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(Kulldorff M. 1998, Lawson A.B. 1993,  
.Bithell J.F. 1995)

)  
.Rezaeian M. 2001, English D. 1996)

(Rushton G. and Lolonis P. 1996,  
Openshaw S. et. al. 1987, Kulldorff M. and  
.Nagarwalla N. 1995)

(Moore D.A. (Disease clustering)  
.and Carpenter T.E. 1999)

.(Everitt B.S.E. 1995)

(general clustering)  
large scale )

(Snow)

(clustering

.(Snow J. 1854)

(spatial autocorrelation)

(specific clustering)

(focused)

Besag J. and Newell ) (non-focused)

.(J. 1991

.(Moore D.A. and Carpenter T.E. 1999)

Odland J. )

.(1988

.( )

.(Odland J. 1988)

.(Rosenberg S.M. et al. 1999)

(Smoothing)

Moore D.A. and Carpenter T.E. )

.(1999

.(Bailey T.C. and Gatrell A.C. 1995)

.(Olsen F.S. et al. 1996 )

( global smoothing)

(Bell (local smoothing)

.B.S and Broemeling L.D. 2000)

(Moran  $I$ )

:(Moran P.A.P. 1948)

$$I = \frac{n \sum_i \sum_j W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_i \sum_j W_{ij} \sum_i (x_i - \bar{x})^2}$$

.(Olsen F.S. et al. 1996)

(statistical model)

$$I = \frac{\sum_i \sum_j W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_i \sum_j W_{ij} \sum_i (x_i - \bar{x})^2}$$

(Cogn

.D. et al. 2003)

(Poisson model)

(Moran  $I$ )

correlation

Semenciw R.M. et al. )

( ) (2000)  
(Semenciw)

(Bailey T.C. and

.Gatrell A.C. 1995)

Semenciw ) / (Moran  $I$ )

.(R.M. et. al. 2000

Geary's  $c$

.(Lorant V. 2001)

Geary R.C. )

.(1954

$$c = \frac{(n-1) \sum_i \sum_j W_{ij} (x_i - x_j)^2}{2(\sum_i \sum_j W_{ij}) \sum_i (x_i - \bar{x})^2}$$

spatial )

(models

Mollie )

.(A. and Richardson S. 1991

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(Sainsbury P. 1955, Ashford  
 J.R. and Lawrence P.A. 1976, Congdon P. 1996, McLoone P. 1996, Whitley E. et al. 1999, Crawford M.J. and Prince M. 1999, Gunnell D. et al. 2000) .( )  
 .(Wakefield J.C. et al. 2000)

(Lester D. 1989, Wasserman  
 I.M. and Stack S. 1995, Rezaeian M. et al. 2001, Rezaeian M. et al. 2004)  
 (Lester)

)  
 / (Moran  $I$  ) .(Walter S.D. 1992)  
 (binary)

.(Lester D. 1989)

(Wasserman) (Stack)  $W_{ij}$   
 ( Moran  $I$  ) .(Semenciw R.M. et al. 2000)

/

/ (Geary's  $c$ ) (Moran  $I$ )  
 (Walter S.D. 1992)

.(Wasserman I.M. and Stack S. 1995)

(Local Authorities)

( Geary's  $c$  ) / ( Moran  $I$  ) .1977)  
 / (STATA)

.(STATA Corp. 1999)

(Rezaeian M. et al. 2001,  
 Rezaeian M. et al. 2004) :

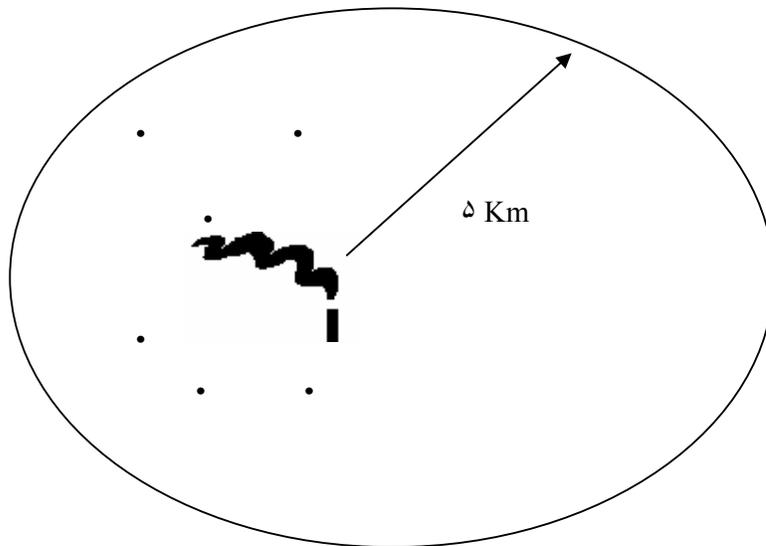
(Semenciw)  
 /  
 Semenciw R.M. et al. )  
 (Lester) (2000)

Rezaeian M. et al. )

(2001

(Upton G.

and Fingleton B. 1985)



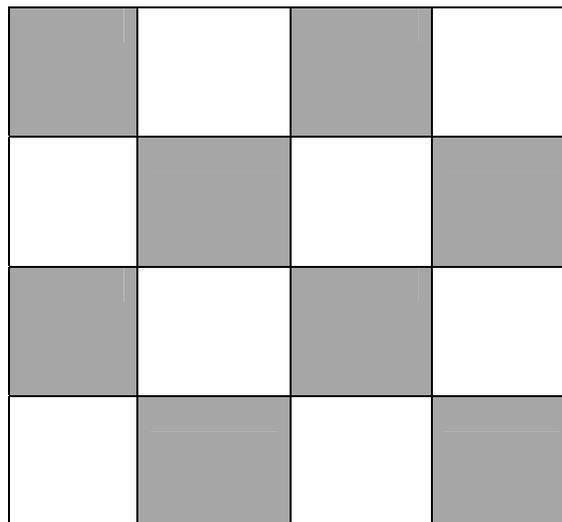
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Bell B.S. and Broemeling L.D. (2000) A Bayesian analysis for spatial processes with application to disease mapping. *Stat Med*, **19**: 957-974.

Besag J. and Newell J. (1991) The detection of clusters in rare disease. *J R Stat Soc Ser A*, **154**: 143-155.

Bithell J.F. (1995) The choice of test for detecting raised disease risk near a point source. *Stat Med*, **14**: 2309-22.

Cogg D., Geoffrey R. and Barker D.J.P. (2003) *Epidemiology for the Uninitiated*. England: BMJ Publishing Group.

Congdon P. (1996) Suicide and parasuicide in London: a small-area study. *Urban*

Ashford J.R. and Lawrence P.A. (1976) Aspects of the epidemiology of suicide in England and Wales. *IntJ Epidemiol*; **5**(2): 133-144.

Bailey T.C. and Gatrell A.C. (1995) *Interactive spatial data analysis*. Harlow: Longman.

- Moore D.A., and Carpenter TE. (1999) Spatial analytical methods and geographical information system: use in health research and epidemiology. *Epidemiol Rev*, **21** : 143-161.
- Moran P.A.P. (1948) The interpretation of statistical maps. *J R Stat Soc Ser B*, **10**: 243-251.
- Odland J. (1988) *Spatial autocorrelation*. California: Sage Publication.
- Olsen F.S., Martuzzi M. and Elliot P. (1996) Cluster analysis and disease mapping- Why, when, and how? A step by step guide. *BMJ*, **313**: 863-6.
- Openshaw S., Charlton M., Wymer C. and Craft A.W. (1987) A mark 1 geographical analysis machine for the automated analysis of point data sets. *Int J Geogr Inf Sys*, **1**: 335-358.
- Rezaeian M. (2001) In the review of the book: An introductory guide to disease mapping. *Stat Methods Med Res*, **10**: 445-446.
- Rezaeian M., Dunn G., St. Leger S. and Appleby L. (2001) Spatial epidemiology of suicide in England and Wales. First European conference, Geographical Information Sciences in Public Health, Sheffield, England. The slide presentation can be viewed at: ([http://gis.sheffield.ac.uk/newconferencepages/slides/ppslides/R\\_ezaeian.htm](http://gis.sheffield.ac.uk/newconferencepages/slides/ppslides/R_ezaeian.htm)).
- Rezaeian M., Dunn G., St. Leger S. and Appleby L. (2004) The production and interpretation of disease maps: A methodological case-study. *Soc Psychiatry Psychiatr Epidemiol*. (in press).
- Rosenberg S.M., Sokal R.R., Oden N.L. and DiGiovanni D. (1999) Spatial autocorrelation of cancer in Western Europe. *European J Epidemiol*, **15**: 15-22.
- Rushton G. and Lolonis P. (1996) Exploratory spatial analysis of birth defect rates in an urban population. *Stat Med* 1996, **15**: 717-26.
- Sainsbury P. (1955) *Suicide in London*. London: Chapman and Hall.
- Semenciw R.M., Le N.D., Marrett L.D., Robson D.L., Turner D. and Walter S.D. (2000) Methodological issues in the development of the Canadian Cancer Incidence Atlas. *Stat Med*, **19**: 2437-2449.
- Snow J. (1854) *On the mode of communication of cholera*. London: Churchil Livingstone.
- STATA Corp. (1999) Stata statistical software: Release 6.0. College Station, *Stud*, **33**: 137-158.
- Crawford M.J. and Prince M. (1999) Increasing rates of suicide in young men in England during the 1980s: the importance of social context. *Soc Sci Med*, **49**(10): 1419-1423.
- English D. (1996) Geographical epidemiology and ecological studies. In Elliott P, Cuzik J, English D, Stern R. (1996) *Geographical and environmental epidemiology- methods for small area studies*, pp 3-13. Oxford: Oxford University Press.
- Everitt B.S.E. (1995) *The Cambridge dictionary of statistics in the medical sciences*. Cambridge: Cambridge University Press.
- Geary R.C. (1954) The contiguity ratio and statistical mapping. *Incorporated Stat*, **5**: 115-145.
- Gunnell D., Middleton N., Whitley E., Frankel S. and Dorling D. (2000) An investigation into recent temporal trends and geographical patterns of suicide. Bristol: University of Bristol.
- Jumars P., Thistle D. and Jones M. (1977) Detecting two dimensional spatial structure in biological data. *Oncologia*, **28**: 109-23.
- Kulldorff M. (1998) Statistical methods for spatial epidemiology: tests for randomness. In Gatrell A, Loytonen M. *GIS and health*, pp 49-62. London: Taylor and Francis.
- Kulldorff M. and Nagarwalla N. (1995) Spatial disease clusters: detection and inference. *Stat Med*, **14**: 799-810.
- Lawson A.B. (1993) On the analysis of mortality events associated with a prespecified fixed point. *J R Stat Soc Ser A Stat Soc*, **156**(3): 363-77.
- Lester D. (1989) Geophysical variables and behaviour: LVI. The spatial autocorrelation of States' suicide and homicide rates. *Percept Mot Skills*; **68**: 218.
- Lorant V., Thomas I., Deliége D. and Tonglet R. (2001) Deprivation and mortality: the implications of spatial autocorrelation for health resources allocation. *Soc Sci Med*, **53**(12): 1711-1719.
- McLoone P. (1996) Suicide and deprivation in Scotland. *BMJ*, **312**: 543-544.
- Mollie A. and Richardson S. (1991) Empirical Bayes estimates of cancer mortality rates using spatial models. *Stat Med* 1991, **10**: 95-112.

- detect environmental effects. *Am J Epidemiol*, **136**: 742-759.
- Wasserman I.M. and Stack S. (1995) Geographical spatial autocorrelation and United States suicide patterns. *Arch Suicide Res*, **1**: 121-129.
- Whitley E., Gunnell D., Dorling D. and Smith G.D. (1999) Ecological study of social fragmentation, poverty, and suicide. *BMJ*, **319**: 1034-1037.
- TX: Stata Corporation.
- Upton G. and Fingleton B. (1985) Spatial data analysis by example: point pattern and quantitative data. Vol. I. New York: John Wiley and Sons, Inc.
- Wakefield J.C., Kelsall J.E. and Morris S.E. (2000) Clustering, cluster detection, and spatial variation in risk. In Elliott P, Wakefield JC, Best NG, Briggs DJ. *Spatial epidemiology, methods and applications*, pp 128-152. Oxford: Oxford University Press.
- Walter S.D. (1992) The analysis of regional patterns in health data. II. The power to

## LARGE SCALE CLUSTERING AND ITS APPLICTION TO THE HEALTH AND EPIDEMIOLOGICAL STUDIES

**Rezaeian M., PhD\*<sup>1</sup>**

*Spatial autocorrelation statistics* provide summary information about the spatial arrangement of data in a map. In fact, these statistics compare neighboring area values in order to assess the level of large scale clustering. Whenever a large number of neighboring areas have either relatively large or relatively small values, large scale clustering may be detected. Detecting such clustering is a very important issue because failure to take into account the spatial dependency of the data may bias the association between mortality and morbidity rates and their risk factors and erroneously suggest a direct relationship between them. The present article, therefore, explains the two most commonly used spatial autocorrelation statistics for continuous data including morbidity and mortality rates.

**Key Words:** *Spatial Autocorrelation, Medical Cartography and Geography*

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