



**Workshop on :**  
**GIS&RS Application in Simulation of Hydrological Process**

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**Venue: Tehran, Iran**



**GIS&RS Application in Simulation of Hydrological Process**



**Query and Spatial Analysis**  
**Raster and Vector**



## Map Overlay

Union, Intersect, Identity, Erase, Symmetrical Difference, Extract  
Point in Polygon, Line in Polygon, Polygon on Polygon  
Clip, Select, Split, Table Select

## Proximity

Buffer, Multiple Ring Buffer, Near, Point Distance

## Statistics

Frequency, Summary Statistics



## Overlay tools

Intersect

Union

Identity

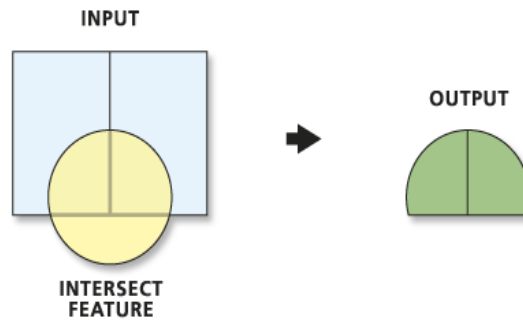
Erase

Symmetrical Difference

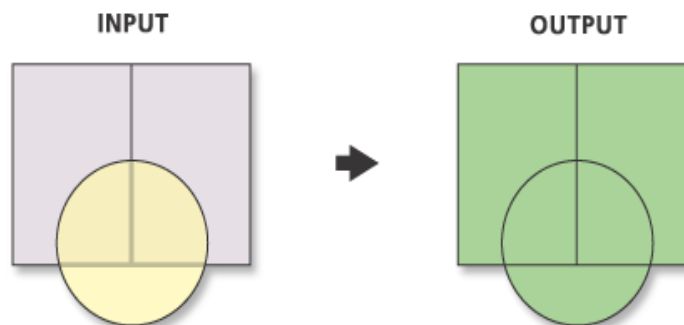
Update



## Intersect

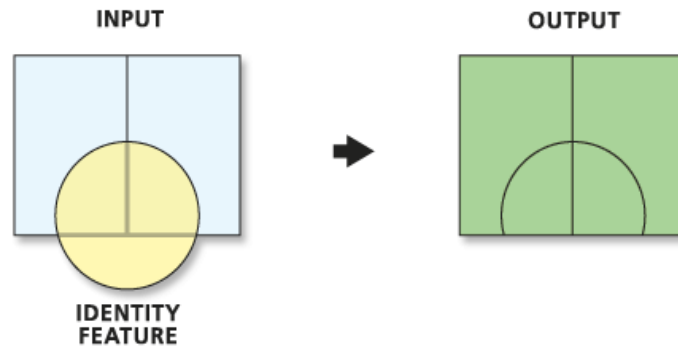


## Union

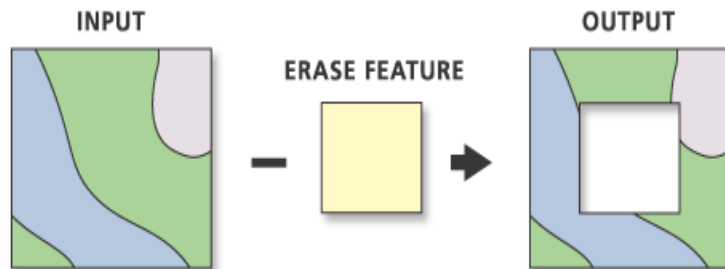




### Identity

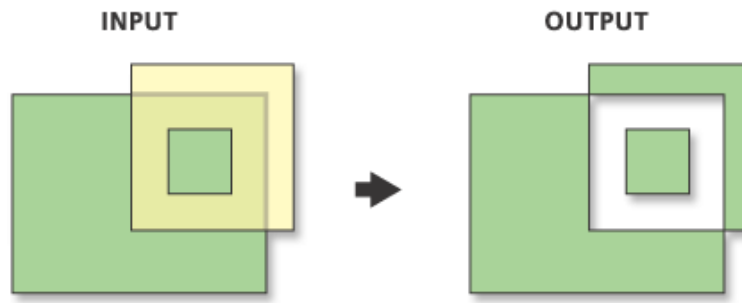


### Erase

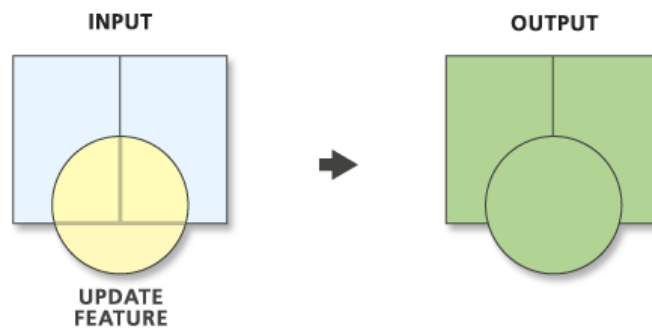




### Symmetrical Difference



### Update





## Extracting tools

Clip

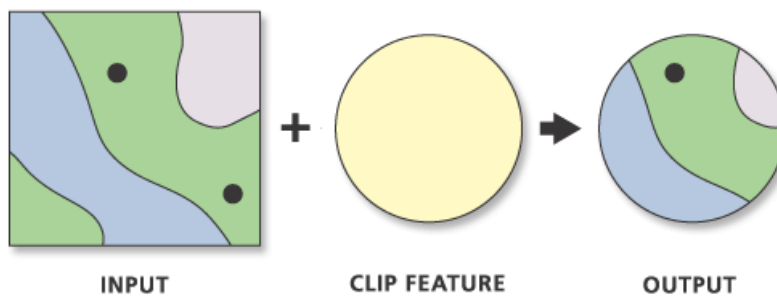
Select

Split

Table Select

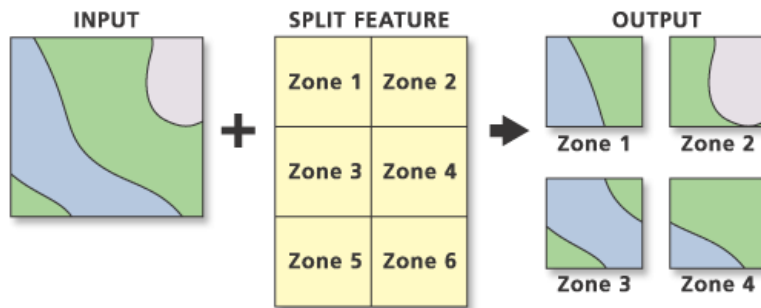


## Clip





## Split

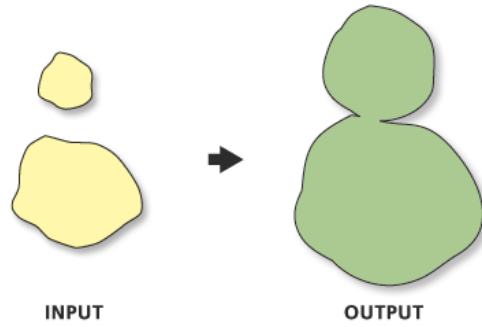


## Proximity tools

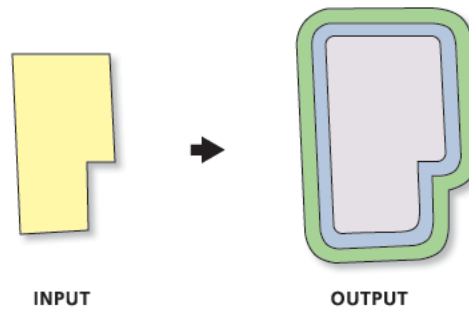
- Buffer
- Multiple Ring Buffer
- Near
- Point Distance



## Buffer



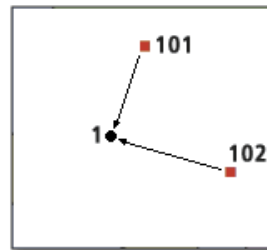
## Multiple Ring Buffer







## Point Distance



| Input_FID | Near_FID | Distance |
|-----------|----------|----------|
| 101       | 1        | 65       |
| 102       | 1        | 83       |

OUTPUT TABLE

- INPUT FEATURES
- NEAR FEATURES



## Statistical tools

Frequency  
Summary Statistics



# Raster Analysis

Local, Focal, Zonal, and Global Functions

Map Algebra

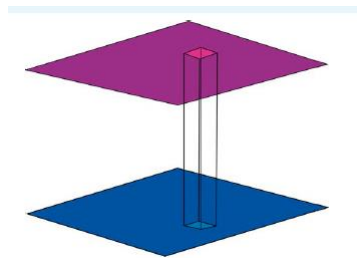
Terrain Analysis

Hydrologic Functions



## Local Functions

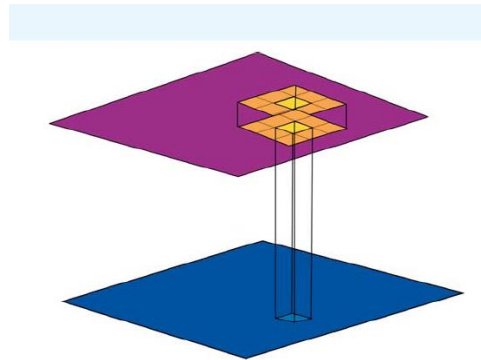
$$\text{Dem2} = \text{dem} * 2$$



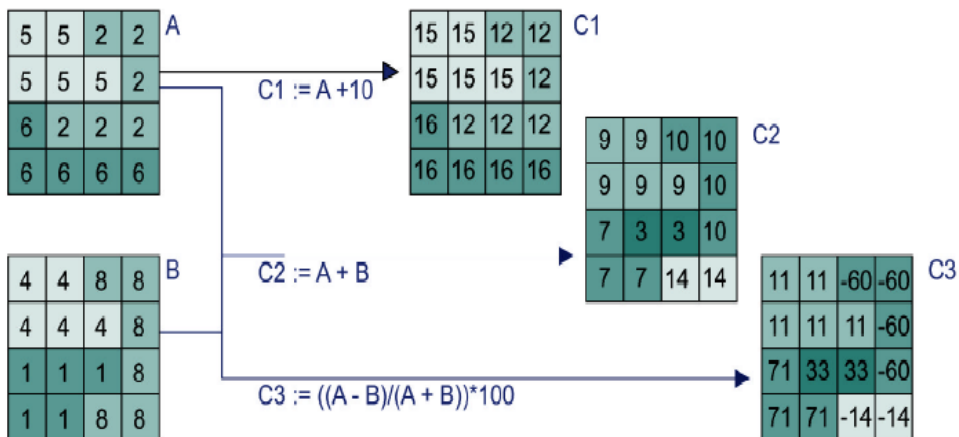


### Focal Functions

$$\text{Dem\_blur} = \text{focalmean}(\text{dem}, \text{circle}, 3)$$

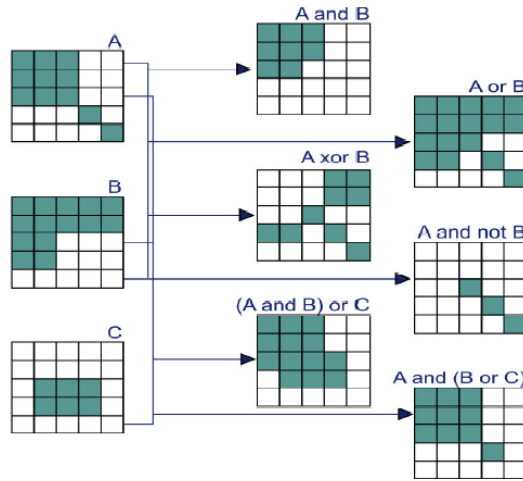


### Arithmetic Operators Example

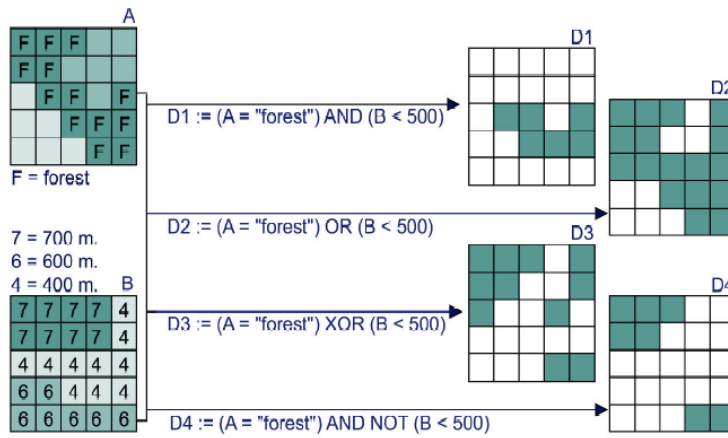




### Logical Operators Example



### Logical and Comparison Operators Combination





- Minimum** Lowest Value
- Maximum** Highest Value
- Range** Maximum – Minimum
- Sum** Total of all values
- Mean** Sum/N
- Sigma** Standard deviation
- Variety** Number of different values
- Majority** Value occurring most often
- Minority** Value occurring least often
- Median** Middle value in a range of ranked values



Examples of Statistical Operations

|   |   |   |
|---|---|---|
| 6 | 1 | 1 |
| 6 | 6 | 1 |
| 1 | 1 | 1 |

|   |   |   |
|---|---|---|
| 5 | 5 | 3 |
| 1 | 5 | 3 |
| 1 | 1 | 1 |

Range

|   |   |   |
|---|---|---|
| 1 | 4 | 2 |
| 5 | 1 | 2 |
| 0 | 0 | 0 |

|   |   |   |
|---|---|---|
| 6 | 1 | 1 |
| 6 | 6 | 1 |
| 1 | 1 | 1 |

|   |   |   |
|---|---|---|
| 5 | 5 | 3 |
| 1 | 5 | 3 |
| 1 | 1 | 1 |

Mean

|     |     |   |
|-----|-----|---|
| 5.5 | 3   | 2 |
| 3.5 | 5.5 | 2 |
| 1   | 1   | 1 |

|   |   |   |
|---|---|---|
| 6 | 1 | 1 |
| 6 | 6 | 1 |
| 1 | 1 | 1 |

|   |   |   |
|---|---|---|
| 5 | 5 | 3 |
| 1 | 5 | 3 |
| 1 | 1 | 1 |

Variety

|   |   |   |
|---|---|---|
| 2 | 2 | 2 |
| 2 | 2 | 2 |
| 1 | 1 | 1 |

|   |   |   |
|---|---|---|
| 6 | 1 | 1 |
| 6 | 6 | 1 |
| 1 | 1 | 1 |

|   |   |   |
|---|---|---|
| 5 | 5 | 3 |
| 1 | 5 | 3 |
| 1 | 1 | 1 |

Majority

|     |     |     |
|-----|-----|-----|
| -99 | -99 | -99 |
| -99 | -99 | -99 |
| 1   | 1   | 1   |



## Operations on Raster Data

Point (Local) operations

Neighbourhood (Focal) operations

Zonal Operations



## Local Operations

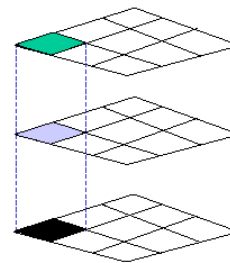
Operation cell by cell

One data layer

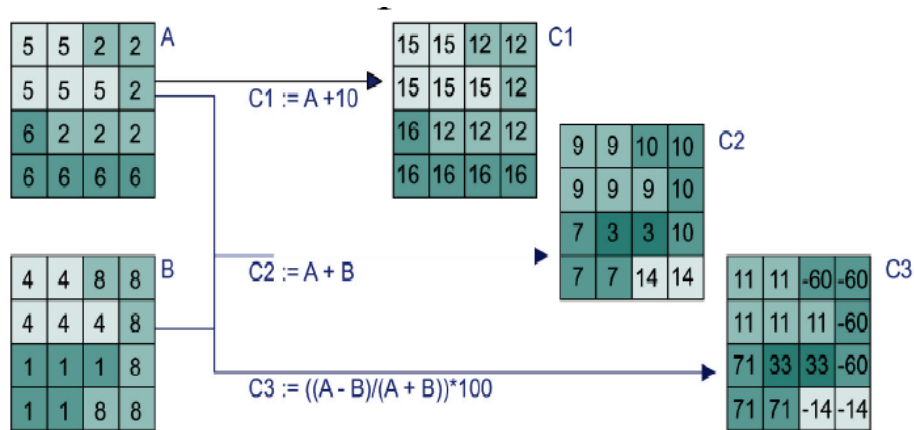
If  $I(i,j) > t$  then  $O(i,j) = A$

More layers (overlay operation)

$O(i,j) = I_1(i,j) - I_2(i,j)$



## Local Operations



## Neighbourhood Operations Spatial Filtering

### Linear Filters

Take a linear combination of values of a window (3x3, 5x5)

### Low Pass Filtering

Integration/Averaging  
Result: Smoothing  
noise reduction  
outlier detection

### Non Linear Filters

Take a non linear combination of values within a window

### High Pass Filtering

Differentiation  
Result:  
Edge enhancement  
(Making edges sharper)  
Edge detectors  
Identification of boundaries



## Smoothing

1/9

|   |   |   |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

Unweighted  
Averaging

1/16

|   |   |   |
|---|---|---|
| 1 | 2 | 1 |
| 2 | 4 | 2 |
| 1 | 2 | 1 |

Gaussian Weighted  
Averaging



## Zone:

Any two or more connected cells with the same value (e.g. covering the class urban area)

Neighbourhood is the zone to which the target cells belong

Usually, one layer defines the zones, another layers contains the values on which the operation is carried out





### Zonal Operations Example

Calculate for the zone  
with land use 6 the  
average height:  
 $O(i,j) = 17.4$

Land use map

|   |   |   |
|---|---|---|
| 6 | 5 | 5 |
| 5 | 6 | 4 |
| 6 | 6 | 5 |

Digital Elevation Model

|      |      |      |
|------|------|------|
| 17.2 | 16.5 | 16.3 |
| 17.5 | 17.1 | 16.8 |
| 17.7 | 17.6 | 17.4 |

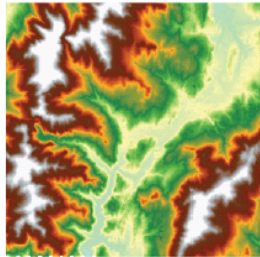


### Earth surface analysis tools

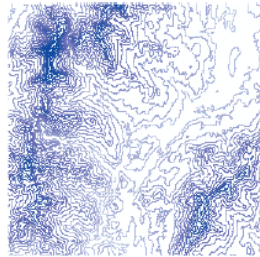
- Contour
- Slope
- Aspect
- Hillshade
- Viewshed
- Cut/fill



### Contours



Input elevation dataset



Output contour dataset

| FID | Shape    | ID | CONTOUR |
|-----|----------|----|---------|
| 0   | Polyline | 1  | 1800    |
| 1   | Polyline | 2  | 1200    |
| 2   | Polyline | 3  | 1000    |
| 3   | Polyline | 4  | 2400    |
| 4   | Polyline | 5  | 1200    |
| 5   | Polyline | 6  | 3600    |
| 6   | Polyline | 7  | 1200    |
| 7   | Polyline | 8  | 1200    |
| 8   | Polyline | 9  | 1600    |
| 9   | Polyline | 10 | 3200    |

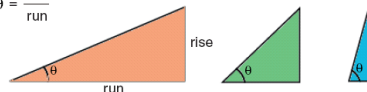


### Slope

Degree of slope =  $\theta$

Percent of slope =  $\frac{\text{rise}}{\text{run}} \cdot 100$

$$\tan \theta = \frac{\text{rise}}{\text{run}}$$



Degree of slope = 30

45

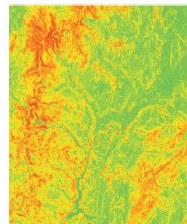
76

Percent of slope = 58

100

375

- 0-7
- 7-15
- 15-23
- 23-31
- 31-39
- 39-47
- 47-55
- 55-63
- 63-70
- 70-78

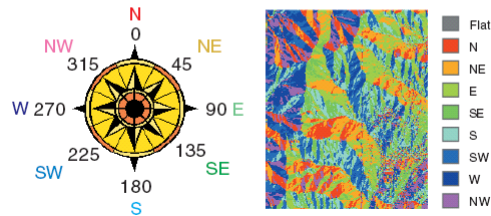


Output slope dataset

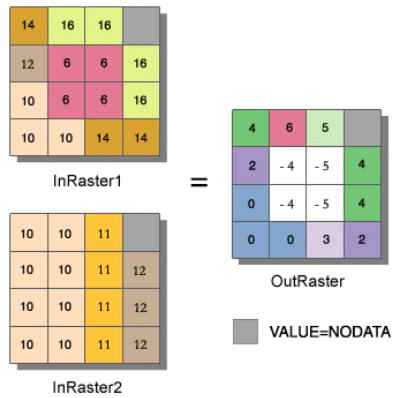


### Aspect

It is measured clockwise in degrees from 0—due north—to 360—again due north, coming full circle. The value of each cell in an aspect dataset indicates the direction the cell's slope faces. Flat slopes have no direction and are given a value of -1.



### Cut/Fill



**Geoprocessing Syntax:**  
CutFill (InRaster1, InRaster2, OutRaster)



**Thank you**  
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