SPATIAL STATISTICS:
Past, Present, and Future

Proceedings from a Symposium, of the same name,
held on the campus of Syracuse University
from March to June, 1989.

Support for the Symposium, from the George B. Cressey/Preston E. James Geography Endowment Fund and from the Office of the Vice–President for Research and Graduate Studies (both of Syracuse University), is gratefully acknowledged. The site of the Symposium was the Department of Geography and the Maxwell School of Citizenship and Public Affairs of Syracuse University.

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J. H. P. Paelinck
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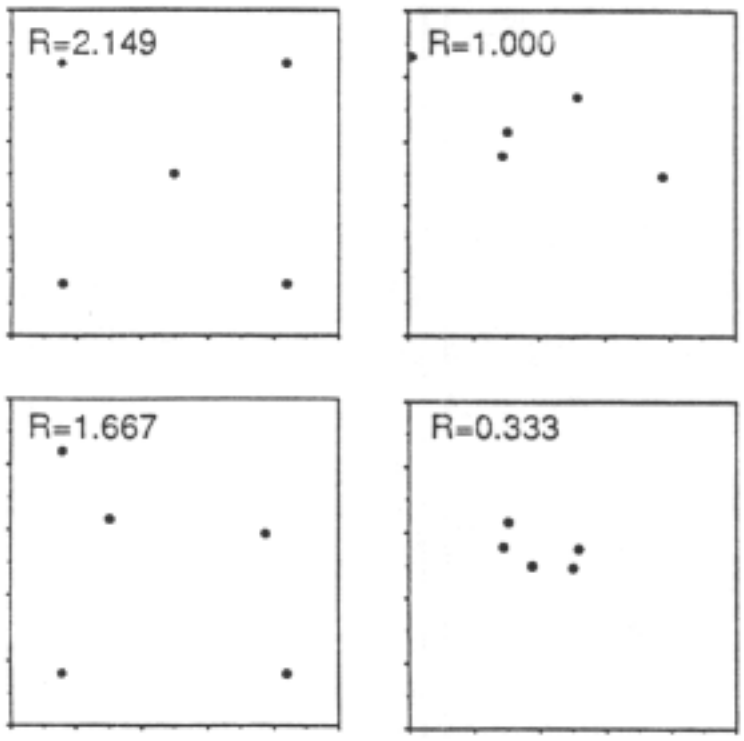
PAST



point pattern analysis

PRESENT

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

geographic configuration

19	83	84	13
38	55	58	26
50	41	38	75
16	78	23	27

no spatial autocorrelation

84	83	58	38
78	75	50	27
55	41	26	19
38	23	16	13

positive spatial autocorrelation

50	23	58	38
19	84	16	55
78	13	83	27
38	75	26	41

negative spatial autocorrelation

Gibb's states

FUTURE

?

TO LESLIE CURRY

WHO FIRST INTRODUCED THE EDITOR TO
THE PROBLEM AREA OF
SPATIAL AUTOCORRELATION

This book is published, on an on–demand basis, by the Insititute of Mathematical Geography (IMaGe), 2790 Briarcliff Street, Ann Arbor, Michigan 48105-1429 (Sandra L. Arlinghaus, Director). Printed and illustrative copy were provided by the Authors to the Editor of this monograph. Effort was made to achieve consistency between and within chapters without discarding individual or cultural preference. Thus, both American and British spellings of, for example, neighborhood/neighbourhood appear within the document but not within a single chapter. Order in the Index is determined, where significant, by American spelling. Typesetting was provided by IMaGe using Plain TEX, a trademark of the American Mathematical Society. Output for the master document, prepared by IMaGe, was generated on a laser–printing Xerox 9700, compatible with TEX, at The University of Michigan. Copies were printed from the master document by Michigan Document Services using a Xerox 5090, programmed to mass–produce books on recycled 20 pound paper with colored parchment inserts.

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Preface

This reader is one product of a symposium held at Syracuse University, hosted by the Geography Department of the Maxwell School of Citizenship and Public Affairs, during the Spring semester of 1989. Each chapter is a contribution by a scholar affiliated with this symposium; most chapters essentially are written versions of presentations made at Syracuse University under the same or similar titles. Two exceptions are those chapters penned by Ord and by Griffith. Keith Ord was unable to deliver his lecture because he was on sabbatical leave from the Pennsylvania State University to the London School of Economics and Political Science during this time period. I have contributed a chapter based upon an invited paper presented to the Sixth European Colloquium on Theoretical and Quantitative Geography, held at the Centre Culturel "Les Fontaines" in Chantilly, France, during September of 1989.

Plans for this Symposium were stimulated by efforts associated with the 1987/88 competition for the NSF National Center for Geographic Information and Analysis (NCGIA), and the NSF Science and Technology Center (STC) program. Motivation for its organization and development arose from the NSF NCGIA solicitation calling for "improved methods of spatial analysis and advances in spatial statistics ..."; this is one reason why two of the lecturers had itineraries that included a presentation at the SUNY/Buffalo NCGIA site during their stays in Syracuse. A second impetus was supplied by an STC proposal for a "Center for Spatial Statistics and Spatial Econometrics." The organization of the Symposium was further inspired by a joint proposal with the Institute of Mathematical Geography, submitted to the Geography and Regional Science Program of NSF, requesting funds to support it.

The objectives of this Symposium were to evaluate the role that contributions in spatial statistics have played, are playing, and should play, in expanding the scope of spatial analysis in geography and the spatial sciences, to critically review state–of–the–art practices, and to establish a research agenda for the future. This edited collection of lectures should establish a timely foundation for building bridges to future applications of spatial statistics, and will disseminate findings that are at the frontiers of applied statistics to the international research community.

A general goal of this Symposium was to promote greater awareness of complications caused by the presence of spatial structure and spatial dependence that lie dormant in data sets, especially in terms of their effect on the validity of traditional statistical analysis. Much of the early work in this area was devoted to the development of indices to measure spatial dependence. Meanwhile, more recent advances, refinements, and applications in this field have been summarized in a number of books; but while these publications provide useful summaries of conceptual developments, numerical examples and issues, and case studies of particular problems, they fail to furnish an historical perspective, to assess meaningful progress to date, or to outline important problems for future research. The very recent spatial analysis literature is, however, lightly peppered with pieces invoking this broader viewpoint, suggesting the timeliness of the symposium theme. Given the emergence of this theme in the current literature, together with its attainment of increasing prominence, the topics and published results of this Symposium should find a receptive audience among researchers from many disciplines dependent on spatial analysis.

The Symposium lecturers visited Syracuse in accordance with the following schedule:

Lecturer	*Date of visit*	*Date of lecture*
R. Haining	3/18—4/05/89	3/31/89
B. Ripley	4/03—4/10/89	4/07/89
R. Martin	4/10—4/23/89	4/14/89
S. Richardson	4/16—4/22/89	4/21/89
A. Sen	4/22—4/29/89	4/27/89
P. Doreian	5/01—5/08/89	5/05/89
K. Mardia	5/06—5/14/89	5/12/89
D. Wartenberg	5/17—5/21/89	5/19/89
J. Paelinck	5/24—5/31/89	5/26/89
G. Upton	6/03—6/12/89	6/05/89
L. Anselin	6/09—6/14/89	6/09/89

The first four of these lectures also were part of the annual Geography Department Colloquium series. Ashish Sen and Graham Upton were the two lecturers who visited the NCGIA at SUNY/Buffalo.

The format of this compendium was shaped, in part, by several invaluable suggestions from lecturers. Robert Haining proposed that the context of papers as well as the audience would benefit from published discussions; the model he had in mind was that employed by the *Journal of the Royal Statistical Society*. Hence, I asked each Symposium participant to both referee one of the other papers, and write a discussion of one of the other papers. In retrospect, not only was Haining's suggestion a good idea, but I feel that the quality of both the papers and the book have been considerably enhanced by it. A second recommendation was made by Graham Upton, who mentioned that an editor's preamble to each paper would be a useful and integrative touch; the model he had in mind was that of a standard science fiction anthology. Again, I believe that this addition has greatly strengthened this publication. The quotations that I have cited were gleaned from *Best Quotations for All Occasions* and *The Pocket Book of Quotations*. Each quotation was judiciously selected in an attempt to capture the flavor of its accompanying paper as well as some special personality trait of the paper's author. As an aside, the topical mapping I found most suitable is as follows:

Anselin — statistics
Doreian — imagination
Griffith — perseverance
Haining — progress
Mardia — wisdom
Martin — criticism
Ord — time
Paelinck — thought
Richardson — inspiration
Ripley — knowledge
Sen — eloquence
Upton — teaching
Wartenberg — learning

At this time I would like to express my sincere appreciation to all of the Symposium participants for making these supplemental sections of the book a true success. The general organizational format used here is the one that I developed earlier for my three edited NATO Advanced Studies Institute volumes.

Each Symposium lecturer stayed in my home while visiting Syracuse, and took part in selected extracurricular activities during his/her stay. We had very enjoyable times hosting numerous receptions, attending special campus luncheons, sampling various restaurants of the city, and making site–seeing tours of the area. Most participants visited the Dinomania robotics dinosaur exhibit. A variety of other activities have made the time horizon of this Symposium memorable, too. For example, Haining accompanied us to an outstanding production by the Syracuse University experimental theater. We engaged in "Finger Lakes" wine tasting at the Plane's vineyard on Cayuga Lake with Ripley. Mardia and I scoured the rare book market of Syracuse. We visited Manas Chatterji, at SUNY/Binghamton, with Paelinck. Sen helped us become acquainted with the single East Indian restaurant of the city. Upton explored the Onondaga County park of Pratt's Falls with us. And, we hosted a backyard bar–b–que with Wartenberg. In addition, most of the European lecturers arrived by airplane in Toronto, facilitating visits to Niagara Falls during the trip between Syracuse and Toronto. All in all, my family helped me to plan several special events that accented each lecturer's stay.

Financial support from the George B. Cressey/Preston E. James Geography Endowment Fund of Syracuse University, and the Syracuse University Office of the Vice–president of Research and Graduate Studies is gratefully acknowledged. The patience, tolerance, and graciousness of my wife through a long parade of visitors to our home is most appreciated, too.

Daniel A. Griffith
Syracuse, New York
February 10, 1990

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