

SPATIAL STATS & INTERPOLATION

GIS Analysis | Winter 2016

1st Law of Geography

Waldo Tober's 1st Law of Geography

"Everything is related to everything else, but near things are more related than distant things."

Spatial Autocorrelation

A measure of the degree to which a set of spatial features and their associated data values tend to be clustered together in space (positive spatial correlation) or dispersed (negative spatial autocorrelation)



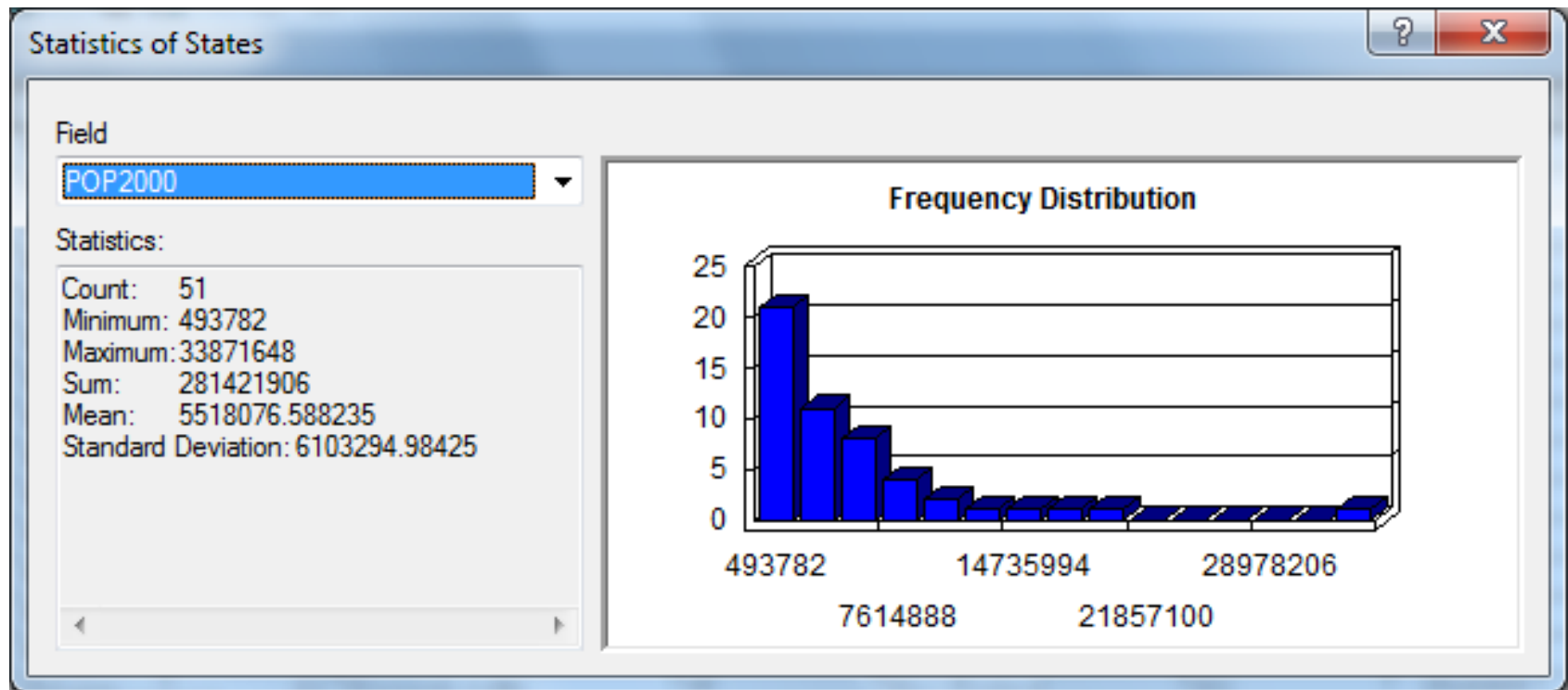
Spatial Descriptive Statistics

Spatial Descriptive Statistics

- *Spatial equivalent* of the descriptive statistics commonly used in statistical analysis, e.g. mean and standard deviation.

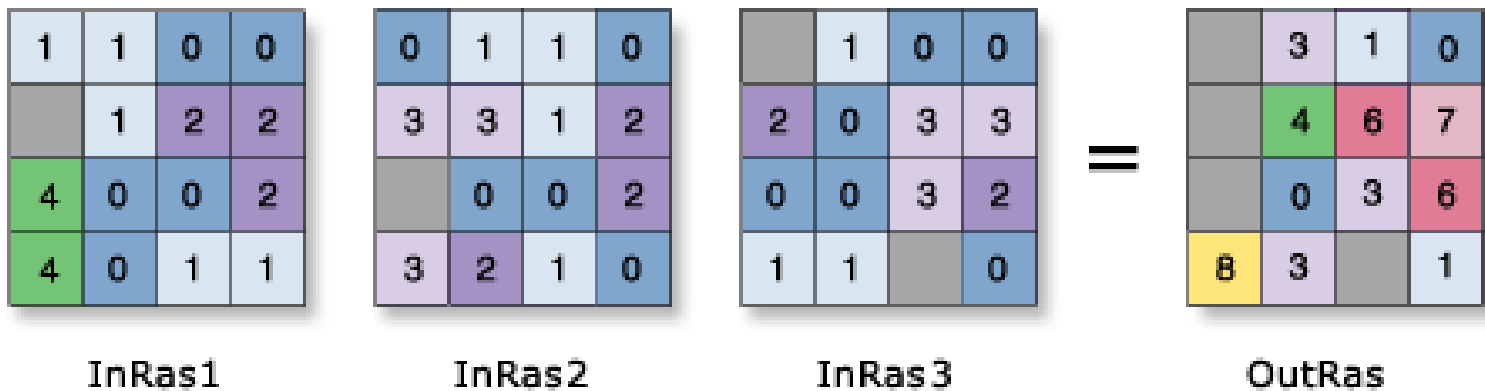
Non-Spatial Statistics

- Attribute Table “Statistics” tool



Non-Spatial Statistics

□ *Cell Statistics* tool



ArcToolbox > Spatial Analyst > Local > Cell Statistics

Common Spatial Descriptive Statistics

- Nearest Neighbor index
- Spatial Autocorrelation (Moran's I)
- Mean Center
- K-means algorithm
- Thiessen (Voronoi) polygons

Nearest Neighbor Index

How clustered or dispersed are features?

- Compares **observed average distance** from features to nearest neighboring features **vs. expected average distance** (if random dispersion). Looks for **spatial patterns in features**.



ArcToolbox > Spatial Statistics > Analyzing Patterns >
Average Nearest Neighbor

Nearest Neighbor Index

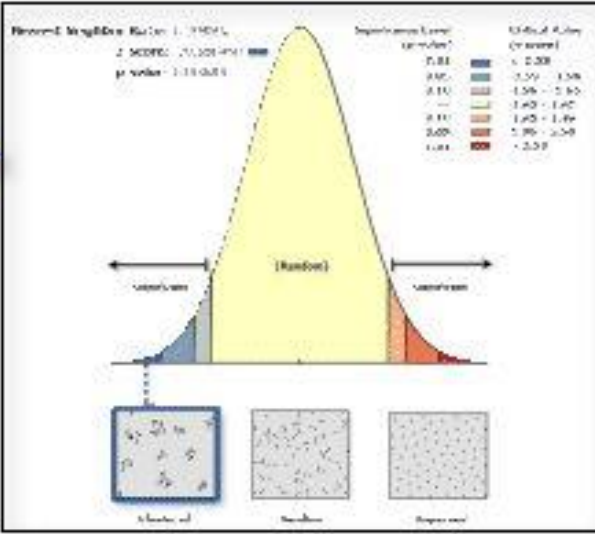
- Output of Nearest Neighbor Index is an *index value* and related statistics; can be viewed in the Geoprocessing “Results” window, or used in analysis models/scripts.

Nearest Neighbor Index

Results [Close]

- Current Session
 - Average Nearest Neighbor [160929_01112010]
 - NRatio: 0.399592
 - NNZScore: -29.68695
 - PValue: 0
 - NNEExpected: 522.234623
 - NNObserved: 208.680781
 - HTML Report File: NearestNeighbor_Result5.html
 - Inputs
 - Environments
 - Messages

Double Click →



Right Click →

Copy
View...

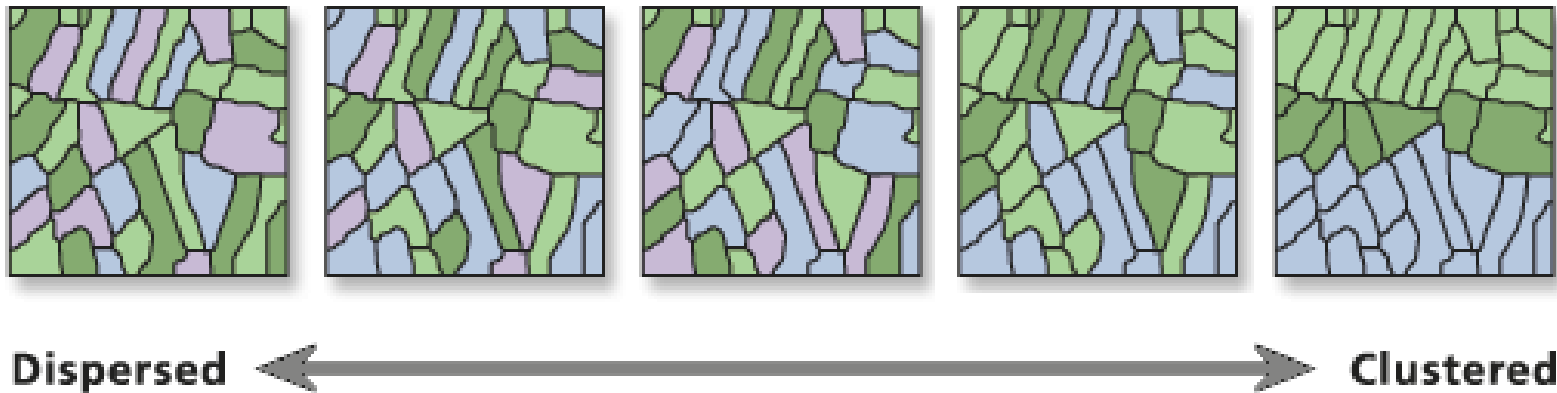
```
Messages
Executing: AverageNearestNeighbor C:\gppa\p\data\w\4\score
\global\shapefile\result5.shp "Euclidean Distance" test #
Running script AverageNearestNeighbor...

Average Nearest Neighbor Summary
Observed Mean Distance: 208.680781
Expected Mean Distance: 522.234623
Nearest Neighbor Ratio: 0.399592
Z Score: -29.68695
p-value: 0.000000

Writing HTML report...
C:\Documents and Settings\Laur357\My Documents\ArcGIS
\NearestNeighbor_Result5.html
Completed script AverageNearestNeighbor...
Succeeded at Fri Jan 08 15:24:45 2020 (Elapsed Time:
16.00 seconds)
```

Spatial Autocorrelation Index (Moran's I)

- Measures the **similarity** among feature **attributes** **relative to feature locations**. Looks for **spatial patterns in attributes**.



ArcToolbox > Spatial Statistics > Analyzing Patterns > Spatial Autocorrelation
(Morans I)

Spatial Autocorrelation Index (Moran's I)

- Output of Spatial Autocorrelation is also an ***index value*** and related statistics accessed via “Results” window.

Spatial Autocorrelation Index (Moran's I)

The screenshot displays the ArcGIS Results window for a Spatial Autocorrelation (Moran's I) analysis. The results are as follows:

- Index: 0.014749
- Z Score: 3.137097
- P Value: 0.001706
- HTML Report File: [MoransI_Result.html](#)

The [HTML Report File](#) is highlighted with a blue box, and a blue arrow labeled "Double Click" points from it to a normal distribution graph on the right. The graph shows a bell curve with a yellow shaded area under the curve. The Z Score is 3.137097, and the p-value is 0.001706. The graph also includes a legend for Significance Level (Z-score) and Critical Value (Z-score).

Significance Level (Z-score)	Critical Value (Z-score)
0.01	< -2.58
0.05	-2.58 - -1.96
0.10	-1.96 - -1.65
...	-1.65 - 1.65
0.10	1.65 - 1.96
0.05	1.96 - 2.58
0.01	> 2.58

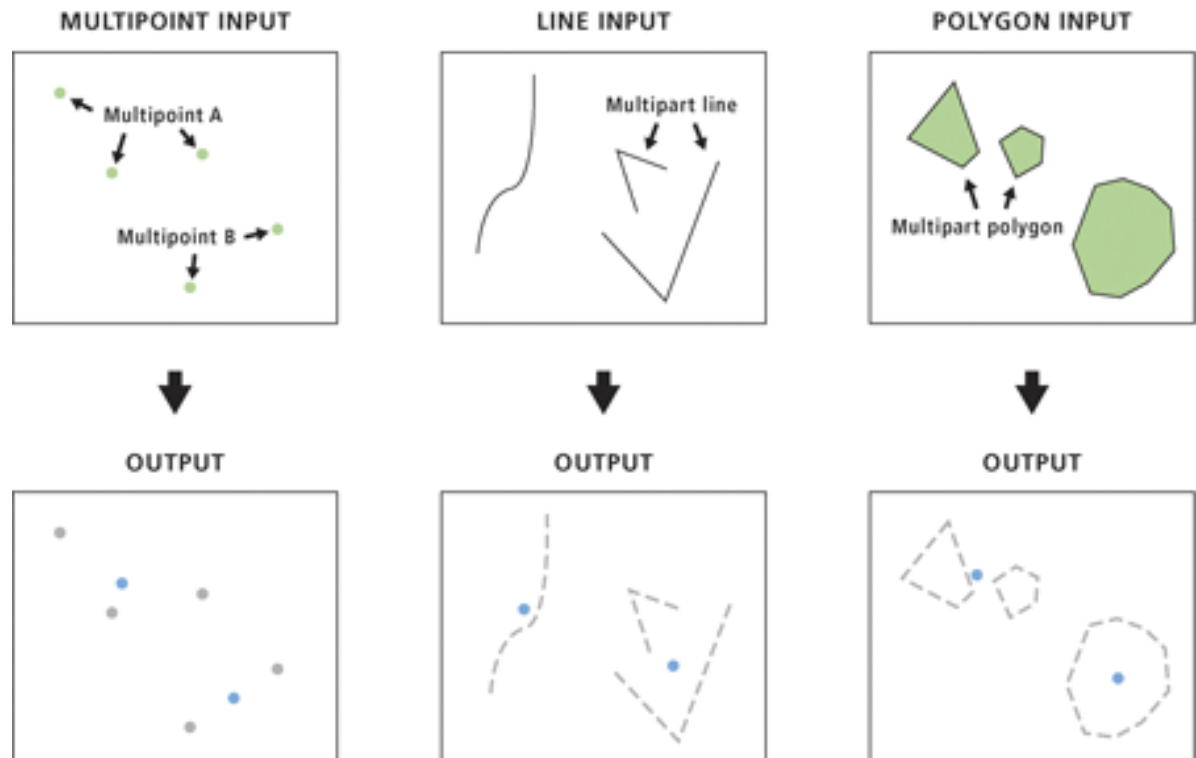
Below the graph are three small maps labeled "Dispersed", "Random", and "Clustered". The "Clustered" map is highlighted with a red box, and a blue arrow labeled "Right Click" points from the Messages window to it.

The Messages window shows the following output:

```
Executing: SpatialAutocorrelation burglaries COUNT true
"Fixed Distance Band" *Euclidean Distance* Nose 5000 #
Running script SpatialAutocorrelation...
Global Moran's I Summary
Moran's Index: 0.014749
Expected Index: -0.002451
Variance: 0.000030
Z Score: 3.137097
p-value: 0.001706
Writing html report...
C:\Documents and Settings\Laur357\My Documents\arcGIS
\MoransI_Result.html
Completed script SpatialAutocorrelation...
Succeeded at Tue Jan 12 15:56:29 2010 (Elapsed Time: 1.00
seconds)
```

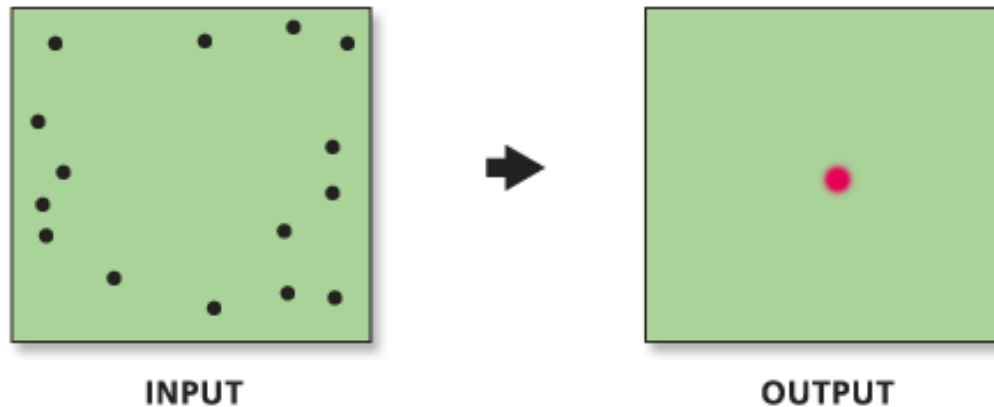
What is a “Centroid”?

- **Point** representing the *center of a feature, or of a group of features* (e.g. multipoints, lines, or polygons).



Mean Center

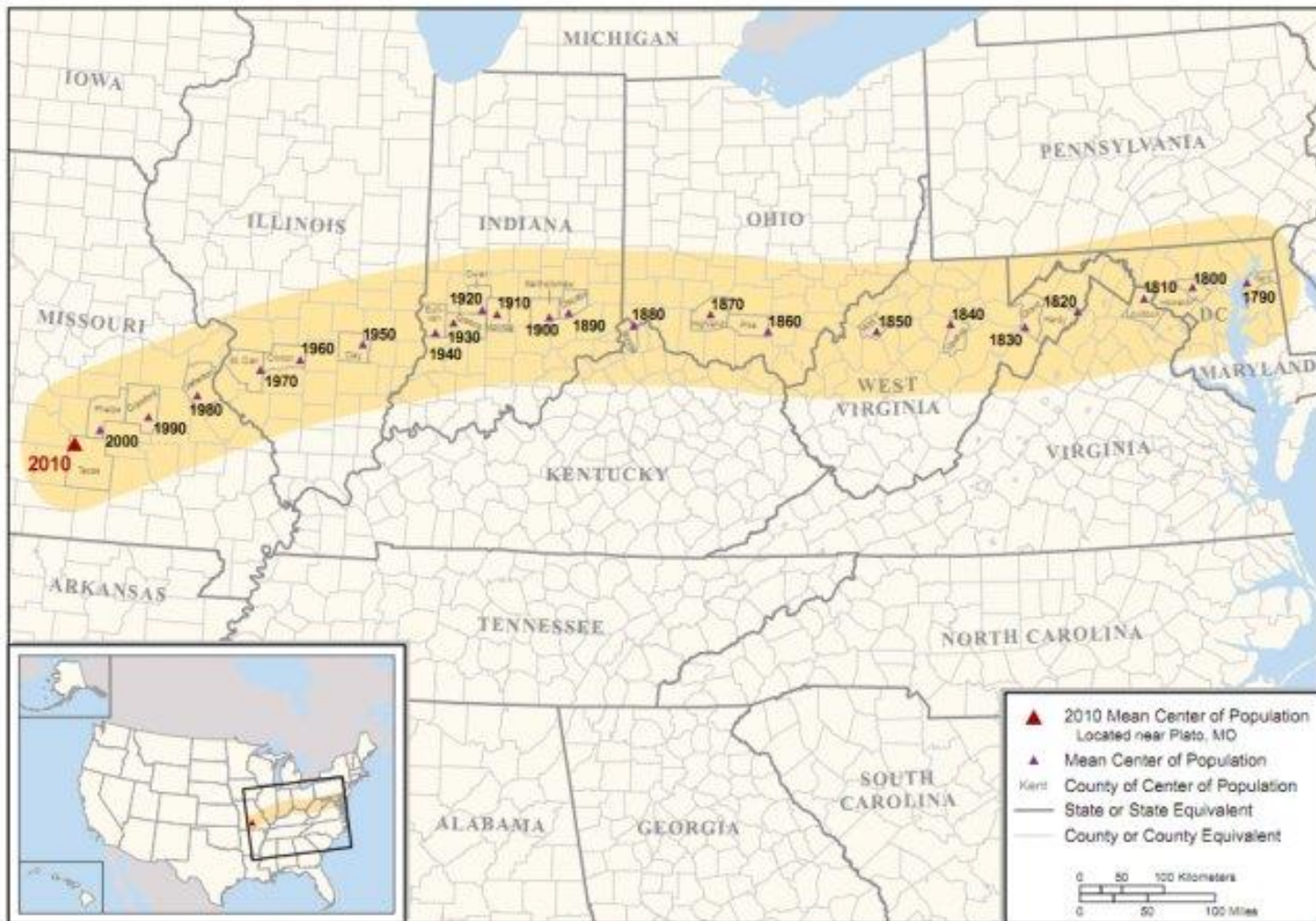
- **Average of all input points or centroids** (based on x/y values). Output is a **single point**.



*ArcToolbox > Spatial Statistics >
Measuring Geographic Distributions > Mean Center*

Mean Center

Mean Center of Population for the United States: 1790 to 2010



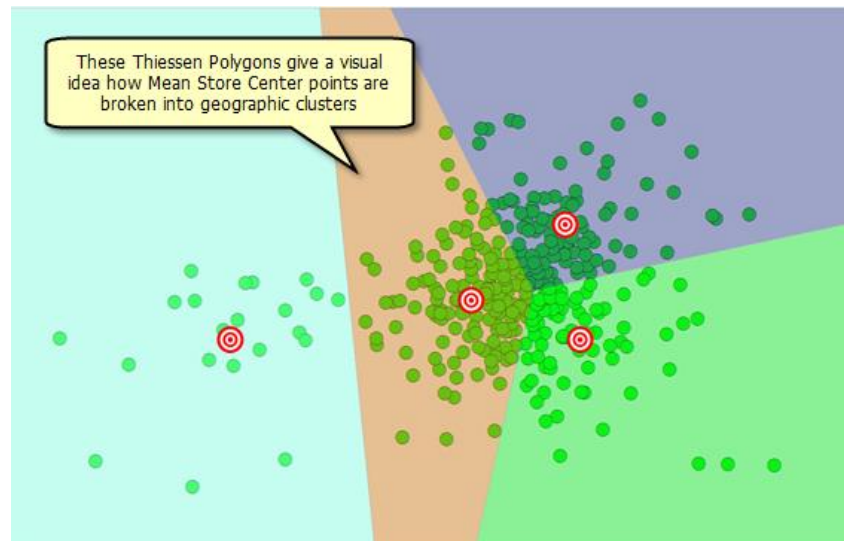
K-means

- An *iterative (repeating) algorithm* that finds **geographic groups of point features** and **determines their mean centers** (e.g. store locations). Output is a **set of points**.



Thiessen (Voronoi) Polygons

- Each thiessen polygon contains a **single point**. Any location within a polygon is closer to its associated point than any other point feature (e.g. store coverage areas). Output is a **set of polygons**.



ArcToolbox > Analysis > Proximity > Create Thiessen Polygons



Spatial Interpolation

Spatial Interpolation

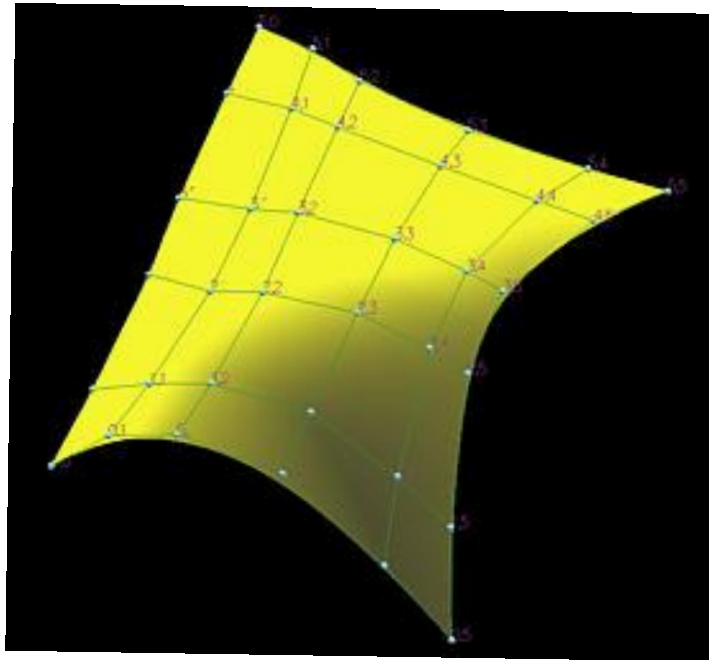
- Estimating values of a continuous representation in places where the values have not been measured
- In ArcGIS, spatial interpolation tools generate a new raster dataset

Spatial Interpolation Methods

- Spline
- Inverse-distance weighting (IDW)
- Kriging

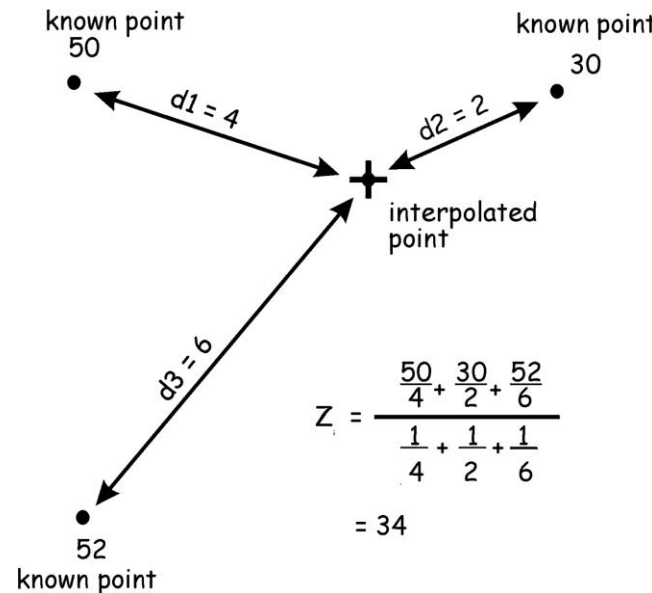
Interpolation | Spline

- Interpolates a surface from a set of points using a “*minimum curvature spline*” technique; conceptually like bending a sheet of rubber to pass through the points.



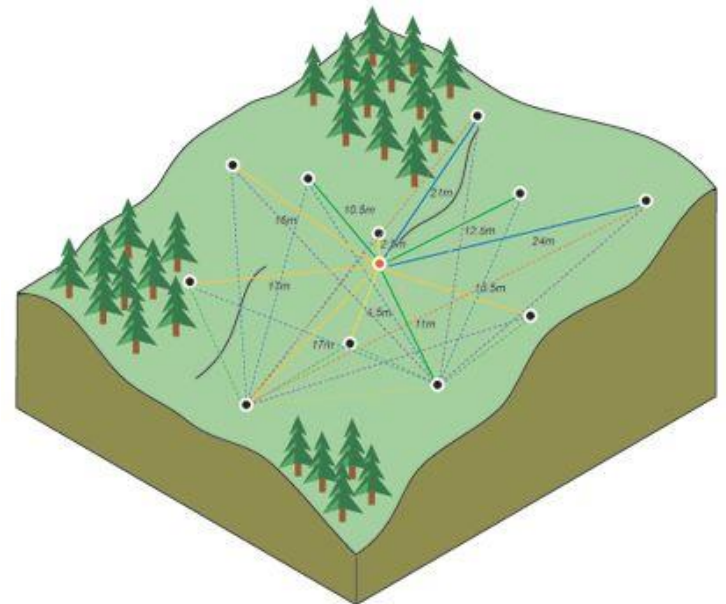
Interpolation | Inverse-distance weighting (IDW)

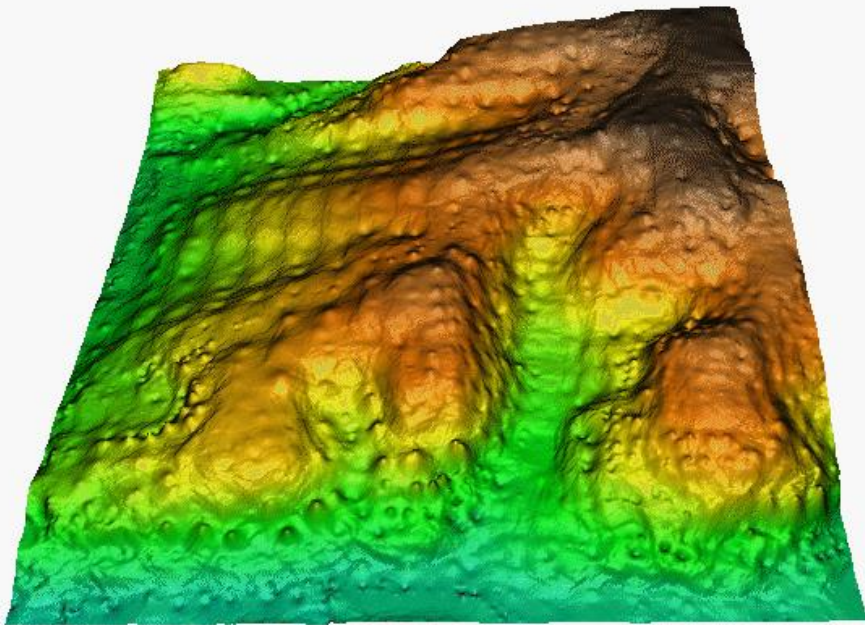
- Estimates unknown values as weighted averages of the known measurements at nearby points, giving the ***greatest weight to the nearest points*** (using Tobler's Law).



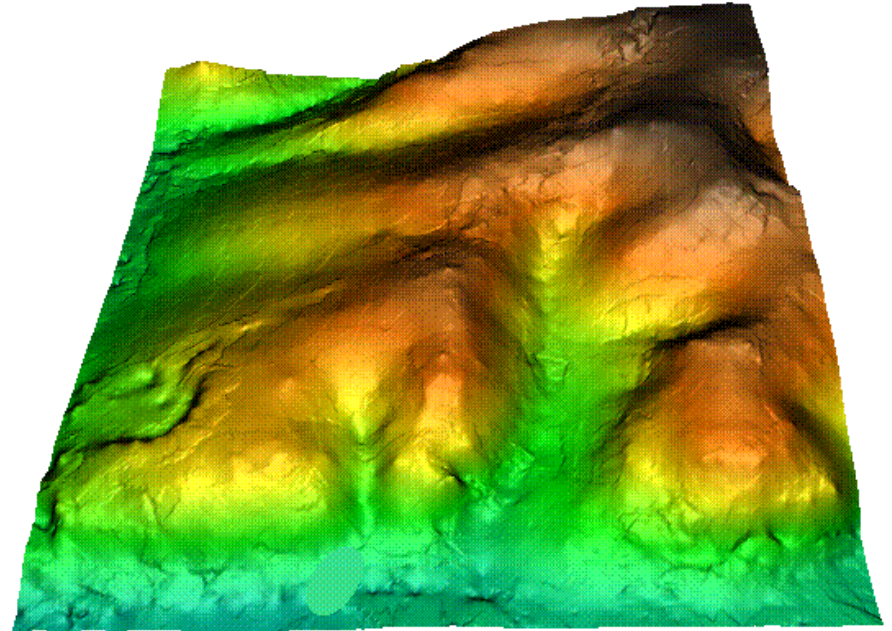
Interpolation | Kriging

- Similar to the IDW method in that it ***applies weights to the data based on distance***;
- Differs from IDW in that it also takes into account the ***form and spatial structure of all the data***.
- Provides a measure of the certainty or accuracy of the prediction.
- Best used when data is known to have spatial autocorrelation





Inverse Distance Weighting (IDW)



Kriging