General Notes for the Introductory Workshop on

Grid-based Map Analysis Techniques and GIS Modeling

*Joseph K. Berry, email **jberry@innovativegis.com**, website **www.innovativegis.com/basis***

Beyond Mapping III *online book posted at…*
***www.innovativegis.com/basis/**, select "Beyond Mapping III"*

Example Applications *posted at…*
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Cartography– manual map drafting (paper map legacy for thousands of years)
Computer Mapping– automates the cartographic process (70s)
Spatial Database Management– links computer mapping techniques with traditional database capabilities (80s)
Grid-based Map Analysis and Modeling– representation of relationships within and among mapped data (90s)…

- ✓ *Surface Modeling*– maps the spatial distribution of a set of point sampled data,
- ✓ *Spatial Data Mining*– characterizes the "numerical" relationships among mapped data and develops predictive models,
- ✓ *Spatial Analysis*– derives new information based on "contextual" relationships among mapped data, and
- ✓ *GIS Modeling*– logical processing of spatial information to characterize a system or solve a problem.

*(See Beyond Mapping III online book, "**Topic 4**" and "**Topic 27**" for more information)*

Raster refers to image display (map values represent the color assigned to each dot; e.g., scanned topographic maps–DRGs or aerial photos–DOQs) while **Grid** refers to map analysis (map values have all of the rights, privileges and responsibilities of a map-*ematics*).
Grid data structure the *Analysis Frame* provides consistent "parceling" needed for map analysis and extends points, lines and areas to *Map Surfaces.*
*(See Example Applications, "**Short Video Demos**" for more information)*

Surface Contouring options include *# of Ranges*, *Calculation Method* (e.g., Equal Ranges with same range for each interval and Equal Count with same number of cells for each interval) and *Color Pallet/Ramp* selection.
Grid Display Types are *Lattice* that forms a smooth "wireframe" by connecting cell centroids with lines whose lengths are a function of elevation differences and *Grid* that forms extruded grids whose heights are a function of elevation differences.
*(See Example Applications, "**Display Types**" for more information)*

Grid Data Types are characterized by their *Numeric Distribution* (independent integers versus range of values) and their *Geographic Distribution* (abrupt boundaries versus gradient). A *Discrete* map has values that simply represent categories (e.g., a Cover type map) that form sharp abrupt boundaries) whereas a *Continuous* map has values that represent a spatial gradient (e.g., a slope map).
*(See Example Applications, "**Data Types**" for more information)*

Spatial Analysis investigates the "contextual" relationships in mapped data…

- **Reclassifying Maps**– New map values are a function of the values on a single existing map… no new spatial information is created
- **Overlaying Maps**– New map values are a function of the values on two or more existing maps… new spatial information is created
- **Measuring Distance**– New map values are a function of the simple or weighted distance or connectivity among map features
- **Summarizing Neighbors**– New map values are a function of the values within the vicinity of a location on an existing map.

*(See Beyond Mapping III online book, "**Topic 24**" for more information)*

Reclassifying and Overlaying Maps– reclassifying operations involve the reassignment of the values of an existing map as a function of its initial value, position, size, shape or contiguity of the spatial configuration associated with each map category; overlay operations involve the creation of a new map where the value assigned to every location is computed as a function of the independent values associated with that location on two or more maps (point-by-point, region-wide and map-wide)
*(See Beyond Mapping III online book, "**Topic 22**" for more information)*

Measuring Distance and Connectivity– the concept of *Distance* as the "shortest straight line between two points" is expanded to *Proximity* by relaxing the assumption of only "two points" then expanded to *Movement* by relaxing the assumption of "straight-line" connectivity.
*(See Beyond Mapping III online book, "**Topic 13**," "**Topic 14**" and "**Topic 25**" for more information)*
*(See Example Applications, "**Determining Proximity**" and "**Creating an Up-Hill Road Buffer**")*

Calculating Visual Exposure– a *Viewshed* identifies all locations that can be seen from a view point(s) while *Visual Exposure* develops a relative scale indicating the number of times each location is seen from a set of viewer points (e.g., a road network).
*(See Beyond Mapping III online book, "**Topic 15**" for more information)*
*(See Example Applications, "**Determining Visual Exposure**" and "**Modeling Visual Exposure**)*

Summarizing Neighbors– a *Diversity Map* indicates how many different types, a *Roughness Map* identifies the variation in slope values, and a *Density Map* reports the total value within a specified distance of each grid location.
*(See Beyond Mapping III online book, "**Topic 11**"and "**Topic 26**" for more information)*
*(See Example Applications, "**Assessing Cover Type Diversity**")*

Surface Modeling maps the spatial distribution and pattern of point data…
- ✓ **Map Generalization**– characterizes spatial trends (e.g., titled plane) by considering all of the samples at once as it fits a surface,
- ✓ **Spatial Interpolation**– derives spatial distributions (e.g., IDW, Krig) by considering small, localized set of samples throughout the map area (roving window), and
- ✓ **Other**– roving window and facets (e.g., density surface; tessellation)

*(See Beyond Mapping III online book, "**Topic 2**", "**Topic 3**" and "**Topic 8**" for more information)*

Spatial Data Mining investigates the "numerical" relationships in mapped data…
- ✓ **Descriptive**– calculates aggregate statistics (e.g., average/stdev, similarity, clustering) that summarize mapped data,
- ✓ **Predictive**– develops relationships among maps (e.g., regression) that can be used to forecast characteristics or conditions at other locations or times, and
- ✓ **Prescriptive**– uses descriptive and predictive information to optimize appropriate actions.

*(See Beyond Mapping III online book, "**Topic 7**", "**Topic 10**" and "**Topic 16**" for more information)*

GIS Models come in three basic types…
- ✓ **Suitability Models**– based on logically sequenced decision criteria similar to a recipe (e.g, animal, shopper and pipeline "habitat")…
  - **Binary Model**– identifies areas that are acceptable based on combining binary maps (0 and 1),
  - **Ranking Model**– develops a ranking of areas based on the number of criteria that are acceptable (0 to 3), and
  - **Rating Model**– develops a "goodness" scale (0 to 9 best) and calculates the average rating for each grid cell.
- ✓ **Statistical Models**– based on numerical relationships (e.g., crop yield), and
- ✓ **Process Models**– based on physical (e.g., erosion potential)

*(See Beyond Mapping III online book, "**Topic 17**", "**Topic 19**", "**Topic 20**" and "**Topic 23**" for more information)*

Capturing and Communicating Model Logic– a flowchart is used where boxes represent maps and lines represent analytical operations to identify the processing steps linking command scripts to mapped data.
*(See Beyond Mapping III online book, "**Topic 21**" for more information)*

Data Conversion investigates vector to/from raster data exchange…
- ✓ **V to R–** burning the points, lines and areas into the grid (fat, thin and split),
- ✓ **R to V–** connecting grid centroids, sides and edges (line smoothing), and
- ✓ **Pseudo Grid–** each grid cell is stored as a polygon

*(See Beyond Mapping III online book, "**Topic 18**" for more information)*
