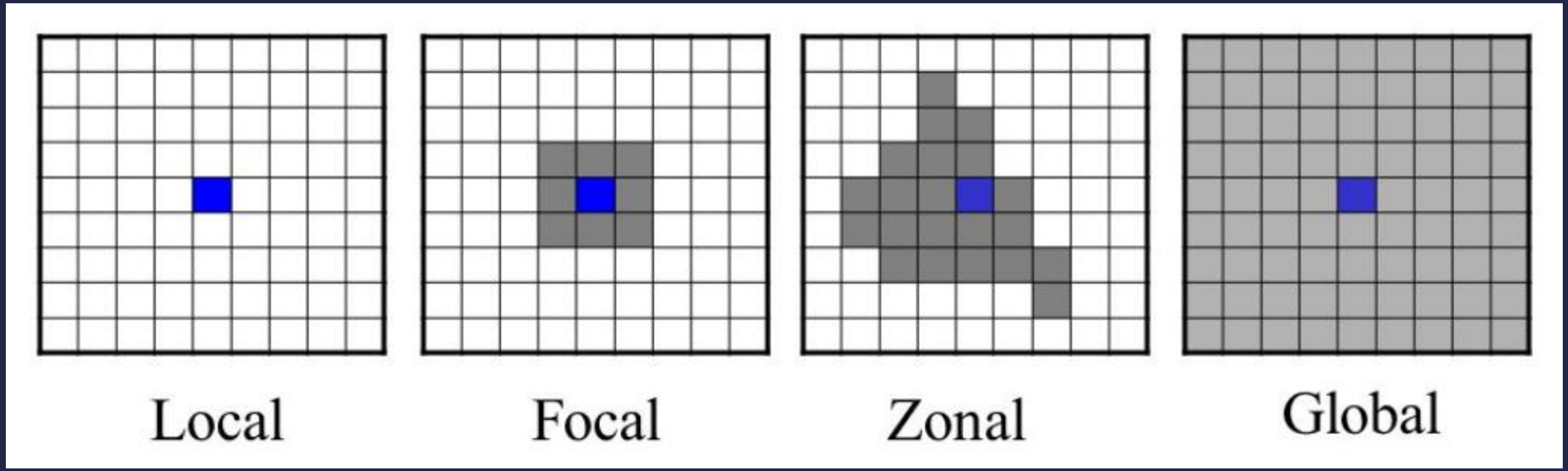
gisgeography.com

MAP ALGEBRA EXAMPLE



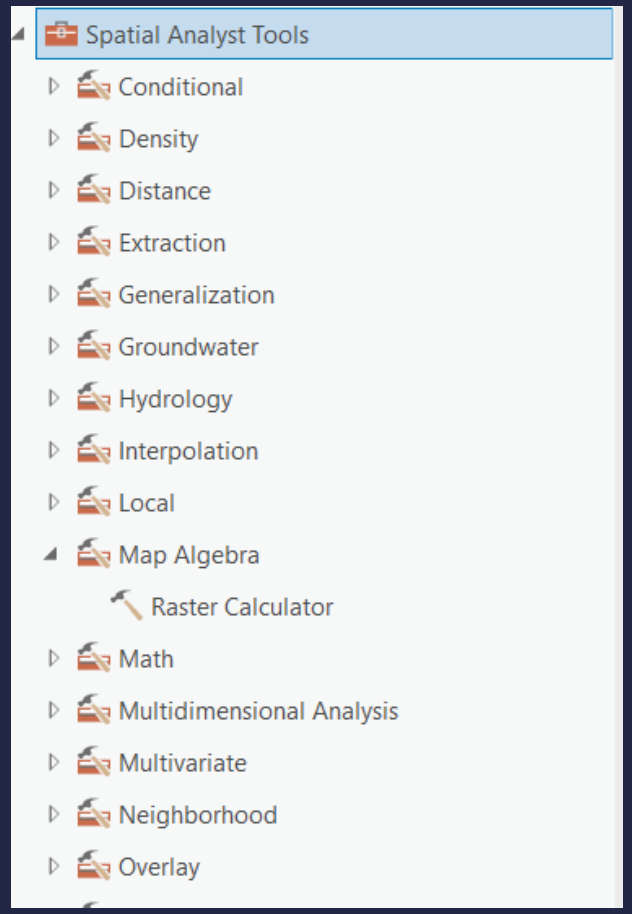
Land Surface Temperature Difference (subtract April 2014 temperature data from April 2015 data), gisgeography.com

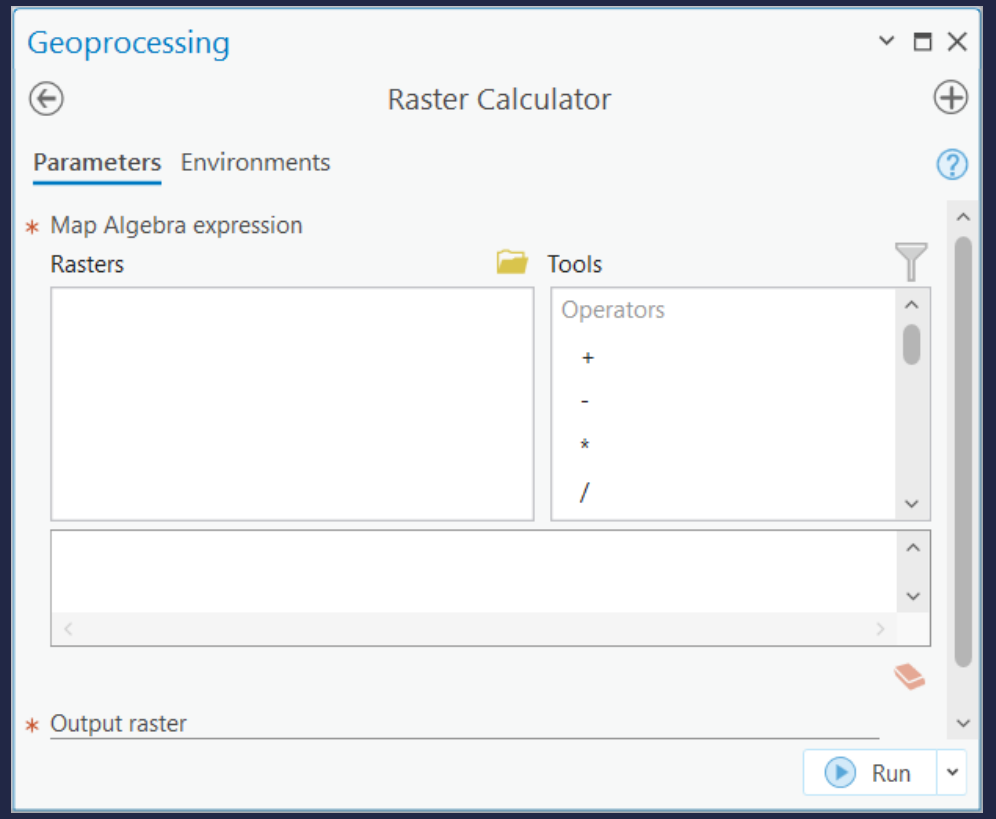
MAP ALGEBRA OPERATIONS



Tomlin 1990

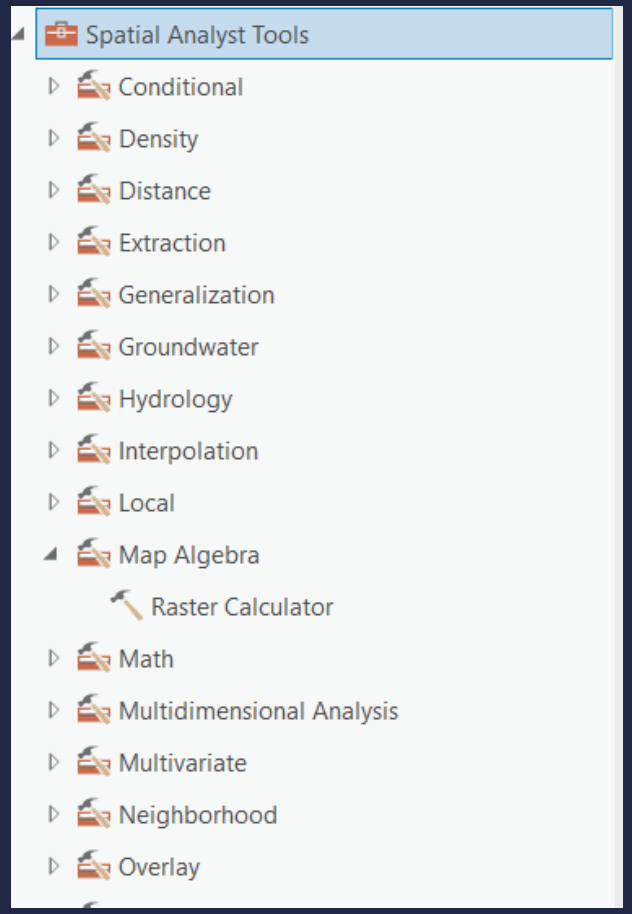
MAP ALGEBRA EXECUTION – RASTER CALCULATOR

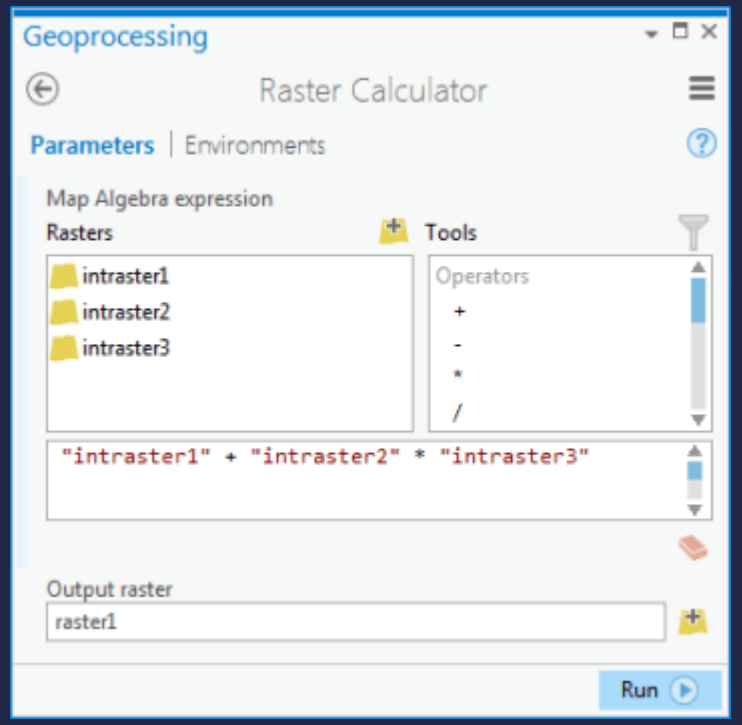


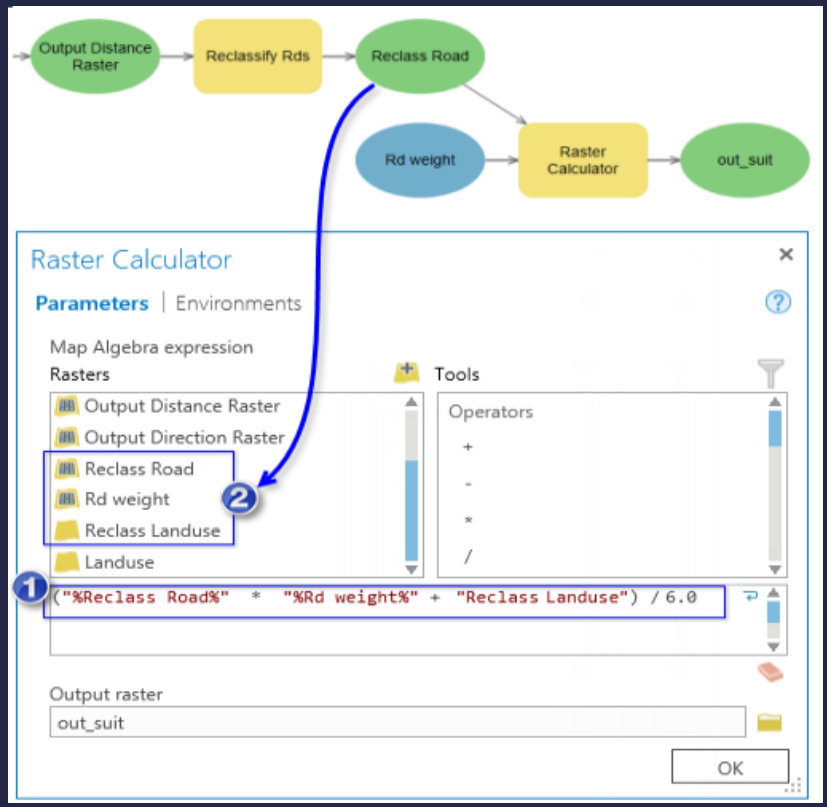


- The Raster Calculator can be used to create and execute a map algebra expression that will output a raster
- It can perform mathematical calculations using tools, operators, and functions, set up selection queries, or type in Map Algebra syntax
- Inputs can be raster datasets or raster layers, constants, and numbers
- Raster calculator can be used in ModelBuilder but not Python

MAP ALGEBRA EXECUTION – RASTER CALCULATOR







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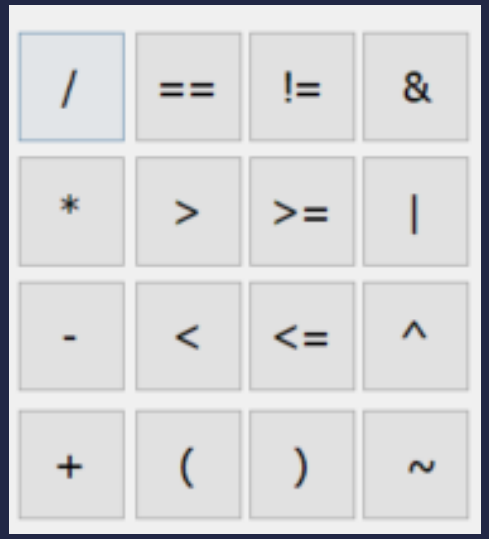
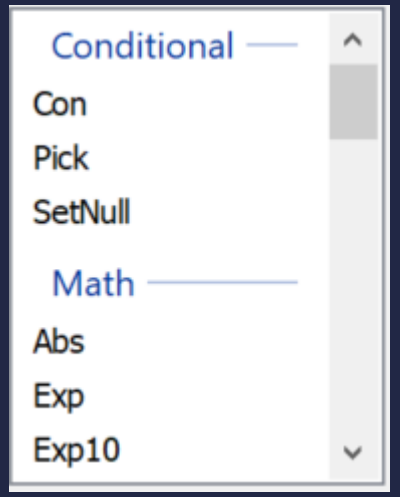
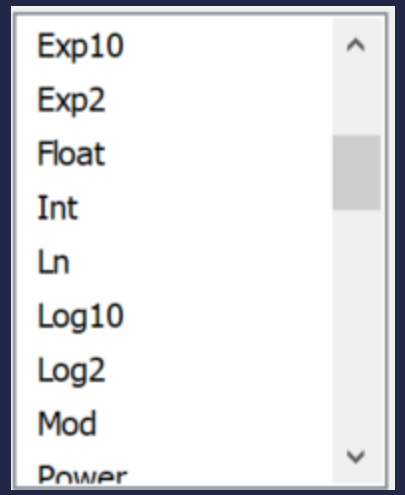
RASTER CALCULATOR OPERATORS

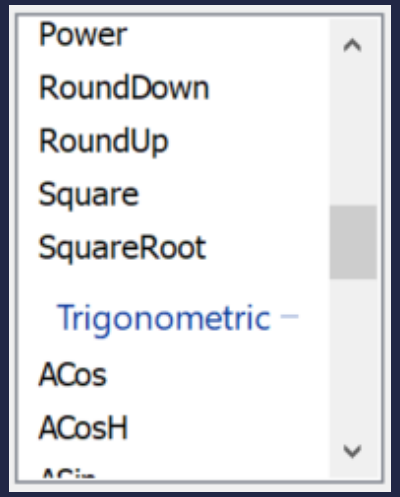


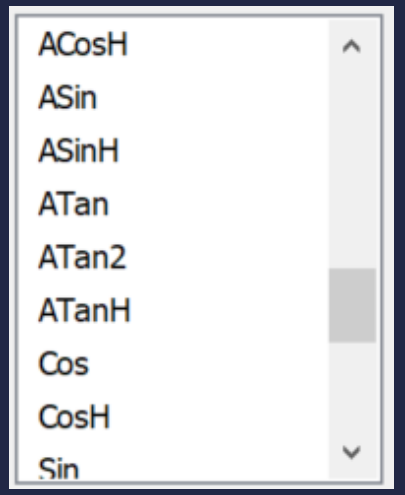
/ (Division)	== (Equal To)	!= (Not Equal)	& (Boolean And)
* (Multiplication)	> (Greater Than)	>= (Greater Than or Equal to)	| (Boolean Or)
- (Subtraction) (Negate)	< (Less Than)	<= (Less Than or Equal to)	^ (Boolean XOr)
+ (Addition)			~ (Boolean Not)

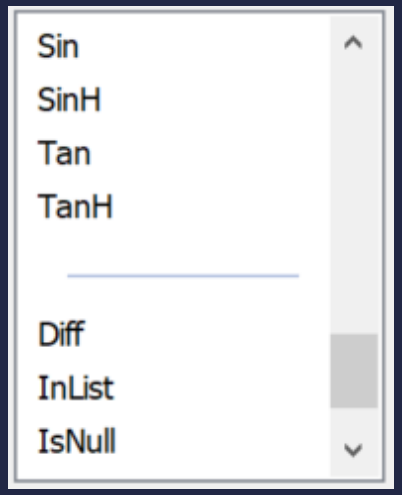
RASTER CALCULATOR TOOLS AND FUNCTIONS

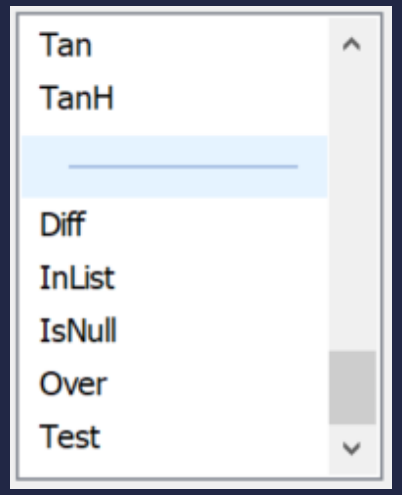




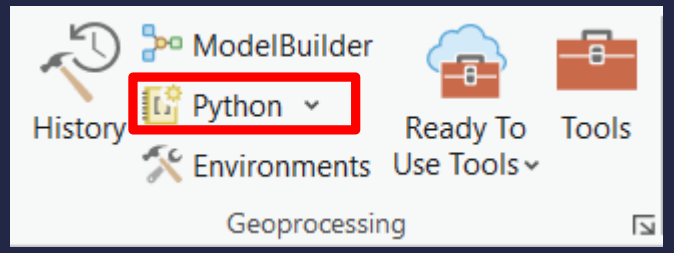


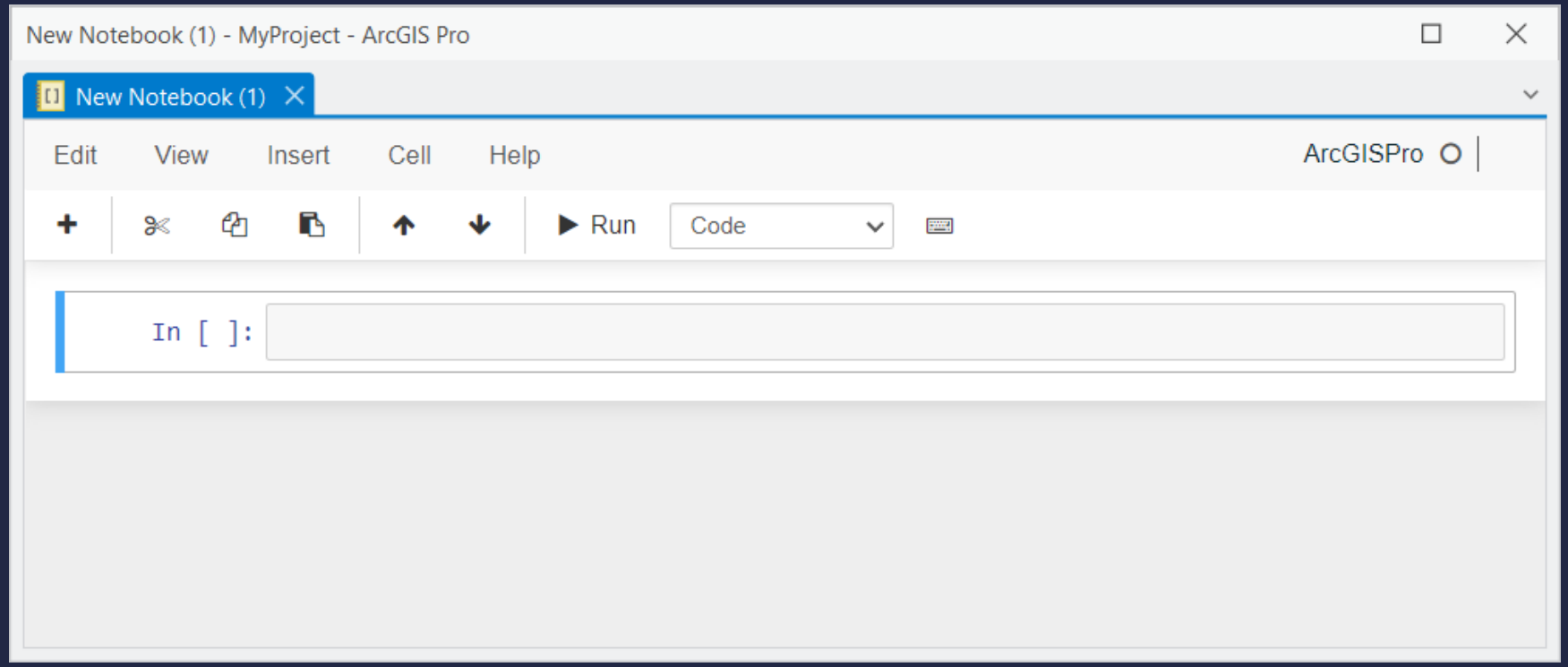






MAP ALGEBRA EXECUTION – PYTHON SCRIPTING





RULES FOR EXECUTING TOOLS IN PYTHON

- A simple Map Algebra to execute a single tool includes the tool name followed by the input dataset and the tool parameters within parentheses
  - Ex: *outRas = Slope("elevation", "PERCENT_RISE", 3)*
- Tool names are case sensitive
- Tools can be embedded one inside the other to create complex expressions. Complex expressions can consist of multiple Spatial Analyst tools but can also include tools from other toolboxes
  - Examples
    - Two Spatial Analyst Tools: *outRas = Slice(Slope("C:/Data/elevation"), 10)*
    - Spatial Analyst and a non-Spatial Analyst Tool:

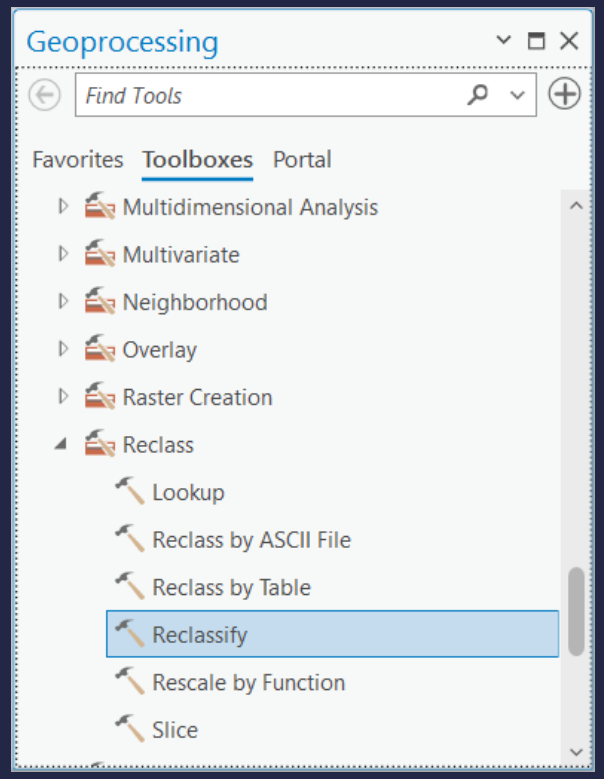
      outRas = ZonalStatistics(arcpy.Buffer_analysis("C:/Data/schools.shp", "#", 500), "OBJECTID", "C:/Data/pop1990", "SUM")

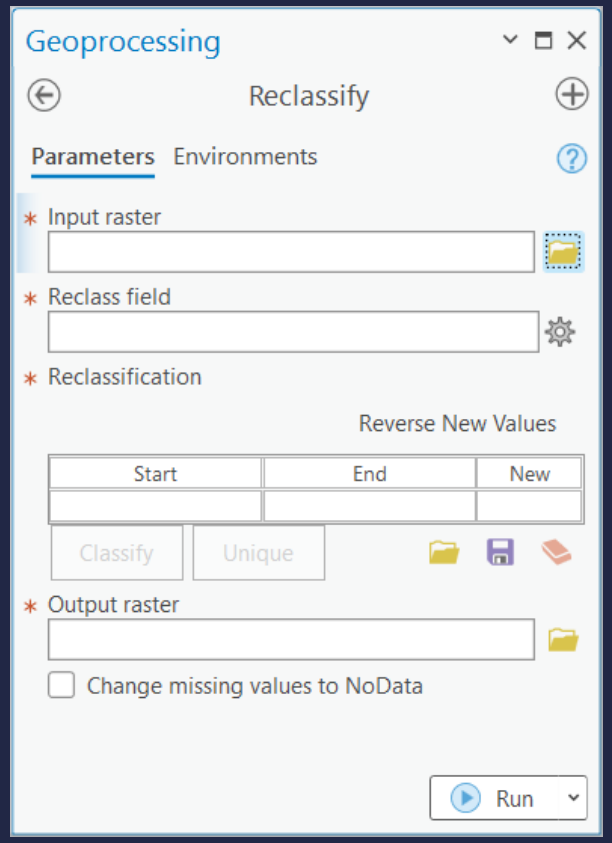
RECLASSIFY

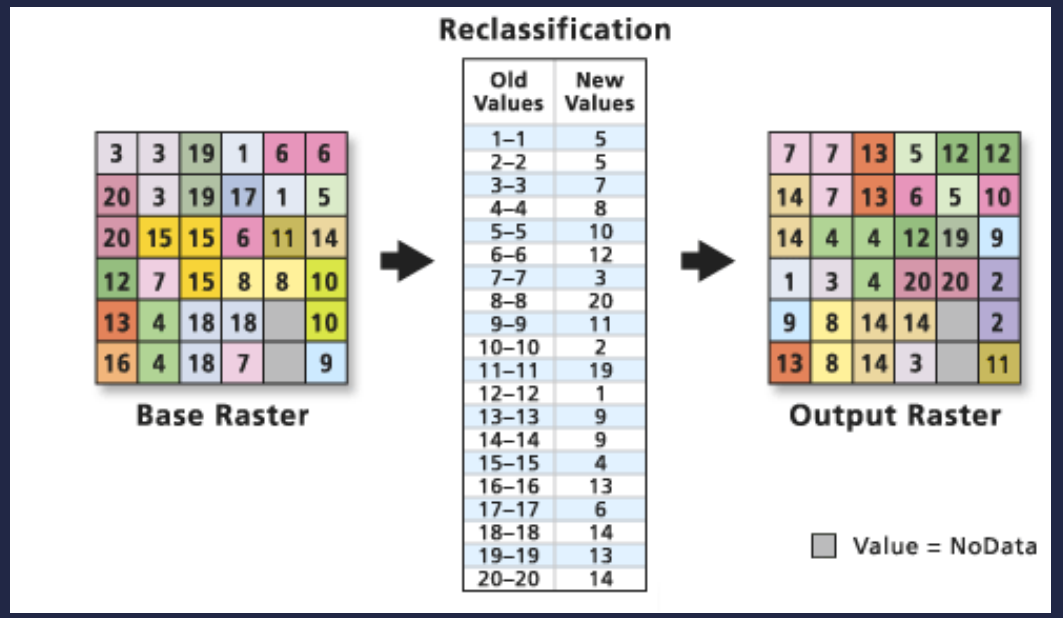
Reclassify a Raster

RECLASSIFY

- Changing the cell values in a raster







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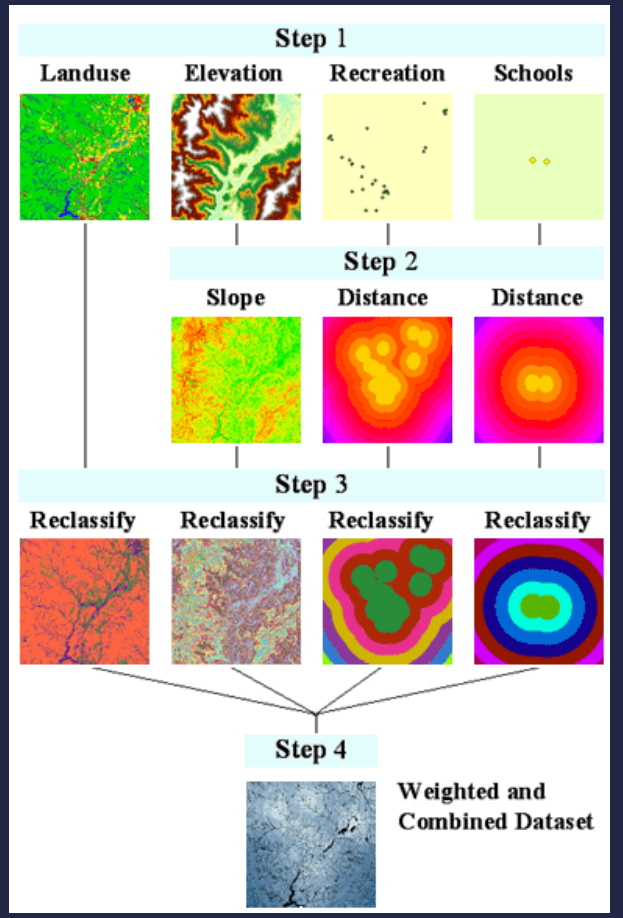
WHY RECLASSIFY

- Commons reasons for this operation
  - Replace values based on new information
  - Group certain values together
  - Assign values based on preference, priority, or sensitivity etc.
  - Reclassify values to a common scale
  - Set specific values to NoData or set NoData cells to a value



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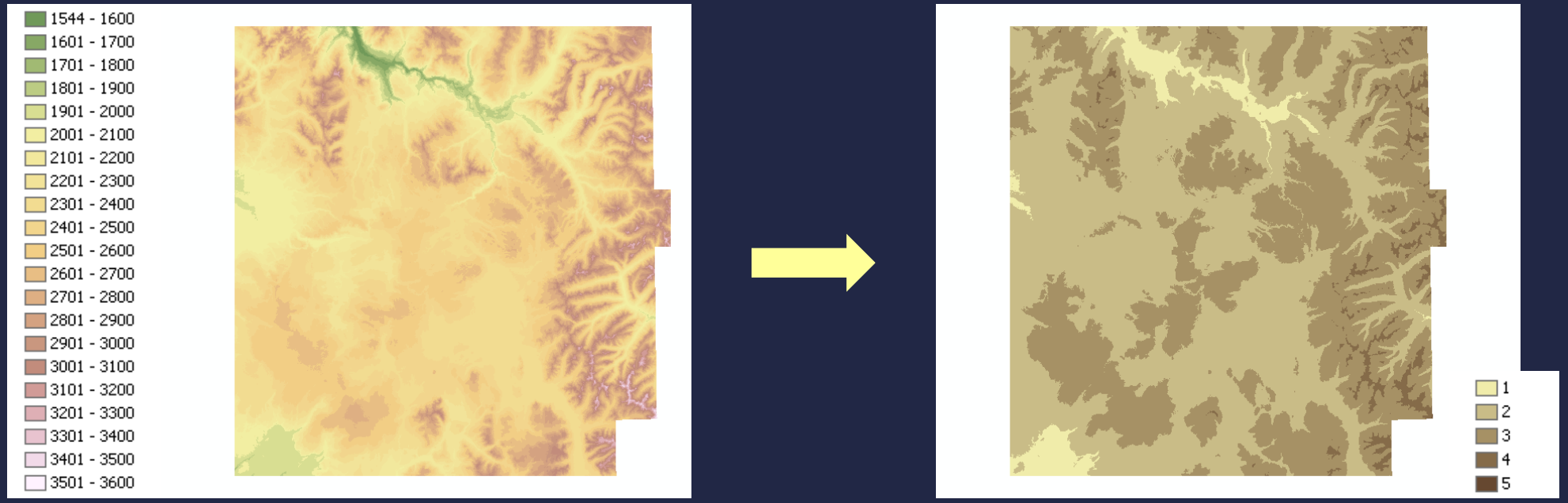
HOW TO RECLASSIFY?

- Several ways to reclassify your data
  - Individual values (Lookup, Reclassify)
  - Ranges of values (Reclass by ASCII File, Reclass by Table, Reclassify)
  - Intervals (Slice)
  - Continuous values using functions (Rescale by Function)
- All reclassification methods are applied to each cell within the image or a zone of the image
- For multiband raster, the first band will be used in the reclassification

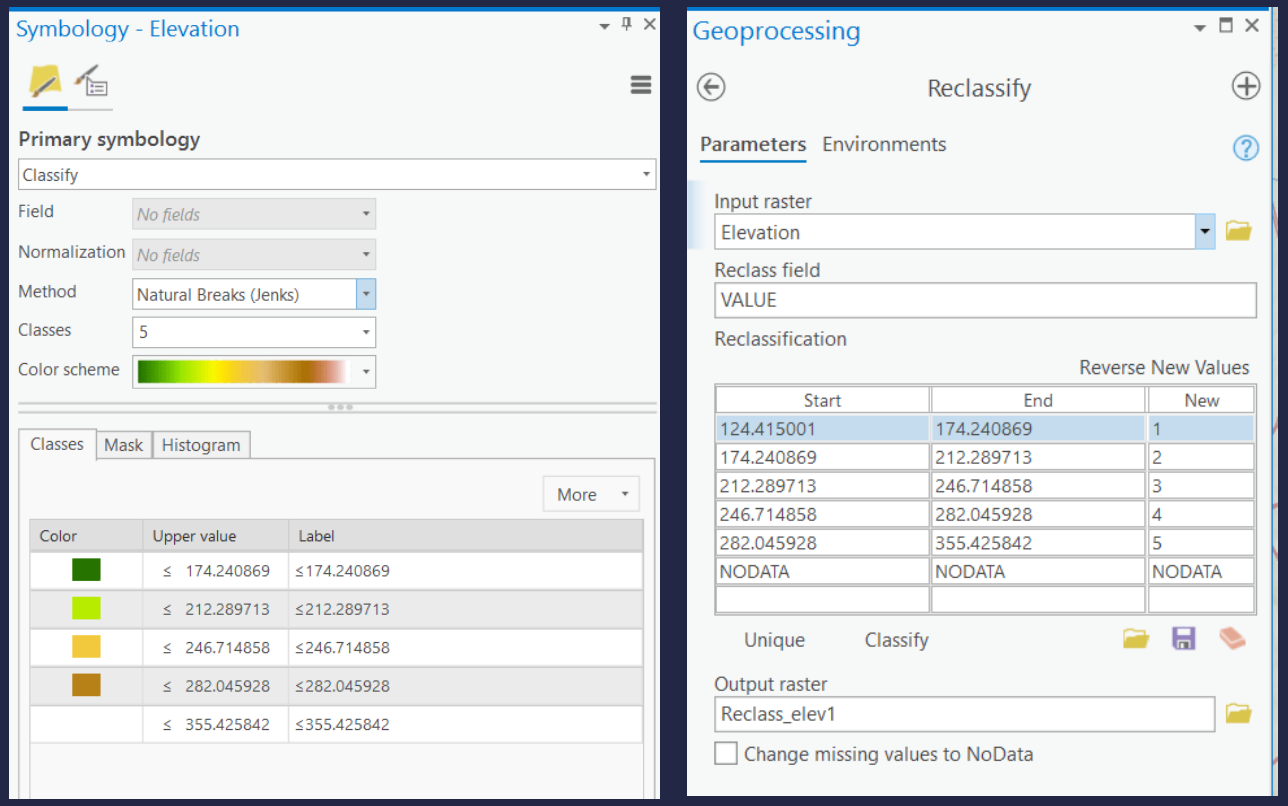
RECLASSIFY – EXAMPLES

- Landuse in an area changed over time
- Grouping various types of forest into one forest class
- Certain landuse type has restrictions (such as wetland restrictions), which means you cannot build there; in such cases, you might want to change these values to nodata in order to remove them from further analysis
- Finding slopes most at risk of avalanche activity – input rasters might be slope, soil type, and vegetation. Each of these rasters might be reclassified on a scale of 1–10 depending on the susceptibility of each attribute in each raster to avalanche activity (that is, steep slopes in the slope raster might be given a value of 10 because they are most susceptible to avalanche activity)

RECLASSIFY – EXAMPLE



RECLASSIFY – EXAMPLES



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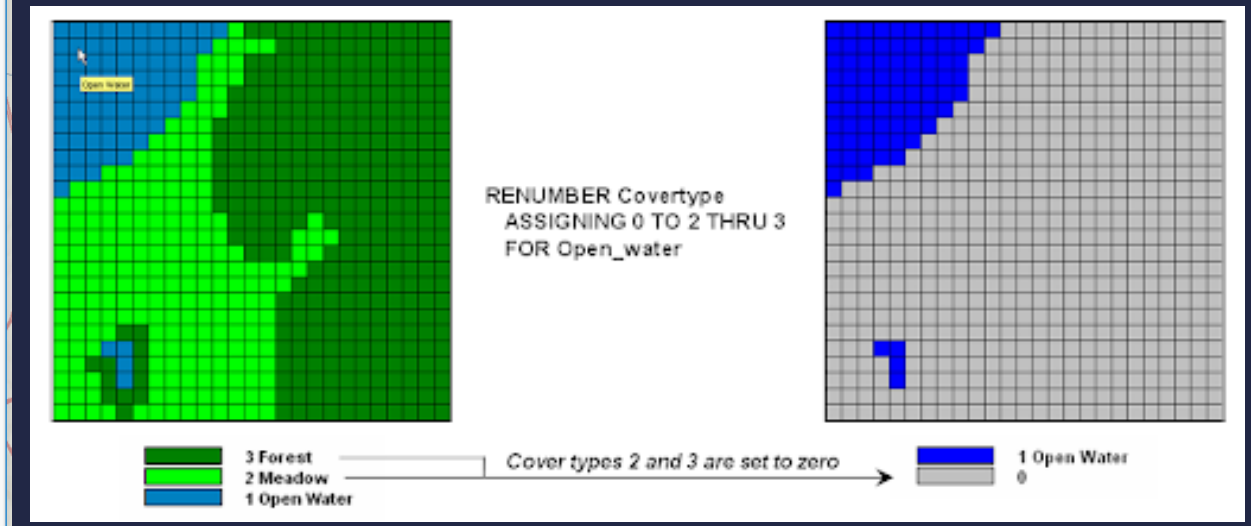

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RASTER OVERLAY

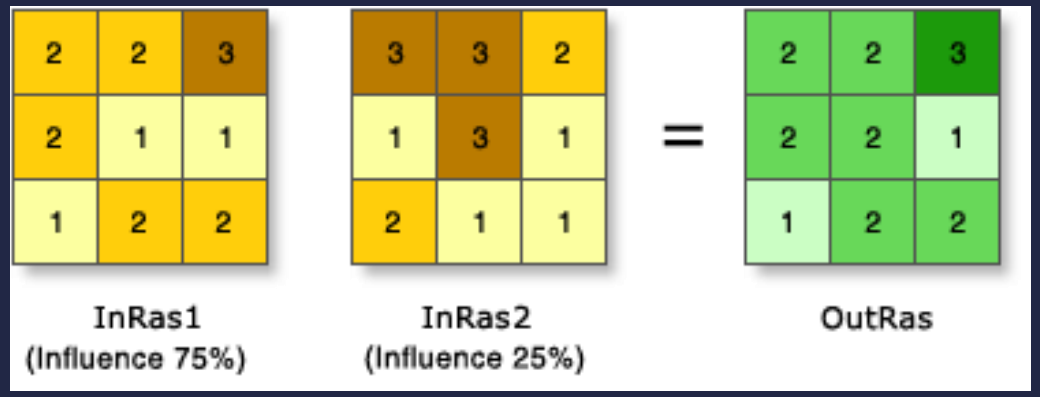
Overlay Multiple Rasters

OVERLAY ANALYSIS

- Overlay analysis tools allow you to apply weights to several inputs and combine them into a single output
- The most common application for overlay tools is suitability analysis
- Tools in ArcGIS Pro
  - Fuzzy Membership
  - Fuzzy Overlay
  - Weighted Overlay
  - Weighted Sum

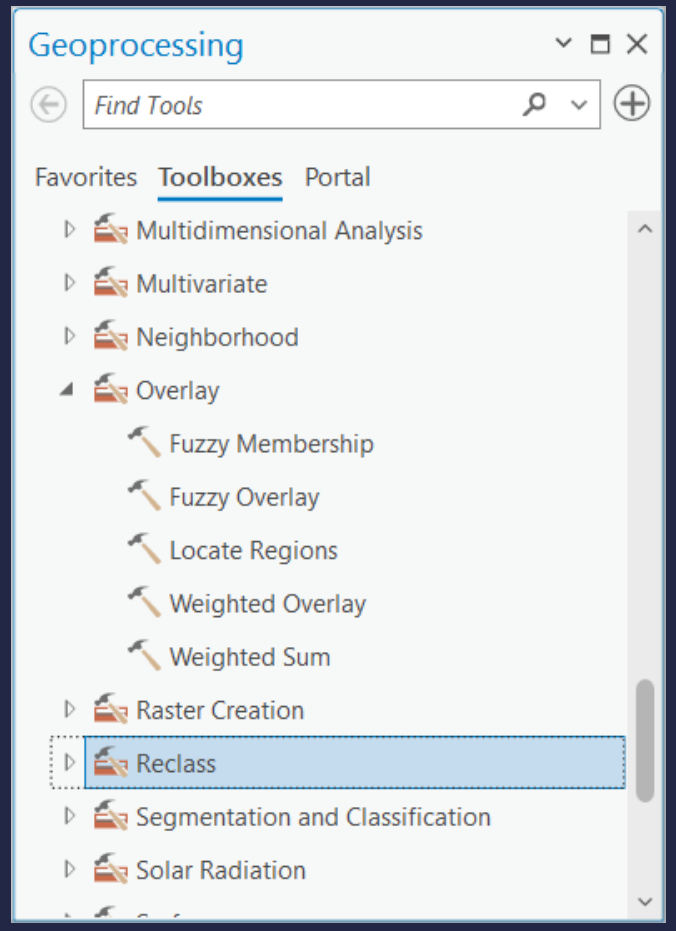
WEIGHTED OVERLAY

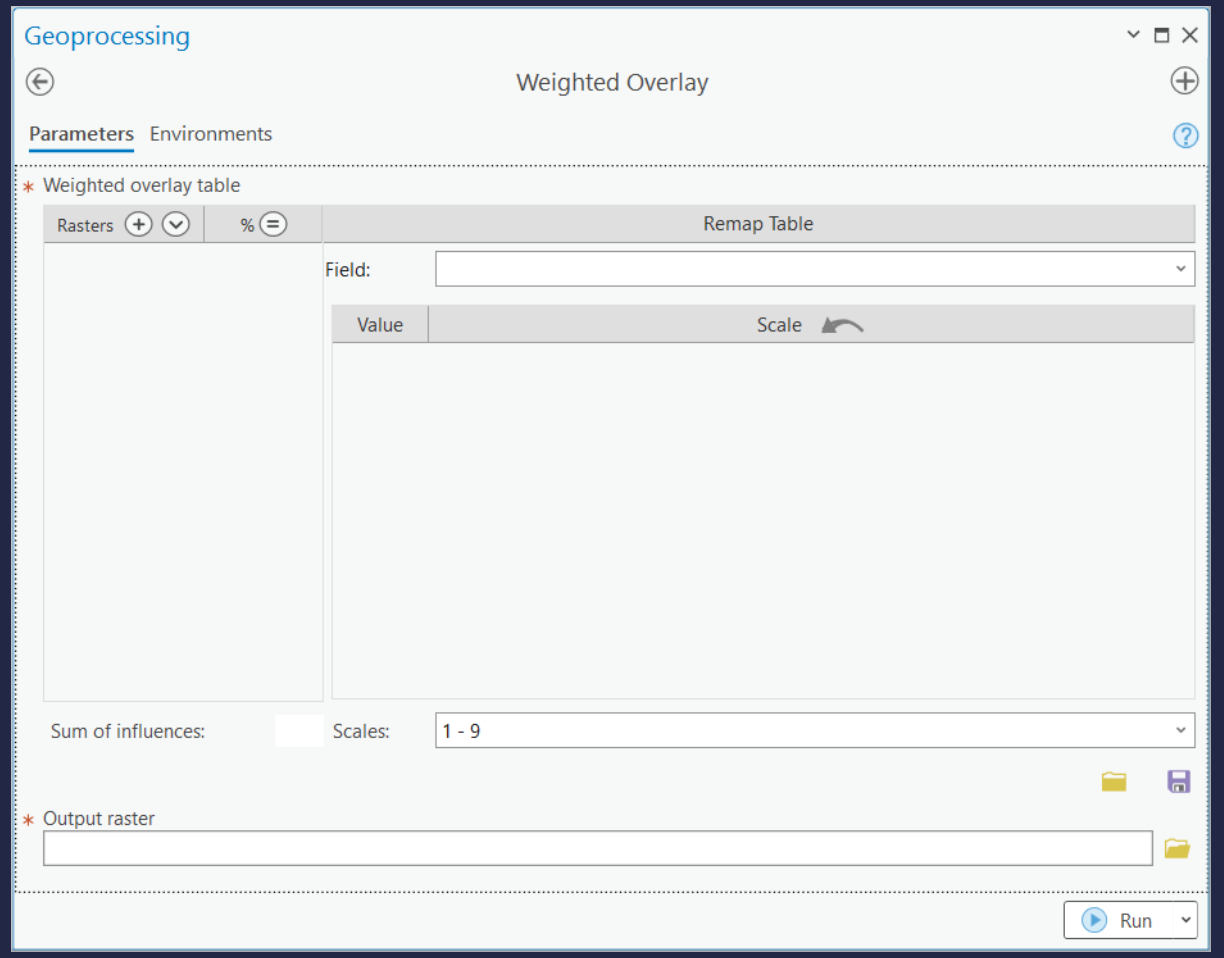
- Overlays several rasters using a common measurement scale and weights each according to its importance or its percentage influence
- All input rasters must be integer
- Each value class in an input raster is assigned a new value based on an evaluation scale



In the illustration, the two input rasters have been reclassified to a common measurement scale of 1 to 3. Each raster is assigned a percentage influence. The cell values are multiplied by their percentage influence, and the results are added together to create the output raster. For example, consider the upper left cell. The values for the two inputs become (2 * 0.75) = 1.5 and (3 * 0.25) = 0.75. The sum of 1.5 and 0.75 is 2.25. Because the output raster from Weighted Overlay is integer, the final value is rounded to 2

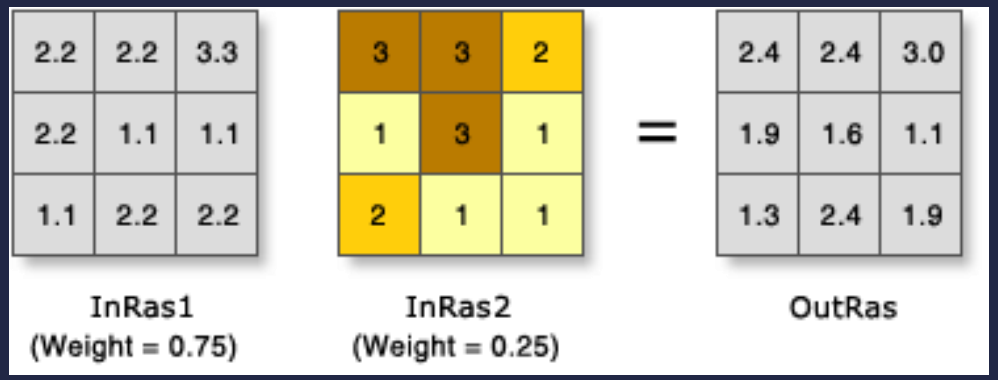
WEIGHTED OVERLAY





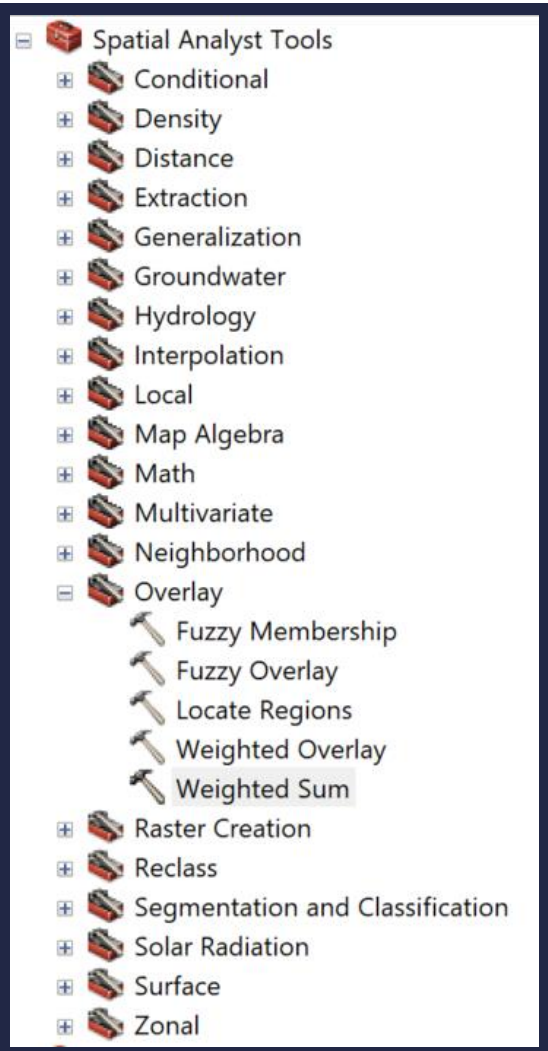
WEIGHTED SUM

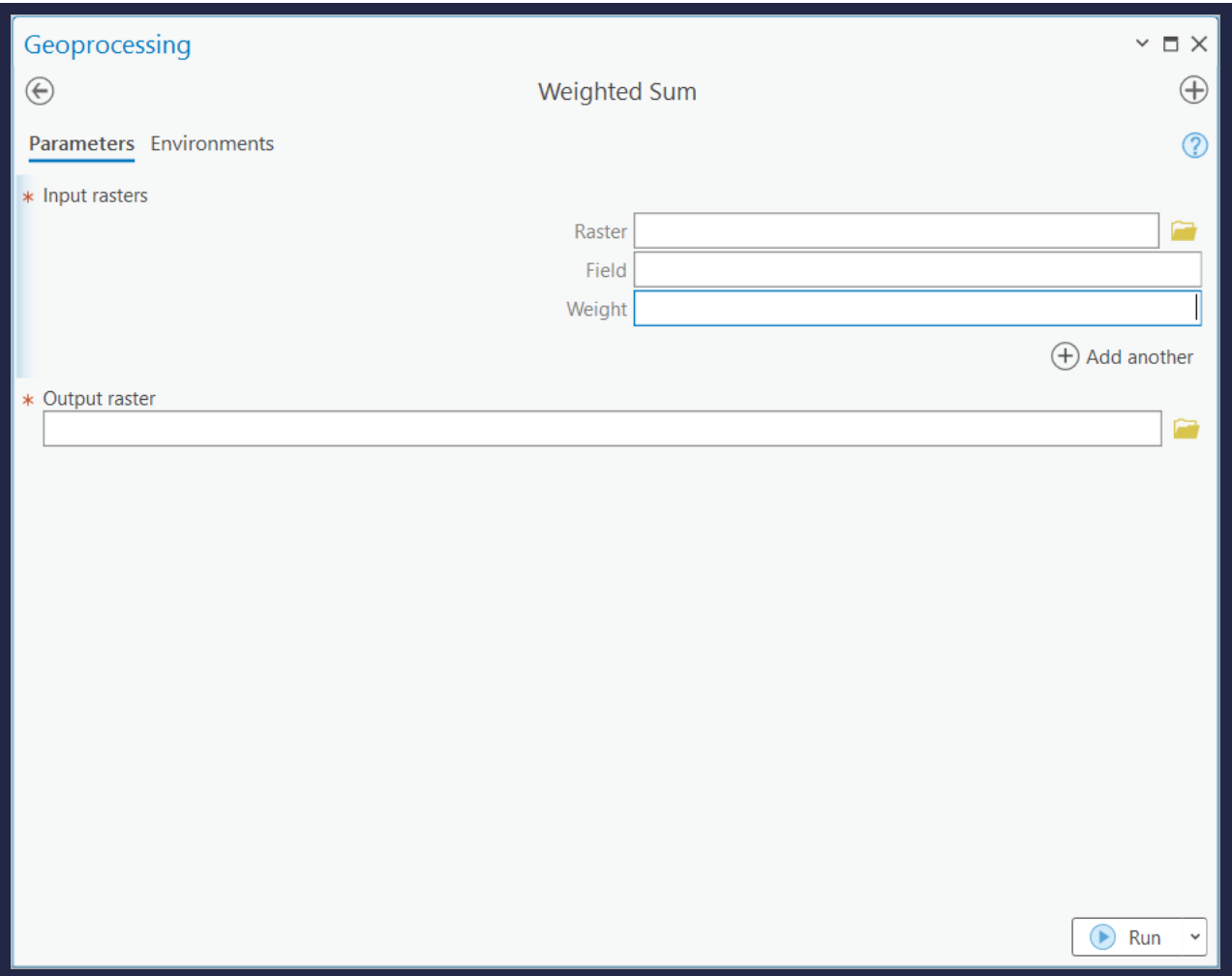
- Overlays several rasters, multiplying each by their given weight and summing them together
- Input rasters can be integer or floating point
- A useful way to add several rasters together is to input multiple rasters and set all weights equal to 1, although the weight values can be any positive or negative decimal value. It is not restricted to a relative percentage nor does it need to be equal to 1.0



In the illustration, the cell values are multiplied by their weight factor, and the results are added together to create the output raster. For example, consider the upper left cell. The values for the two inputs become (2.2 * 0.75) = 1.65 and (3 * 0.25) = 0.75. The sum of 1.5 and 0.75 is 2.4.

WEIGHTED SUM

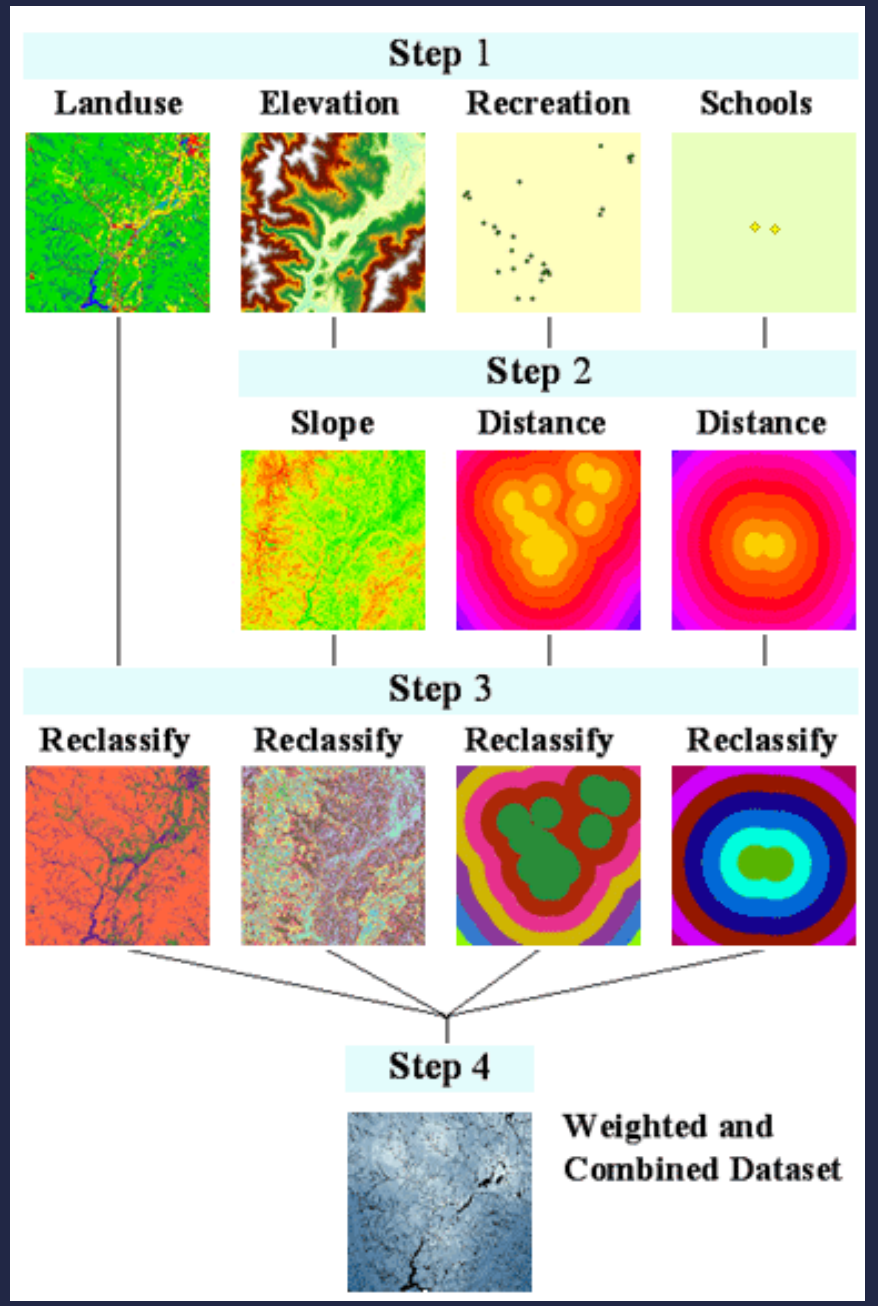




SUITABILITY MODELING

- Overlay analysis is a group of methodologies applied in optimal site selection or suitability modeling
- It is a technique for applying a common scale of values to diverse and dissimilar inputs to create an integrated analysis
- General steps to perform overlay analysis
  - Define the problem
  - Break the problem into sub-models
  - Determine significant layers
  - Reclassify or transform the data within a layer
  - Weight the input layers
  - Add or combine the layers
  - Analyze

Example of using reclassification in a Weighted Overlay workflow – Finding the best locations for a school



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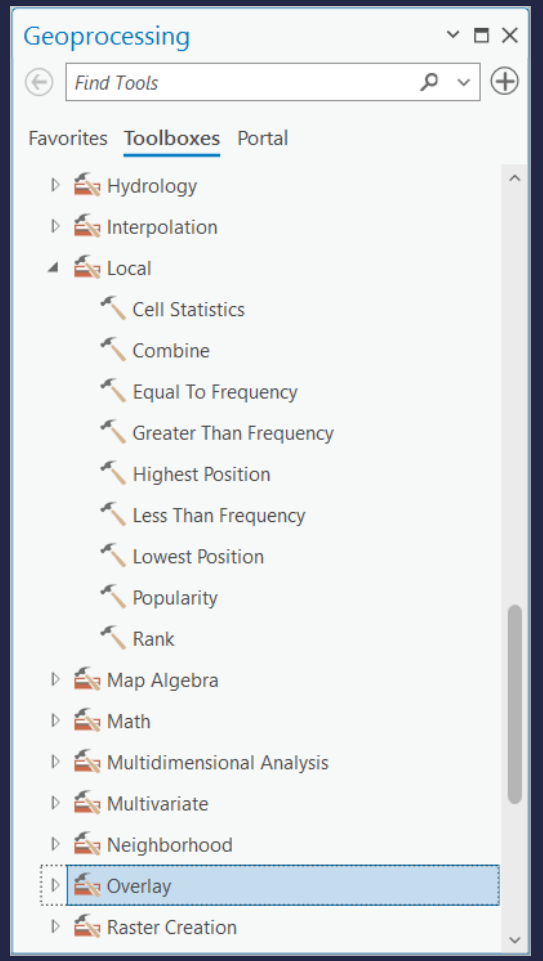
RASTER STATISTICS

Calculating statistics for rasters

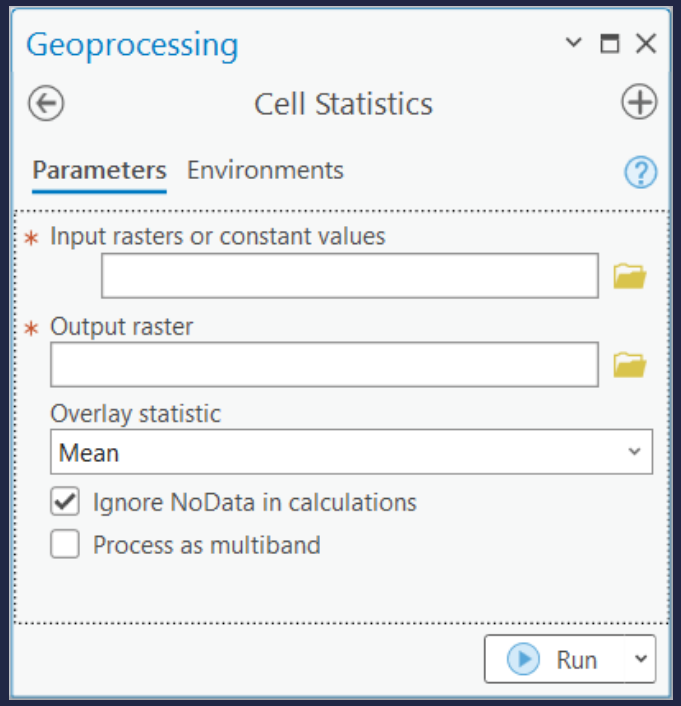
LOCAL STATISTICS

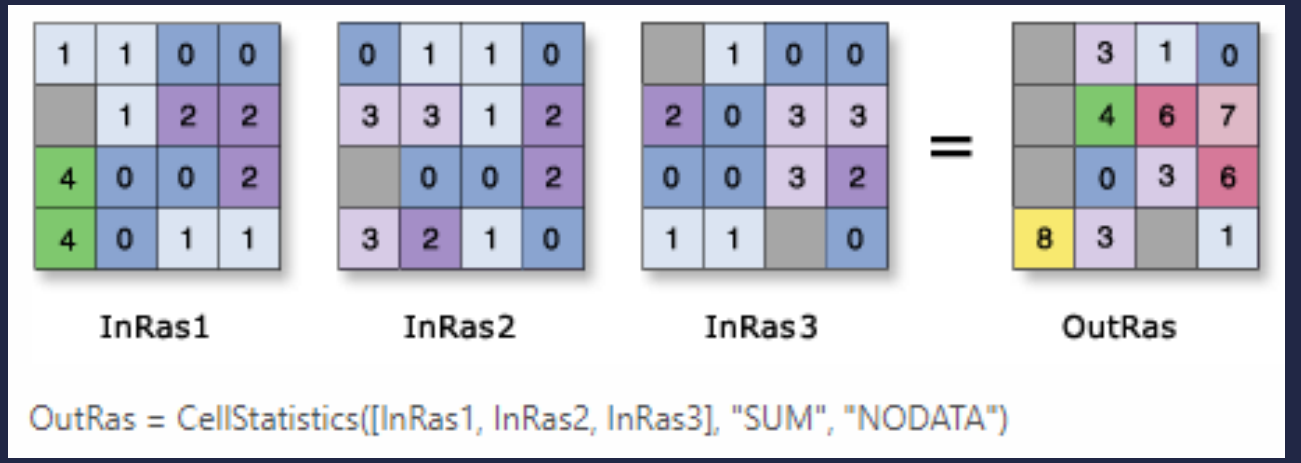
- Available under Local Toolset
- The local tools are those where the value at each cell location on the output raster is a function of the values from all the inputs at that location



CELL STATISTICS

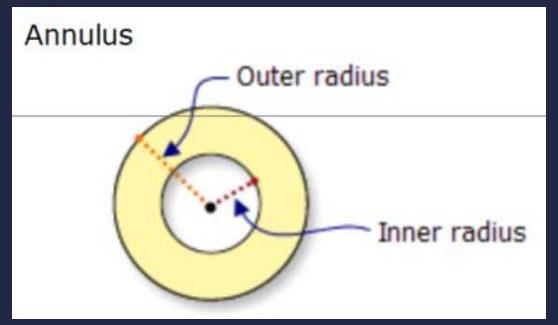
- Calculates a per-cell statistic from multiple rasters
- The available statistics are Majority, Maximum, Mean, Median, Minimum, Minority, Range, Standard deviation, Sum, and Variety

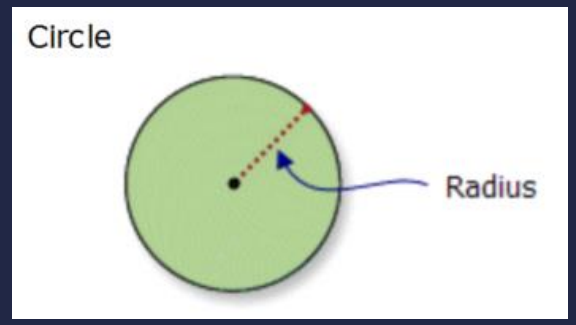


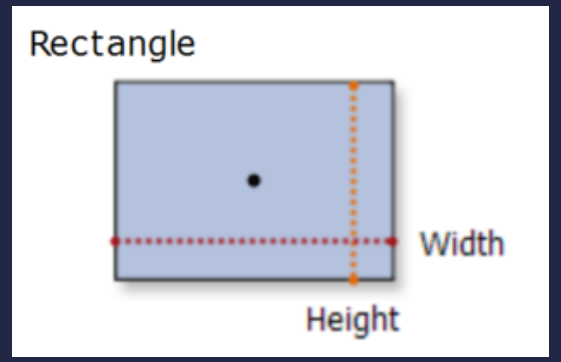


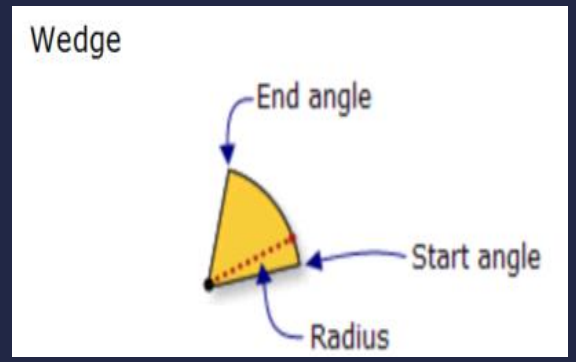
NEIGHBORHOOD STATISTICS

- Also known as Focal Operations
- Neighborhood tools create output values for each cell location based on the location value and the values identified in a specified neighborhood
- The neighborhood can be of two types: moving or search radius
- Neighborhood shapes can be: a rectangle of any dimension, a circle of any radius, an annulus (a doughnut shape) of any radius, and a wedge in any direction
- Focal Statistics Tool – overlapping neighborhoods
- Block Statistics Tool – non-overlapping neighborhoods

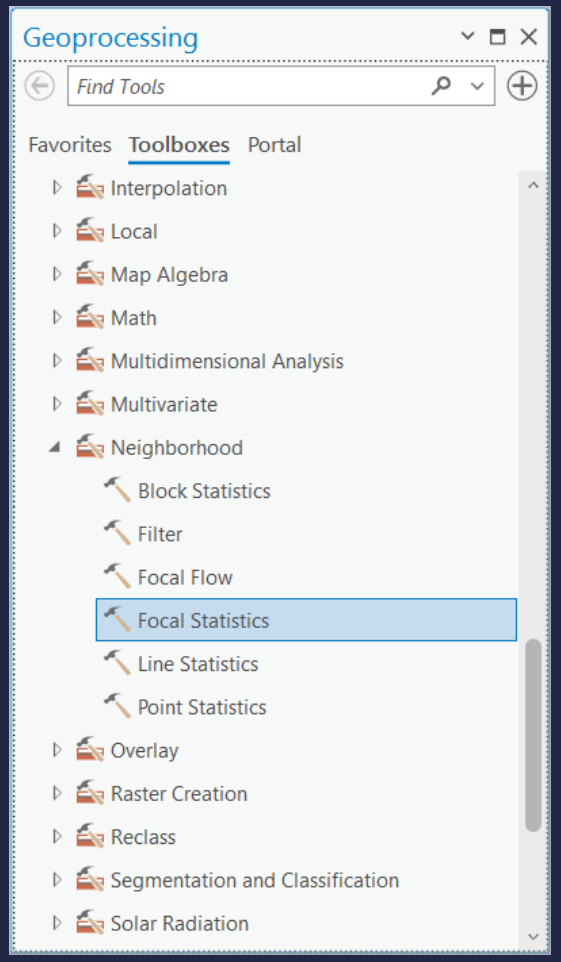


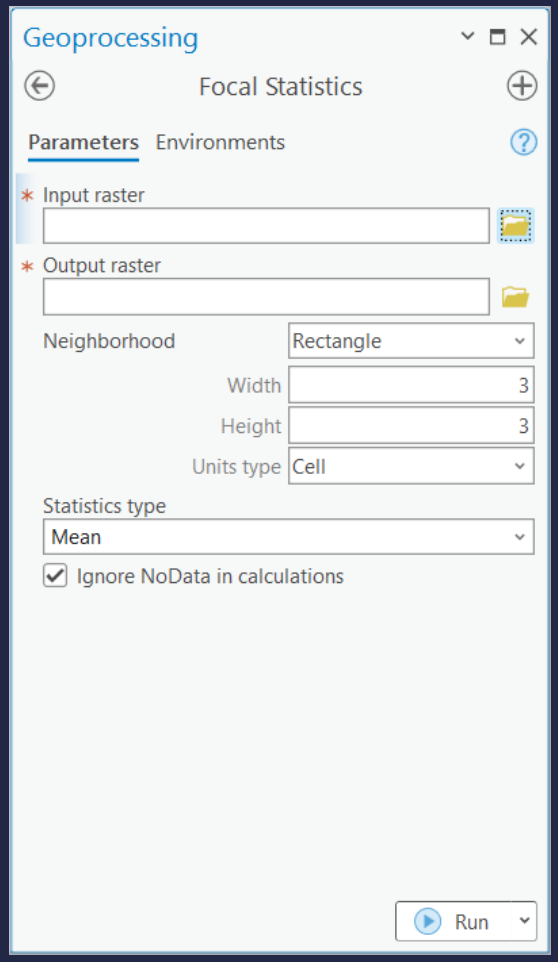






NEIGHBORHOOD STATISTICS





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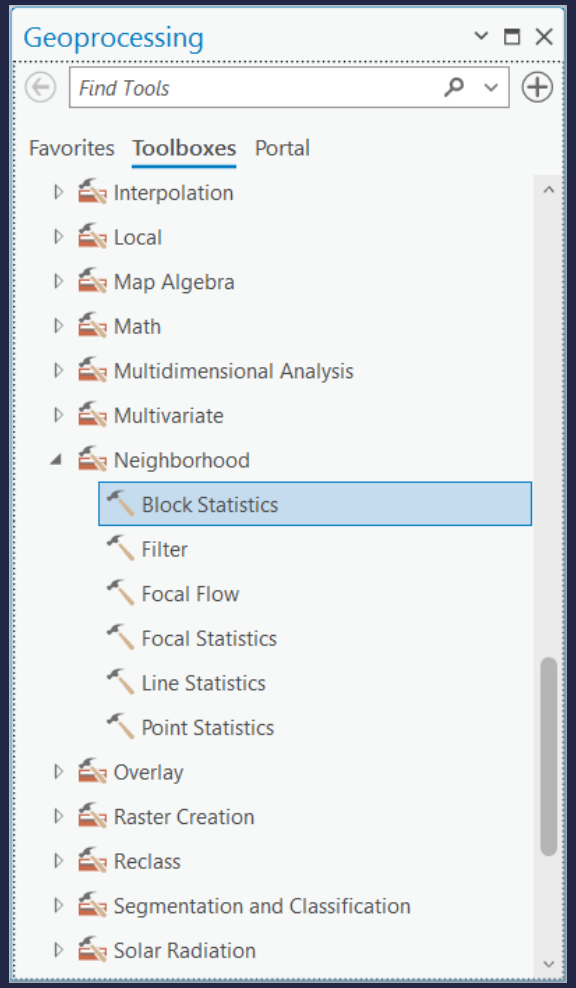
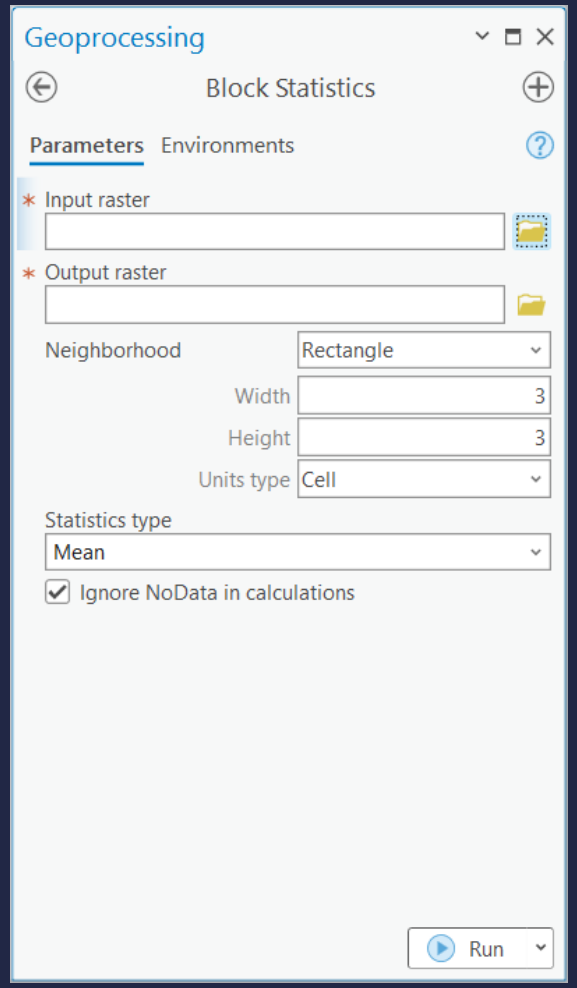
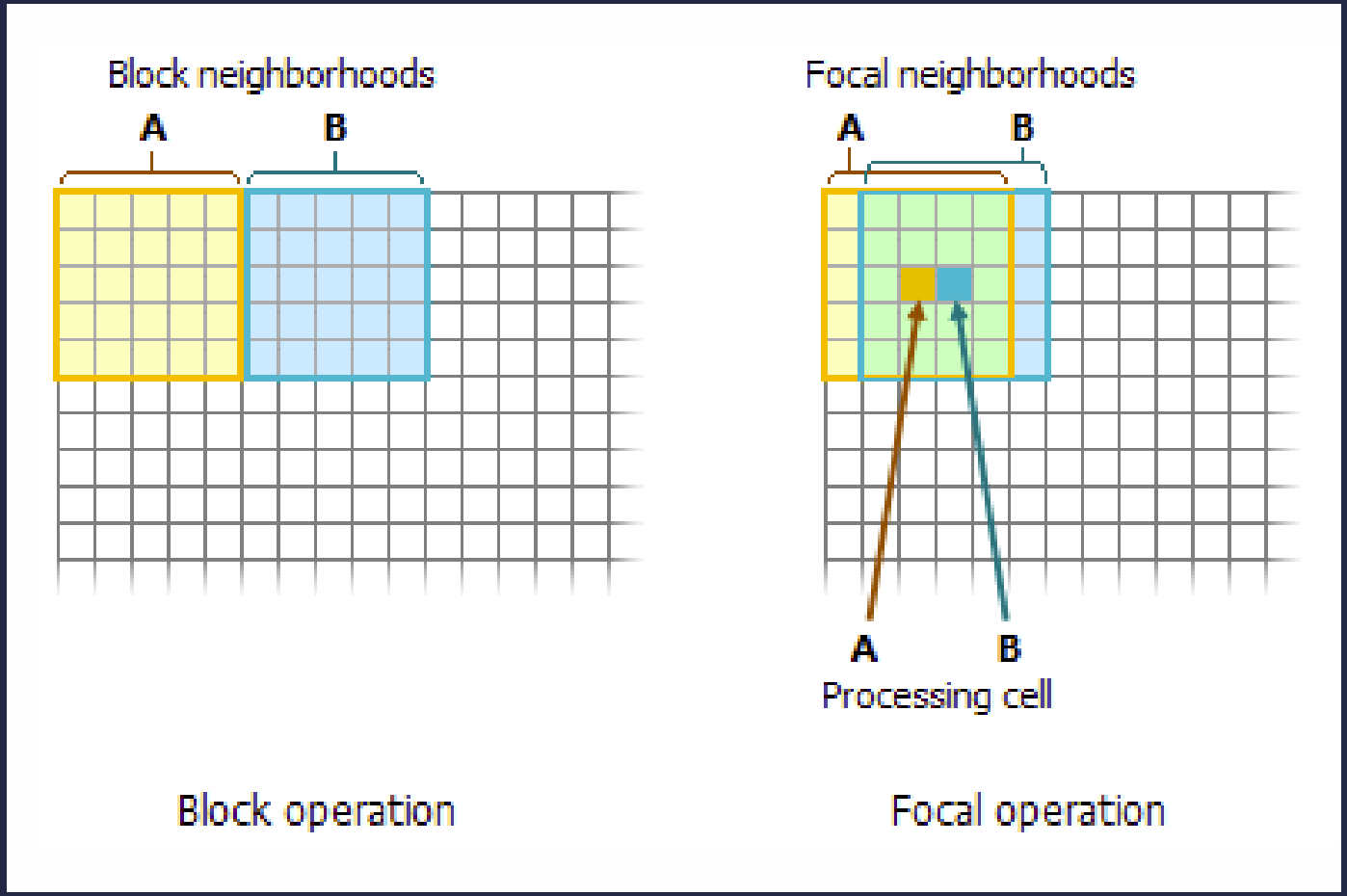


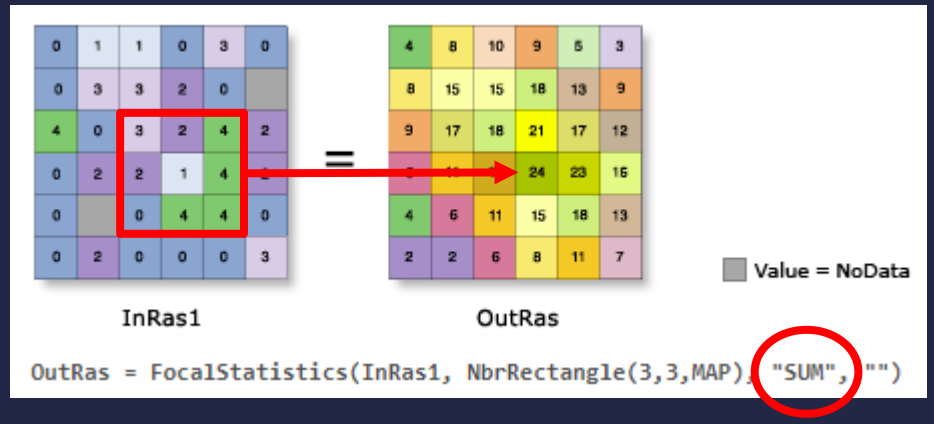


FOCAL VS. BLOCK OPERATIONS

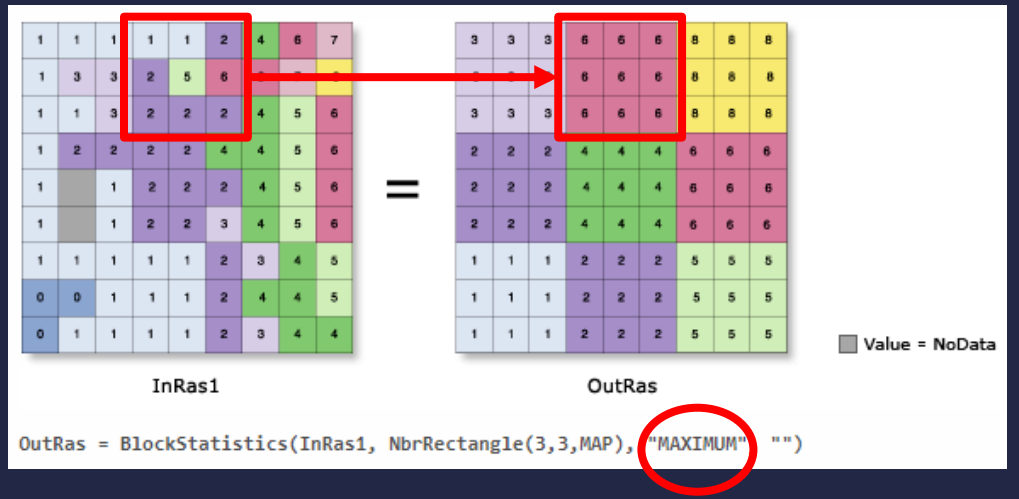


FOCAL VS. BLOCK STATISTICS

Focal Operations

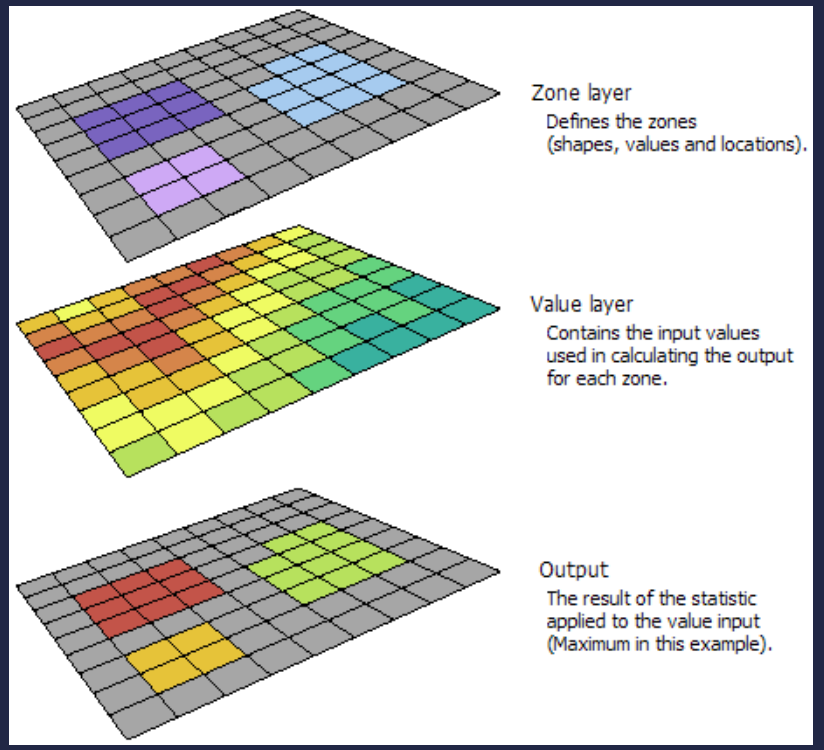


Block Operations



ZONAL STATISTICS

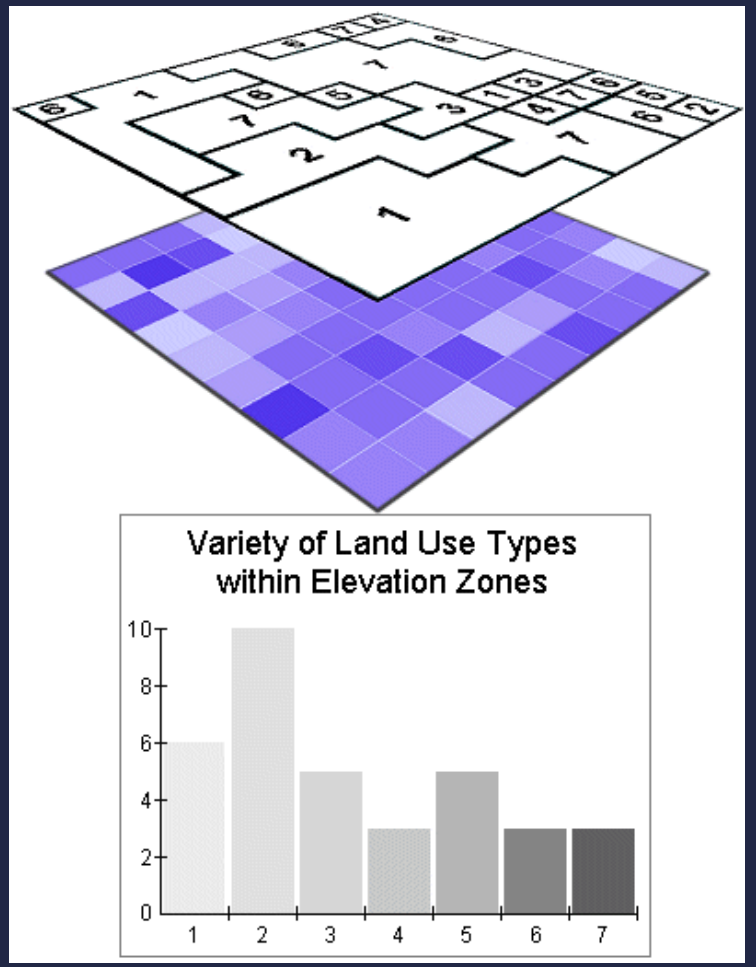
- A statistic is calculated for each zone defined by a zone dataset, based on values from another dataset (a value raster)
- A single output value is computed for every zone in the input zone dataset



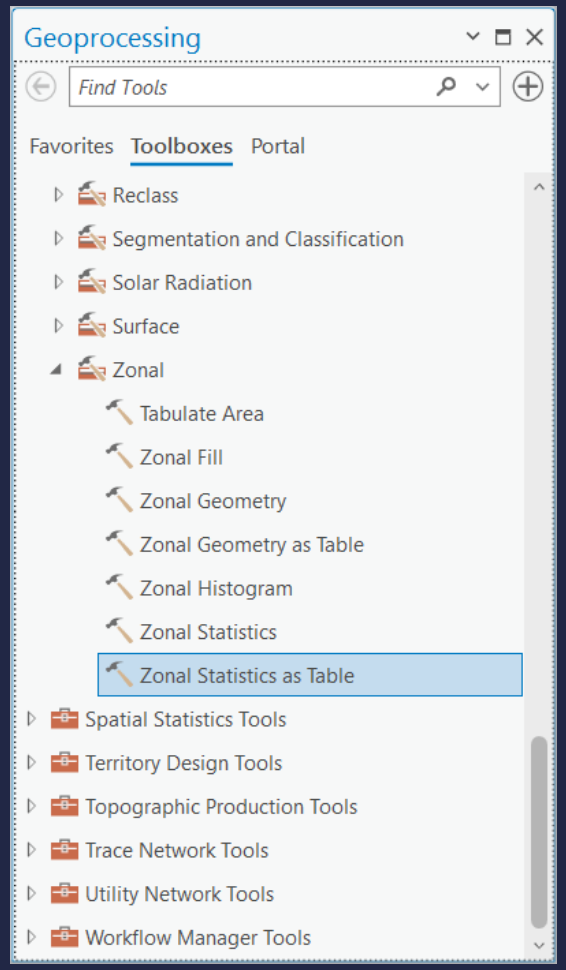
http://desktop.arcgis.com/en/arcmap/latest/tools/spatial-analyst-toolbox/h-how-zonal-statistics-works.htm

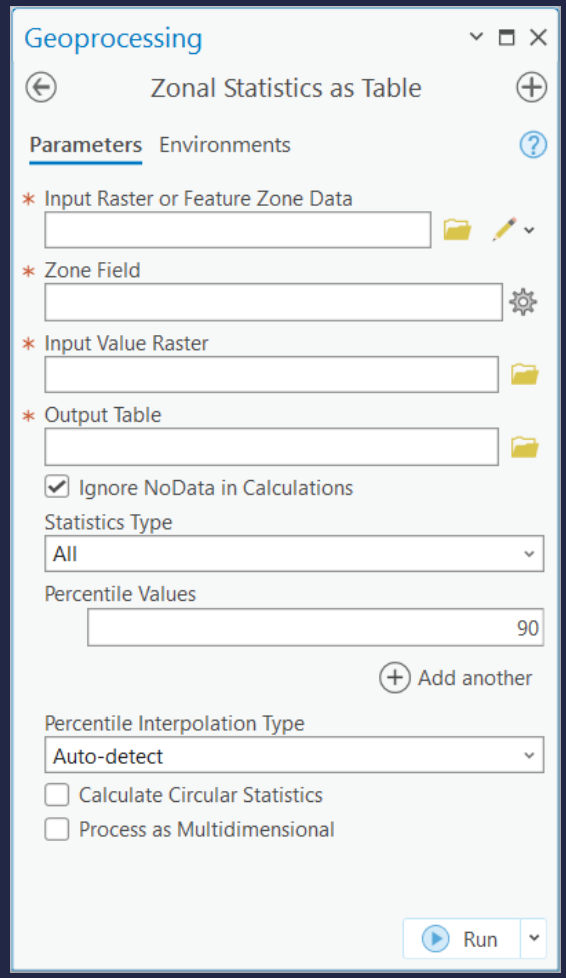
ZONAL STATISTICS

- Example: How many different types of vegetation there are in each elevation zone (variety)
- The graphics show an example of the inputs and outputs from the Zonal Statistics function; the variety of land use types per elevation zone is displayed in the output chart; the most variety of species occurs at elevation levels of around 2



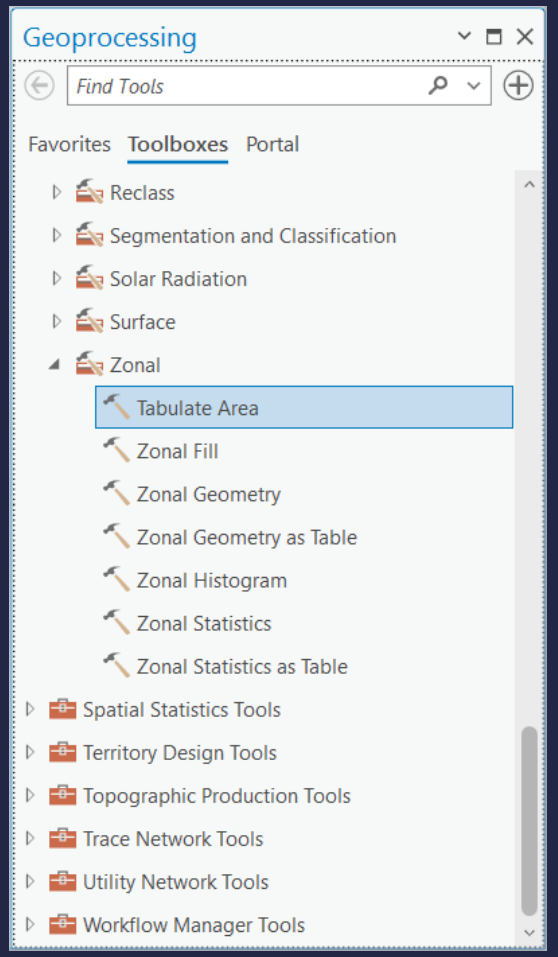
ZONAL STATISTICS AS TABLE

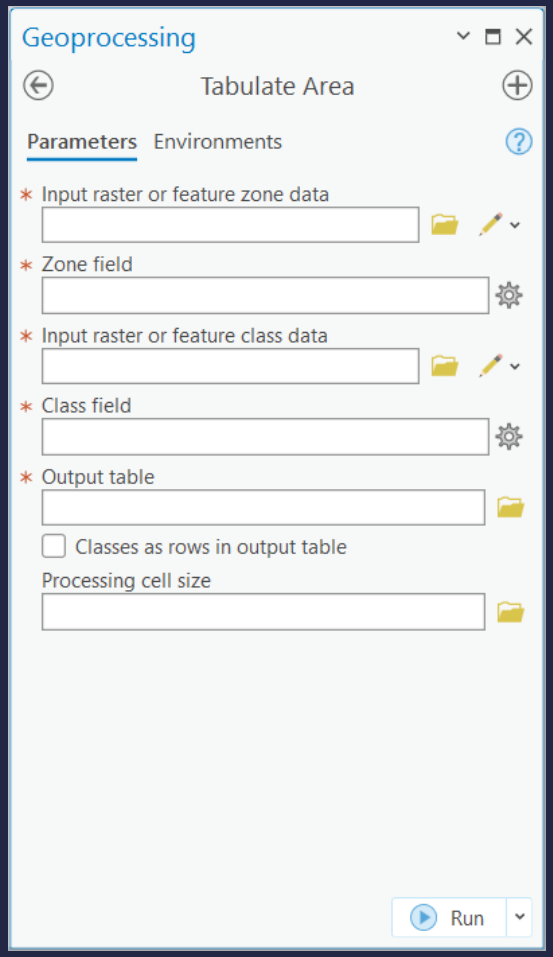




TABULATE AREA

Calculates cross-tabulated areas between two datasets and outputs a table





TABULATE AREA

ZoneRas

ClassRas

Value = NoData

Tabarea1.dbf

=

VALUE	VALUE_10	VALUE_11	VALUE_12	VALUE_13
0	3	1	1	0
1	2	2	0	1
2	0	1	2	0
4	0	0	0	1

TabulateArea(ZoneRas, "VALUE", ClassRas, "VALUE", Tabarea1.dbf, 1)