

Geostatistics for Environmental Exposure Mapping and Assessment

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1:00pm-5:00pm

Geostatistics is the set of statistical techniques used in the analysis of spatially referenced data. A common application of geostatistics is in mapping environmental exposures, for example mapping air pollution based on data from a set of monitoring stations. Even when spatial prediction is not the primary objective, as with problems in environmental exposure assessment, geostatistical techniques can and should be considered.

In this half day workshop we will provide the statistical framework for geostatistics beginning with a brief introduction on where geostatistics fits under the larger umbrella of spatial statistics. The concepts of spatial dependence, variograms, and kriging will be covered in applications of environmental exposure mapping. The use of geostatistics in models of exposure assessment will be motivated by considering the potential for residual spatial variation and its effects on model inference. The workshop will conclude with a discussion on geostatistical computing and a demonstration in the R Statistical Computing Environment.

References Requested

As requested I have put together a list of references on geostatistics some covering other areas of spatial statistics. There are certainly more out there, but these are the ones I have on my shelf. If you have a suggested reference I would be happy to review it and provide some feedback.

- Waller, LA and Gotway CA (2004) *Applied Spatial Statistics for Public Health Data*, Wiley, NY.

A nice recent and readable text covering all 3 areas of spatial statistics I mentioned in the introduction. The chapter on geostatistics takes a more traditional approach but still a very worthwhile reference. From the title you can see the focus is in public health and there are some upfront supporting chapters along these lines.

- Diggle, PJ (2003) *Statistical Analysis of Spatial Point Patterns*, second edition, Arnold, London.

Another nice readable text with primary focus on the analysis of point pattern data, that being where the locations are the data denoting occurrence of events.

- Lawson, AB and Williams, FLR (2001) *An Introductory Guide to Disease Mapping*, Wiley, NY.

I am not all that familiar with this book, although I do know as the title suggests its very introductory. Very low on the technical and very high on the words. Not necessarily focused on geostatistics, but I believe more on the analysis of aggregated areal level data, rates, standardization techniques, etc.

- Lawason, AB (2001) *Statistical Methods in Spatial Epidemiology*, Wiley, NY.

A follow up to his introductory text listed above. Definitely at a higher technical level with focus still on disease mapping, dealing more with aggregated areal level data and some point pattern data with little to no geostatistics.

- Elliott, P, Wakefield, JC, Best, NG, and Briggs, DJ (eds) (2000) *Spatial Epidemiology: Methods and Applications*, Oxford University Press, NY.

This edited volume has several research type papers covering all aspects of spatial statistics in regards to epidemiological research and practice. The level is mixed. There is one chapter on geostatistics written by Noel Cressie. Peter Diggle has a nice overview chapter and there is another chapter taking a critical look at all those cluster detection algorithms currently used.

- Cressie, NC (1991) *Statistics for Spatial Data*, Wiley, NY.

A very comprehensive and technical text on all fields of spatial statistics. Although written some 15 years ago (second edition in 1995 I think) still provides a great reference for those with research focus in these areas. Although not a text I would recommend for non-statisticians.

- Journel AG and Huijbregts ChJ (1978) *Mining Geostatistics*, Academic Press, NY.
One of the first texts written on the subject of geostatistics. Journel is more of an earth scientists than statistician. A very hard book to read one reason being if you are not familiar with mining and earth science terminology. Not a text I would recommend at all, unfortunately this is what was available to me at the time I was trying to learn geostatistics.
- Isaaks EH and Srivastava RM (1989) *An Introduction to Applied Geostatistics*, Oxford University Press, NY.
The title is certainly appealing. The book takes a very traditional approach, and is now 15 plus years old. The authors are out of the Journel camp and there are some things in the book I certainly don't agree with.
- Diggle, PJ et al. (1998) Model-based Geostatistics, *Applied Statistics*, 47, 299-350.
The article I made reference to at the workshop. A very up to date and unifying approach to geostatistics covering the analysis of continuous as well as count and binomial related spatial data. The article has several highly regarded discussants making it a good article to be familiar with, however it may be at a statistical level a bit higher than what may be appropriate for the workshop audience.
- Bailey TC and Gatrell, AC (1995) *Interactive Spatial Data Analysis*, Pearson Education Limited, England.
Covers all areas of spatial statistics. The geostatistics chapters are more traditional. Overall the book has very nice interpretations of techniques and a well written teaching style. At the time an excellent book and still remains a valuable resource.
- Lawson, AB and Kleinman K (eds) (2005) *Spatial and Syndromic Surveillance for Public Health*, Wiley, NY.
A very recent book, see amazon.com for product details. This is a semi hot topic now, especially following the 911 attacks and more recent terror events.
- <http://sal.uiuc.edu/csiss/Rgeo/>
This is the R web site that covers what is available for the analysis of spatial data within R. I showed this in the workshop. There is also a link for those components of R that focus on geostatistics.