
There are a few books in this world that are known universally by a single word. Within the domain of those interested in the subject, David Watson’s “Contouring” may become one of these, by virtue of being cited, checked, and quoted by those struggling with the problem of representing supposedly continuous surfaces defined by a few, arbitrarily distributed data.

This does not necessarily make the book ideal, easy, or even satisfying. It is often infuriating in the level of coverage of various topics, appearing at places to contain too much detail, and at other places too little. Nevertheless, it seems to be a basic resource that cannot be ignored, and it is certainly one of the few books to address the variety of, and assumptions about, methods of surface representation at the level needed for most geoscientists.

In order to understand this book, it is first necessary to grasp something of the motivation behind it. Central to the text itself is a collection of six programs written in BASIC and given in the Appendix and on the diskette. (These are actually doubled-one of each for screen output and for plotter.) These each implement one general category of interpolation methods: “rectangle-based”, “fitted-function”, “distance-based”, “triangle-based” and “neighborhood-based” (two). Each of these may have various options for gradient estimation and screen or plotter output, etc. The programs are designed to function on a minimal PC system, with a simple BASIC interpreter, and most options are selected by modifying a line in the BASIC code. They all seem to function well, although my first criticism concerns the absence of any statement about the BASIC interpreter needed. In the test runs, however, it was necessary only to change the name of one parameter that happened to conflict with a reserved name. Thus the code is close to being “standard”. Also worth noting, but unstated, is that the plotter output assumes standard HPGL plotter emulation. The code itself is an invaluable “hands-on” source of algorithms for those wishing to include the book’s ideas in their own programs, although more internal documentation would be desirable.

The second part of the motivation for this book comes from the realization by several researchers in the early 1980s that for many types of interpolation, traditional algorithms were posing the question incorrectly. Attempting to fit functions of the arbitrary X, Y coordinate system to arbitrarily distributed data produced inadequate results whenever it was expected that the surface would precisely fit the data and produce no “artifacts” (visible rapid changes in elevation or slope not justified by the data). This problem arises especially in the geosciences, because we are trained to interpret subtle surface changes as meaningful, whereas to a mathematician the production of surface and slope continuity seems to resolve the issue. The 1980s researchers concerned reversed the question, and generated local coordinate systems based on the local data distribution. These could be shown to have properties definable at each data point and its immediate neighborhood. These are variously known as “natural neighbor” or “area-stealing” methods, and are based on the Voronoi diagram (the dual of the Delaunay triangulation, used for Triangulated Irregular Network generation). These are effectively “object-oriented” rather than “coordinate-oriented” methods. Watson was one of these researchers, and many parts of the book compare this approach with various, more traditional, methods.

Given this background, the structure of the book becomes clear. The short Part 1 describes in simple terms how to run the sample programs, prepare data sets, select the options and specify the screen display parameters. A small section also is included that describes area, volume, and circumcenter calculations for triangles and tetrahedra.

Part 2 starts with a useful survey of traditional manual methods and some of the problems to be resolved, in particular problems of arbitrary data distribution, surface plausibility and precision. The commonsense observations presented here should be required reading for every geoscience undergraduate (and many graduates as well). Then follows a section on data sorting-in particular proximal ordering, especially with the natural-neighbor definition of proximity. This is not particularly easy reading, but it may help to comment that perhaps the most useful proximal ordering of a data set is its Delaunay triangulation, with which many people are familiar.

The next section discusses subset selection—which nearby data points to use for a weighted-average estimate, for example. Most algorithms fail here, as data may be accepted into, or rejected from, the subset while having a nonzero influence. This produces discontinuities in the resulting surface that may be masked by the coarse grid usually generated. This, along with the following section describing local coordinate systems, should be reread several times until the message sinks in. It is followed by a nice
discussion of gradient-estimation techniques, including least-squares, spline, cross-product and neighborhood methods. These are needed in the next section on interpolation, in order to generate surfaces that approach good elevation and slope values as the surface approaches the data point.

Watson defines “ideal” interpolation as a surface that: fits the data to a specified level of precision; is single-valued, continuous and smooth at all locations; depends on a local subset of the data (determined by the local data configuration); and has some control of surface “tautness”. He summarizes fitted function (trend-surface) methods as well as various manual methods including proximal polygons, triangulations, grids, and inverse-distance weighting. He categorizes computer methods into distance-based methods (inverse-distance weighting observations; inverse-distance weighting gradients; blended inverse-distance weighted surfaces), fitted-function methods (Lagrange; collocation; minimum-curvature splines; kriging; relaxation surfaces; approximation surfaces), triangle-based methods, rectangle-based methods and neighborhood-based methods. Each category may have half-a-dozen specific approaches, and this forms a most comprehensive survey, complete with an easily readable summary of the properties (good and bad) for each. In so doing he has included weighted averages, bilinear and Bezier patches, and Taylor interpolants, to name a few. The neighborhood-based methods include linear, gradient, and blended-gradient approaches, and he notes that these (especially the blended-gradient approach) come closest to his ideal. The next section elaborates on global and local blending functions, as well as roughness and outlier indexes. These descriptions, along with the BASIC code listings, should suffice to describe all the methods mentioned. The last sections cover output display and efficiency issues. There is an extensive bibliography, and full program listings.

As mentioned in my introduction, this is not always an easy book to follow, and personally I would have appreciated a more extended description of the comparative advantages of the natural-neighbor approach, as well as more explanatory figures and internal documentation of the BASIC code. Nevertheless, I believe that this book brings out into the open most of the decisions necessary for developing and choosing interpolation methods for “precise” data, and will be referenced extensively over the next few years. If you are in the business of making those decisions—make sure you can say “Watson says...!” I for one have clarified many details of contouring practice from reviewing this book.

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