Topic Series 18
GIS Statistical Surfaces

Surface Basics **(Overhead)**

Although we largely tend to think of data for natural resource management as a 2-D phenomenon (**flat maps**), much of the data we work with has either a physical or implied third dimension. The most obvious type of data we use that can be assessed in 3-D is **topography** or that data derived from contour maps or terrain analysis.

With increased capabilities in the computational realm, more analysts are taking advantage of visualization capabilities to better understand trends in data that can be viewed in 3-D. Keep in mind that not only can terrain data be treated this way, but also surfaces derived from a multitude of other variables that we can characterize in geographic space. Examples of other geographic surfaces that can be visualized in 3-D are: weather data (barometric, and temperature maps), oceanographic data, subsurface geology, etc.

When we work with 3-D visualizations, we are manipulating data that have x, y, z components that can be used to create a **statistical surface**. We give it the term statistical surface to denote that it is derived from sampling at some intensity on a regular or irregular sample frame. Since a point has no dimension, it is not possible for us to sample all possible locations that make up the surface.

Surfaces can be based on measured values that are either **continuous** (either **known or derived** value at all possible locations in the represented surface; i.e. A terrain model) or **discrete** (fixed measurement units like integer values for individual locations; i.e. Houses per square mile).

Most of you should be familiar with the concept of **contour lines**; lines that connect points of equal elevation on a map. This is the common construct used to define a topographic surface in 2-D. The general term for lines that connect points of equal statistical value is **isarithm**. In weather data these may be **isobars** (equal pressure) or **isotherms** (equal temperature). The interval or difference in value between isarithms will dictate how rapidly elevations change in value across the surface.

In GIS, **digital elevation models (DEMS)** are used for elevation data. (**overhead**) These are raster surfaces generated from discrete point samples. Each pixel in the DEM has an x, y location and z (elevation) value (**overhead**). Another common approach to representing terrain is through **triangular irregular networks (TIN**). TINs connect adjacent points to form triangular planes (facets) that represent the terrain surface. (**overhead**)

Interpolation **(overhead)**

The Z (elevation/magnitude) values for a continuous surface are based on samples. In order to generate the continuous surface (get information at the un-sampled locations) we must use predict values at locations that are not sampled by use of **interpolation**.

Linear interpolation assumes that the change in value between known points is uniform over the surface (change per unit distance is constant for the distance between the knowns. This method of interpolation is not always appropriate for natural phenomena that we would map. In such instances, we'd use non-linear methods such as **distance weighted**, **polynomials**, **splines (fitted curves)**, and **kriging**.

Terrain Analysis

One of the most practical statistical surfaces is the contour map. Elevations derived from topographic surfaces provide a lot of baseline information that can be used to derive complex relationships about the terrain. For instance, identification of streams and stream divides (the highest points between streams) can be used to define **drainage basins or watersheds.** Similarly, the elevation data can be used to model regions that would be obscured from view from a specific vantage point. The area that can be viewed is called a **viewshed**.

Perspective views - are developed from elevation data by use of raster DEM's or **TIN's** and more advanced raster models with **draped imagery.** **(example overheads)** The perspective is defined by the view location including: **azimuth** (direction you are looking), the **altitude or elevation** above terrain, the **depression angle** (**view angle from horizontal**), the **field of view,** and the **vertical exaggeration** (elevation exaggeration). **(overhead)**

Slope and Aspect - these two terrain variables are important in many types of landscape analysis. **Terrain profiles** can show us the cross section changes in elevation over different paths in possible route selection for engineering processes. **Slope** calculations can be used to determine erosion rates for landscape or traversability of the terrain. **Aspect (the direction of slope)** are often important in ecological studies, particularly in mountains. In the western US, in conjunction with elevation and slope, aspect is a key determinant of vegetation type due to influences on temperature, soil moisture, soil depth and solar illumination.

Discrete Surfaces **(overheads)**

Measurements on points and polygons can be presented in the form of **dot maps** or **choropleth maps**. Dot maps can depict locations where a single observation of a variable occurred (bird sighting) or where multiple observations occurred (flock-o-birds). The way multi-observation or magnitude data in point locations are distinguished is to use variable dot sizes or even graphics such as pie charts. Choropleth maps depict the changes in observed measurements within polygons by using differential shading or colors.