Concepts of Geographic Analysis

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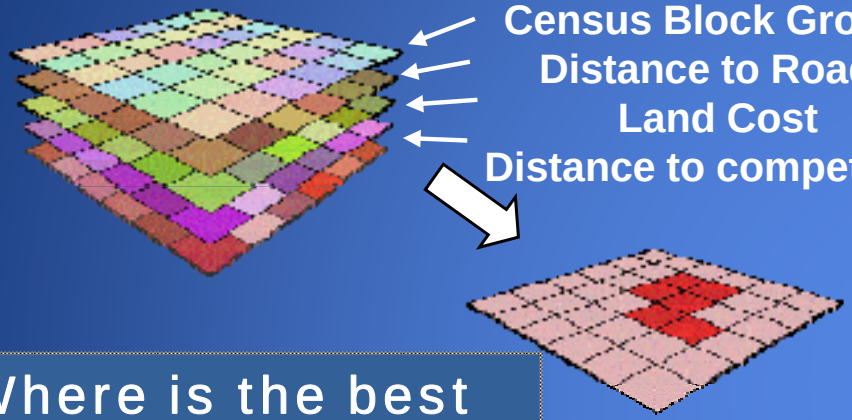
Parts of a GIS System (my definition)

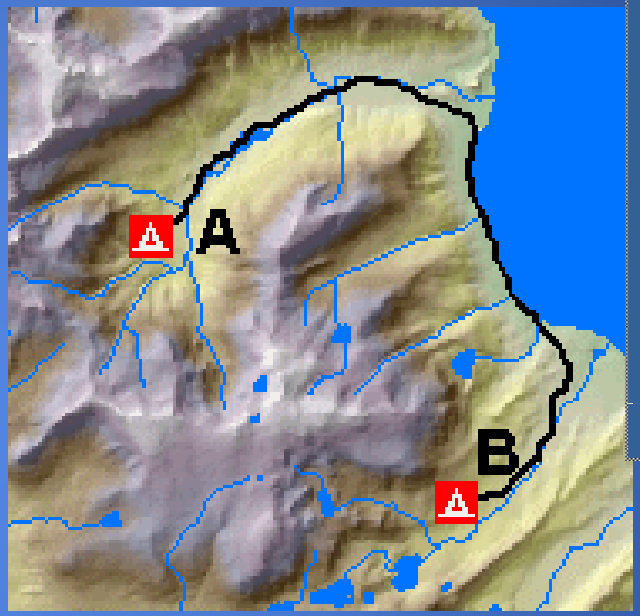
- Data collection
- Data storage and retrieval
- Data maintenance
- Geographic Analysis and Modeling
- Presentation – Maps and reports

Geographic Analysis Examples



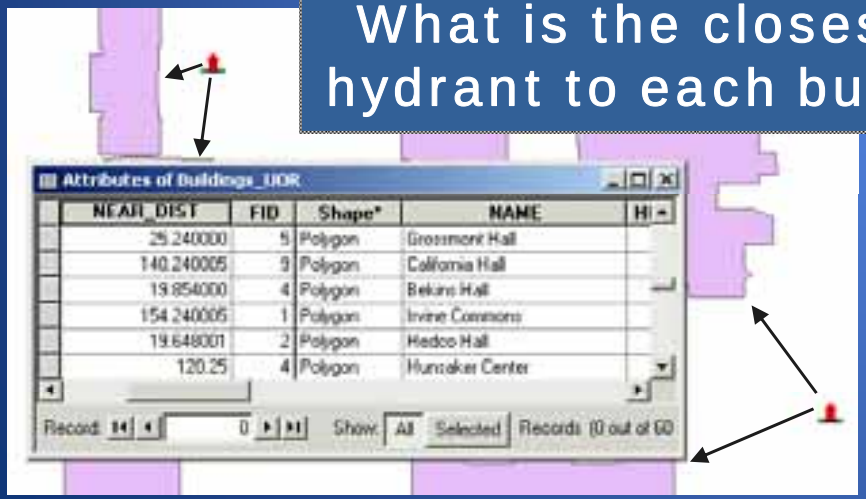
Census Block Groups
Distance to Roads
Land Cost
Distance to competitors

Where is the best location for a store?



What is the fastest route over rugged terrain?

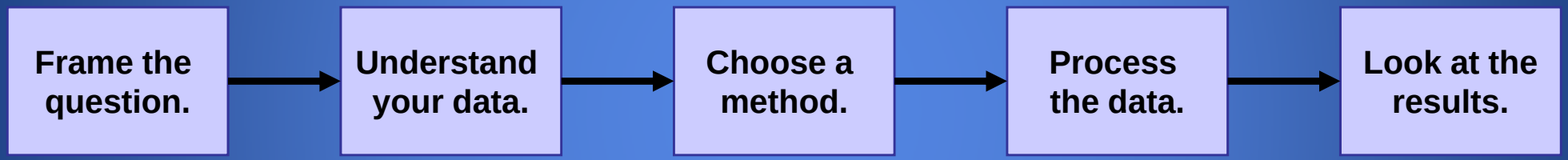
What is the closest fire hydrant to each building?



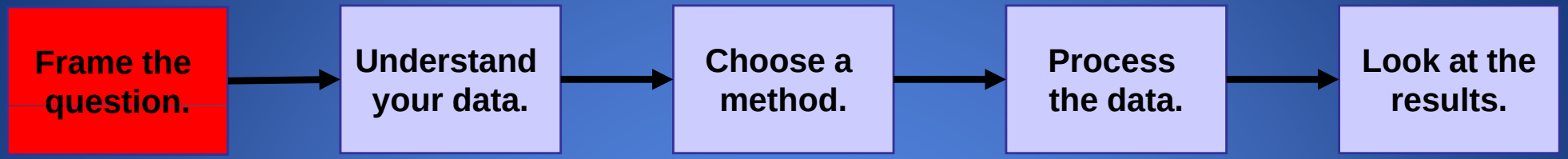
How many people are within a contamination zone?

Analytic process

Five steps of the analytic process

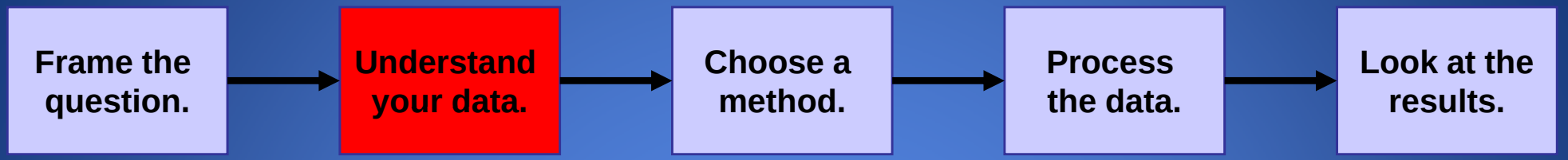


Framing the question



- What information is needed?
- How will analysis results be used?
- Who will use the results?
- Be specific.
  - Helps to determine methods and data to use
  - Helps to know how to present the results
- Example: What percentage of the forest is in the watershed?

Understanding your data

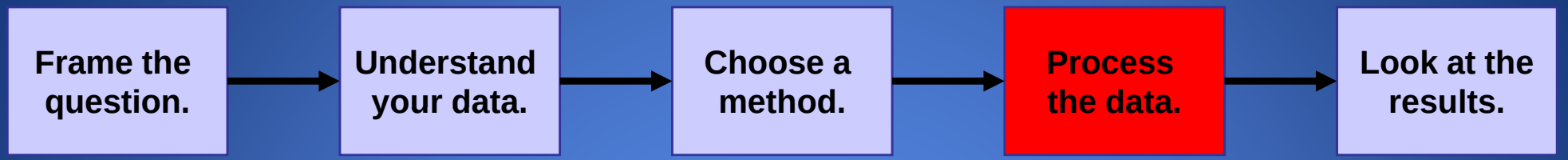


- Know what features and attributes you have.
  - Type of features determines method.
    - Discrete versus continuous
    - Additional data required by specific methods
  - Type of attributes determines type of analysis.
    - Attributes describe and identify features.
    - There are categories, ranks, counts, amounts, and ratios.
- Know what you must obtain or create.

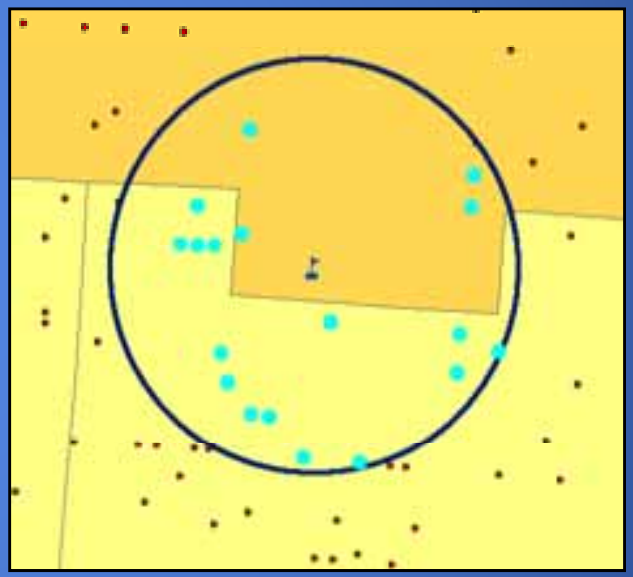
Choosing a method

- Method: Process(es) used in GIS to get information
- Which method to use based on
  - Original question
  - How analysis results will be used
  - Efficiency and effectiveness
- Many ways to achieve results
  - Research and test to determine most efficient option.
  - Determine which option provides the most accurate information.
  - Document your workflow.

Processing the data



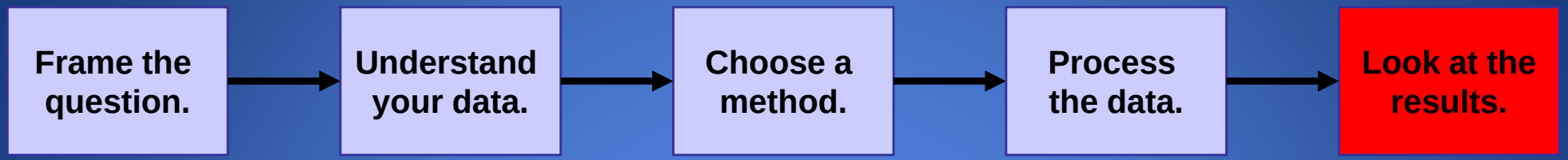
- Use a method to perform the necessary steps in GIS.
- Understand all concepts that are being used.
  - Examples: Spatial joins, buffers, and intersects
- Understand the context for choosing required analysis parameters.



Buffer value set to 0.1 mile. Intersect determines crimes within 0.1 mile buffer of school.

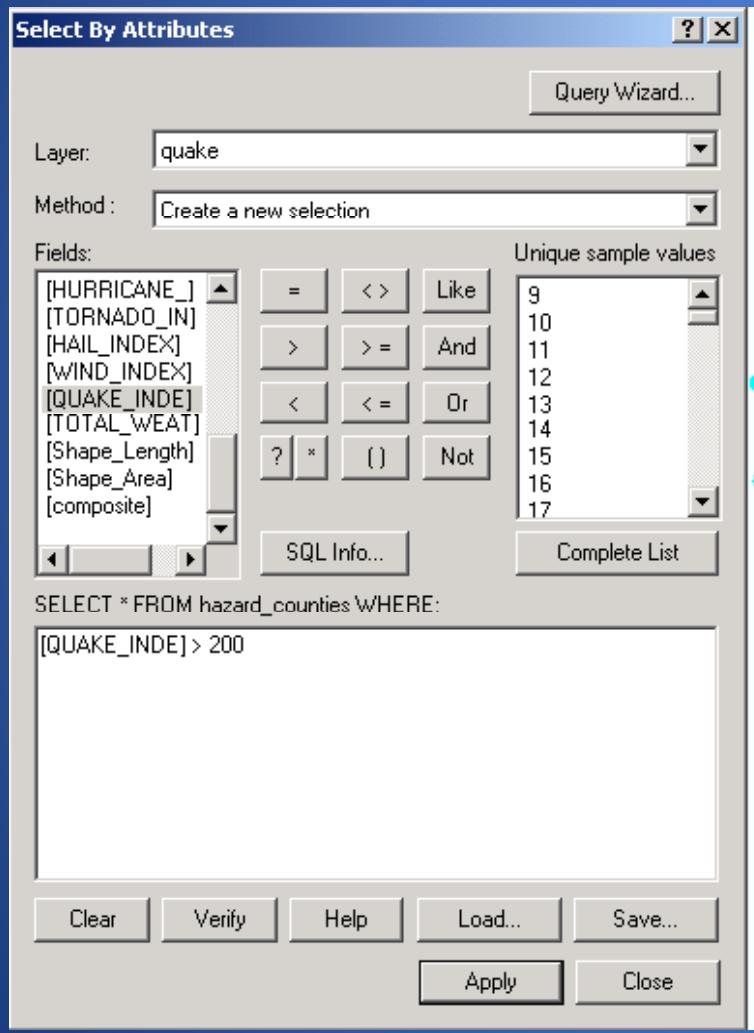
Important because most children within 0.1 mile walk to school

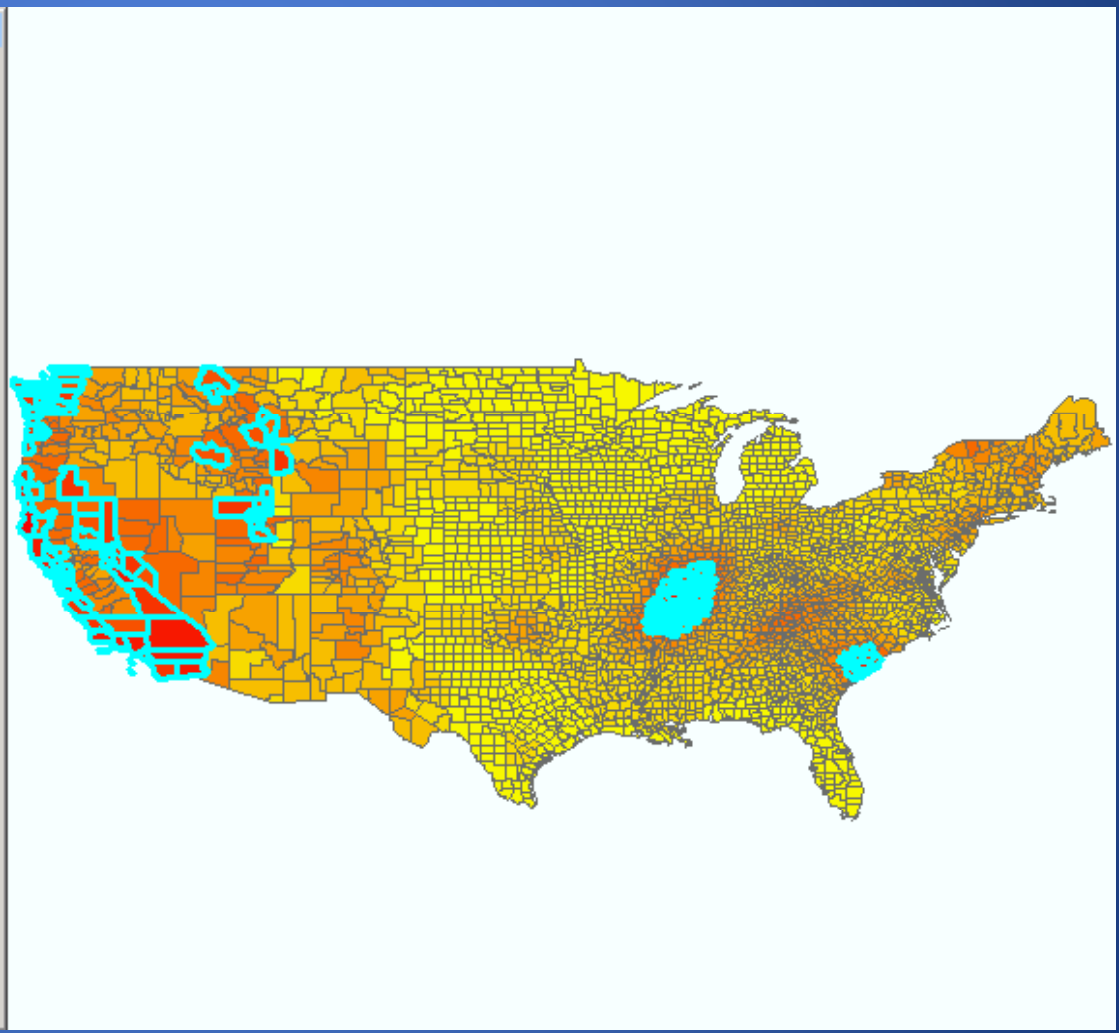
Looking at the results



- How will results be displayed?
  - Map, values in a table, charts, and so on
- Evaluation of results
  - Determine if information is valid and useful.
  - Determine whether to rerun analysis with different parameters.
- Additional considerations for results
  - Information to include on map
  - How to group attribute values for best effect

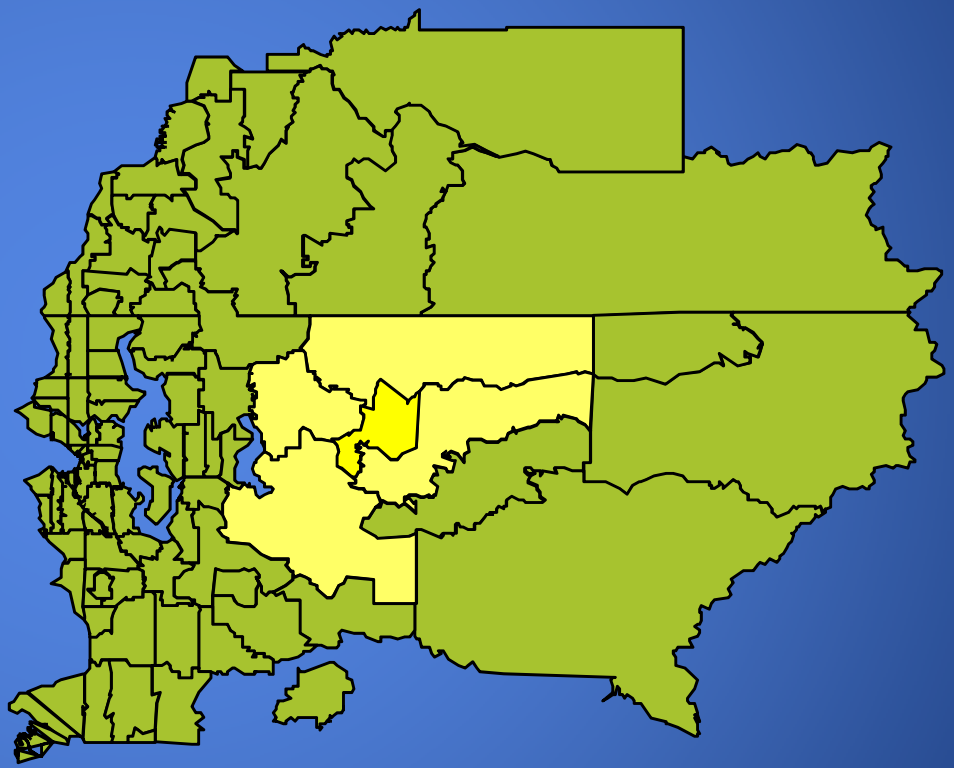
Attribute Selection





Spatially related features

- **Examples:**
  - **Disjoint**
  - **Touching**
  - **Crossing**
  - **Overlapping**
  - **Within**
  - **Contains**
  - **Equals**



Spatial Join

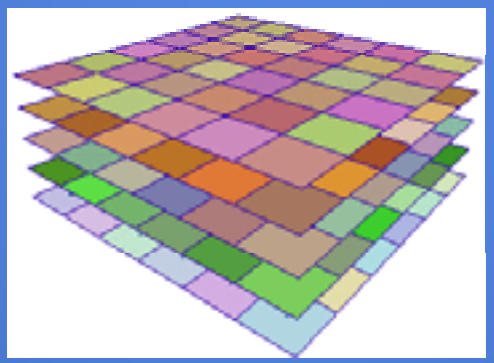
- Like joining tables, but the common column is “shape”
- Example:
  - Join crime locations to the blocks in which they lie
  - Use the joined table to analyze crime levels

Modeling spatial problems

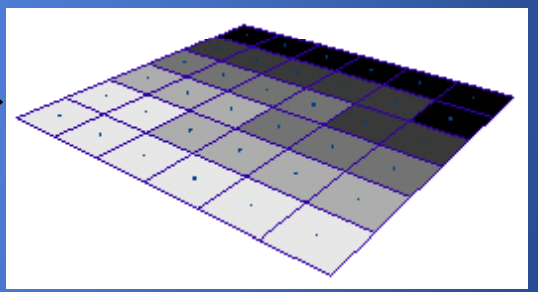
- **Models help understand and solve complex problems**

Reality

GIS layers



Suitability for store



Model criteria:
- Zoned commercial
- Near target population
- Away from competition

What is a model?

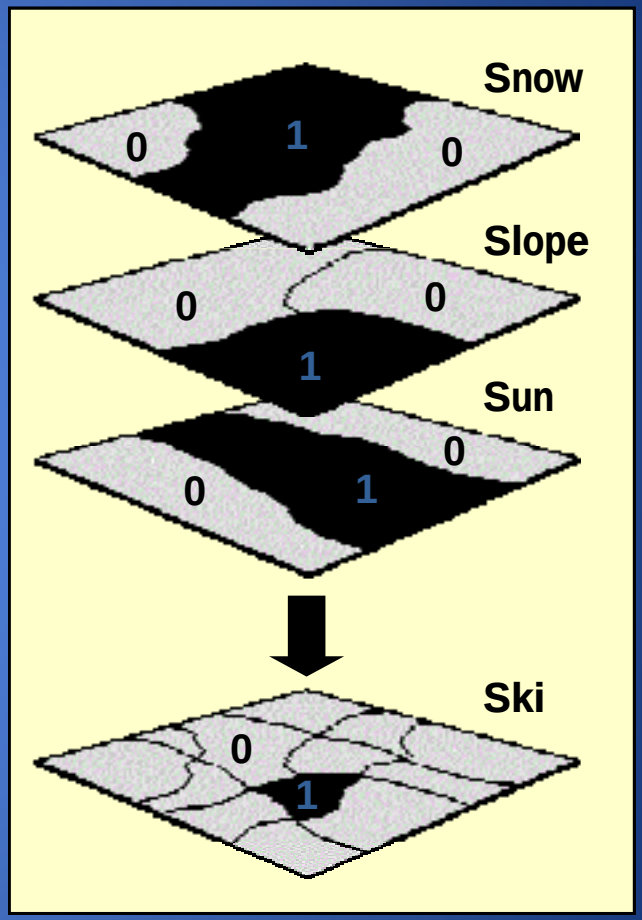
Any representation of a real or hypothetical object or process that portrays, simulates, or predicts its properties or behavior.

Model Examples

- A model airplane
- Chemical “tinker toys”
- A hazard map
- An analysis of site suitability
- A groundwater pollution model
- A property value estimation

Binary suitability models

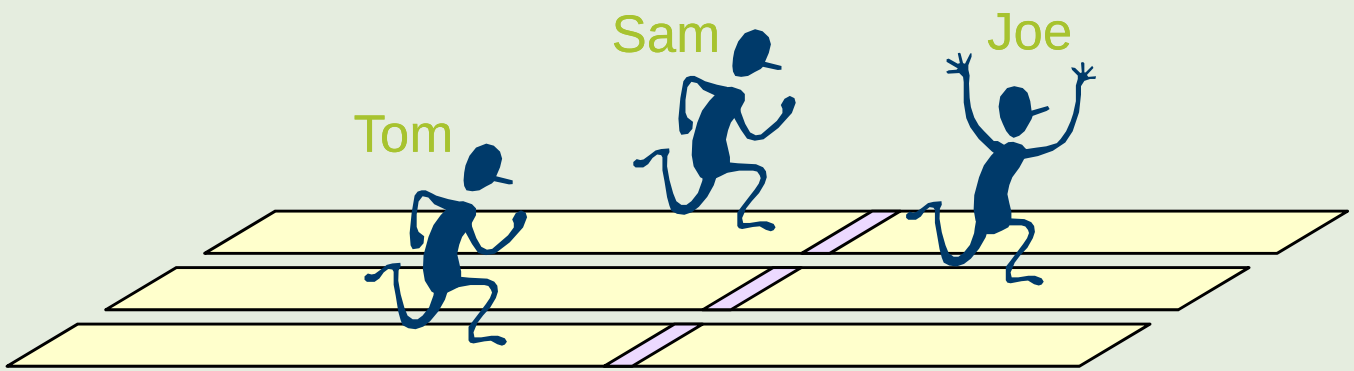
- Use for simple problems
- Advantages:
  - Easy
- Disadvantages:
  - No “next–best” sites
  - All layers have same importance
  - All good values have same importance



Data types and math in modeling

Valid math depends on the data type.

Type	Examples	Legal math
Nominal	ID, Land-use code, Phone number	=
Ordinal	Importance, Order of completion	<, =, >
Interval	Time of day, Temperature	<, =, >, +, -
Ratio	Age, Distance, Weight, Counts	<, =, >, +, -, *, /



Runner	#72—Tom	#43—Sam	#10—Joe	Nominal
Finished	3rd	2nd	1st	Ordinal
Time of day	4:05:09	4:05:07	4:05:03	Interval
Elapsed time	81 sec	79 sec	75 sec	Ratio

Type	Examples	Legal math
Nominal	ID, Land-use code, Phone number	=
Ordinal	Importance, Order of completion	<, =, >
Interval	Time of day, Temperature	<, =, >, +, -
Ratio	Age, Distance, Weight, Counts	<, =, >, +, -, *, /

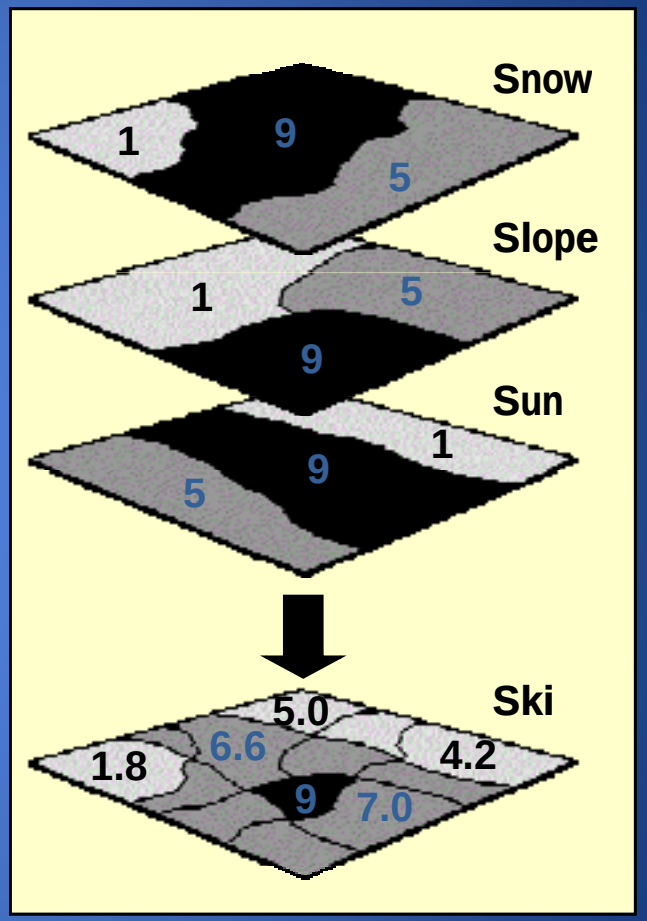
Weighted Suitability

- Used to quantify suitability
- Advantages:
  - Inputs not restricted to yes/no values
  - Results are ratings instead of yes/no values
- Disadvantages:
  - Preference assessment is harder
  - Requires RATIO data!
  - Easy to make erroneous assumptions about data

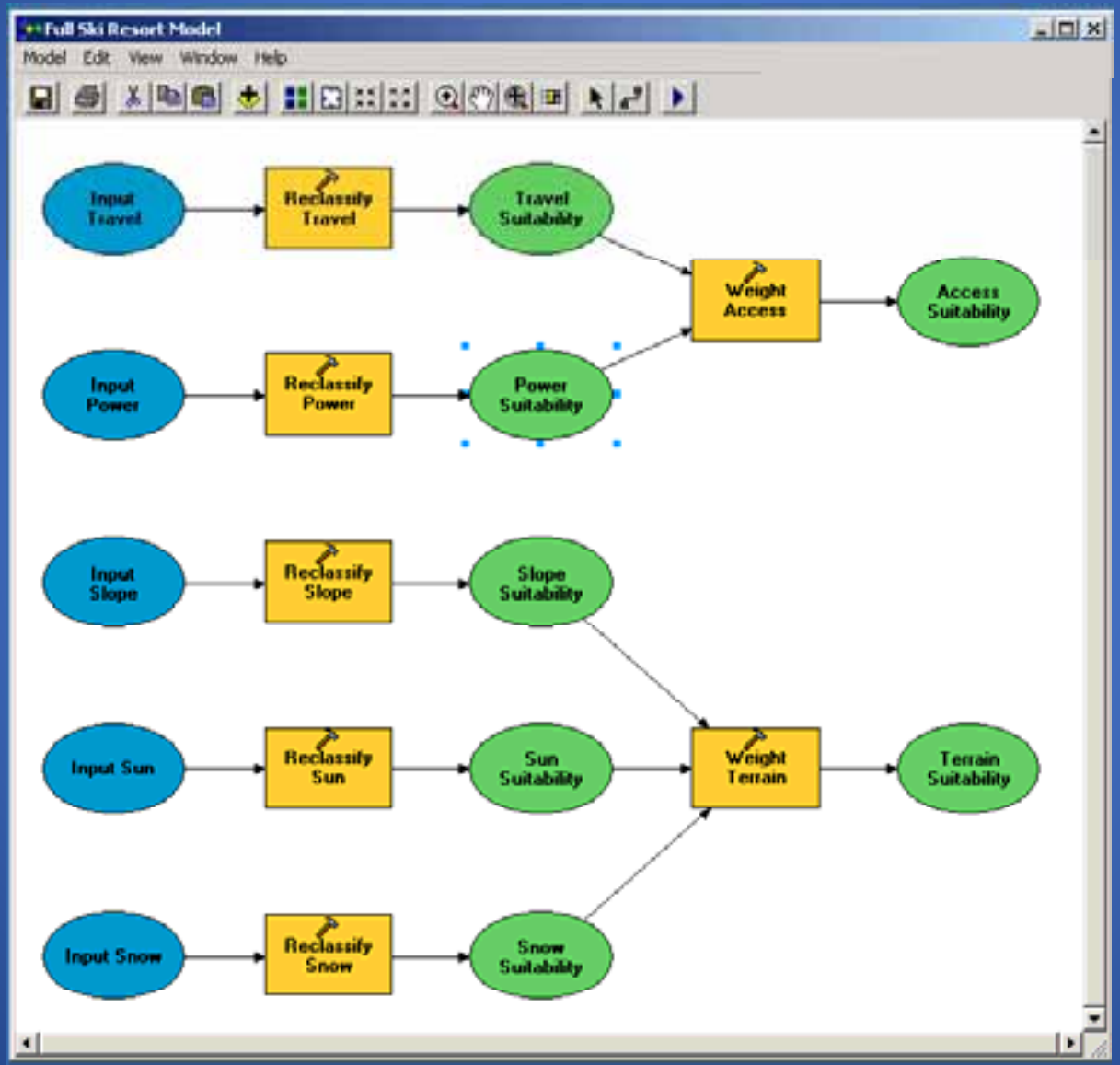
Weighted suitability method

- **Classify layers into the same suitability scale**
  e.g. 1-9 (9 = best)
- **Weight and add together:**

Ski = ([snow] * .5)
+ ([slope] * .3)
+ ([sun] * .2)

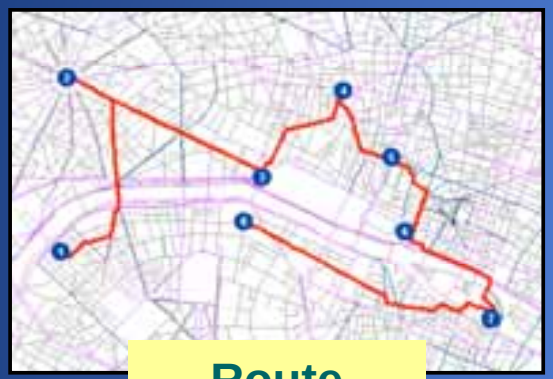


Analysis Can Get Complicated – Use Model Builder

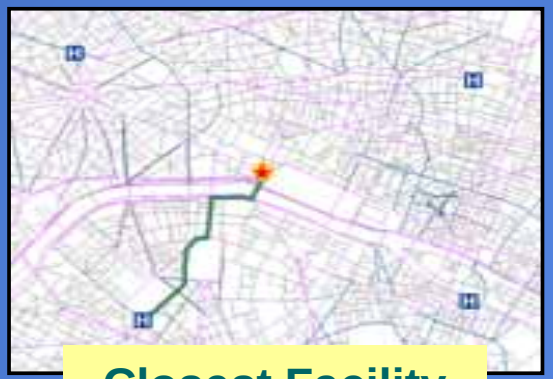


Network Analyst

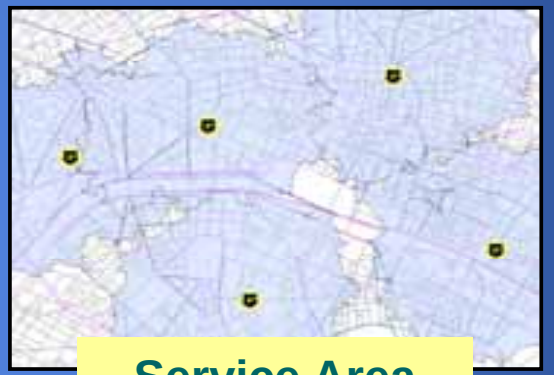
- Extension for analyzing transportation networks
  - Five network solvers
  - Uses network datasets



Route



Closest Facility

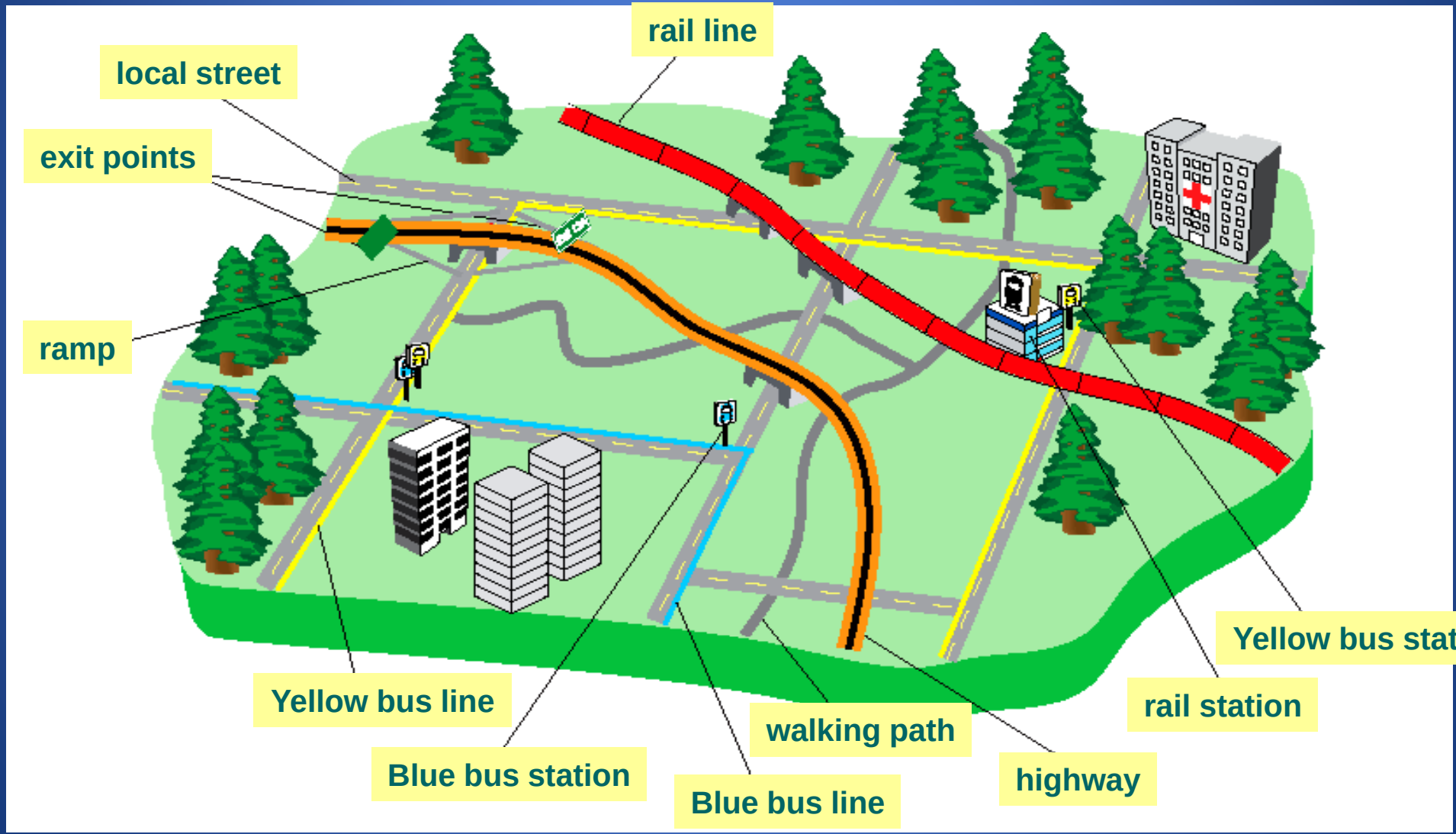


Service Area

Origin-Destination (OD) Cost Matrix

Vehicle Routing Problem

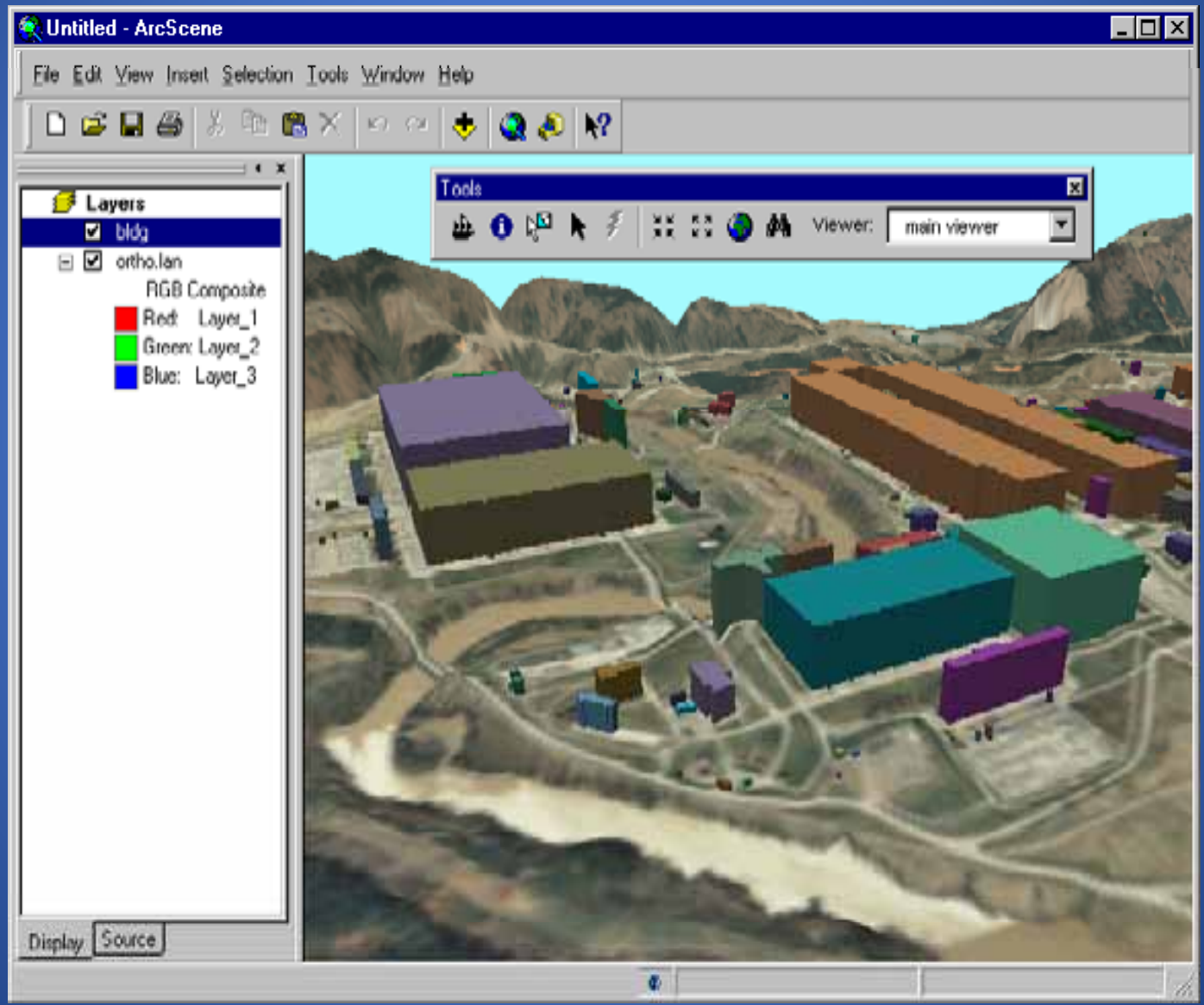
Network Analyst handles turns, oneways, and multimodal networks



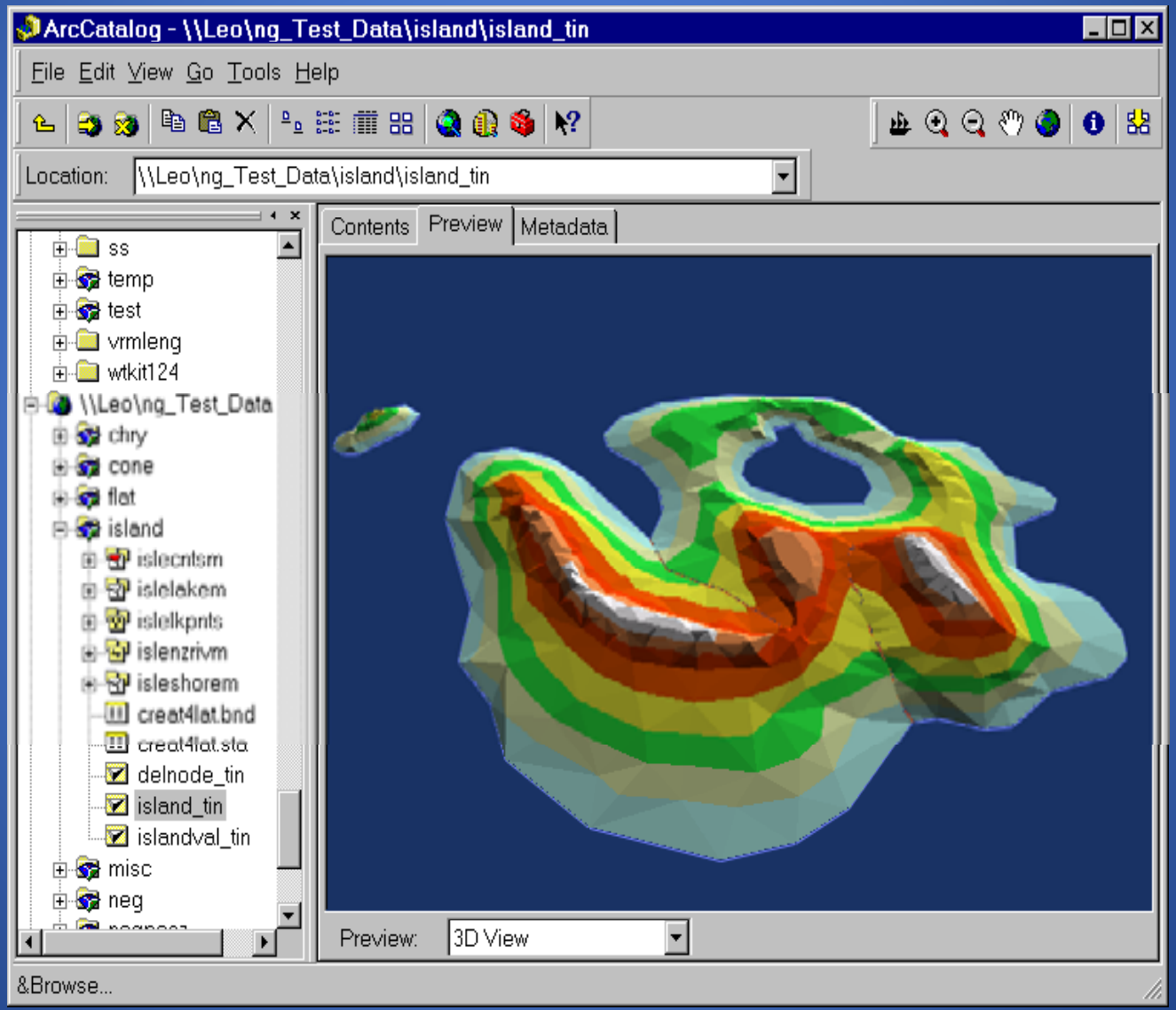
Surface Analysis

- Surfaces can be made from RATIO or INTERVAL data
- Elevation
- Temperature
- Population density
- Land value

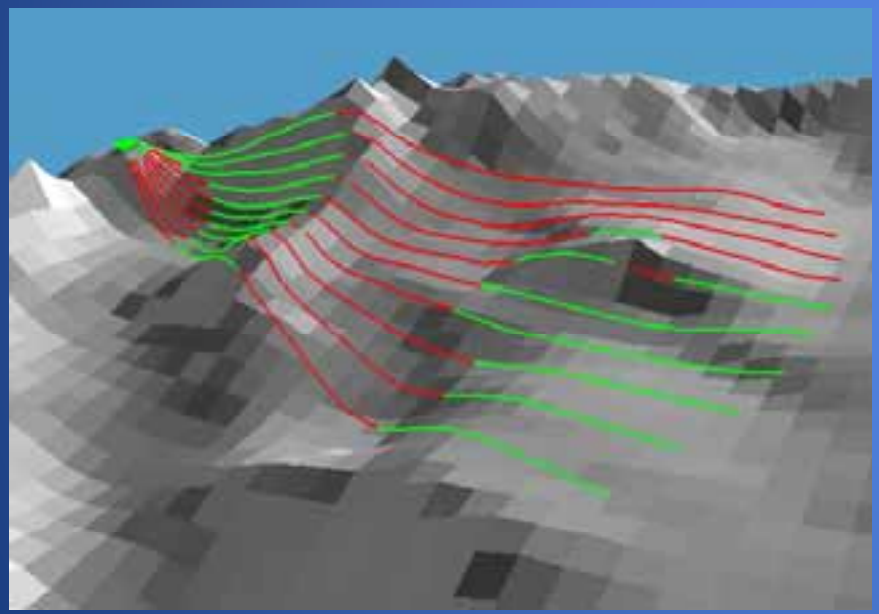
3-D Analyst

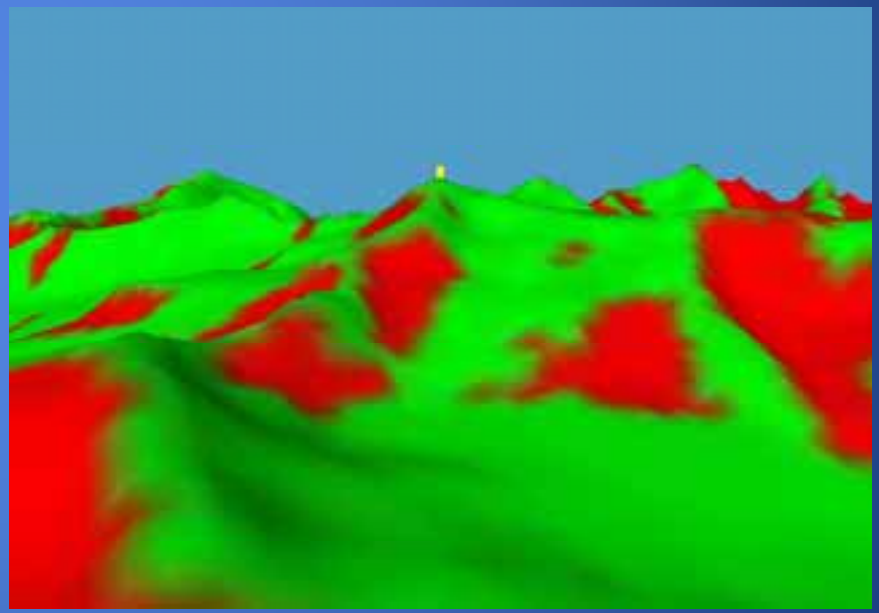

Untitled - ArcScene
File Edit View Insert Selection Tools Window Help
Layers
bldg
ortho.lan
RGB Composite
Red: Layer_1
Green: Layer_2
Blue: Layer_3
Display
Source
Tools
Viewer:
main viewer

Representing a surface as a Terrain

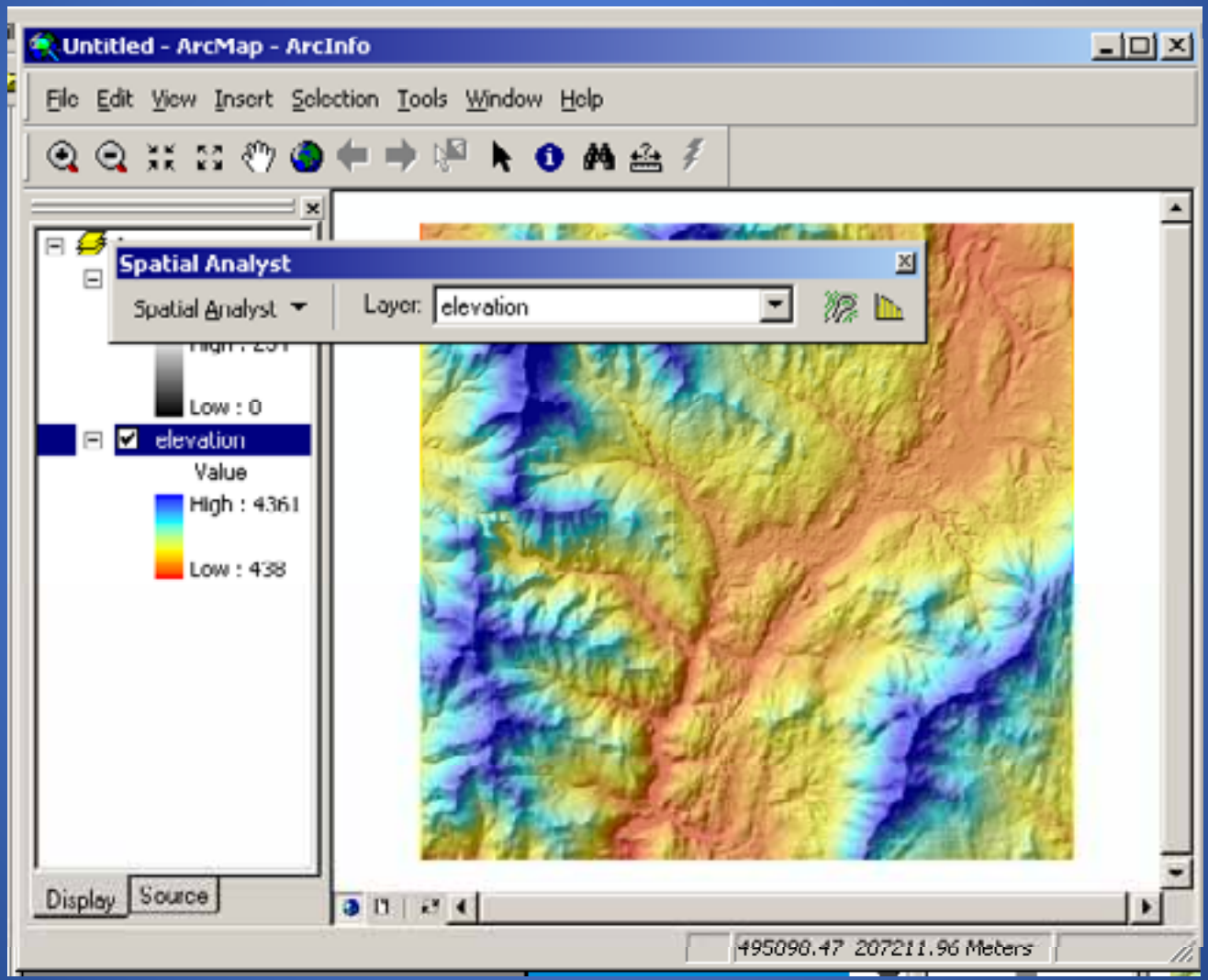


Visibility Analysis

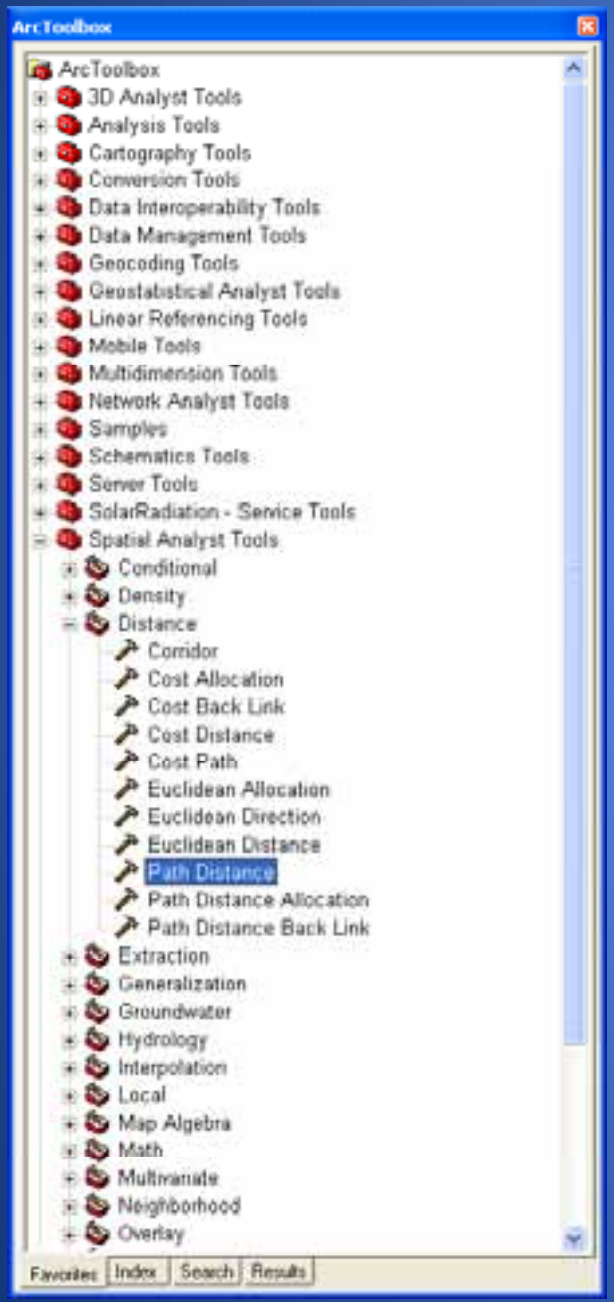


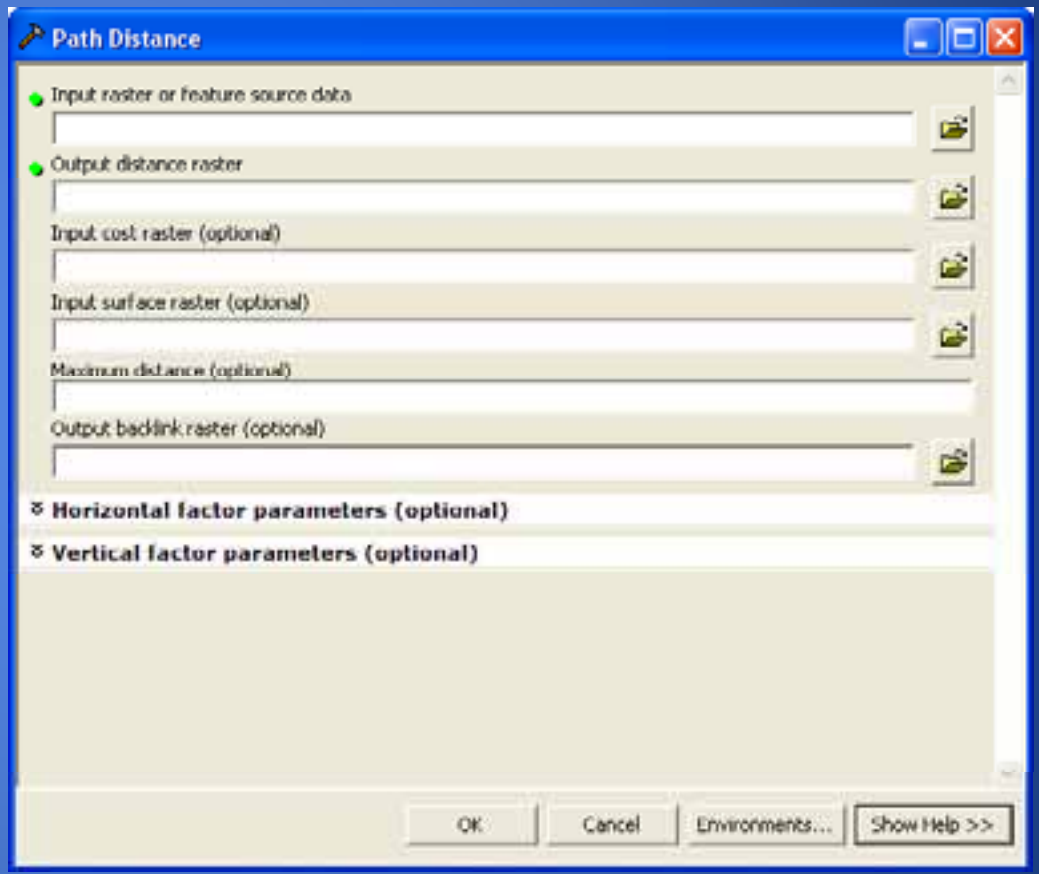


Spatial Analyst

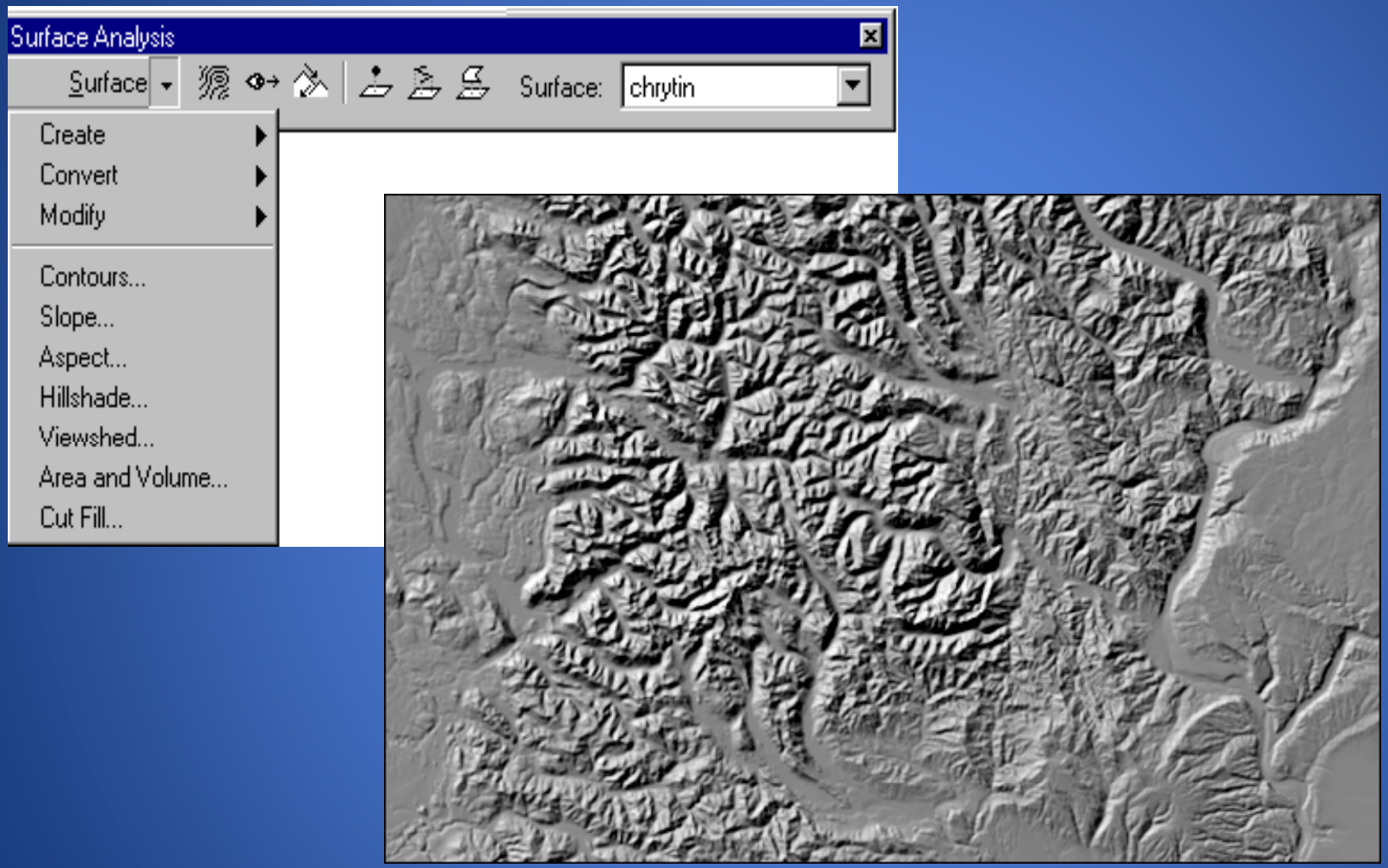


Spatial Analyst Tools

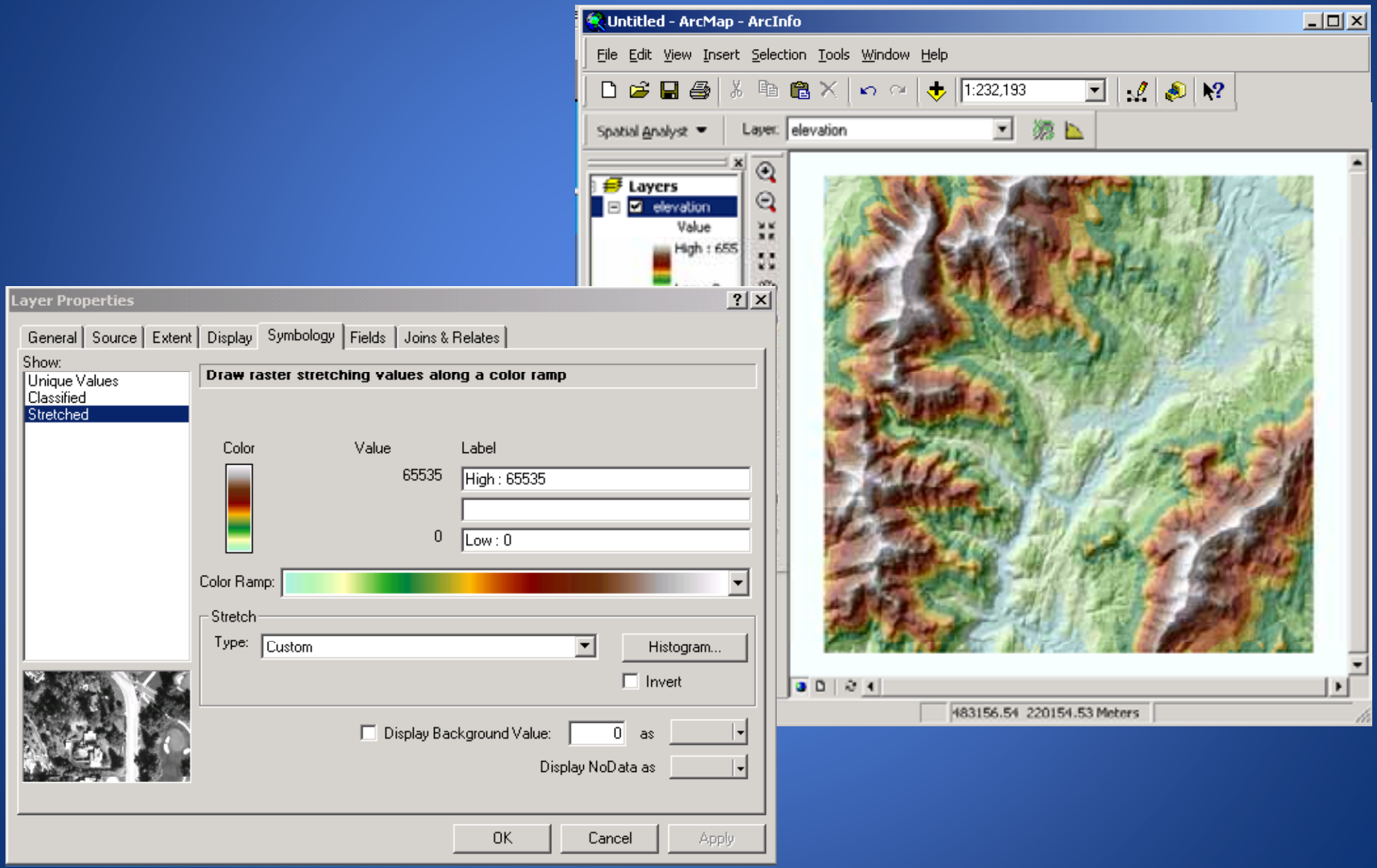




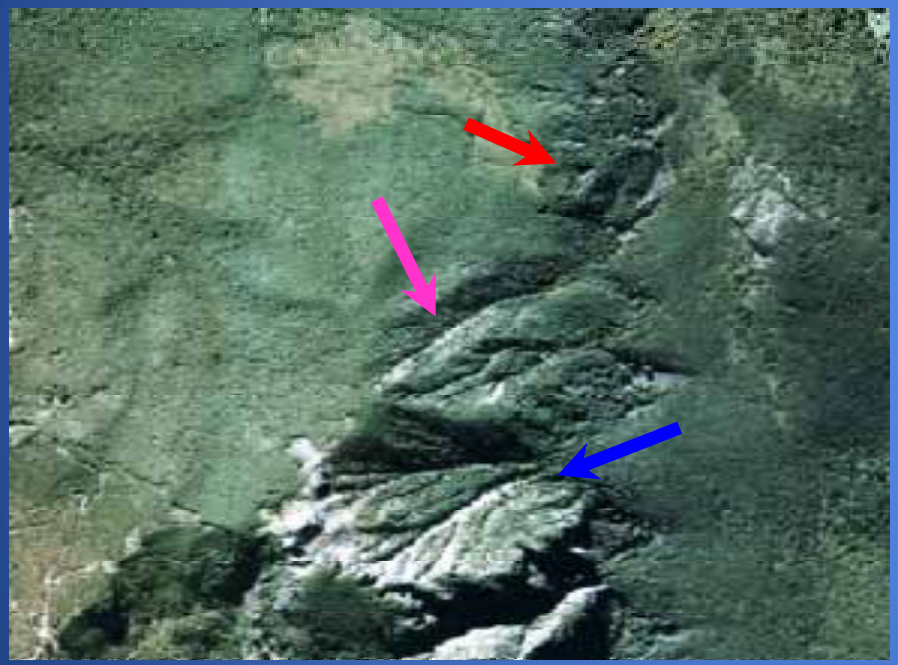
Hillshade

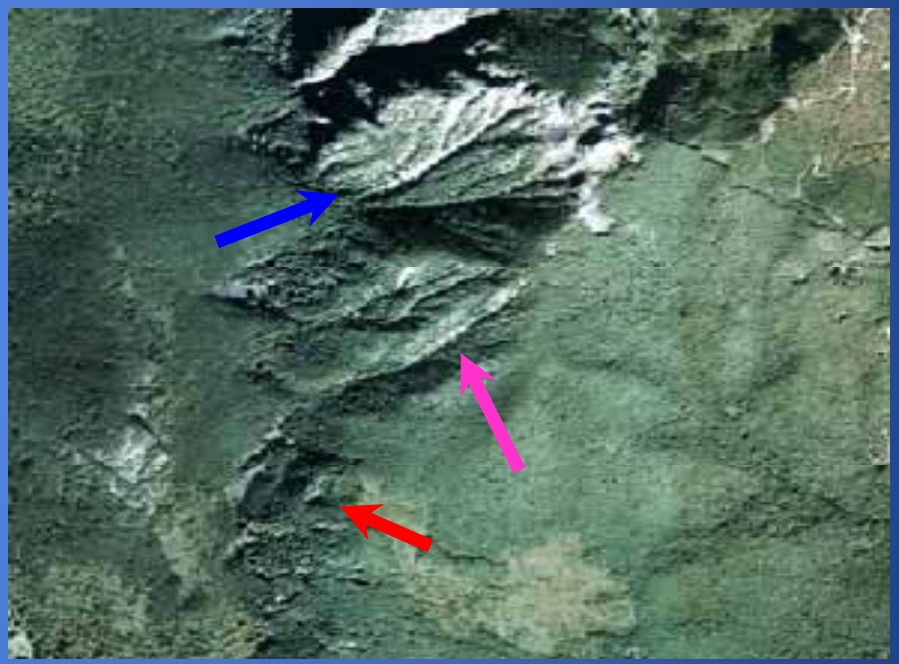

Surface Analysis
Surface
Surface:
chrytin
Create
Convert
Modify
Contours...
Slope...
Aspect...
Hillshade...
Viewshed...
Area and Volume...
Cut Fill...

Using Map Legends

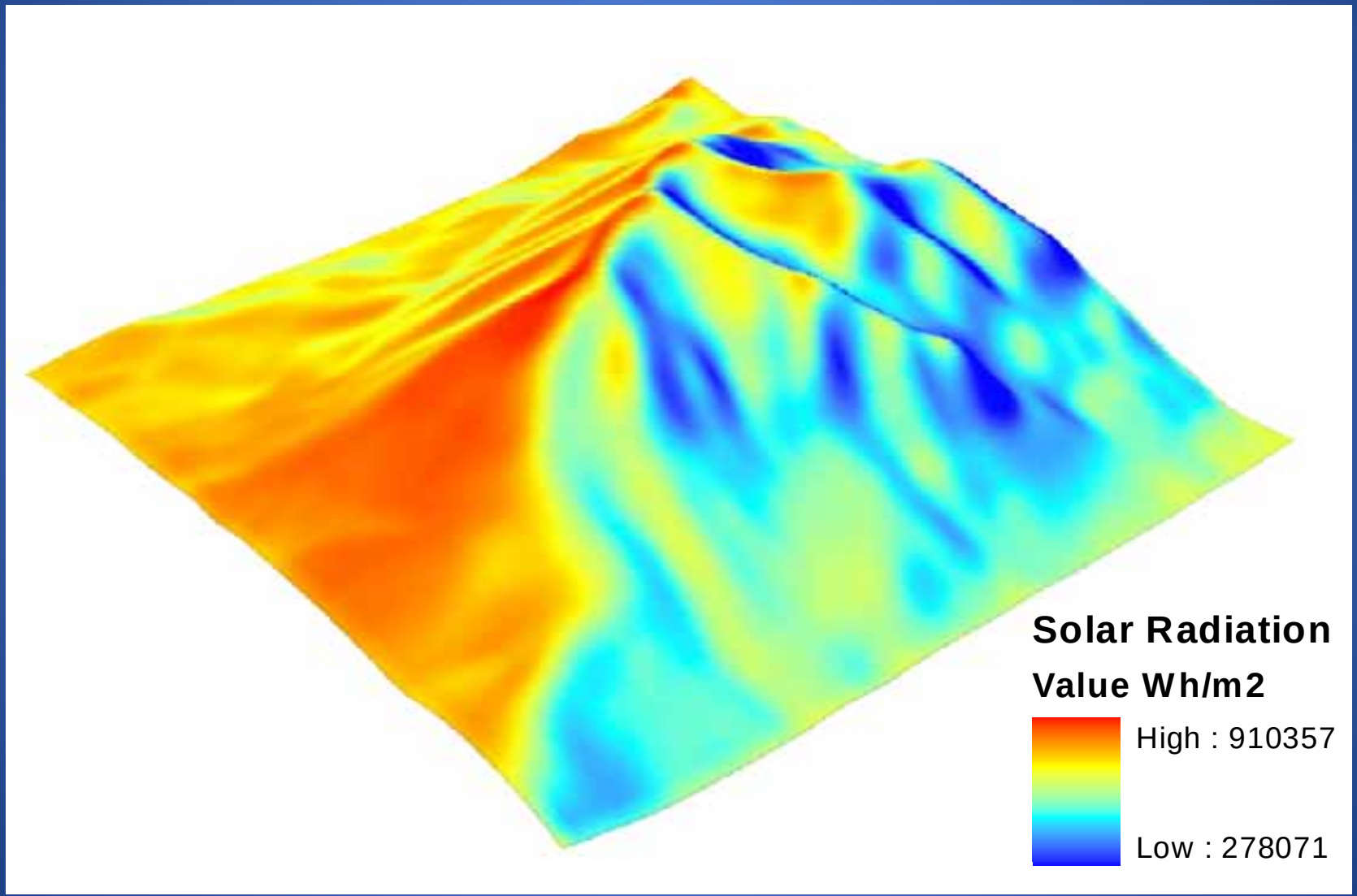


Put the Sun in the North or the Landscape appears inverted!

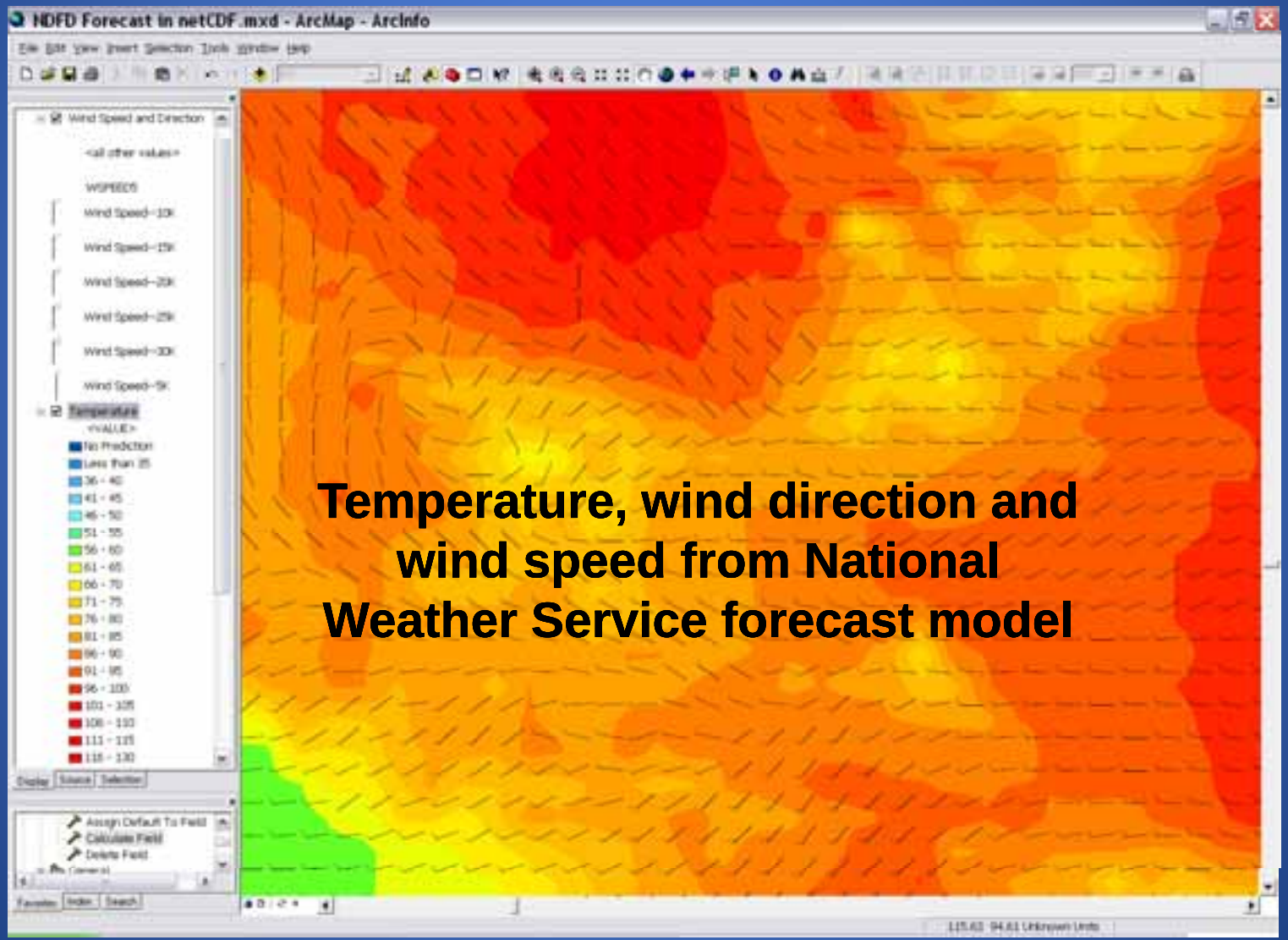




Solar Radiation Analysis

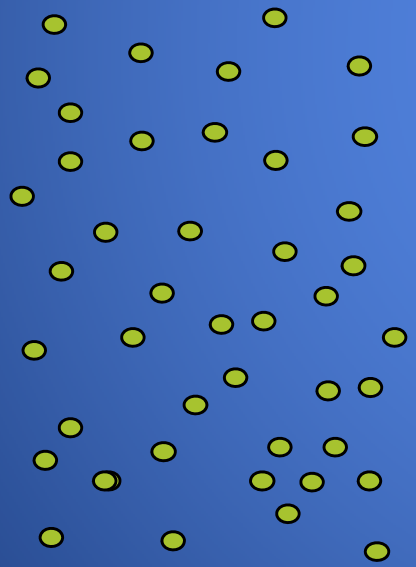


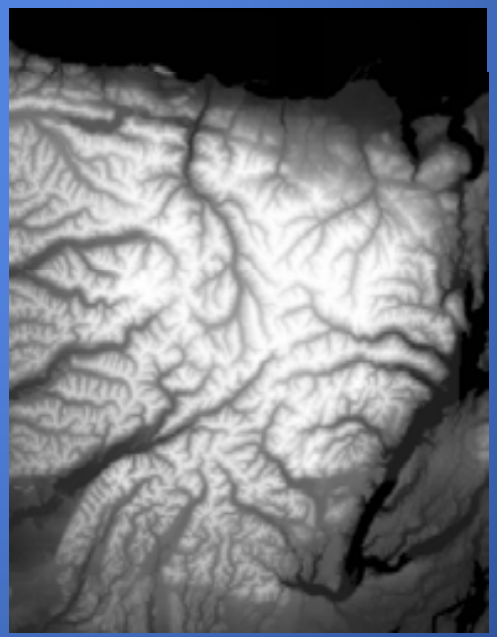
NetCDF Format Handles Multiple Dimensions



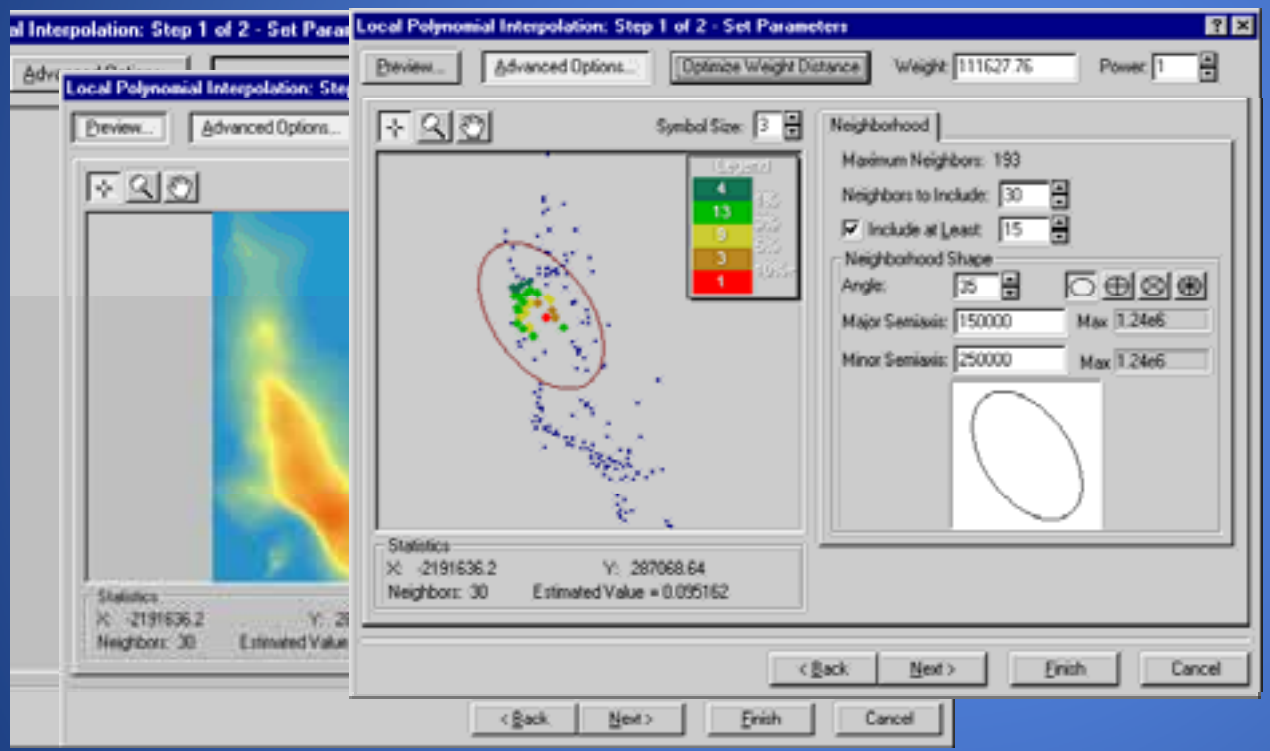
Interpolation

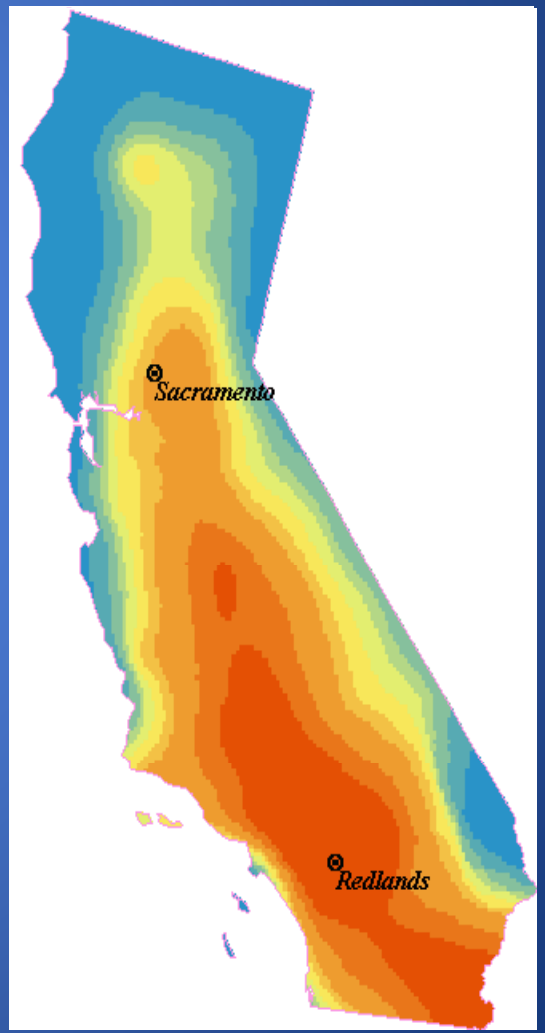
- 3D Analyst
- Spatial Analyst
- Geostatistical Analyst



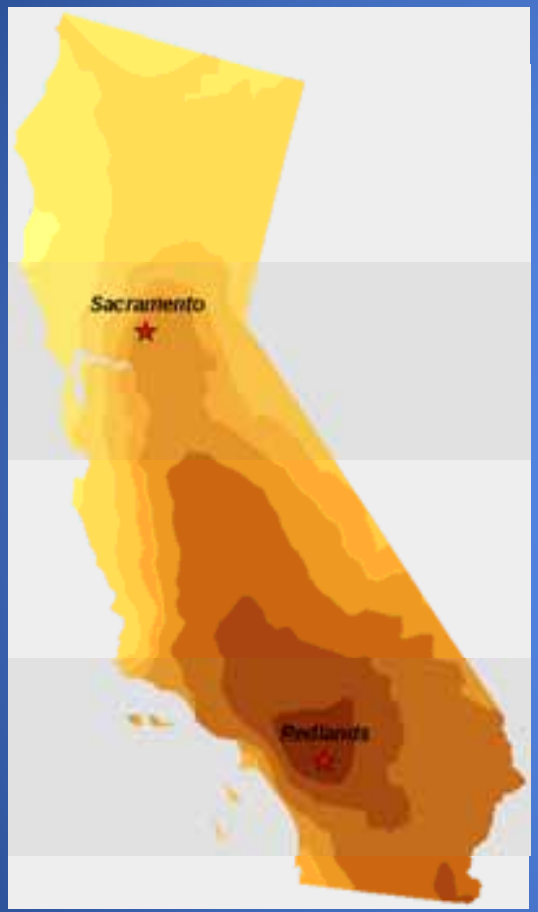


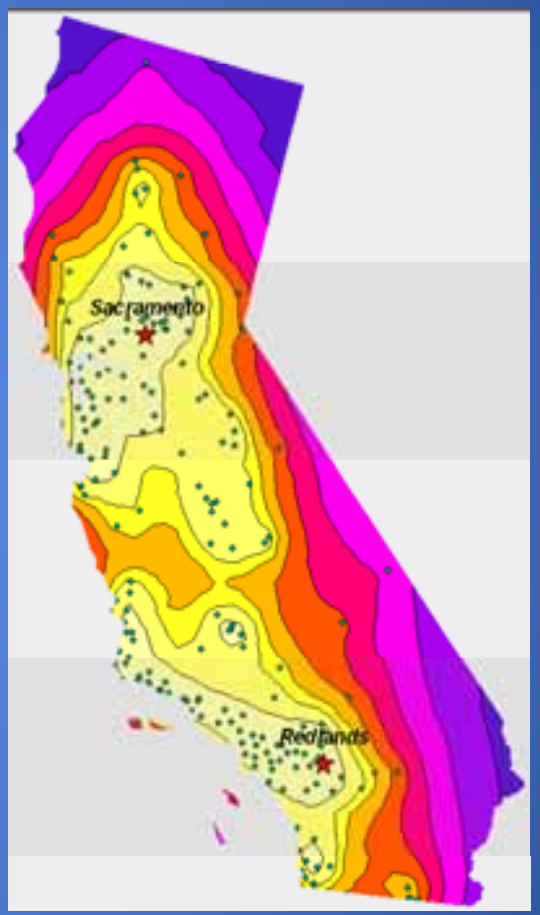
Geostatistical Analyst



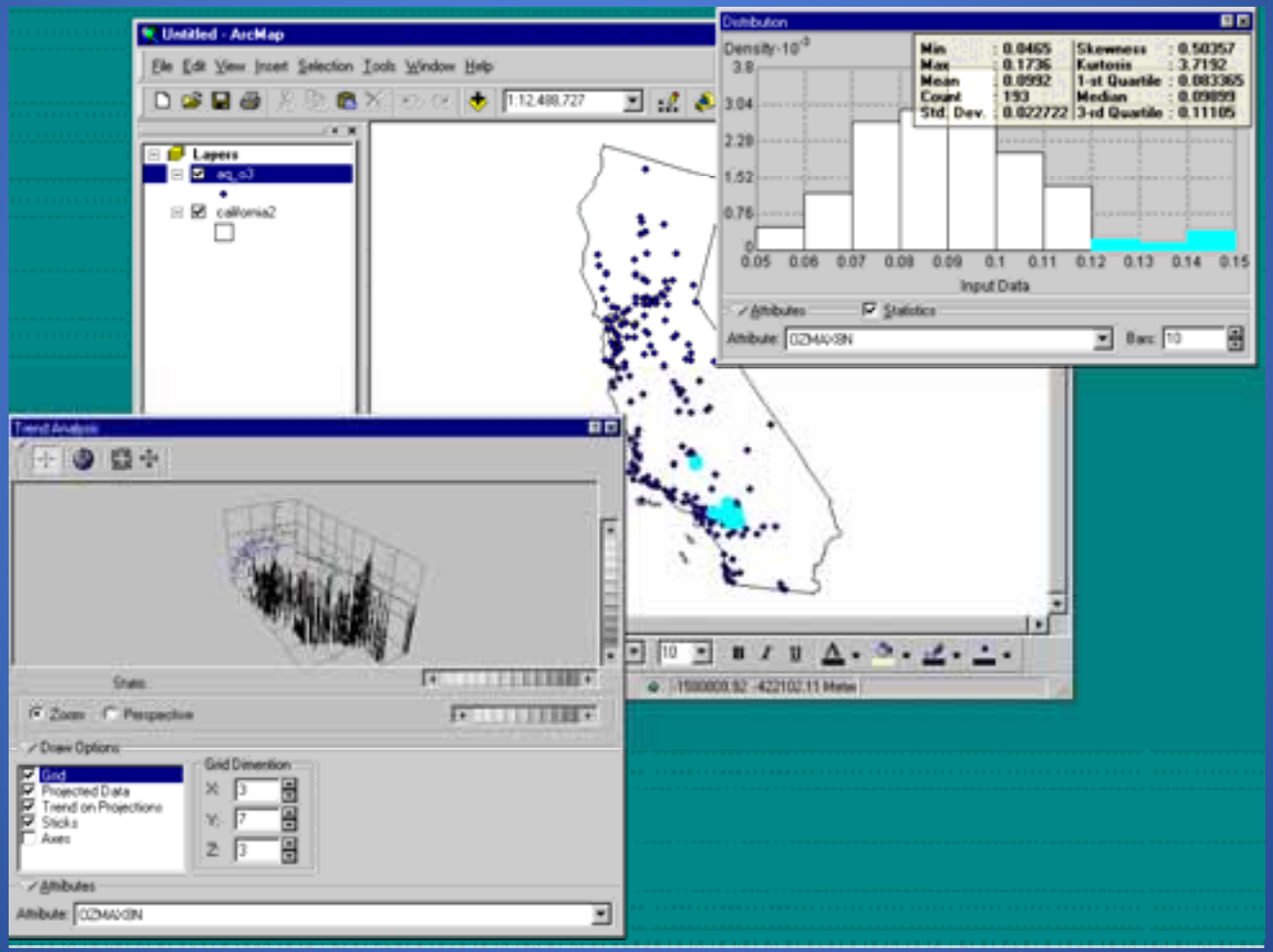


Errors in interpolation



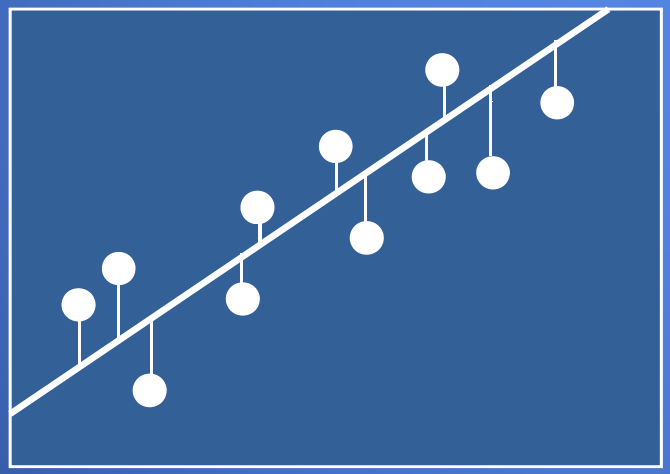


Exploratory Data Analysis



Example: Predicting land value

- Predicted value =
- A0 + A1N1 + A2N2 + ...
- Use comps to create regression equation
- Apply regression equation to predict the value of other parcels



Create Response Surfaces

- Putting the location into location, location, location
  - Neighborhood codes are not good enough
  - Property values respond to much more subtle spatial variations

Interpolating a land value surface

- A land value surface shows underlying land value as hills and valleys
- This surface can be used as a component of the land value estimate
- Surface modeling is useful for estimating how land value trends change spatially

Evaluate Residuals

- Map residuals between regression model predictions and sales
  - ASR – Assessed value/sales ratio
- Interpolate these residuals to a surface
- Refine the model to reduce these residuals

Model Calibration

- Calibration is the process of tuning a model to produce accurate results
- Three main sources of error
  - Omitting important factors
  - Applying incorrect mathematical methods to represent the subject phenomenon
  - Errors in weights or coefficents

Sensitivity Analysis

- **Sensitivity Analysis is the process of systematically determining the importance of each factor to the overall accuracy of the model**
- **Artificially adjust each factor and see how much the overall result is affected**
- **Concentrate your modeling and data collection effort on the most important factors**

Present data to confirm your model

- Visualize data to apply “common sense” confirmation to your model
- Visualize the results to see if they are reasonable
- Compare different model scenarios as surfaces

To learn more

- There are numerous sessions on geographic analysis
  - Friday, February 19 - 8:30 – 10:00 AM
    - Using Spatial Statistics
    - ModelBuilder – An Introduction
    - Introduction to Spatial Analysis for Geospatial Intelligence
  - Friday, February 19 - 10:30 AM - Noon
    - Regression Analysis in ArcGIS

To learn more

- There are a number of tutorials that come with ArcGIS Desktop
  - 3D Analyst
  - Geoprocessing
  - Geostatistical Analyst
  - Network Analyst
  - Spatial Analyst
- ESRI has a large number of training classes
  - http://training.esri.com/gateway/index.cfm

To learn more

- **Geoprocessing Resource Center**

  http://resources.esri.com/geoprocessing/

Thank you for coming.

Enjoy the rest of the conference!