An Overview of Solving Spatial Problems using ArcGIS

- **Joseph B Bowles**
- **esri**

Objectives

What can you do with spatial analysis?

How to apply analysis to solve spatial problems?

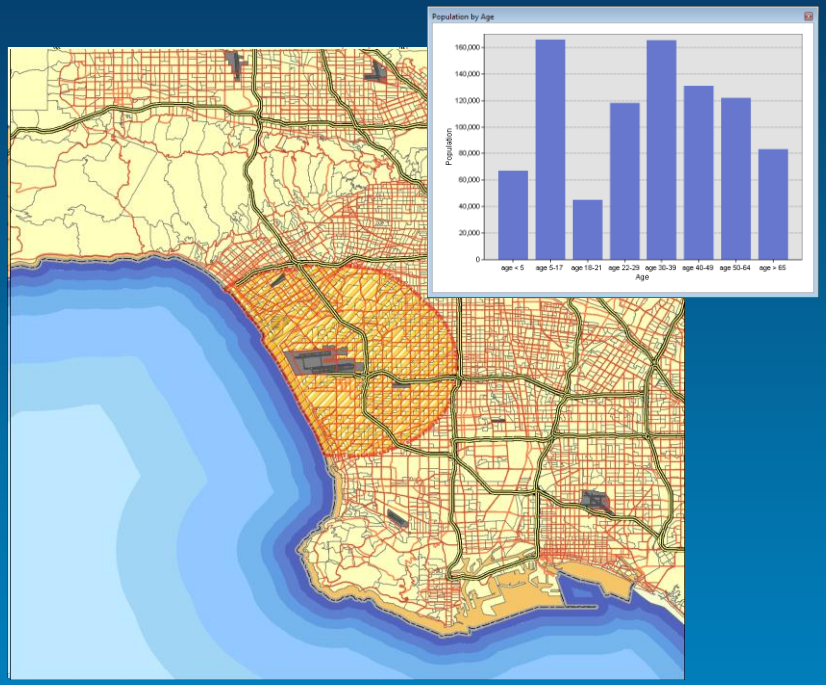
Where can you go next to learn more?

Topics Covered

- Introduction to Spatial Analysis
- Vector Data Analysis and Statistical Modeling
- Raster Data Analysis and Interpolation
- Automating Analysis Workflow
- Take away points

The Basis of Spatial Analysis

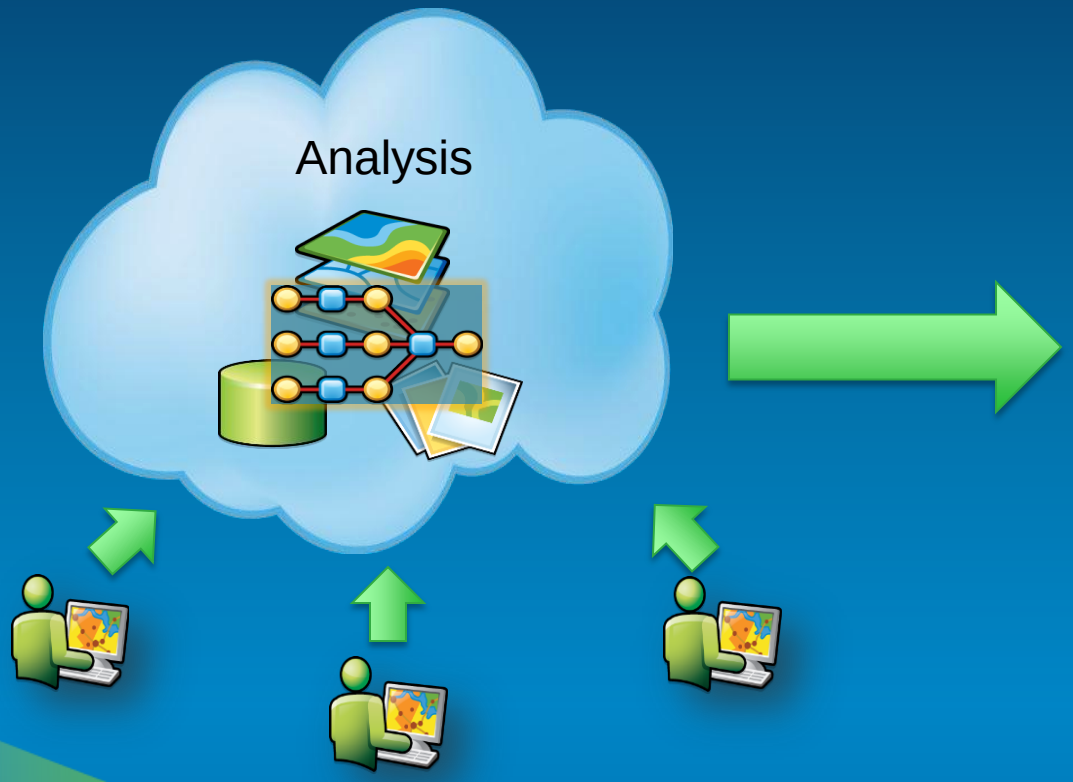
- **Spatial relationships**
  - **Containment**
  - **Adjacency**
  - **Distance**
  - **Selection and Statistics**



The Spatial Analysis Workflow

Frame question	Explore Data	Choose method	Perform analysis	Examine results	Share analysis
Break it down	Projection	Identify tools	Automation:	Visually but …	Present the results
Audience?	Accuracy	Review question	Use models, code	importantly,	Share with other
Identify requirements	Scale	Common approaches		statistically	GIS Professionals?
	Format	Data suitable?			On the web?

The Collaborative Workflow



To help solve real problems by real people

GIS Professionals

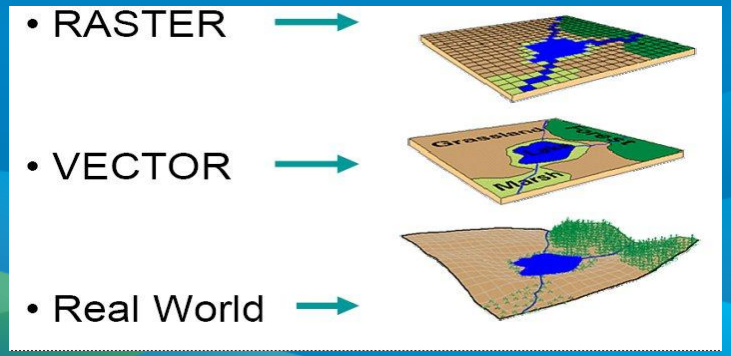
Tobler's first law of geography

Everything is related to everything else,

but near things are more related than distant things

Vector vs. Raster

- The two basic data structures for storing and manipulating GIS data
- Vector
  - A coordinate-based (points, lines, and polygons)
  - Attributes are associated with each vector feature
  - Good for representing clearly defined objects
- Raster
  - A cell-based data model
  - Each cell contains an attribute value
  - Especially suited for continuous data such as elevation, air pollution, and precipitation.



Vector Data Analysis and Statistical Modeling

Solving problems:

- What is inside an idea?
- What is nearby?
- What is the spatial pattern?
- Where are clusters of high and low values?
- How do things move over time?
- Why things occur where they do?

What is inside an area?

- **Step 1: Frame the question:**
  - **How do gas prices differ in different counties in Southern California?**

What is nearby?

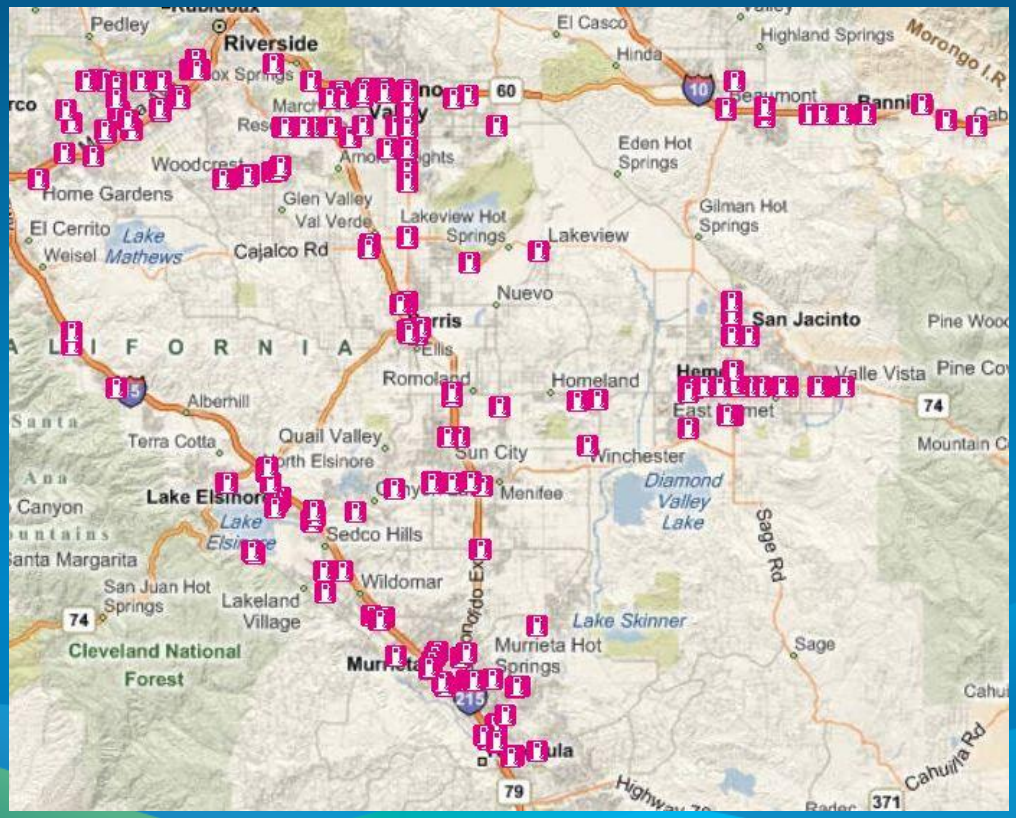
Step 1: Frame the question

- Where is the closest gas stations from each freeway exit?

What is nearby?

Step 2: Explore the data

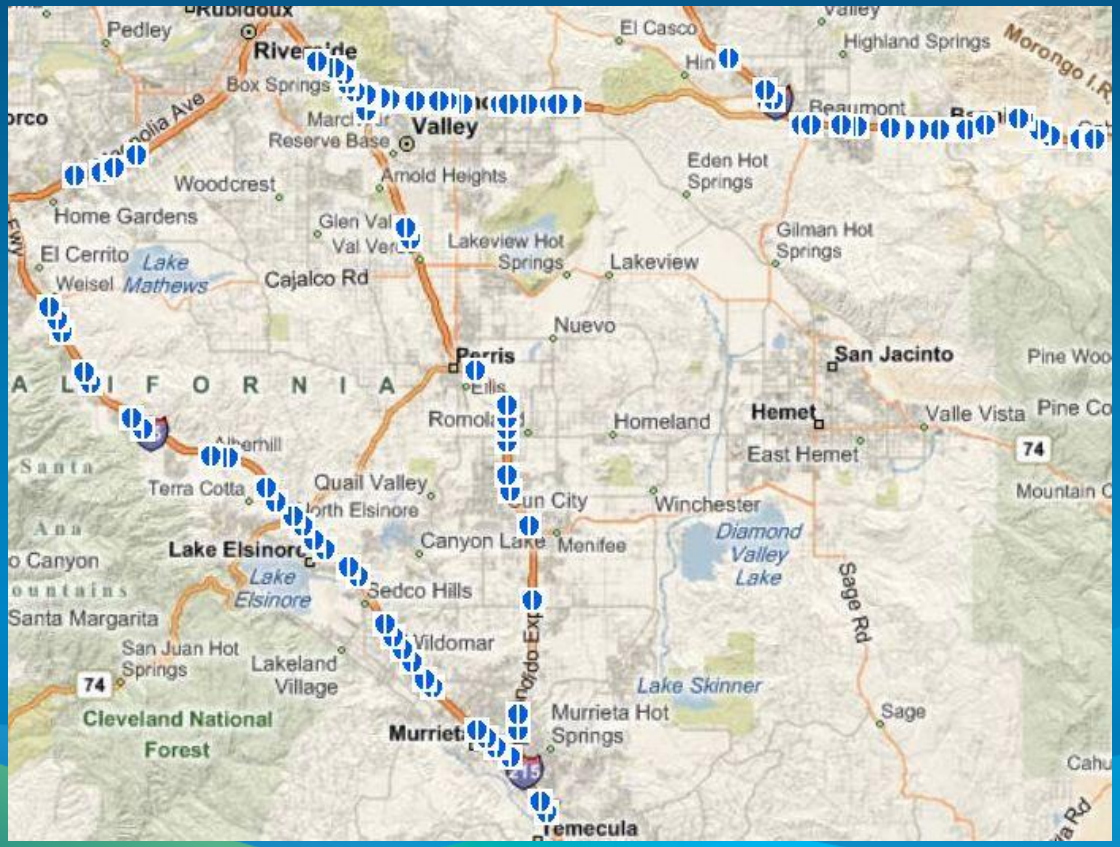
- Gas station locations



What is nearby?

Step 2: Explore the data

- Freeway exits



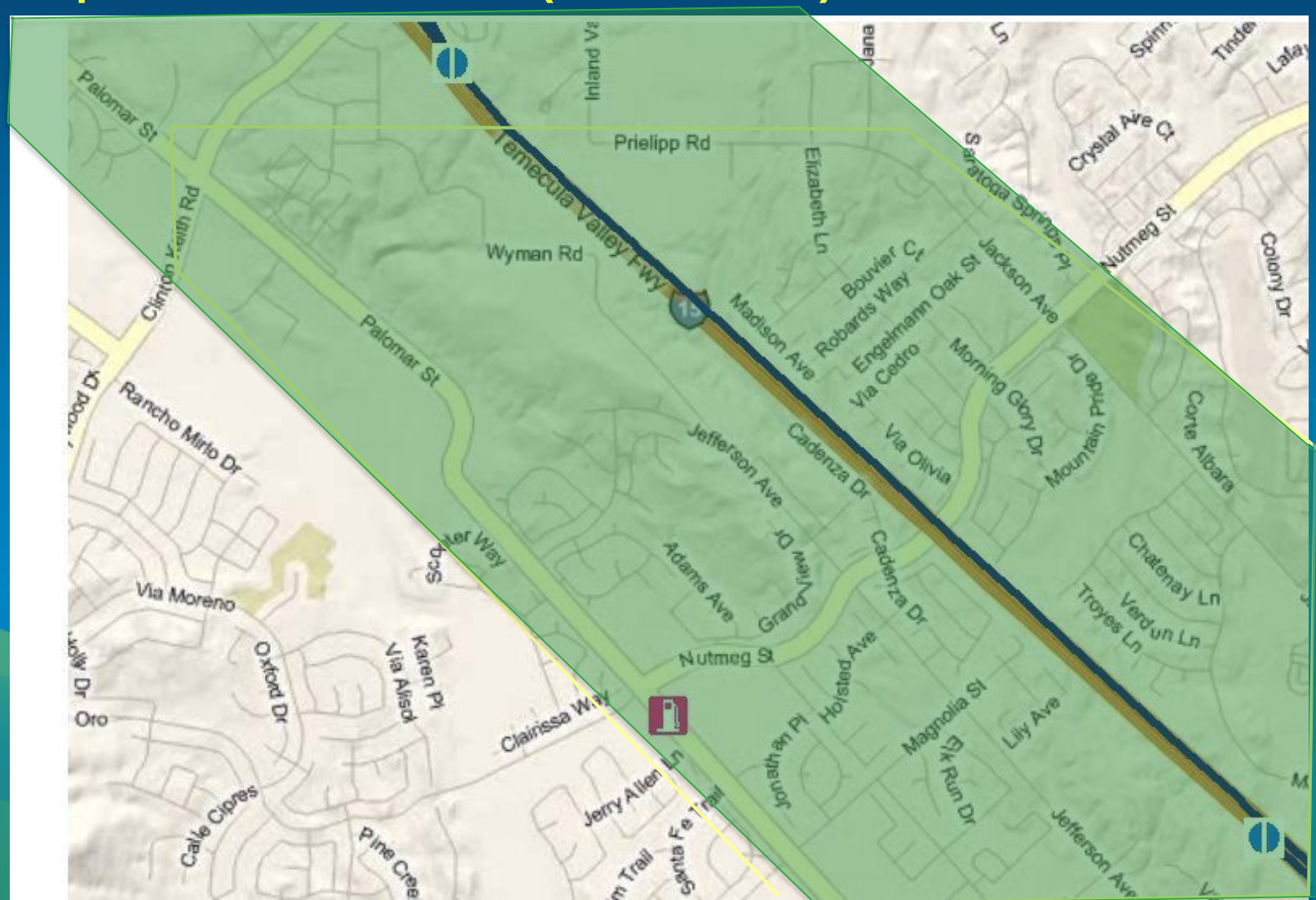
What is nearby?

Step 3: Choose a Method

- Create a (1 mile) buffer around freeway and locate gas stations inside

What is nearby?

Step 3: Choose a Method (within Buffer)



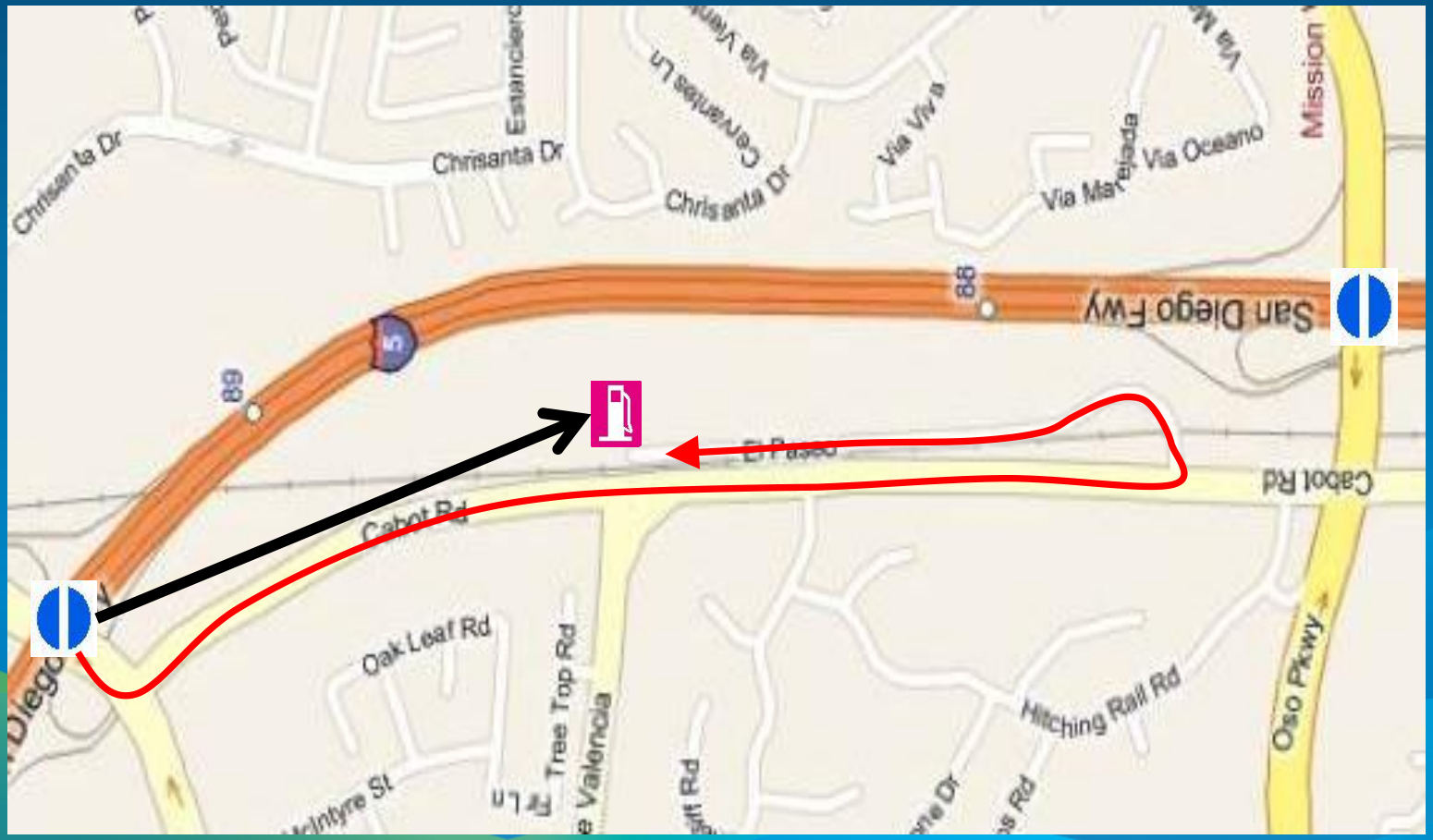
What is nearby?

Step 3: Choose a Method

- Calculate the crow's flight (Euclidean distance) from each exit with the Near tool.

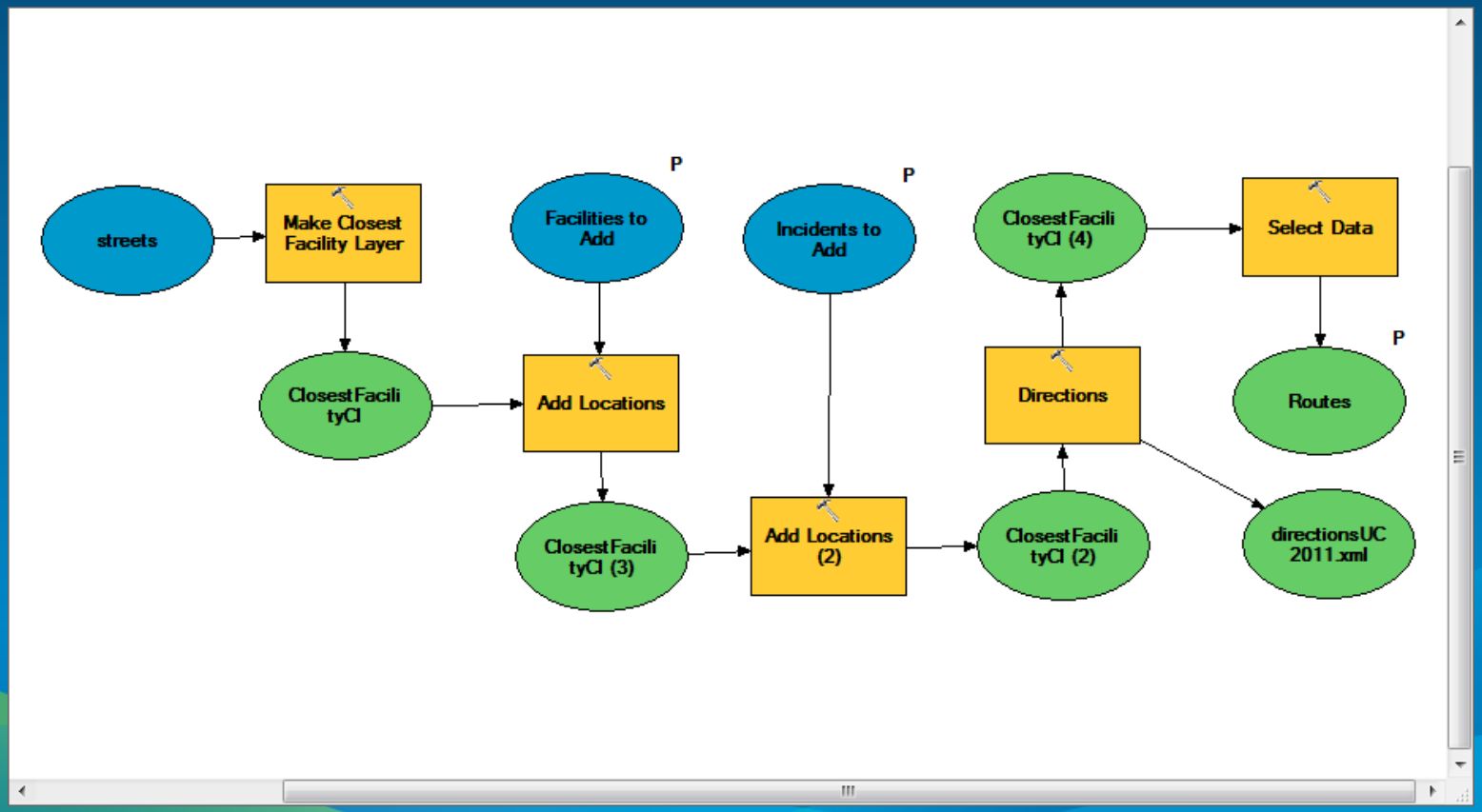
What is nearby?

Step 3: Choose a method (crow's flight)



Third Approach

Use network analysis tools (Closest Facility) that consider street network



What is the spatial pattern?

Step 1: Frame the question:

- Are there areas where gas stations have similar prices (high or low)?

Where are clusters of high and low values?

Step 1: Frame the question:

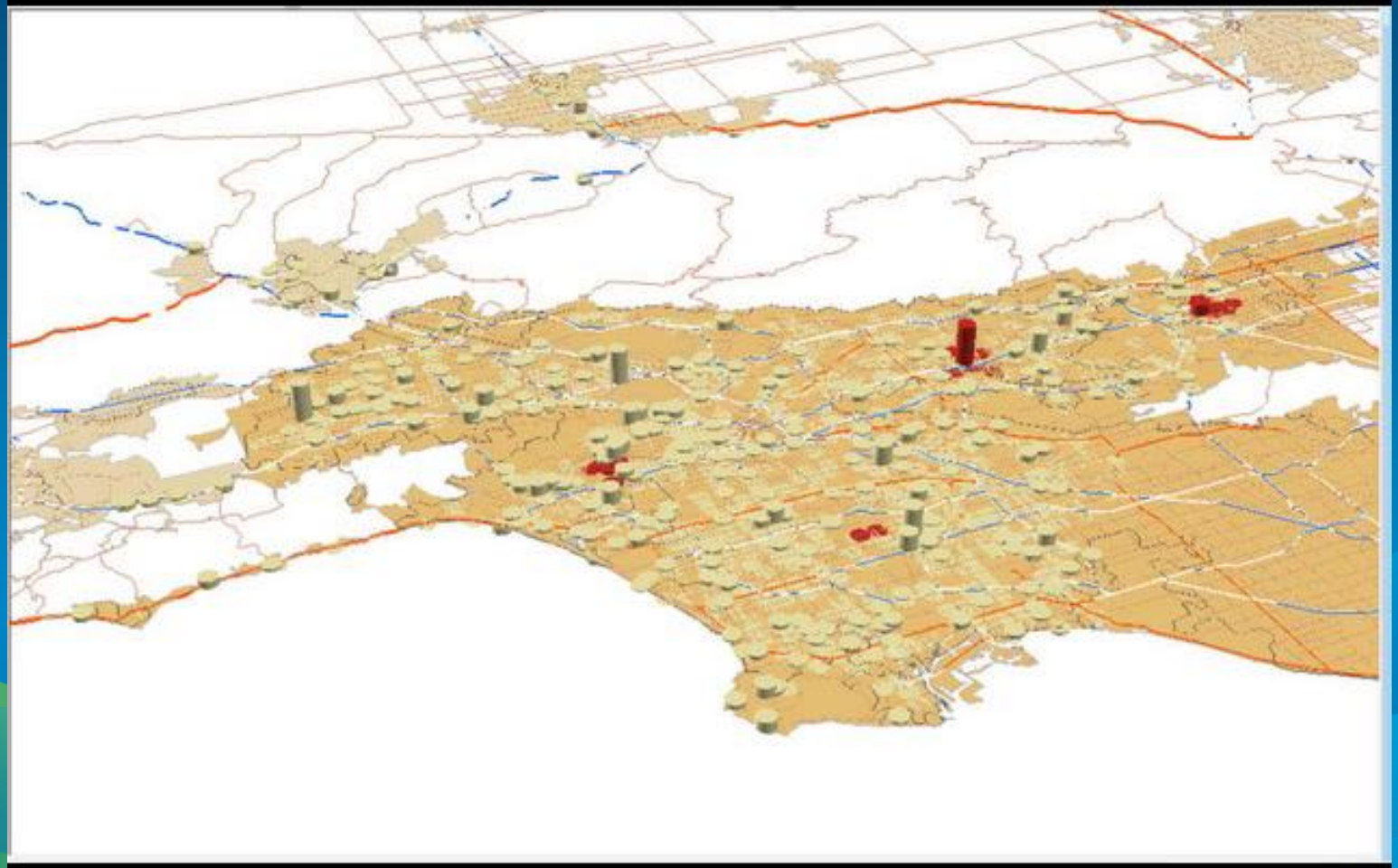
- Where are areas with high gas prices and where are areas with low prices ?

How does spatial pattern change over time?

Step 1: Frame the question:

- When the gas price goes up, do gas stations in different areas increase the price at the same time?
- If not, which areas are leading the pack? Which areas are trailing behind and catching up later?

How does spatial pattern change over time?



What contributes to the spatial pattern and by how much?

Step 1: Frame the question:

- Why the gas price is higher in Beverly Hills than in Pomona ?

Raster Data Analysis and Interpolation

Raster Data Analysis

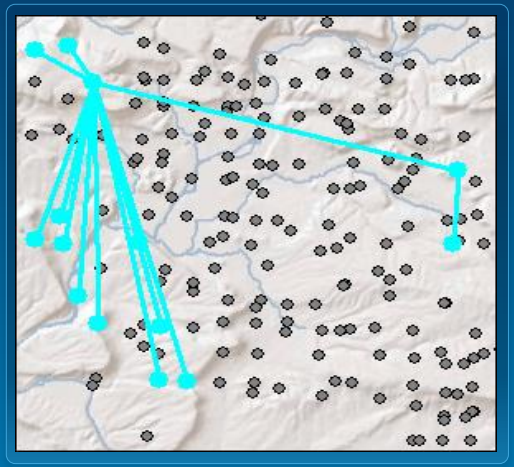
- Spatial Analyst - powerful spatial modeling and raster based spatial analysis features
  - How steep is it at this location?
  - What direction is this location facing?
  - Where is the best location for a new facility?
  - What is the least-cost path from A to B?

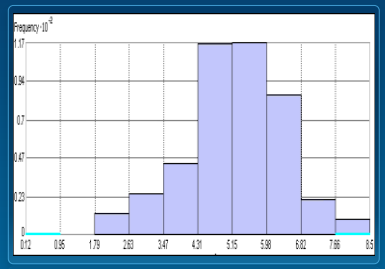
- GeoStatistical Analyst - data exploration and interpolation for continuous spatial data
  - What are the trends in the data?
  - How to estimate values for the whole area based on the measured samples?
  - How confident can I be with the estimation?

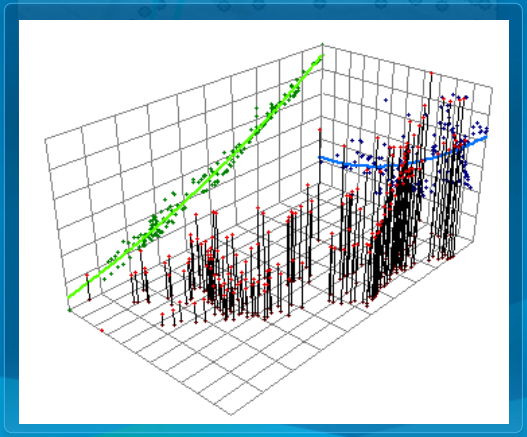
Spatial Data Exploration

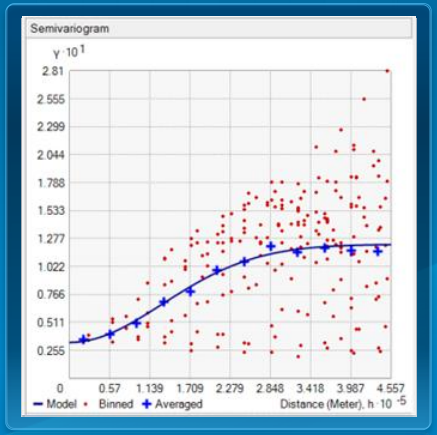
- Understanding the data:
  - Spatial dependency
  - Stationarity
  - Data distribution
  - Trend
  - Outliers

- Tools to prepare data for analysis



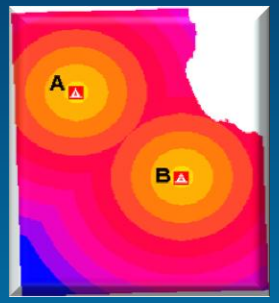




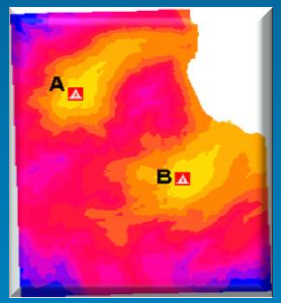


Distance and Proximity Analysis

- **Straight line distance**
  - **From the cell to the closest source**



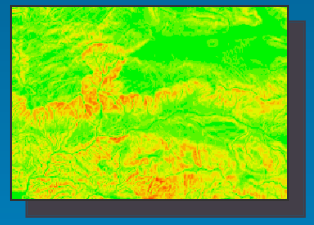
- **Cost weighted distance**
  - **Modifies distance by a weight or ‘cost’ of travelling through any given cell**

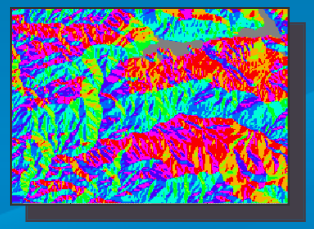


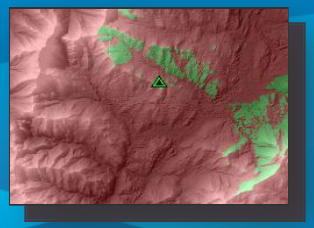
- **Shortest path**
  - **Finds the path from a destination point to a source including by cost**

Surface Analysis

- **Hillshade**
  - hypothetical illumination of a surface for analysis or display
- **Slope**
  - identifies the slope, or maximum rate of change, from each cell to its neighbors
- **Aspect**
  - identifies the steepest downslope direction from each cell to its neighbors
- **Viewshed**
  - Identify how many and which cells can be seen from each other or from observation points

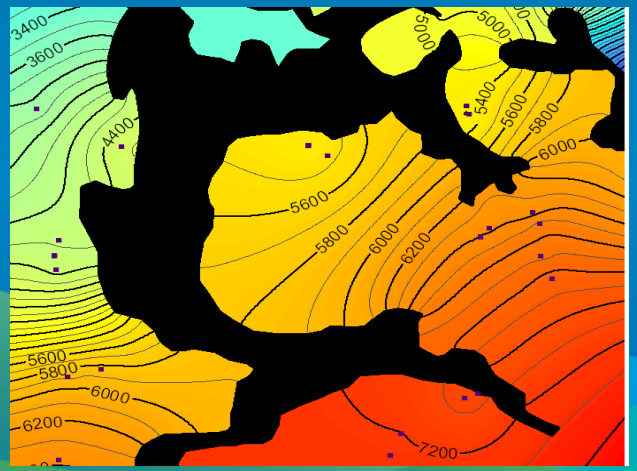


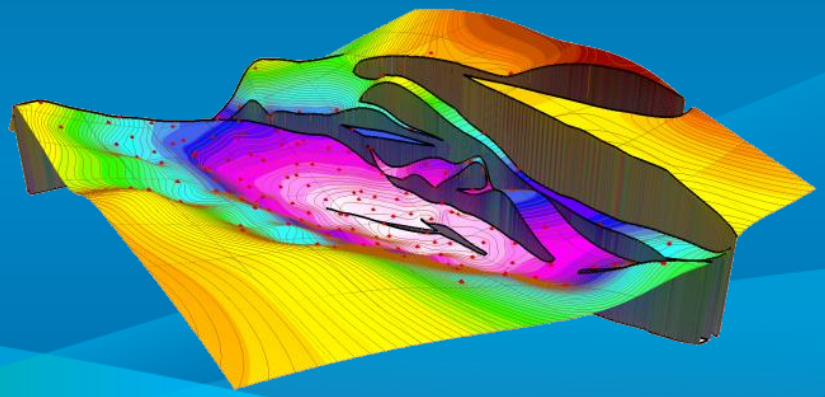




Adding complexity

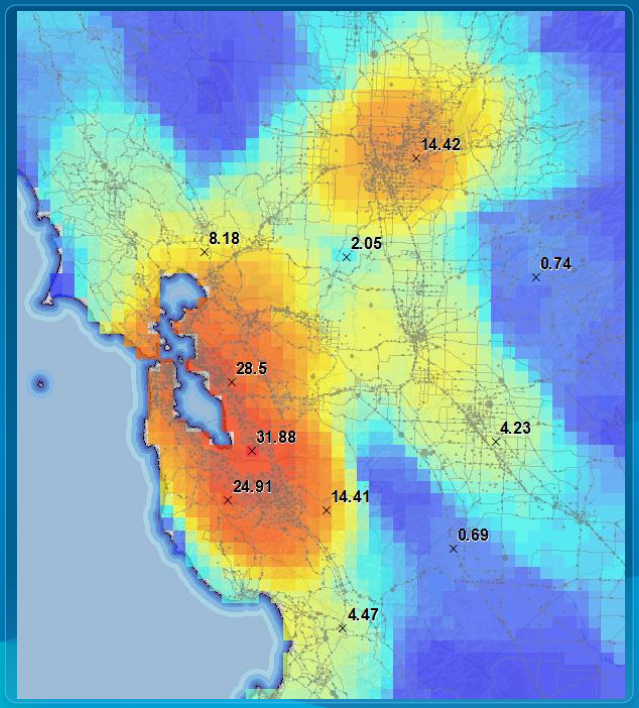
- Create contours from surfaces
  - Contours that honor barriers, faults, and void areas
- Create hydrological surfaces
  - Interpolates a hydrologically correct raster surface from point, line, and polygon data.



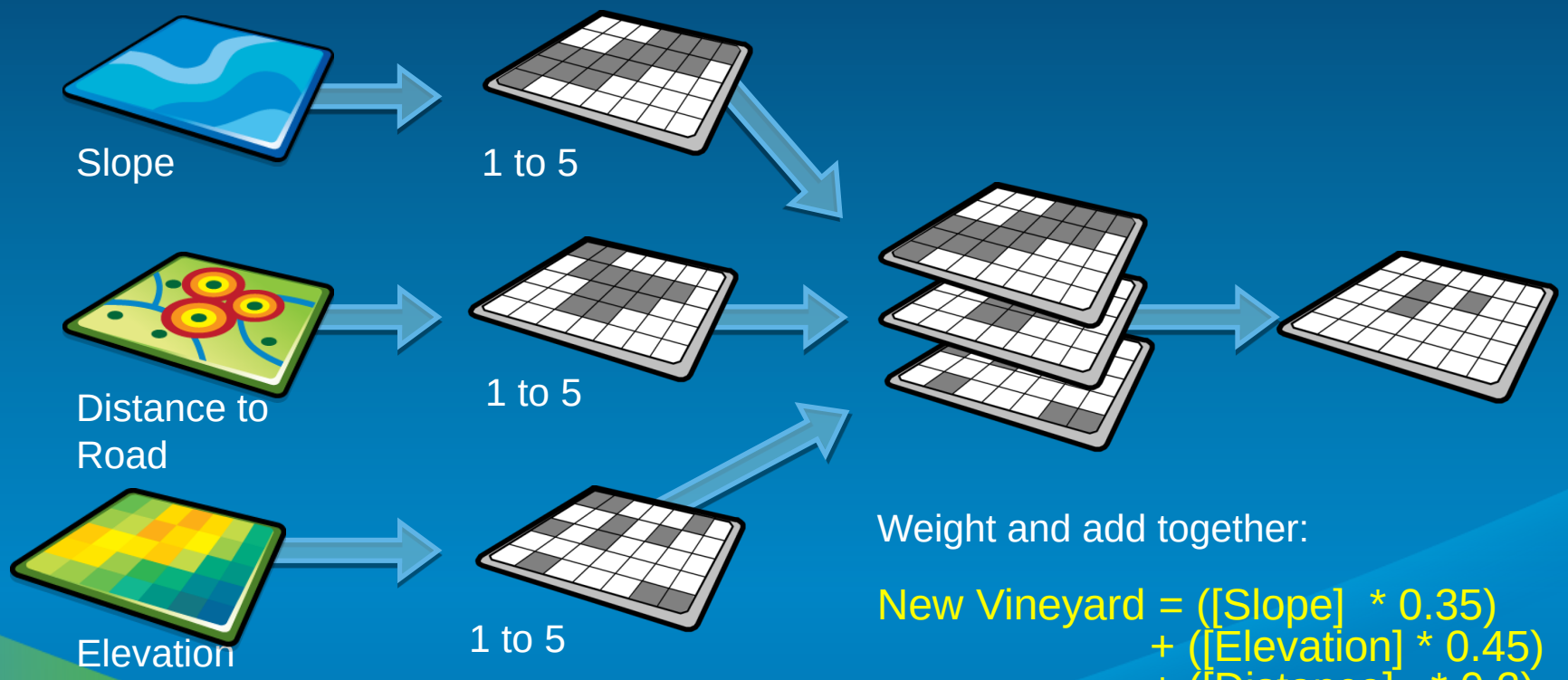


Density Analysis

- Count occurrences of a phenomena within an area and distribute it through the area
  - Show where point or line features are concentrated
  - Use points or lines as input
    - Population per km ^{2}
    - Road density per mile ^{2}



Suitability Modeling *“where is the best place”*

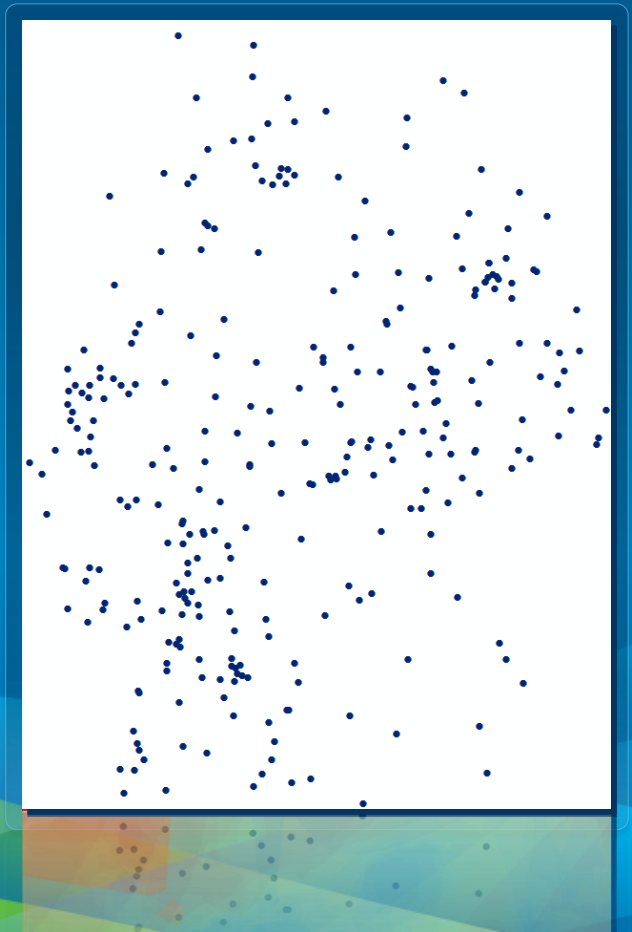


Weight and add together:

New Vineyard = ([Slope] * 0.35)
+ ([Elevation] * 0.45)
+ ([Distance] * 0.2)

Statistical Analysis - Interpolation

- **From sample points to a continuous surface**



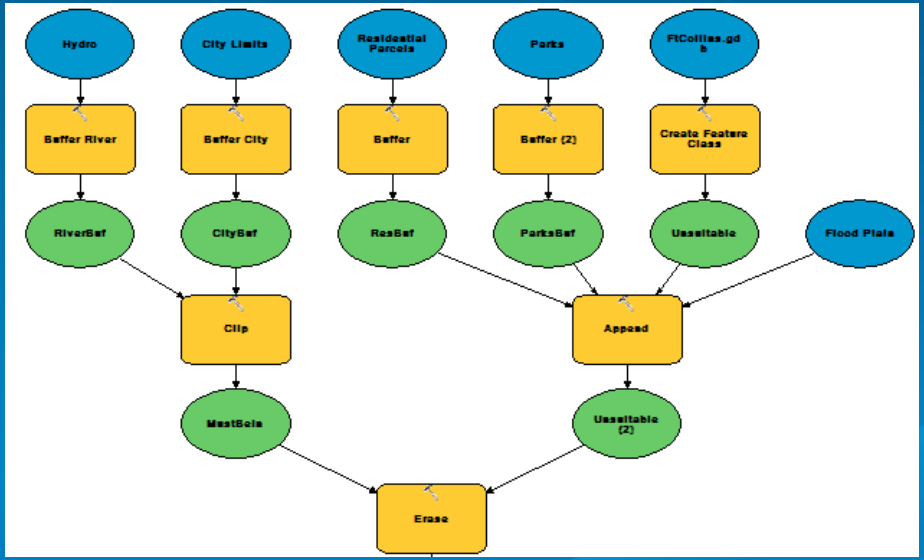
Interpolation Techniques

- All based to a certain degree on a basic principle of geography
- Data defines the correct approach:
  - All predictions area made from the weighted average of neighboring points
  - The method by which the weights are determined differs by technique
  - Different data assumptions must be met

Automating Analysis Workflow

Automating Analysis Workflow

- ModelBuilder
  - Process flow diagram
- Scripting
  - Python
- System Languages
  - C++, .Net, Java



Why Build Models?

- Automate analysis workflow
- Record and document a methodology
- Share analysis knowledge
- Easily communicates what is being done
- Create custom tools
- Aggregate common operations into one tool

Take away points…

- Spatial analysis is the true power of GIS. It is our core competence
- ArcGIS spatial analysis capabilities help advanced users to do their work better with sophisticated analytical tools
- Being able to share the GIS Analysis online reduces the learning curve for complex analysis

Features of the Analysis Resources Center

- Features Stories
- Model and script tools
- Education Gallery
- Blogs
- Forums
- Videos
- Twitter feed

- **Creating Geoprocessing Services**

Geoprocessing Services

- The geoprocessing service allows you to publish custom tools to be used via ArcGIS Server
- Geoprocessing services can be used by many different client applications
  - ArcGIS Desktop
  - ArcGIS Engine
  - ArcGIS Explorer
  - WSDL
  - REST
    - JavaScript
    - FLEX
    - Silverlight

Geoprocessing Services

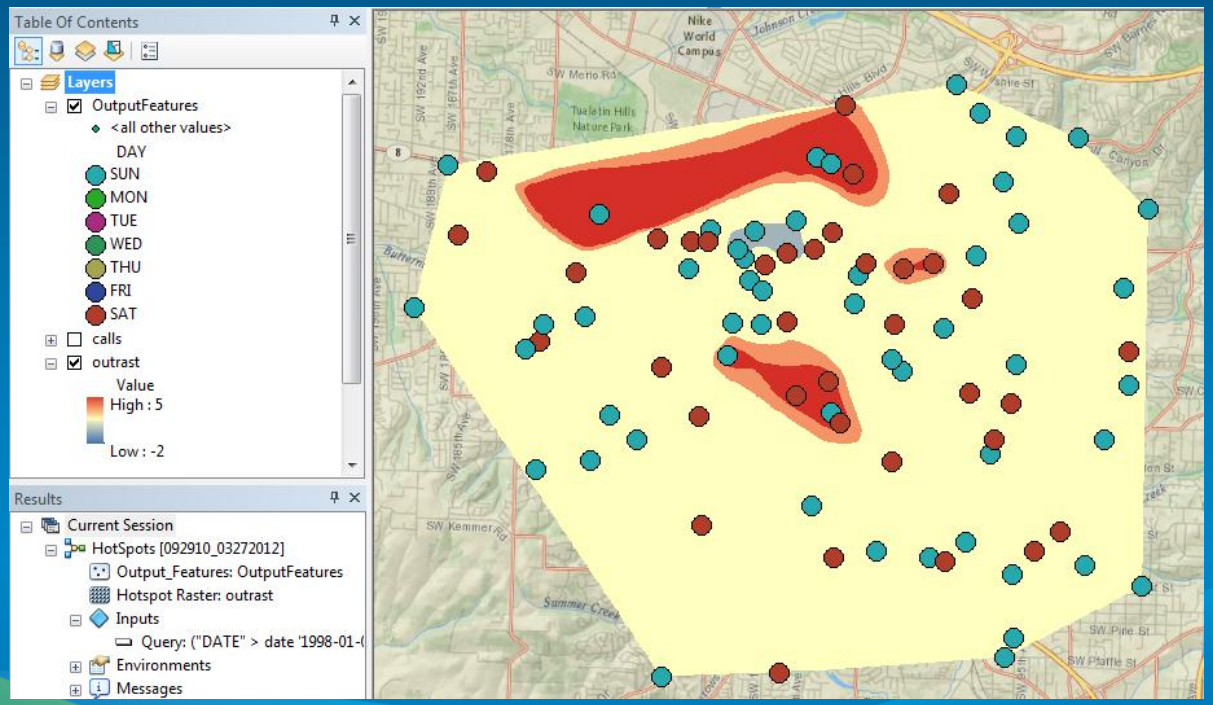
- The service is composed of both the tools and the data needed by the tools
- Endless array of tasks can be created
  - Spatial analysis (vector, raster, network…)
  - Data Management (geodatabase, file based data)
  - Conversion (ETL and data loading)
- You need to be knowledgeable about using geoprocessing tools to create a good geoprocessing service

Geoprocessing Service Behavior

- Geoprocessing Services are very flexible and allow many different behaviors
- Before Authoring and Publishing, identify what you want your service to do and how you want it to behave with clients. Key questions:
  - Does the input data come from the client or data on the server?
  - Do you want to draw results with map server or download and draw data on the client?
  - Do you want to save data on the server?

How to create a service

- All services start from a successful result
- The result acts as a template to build the service

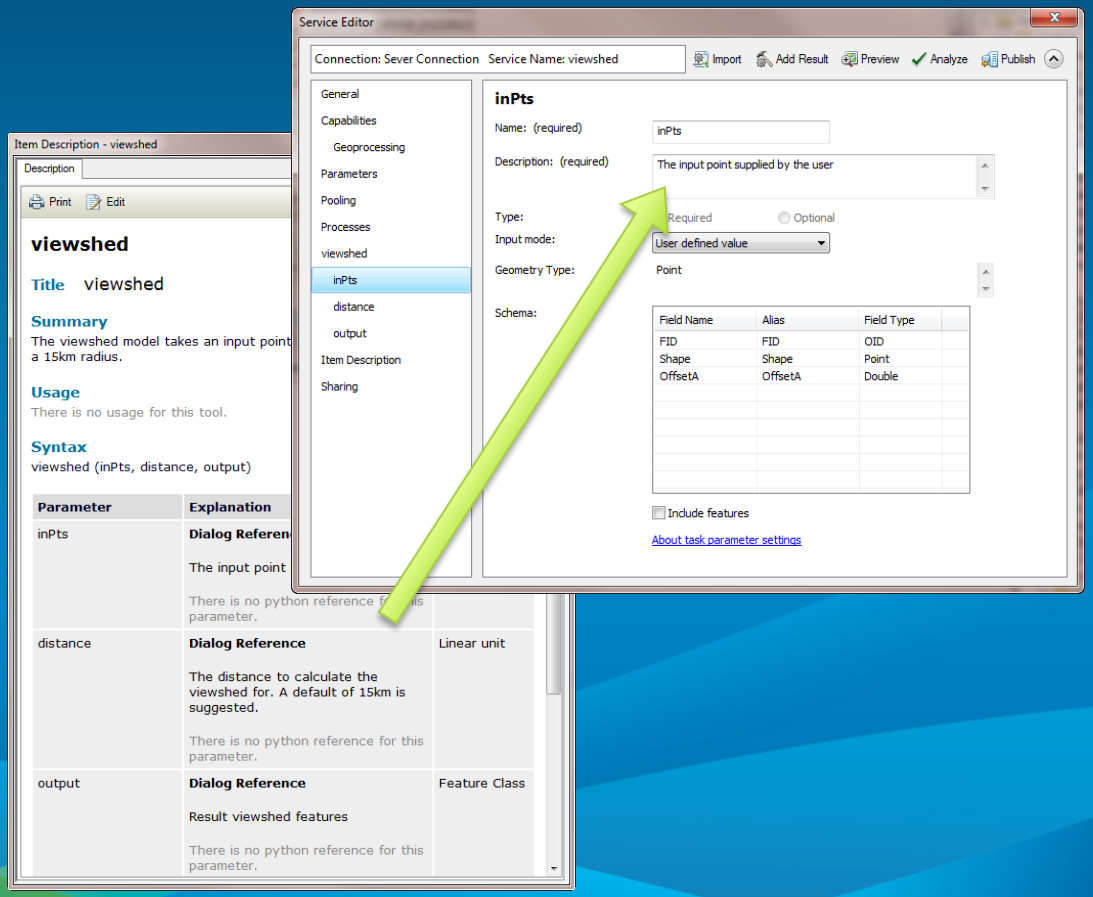


Quick Tour of Publishing: http://esriurl.com/gpSrvQuick

Documenting your task

- All tasks must be documented
- Fill out the Item Description

- You can update metadata specific to the task you are publishing inside the Service Editor

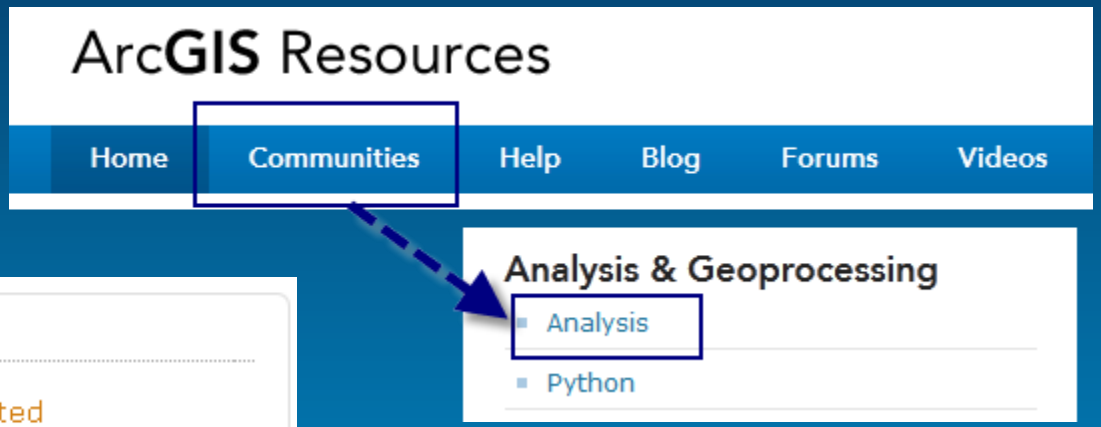


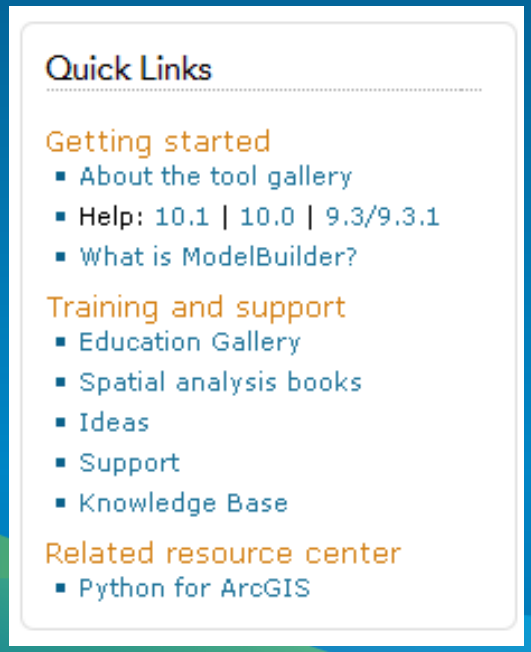
Documenting your service:
http://esriurl.com/gpSrvDoc

Publishing Wizard

- Manages parameter types
- Makes model or script portable
  - Fixes paths to data inside model and scripts
- Makes sure data is accessible to the service
  - What data is needed is packaged

Analysis and Geoprocessing Resource Center

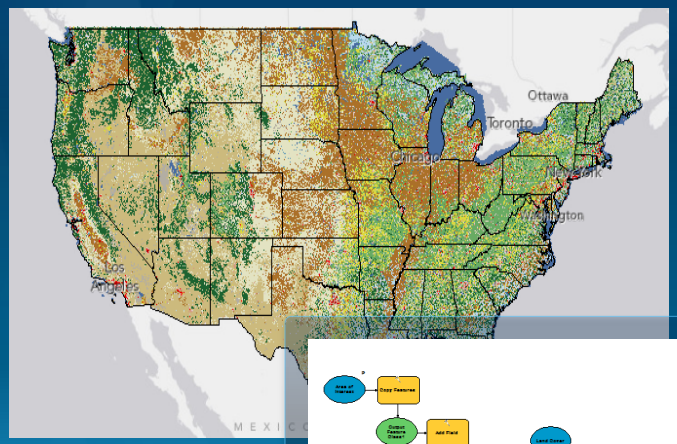


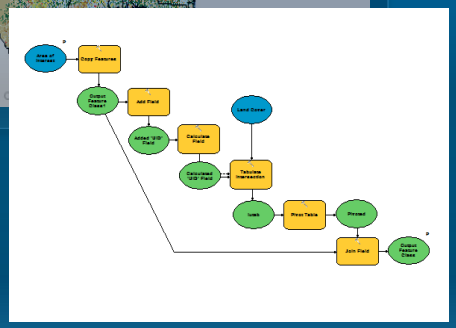


Quick Links:

Education Gallery: you can find User Conference presentations here

About the tool gallery: learn all about the new gallery of geoprocessing tools and analysis hosted on ArcGIS Online





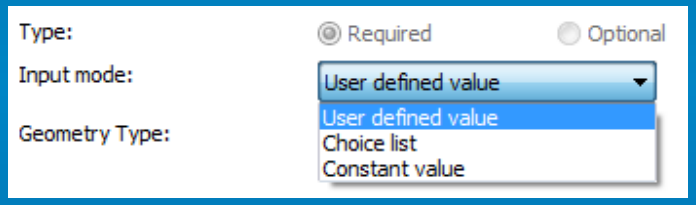
Landuse Report

Landuse Report Characteristics

- Synchronous
- Inputs: polygon features (area of interest)
- Output: featureclass (attributes used to chart results)
- Project Data: raster

Parameter transformation

- Unsupported parameter types are handled through publishing
- You can update the Input Mode depending on the parameter type
- User Defined Value: allows the end user to interactively add features or enter text and number values
- Choice list: allows the end user to select from a list of layers already on the server
- Constant value: hard codes the parameter; the end user will not be able to provide input



Accessing your data

- Data Store tells ArcGIS Server about your data
- Without a Data Store entry, all required data is copied to the server
- Data Store acts as a lookup table

• C:\data\analysis • SDE: sqlserver:dtuser	Update Paths	• E:\fileShare\gisdata\landAnalysis • SDE: sqlserver:agsuser
• C:\gisdata\projects • SDE: oracle:sdeuser	Same Paths	• C:\gisdata\projects • SDE: oracle:sdeuser

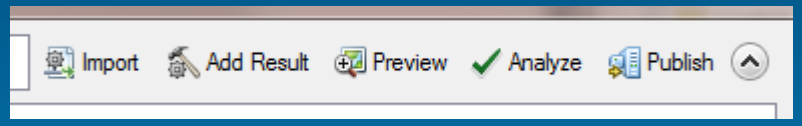
Data Store: http://esriurl.com/datastore

What happens during publishing?

- Project data
  - Copied if not in data store
  - Path updated if registered with the data store
- Output and Intermediate paths
  - Changed to scratchFolder and scratchGDB

Multiple Tasks

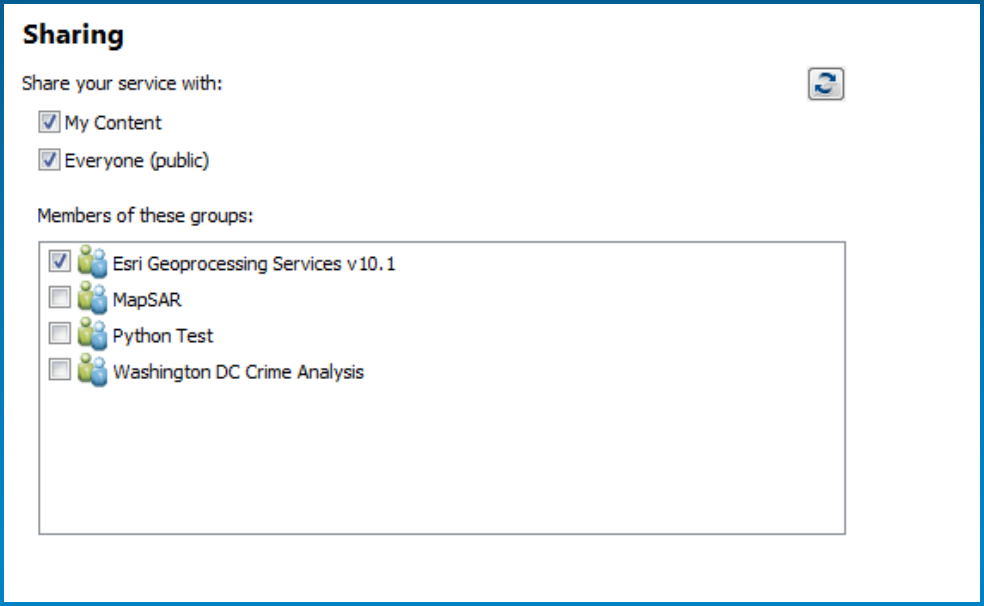
- Use Add Result to create a service with multiple tasks

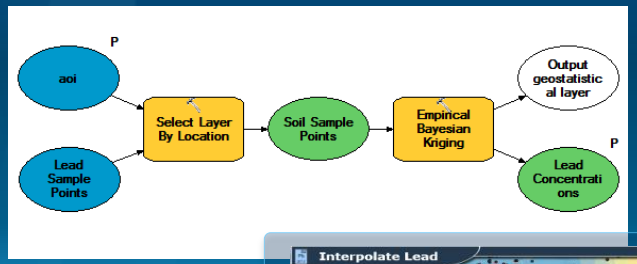


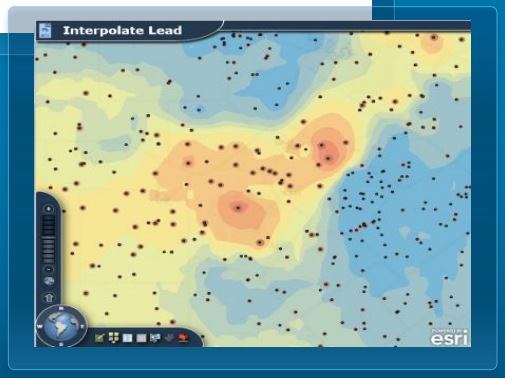
- Use Preview to see how the task would appear to a user consuming the service from ArcMap

Sharing your service

- Make your service discoverable on ArcGIS.com
- Provide good metadata and search tags







Interpolate Lead

Interpolate Lead Service Characteristics

- Asynchronous
- Inputs : Area of interest (provide by a feature set in ArcMap, or the map extent in a web application)
- Output: Surface (raster)
- Project Data: Points (with observed lead values. These points are from an enterprise database. A feature service is used to update the points)

Result Map Service

- A result map service (RMS) provides an alternative way to get results from the Geoprocessing Service.
- An image is returned to the client.
  - The data can still be downloaded.
- Use a RMS when:
  - Want better cartography than the client can support
  - It is impractical to render a large dataset in a client.
- Execution must be Asynchronous when using a RMS

Synchronous vs. Asynchronous

- **Execution mode defines how the application interacts with the geoprocessing service**

- **Synchronous**
  - Application waits until job is completed and results are returned
  - Application always draws results
  - Appropriate for faster processing jobs. (<10 seconds)

- **Asynchronous**
  - Application is free to do other tasks during this time.
  - Results are saved on the server
  - Results can be drawn by the server
  - Results can also be downloaded if desired
  - Appropriate for longer processing jobs.
  - Can only use a Result Map Service with Async.

Creating Script Tools

- Paths and data handled the same as models
- Importing of modules
  - First looked in the same folder as source script
  - Second the PythonPath is searched
- Output and Intermediate paths
  - os.path.join(arcpy.env.scratchFolder, “out.shp”)
  - os.path.join(arcpy.env.scratchGDB, “out”)
  - In_memory\out

Enhancements at 10.1

- Easier publishing
- Native 64bit
- Dynamic legend in Result Map Service
- Local Jobs Directory
  - No longer have to set this. Its automatically used when server participates in multimachine cluster
- Grid path limit expanded
  - Can now use paths of up to 255 characters when working with grids
- Raster supported in_memory workspace
- Multivalue for all supported parameter types
- Better handling of feature sets in the WebAPIs

Publishing Custom GPFunctions

- Can publish custom GPFunctions: .net, c++, java
- Publishing DOES NOT package the dll
- You have to install the dll on the server machine before publishing
- Need to build 64 bit or Any compiler
- Need to register separately for server install
  - Desktop 32 bit
  - Server 64 bit

- **Questions**

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