

Esri Ocean GIS Forum

Nov 1, 2016 | Redlands, CA



Scientific Tools for Marine and MetOcean Analysis

Spatial Statistics Tools

In ArcGIS

Geostatistical Analyst

- interactive ESDA
- interactive modeling including variography
- many Kriging models (6 + cokriging)
- pre-processing of data - Decluster, detrend, transformation
- model diagnostics and comparison

Spatial Analyst

- rich set of tools to perform cell-based (raster) analysis
- kriging (2 models), IDW, nearest neighbor ...

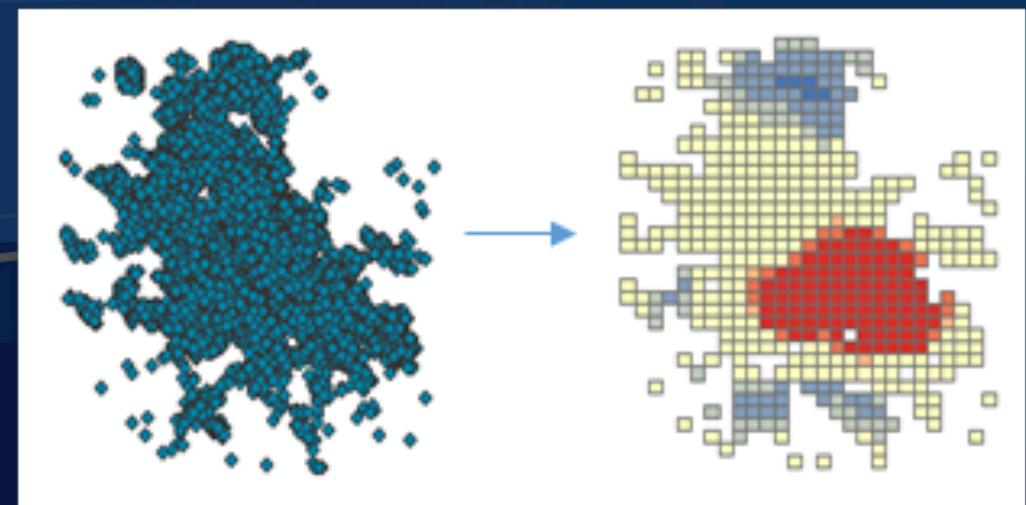
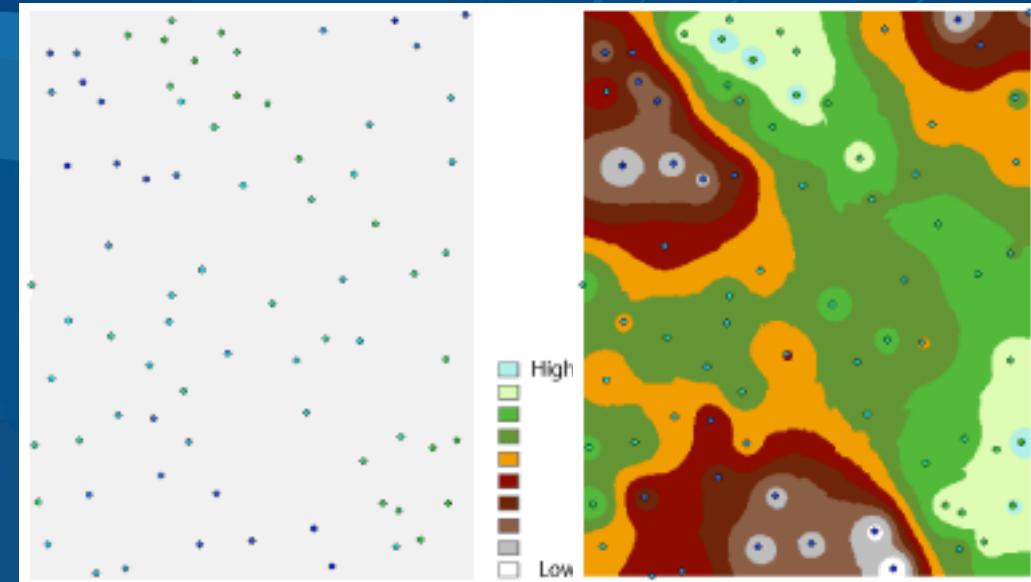
Spatial Statistics

- ESDA GP tools
- analyzing the distribution of geographic features
- identifying spatial patterns and relationships

Geostatistics

and

Spatial Statistics

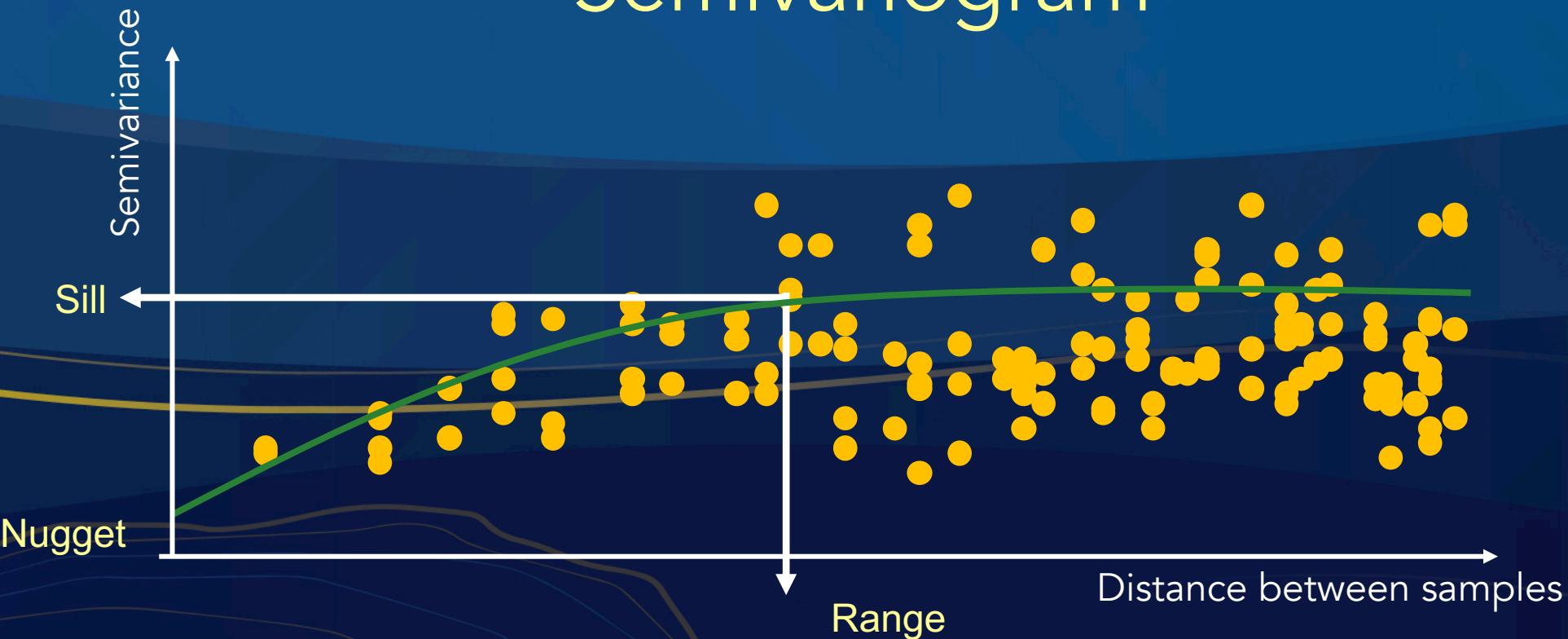


What are GeoStatistics?

Geostatistics

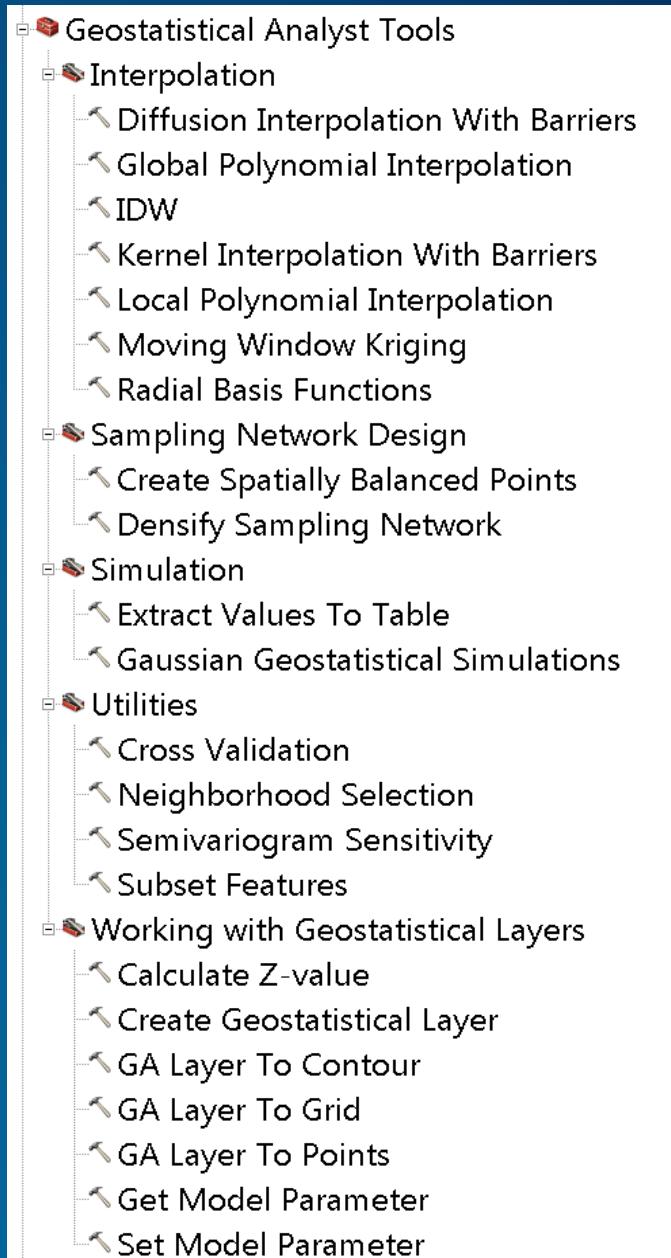
The statistics of spatially correlated data

Semivariogram



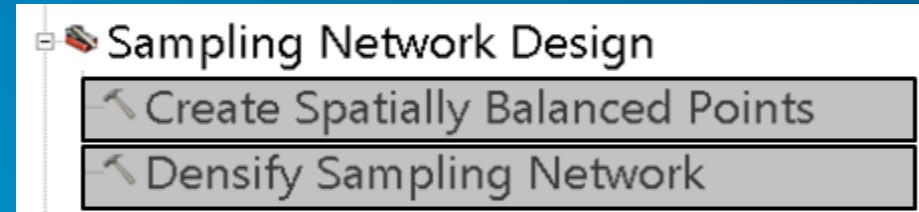
Geostatistical Analysis ...

- Exploratory Spatial Data Analysis
 - Histogram, QQplot, Trend Analysis, ...
- Deterministic interpolation
 - IDW, GPI, RBF, LPI
- Geostatistical Interpolation
 - Kriging / CoKriging
 - Ordinary, Simple, Universal, Indicator, Probability, Disjunctive
- Interpolation in the presence of barriers
 - Kernel Smoothing, Diffusion Kernel
- Sampling Network Design
- Geostatistical Simulation
- ...



• Create Spatially Balanced Points

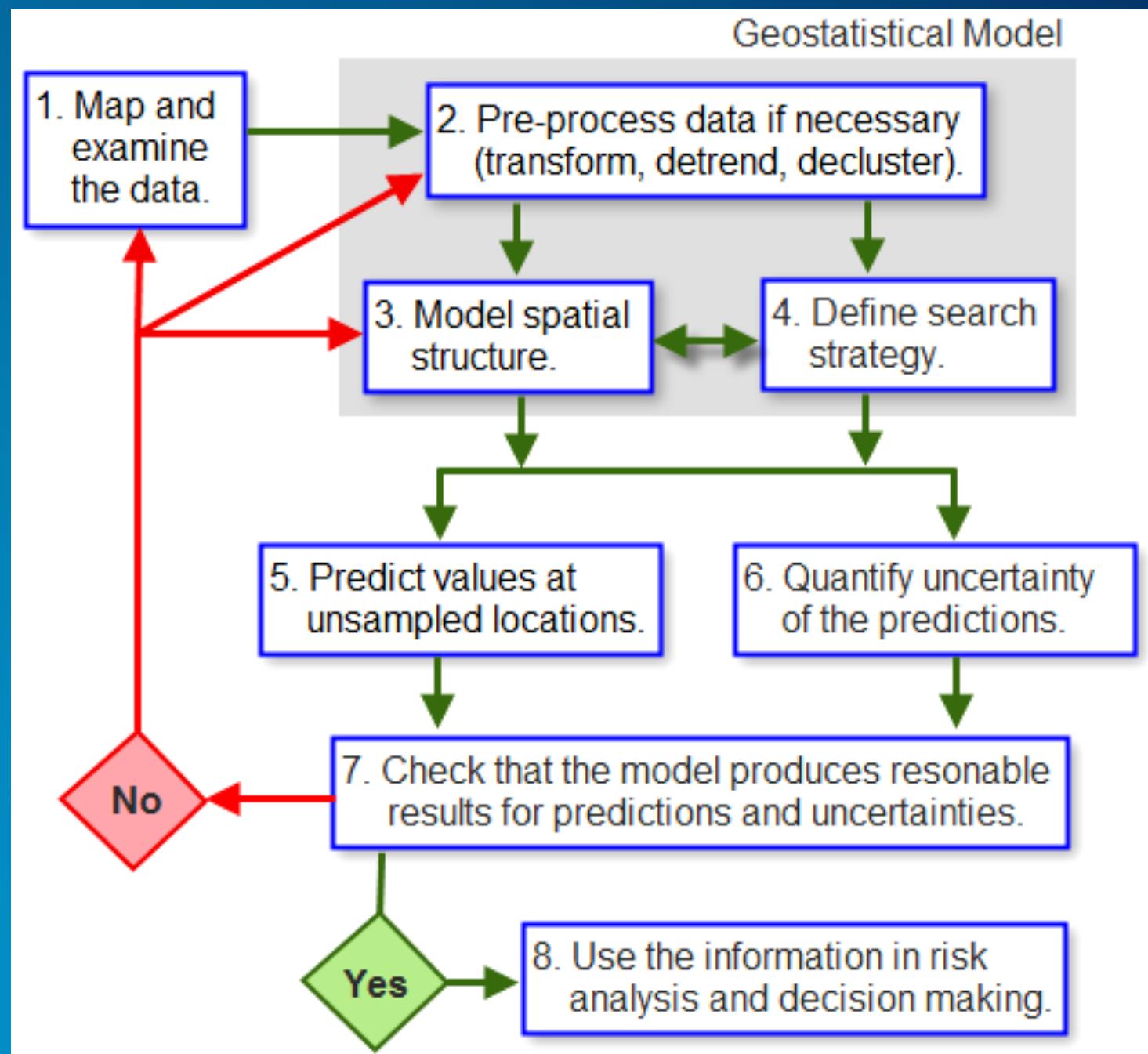
- based on *a priori* inclusion probabilities
- output is spatially balanced
 - the spatial dependence between samples is minimized.



• Densify Sampling Network

- based on a predefined geostatistical kriging layer
- uses, *inter alia*, the Std Error of Prediction surface to determine where new locations are required or which can be removed.

Geostatistical Workflow



What are Spatial Statistics?

Spatial Statistics are a set of exploratory techniques for describing and modeling spatial distributions, patterns, processes, and relationships.

spatial statistics

- Software-based tools, methods, and techniques developed specifically for use with geographic data.
- Spatial statistics:
 - Describe and spatial distributions, spatial patterns, spatial processes model, and spatial relationships.
 - Incorporate space (area, length, proximity, orientation, and/or spatial relationships) directly into their mathematics.

Toolsets and tools for Spatial Statistics

- Core functionality with ArcGIS 10
- Most tools delivered with their source code.
- Most tools available at all license levels.

Focus on 4 toolsets:

1. Analyzing Patterns
2. Mapping Clusters
3. Measuring Geographic Distributions
4. Modeling Spatial Relationships

 Spatial Statistics Tools.tbx	
 Analyzing Patterns	
 Average Nearest Neighbor	
 High/Low Clustering (Getis-Ord General G)	
 Incremental Spatial Autocorrelation	
 Multi-Distance Spatial Cluster Analysis (Ripleys K Function)	
 Spatial Autocorrelation (Morans I)	
 Mapping Clusters	
 Cluster and Outlier Analysis (Anselin Local Morans I)	
 Grouping Analysis	
 Hot Spot Analysis (Getis-Ord Gi*)	
 Optimized Hot Spot Analysis	
 Similarity Search	
 Measuring Geographic Distributions	
 Central Feature	
 Directional Distribution (Standard Deviational Ellipse)	
 Linear Directional Mean	
 Mean Center	
 Median Center	
 Standard Distance	
 Modeling Spatial Relationships	
 Exploratory Regression	
 Generate Network Spatial Weights	
 Generate Spatial Weights Matrix	
 Geographically Weighted Regression	
 Ordinary Least Squares	



-  Spatial Statistics Tools

-  Analyzing Patterns

- ⌚ Average Nearest Neighbor
 - ⌚ High/Low Clustering (Getis-Ord General G)
 - ⌚ Incremental Spatial Autocorrelation
 - ⌚ Multi-Distance Spatial Cluster Analysis (Ripleys K Function)
 - ⌚ Spatial Autocorrelation (Morans I)

-  Mapping Clusters

- ⌚ Cluster and Outlier Analysis (Anselin Local Morans I)
 - ⌚ Grouping Analysis
 - ⌚ Hot Spot Analysis (Getis-Ord Gi*)
 - ⌚ Optimized Hot Spot Analysis
 - ⌚ Similarity Search

-  Measuring Geographic Distributions

- ⌚ Central Feature
 - ⌚ Directional Distribution (Standard Deviational Ellipse)
 - ⌚ Linear Directional Mean
 - ⌚ Mean Center
 - ⌚ Median Center
 - ⌚ Standard Distance

-  Modeling Spatial Relationships

- ⌚ Exploratory Regression
 - ⌚ Generate Network Spatial Weights
 - ⌚ Generate Spatial Weights Matrix
 - ✎ Geographically Weighted Regression
 - ⌚ Ordinary Least Squares

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**python
script!**



OptimizedHotSpotAnalysis - Notepad

File Edit Format View Help

```
#### Remove Locations Outside Boundary FC ####
featureLayer = "ClippedPointFC"
DM.MakeFeatureLayer(tempFC, featureLayer)
if self.boundaryFC:
    msg = ARCPY.GetIDMessage(84454)
    ARCPY.SetProgressor("default", msg)
    DM.SelectLayerByLocation(featureLayer, "INTERSECT",
                             self.boundaryFC, "#",
                             "NEW_SELECTION")
    DM.SelectLayerByLocation(featureLayer, "INTERSECT",
                             "#", "#", "SWITCH_SELECTION")
    DM.DeleteFeatures(featureLayer)
else:
    if additionalZeroDistScale == "ALL":
        msg = ARCPY.GetIDMessage(84455)
        ARCPY.SetProgressor("default", msg)
        DM.SelectLayerByAttribute(featureLayer, "NEW_SELECTION",
                                  "'Join_Count' = 0'")
        DM.DeleteFeatures(featureLayer)

    else:
        distance = additionalZeroDistScale * fish.quadLength
        distanceStr = self.ssdo.distanceInfo.linearUnitString(distance,
                                                               convert = True)
        nativeStr = self.ssdo.distanceInfo.printDistance(distance)
        msg = "Removing cells further than %s from input pointsd...."
        ARCPY.AddMessage(msg % nativeStr)
        DM.SelectLayerByLocation(featureLayer, "INTERSECT",
                             self.ssdo.inputFC, distanceStr,
                             "NEW_SELECTION")
        DM.SelectLayerByLocation(featureLayer, "INTERSECT",
                             "#", "#", "SWITCH_SELECTION")
        DM.DeleteFeatures(featureLayer)

    DM.Delete(featureLayer)
del collSSDO

ARCPY.env.extent = oldExtent
```



Let's describe our data first

Descriptive Stats

- Mean (average)
- Mode
- Median
- Standard deviation
- Weighted average

Spatial Descriptive Stats

- Mean center
- Central feature
- Median center
- Directional distribution
- Mean center with attribute weight

These are in the **Measuring Geographic Distributions** toolset

In describing patterns, we can

Which site is most accessible?

Is there a directional trend or bias in sales ratios?

What is the primary direction of urban growth?

Where is the population center?

Which gang has the broadest territory?

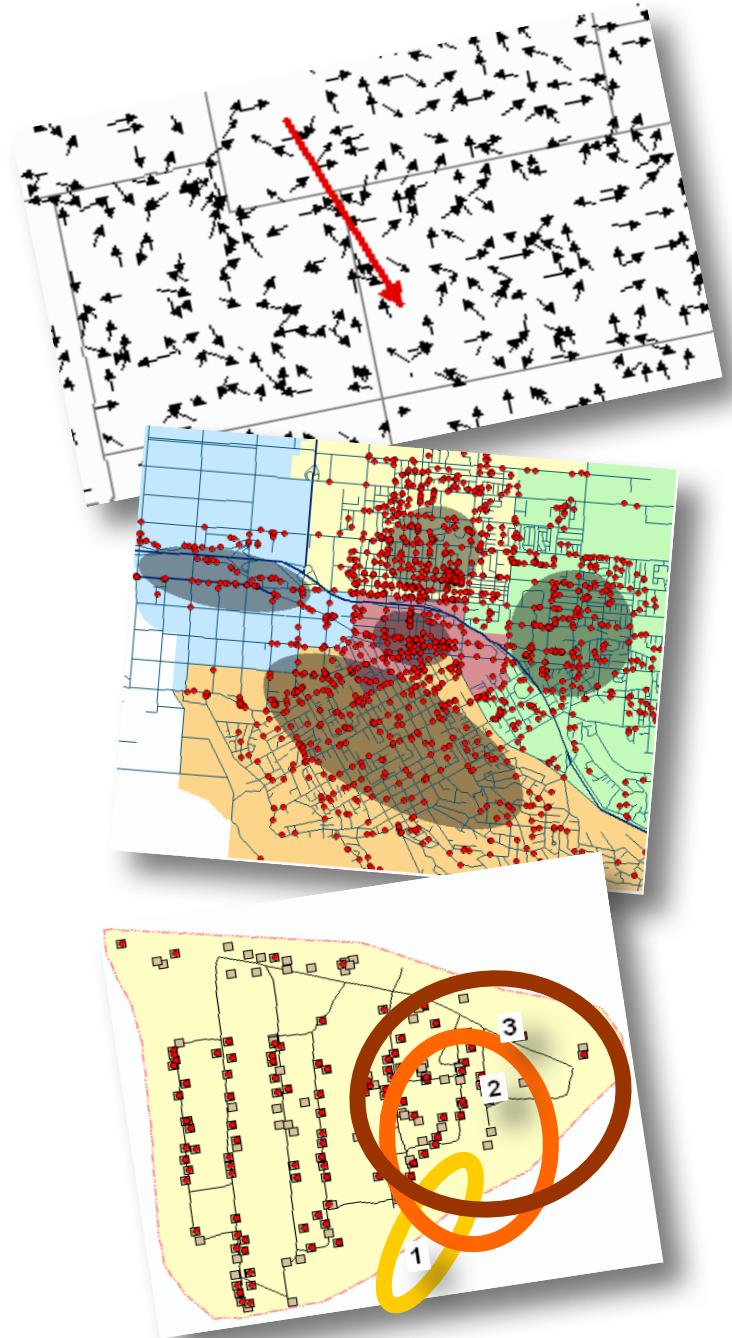
We need some tools



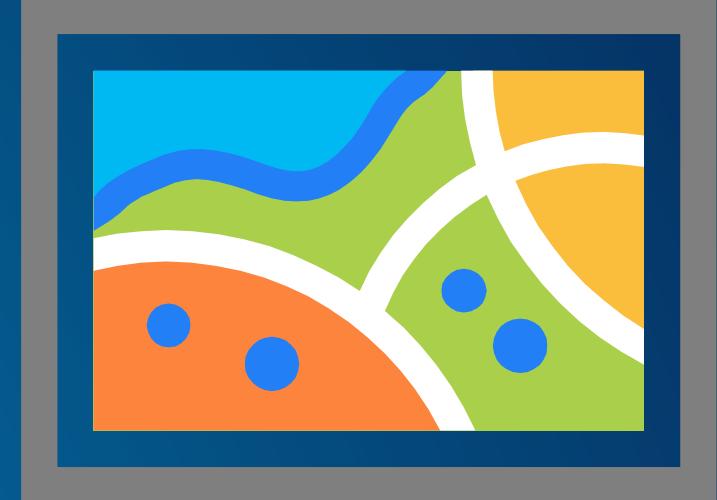
- Measuring Geographic Distribution
- Analyzing Patterns
- Mapping Clusters



Spatial Statistics Toolbox



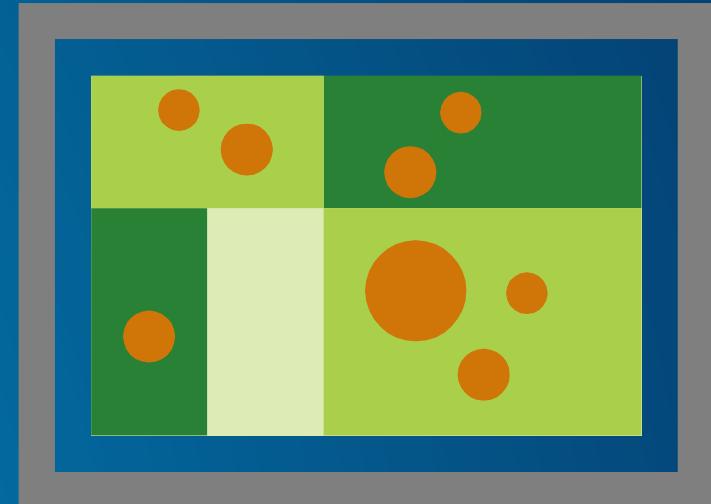
Measuring Geographic Distributions



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These tools address questions such as Where's the center? What's the shape and orientation? How dispersed are the features?

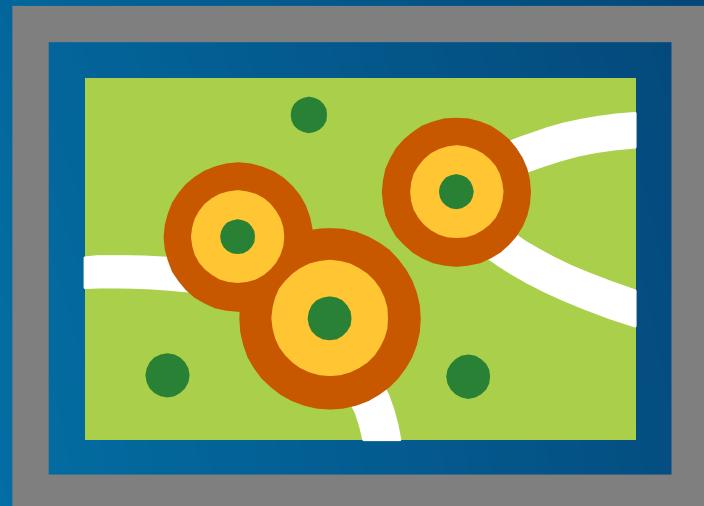
Analyzing Patterns



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Identifying geographic patterns is important for understanding how geographic phenomena behave

Mapping Clusters



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These tools address questions such as Where's hot spot? Where are biological diversity and habitat quality highest? Where are anomalies and outliers?

Resources:

- Spatial Statistics Blog: esriurl.com/spatialstat
- Desktop Analytics Case Studies:
<http://desktop.arcgis.com/en/analytics/casestudies/>
- [Overview of the Spatial Statistics Toolbox](#)
- [Overview of Space Time Pattern Mining](#)



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