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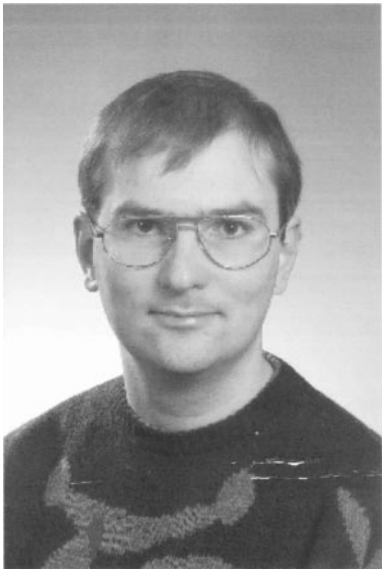
Association Announcement

2003 Andrei Borisovich Vistelius Research Award



K. Gerald van den Boogaart

Karl Gerald van den Boogaart use to study mathematics and geography at Augsburg University, Germany. I met him first in 1997 on the occasion of an S-plus short course taught by Bill Venables, where he happened to sit right next to me when we had to work our way through Bill's exercises. He caught my first attention when he knew the answers to all my questions I would otherwise have had to ask Bill. One night on a tram ride from the university into the city of Augsburg he asked me about geomathematics and I tried to give him an idea of what it is about—development and application of useful methods for the (re)solution of geoscience problems; including problems which do not possess a solution in the strict sense of a "pure" mathematician. Today, I assume that this aspect was most appealing to Gerald.

We stayed in touch by e-mail and I told him more about the subject of geomathematics—spherical probability, statistics of orientations, geostatistics, groundwater flow models, fractals, self-organization, expert systems, data and knowledge bases, etc.—its role in the evolution of geology, and provided him with the references I thought to be most instructive and enlightening. At that time Gerald was working on his diploma thesis "Markovian random fields: A statistical model for anthropogeography" supervised by Prof. Antony Unwin, PhD, head of the Computer Oriented Statistics and Data Analysis group. I also told him of the graduate programme on "spatial statistics" of the Department of Mathematics and Computer Science of Freiberg University of Mining and Geology, which had been initiated by Prof. Dr. Hans Bandemer and then directed by Prof. Dr. Dietrich Stoyan. Before he successfully finished his studies in spring of 1998, I asked him if he was interested to join the spatial statistics programme and work on the development of statistical methods for individual crystallographic orientation measurements as done by electron back scatter diffraction (EBSD).

When I suggested and explained the project to the programme's committee it was Prof. Stoyan who slightly intimidated me when he asked if I really hoped to accomplish some useful results. After all, I had just joined Freiberg's geoscience faculty and Gerald was to be my first PhD student. Gerald came to Freiberg, introduced himself with a talk about the major results of his diploma thesis and applied for my PhD project. When Prof. Stoyan asked him the same question about the prospects Gerald showed broad optimism and replied that he had already some ideas how to tackle the problem. Of course, a background in Markovian random fields is helpful!

Three years later, in fall 2001, Gerald received his PhD from the department of Mathematics and Computer Sciences of Freiberg University of Mining and Technology on completion of his PhD thesis "Statistics for individual crystallographic orientation measurements."

Crystallographic orientations differ from other data by their scale and their spatial dependence. As cosets of rotations they do not belong to any of the common scales of statistical data, and for physical reasons they do not generally comply with the independence assumption of classical statistics. To handle this nonlinear scale the statistical moments are replaced by the harmonic C-coefficients derived from the characteristic representations of the corresponding group. They provide an appropriate approach to consider crystallographic symmetries and to correct estimators for their bias. Moreover, the crystallographic exponential family is introduced for this scale. Two independent and complementary stochastic models of the spatial dependence are developed and applied to infer the variance of estimators. The first approach, motivated by the notion of crystal grains, allows the estimation error based on knowledge of the microstructure to be inferred. It requires some restrictive assumptions concerning the interaction between grains. The second approach, motivated by spatial statistics, is based on the sole assumption of a known finite range of dependence and applies generally. The theory developed by

Gerald van den Boogaart with novel and genuine arguments provides for the first time the means to do quantitative orientation data analysis including simulation conditional to a distribution and a spatial correlation estimated from experimental data. The referees stated in their report that the term "quantitative" in EBSD texture analysis had been raised to its proper meaning: to assign a variance to each estimator.

His thesis and its oral defense earned him the best score "summa cum laude" which translates to "with distinction." In 2002, he was awarded the price for junior scientists by the "Dresdener Gesprächskreis für Wirtschaft und Wissenschaft (Dresden round table on Economy and Science)" for outstanding results accomplished in his PhD thesis.

From 2001 until very recently he was appointed lecturer and taught exploratory analysis of multivariate geological data, geostatistics, and geoinformatics. Since January 2003, he has been full time assistant professor with the geoscience mathematics and informatics group of the Geology Department at Freiberg. He has been working on statistical and geostatistical analysis of data that are special to geosciences, such as crystal orientation from EBSD, apatite fission tracks, crystal size, directions, axes, and rotations. Given the geological setting and the origin of these data, they usually do not comply with the modeling assumption of independence of classical statistics. Thus, his major research interest could be best described as statistics in the case of dependence.

The common theme of his contributions to IAMG's journals and conferences is the generalization of geostatistics and the extension of its application which often requires revisiting its very basics. Thus, he has focused on semivariogram estimation in the case of nonstationary processes ("drift") or processes governed by a differential equation, in particular on unbiased estimation of the sill, the variance of an experimental semivariogram value, of the kriging error, etc. His contributions towards an extension of applied geostatistics consider data on manifolds like spheres, hemispheres, or the special orthogonal group SO(3); to put it simply, data satisfying geometrical constraints leading to topologies and metrics different from the conventional ones. His work can be seen to be complementary to compositional data analysis as put forward by Vera Pawlowski and her coworkers.

Gerald van den Boogaart has authored or coauthored five papers in reviewed journals, two of them in "Mathematical Geology," and 16 contributions to International Conferences including IAMG'2001 (Cancun), IAMG'2002 (Berlin), gOcad meetings in 2000 and 2001, and the 2002 Denver X-ray Conference, which won its authors the "Best XRD Poster Award."

His contributions to IAMG'2001 (Cancun) are devoted to considerations of the central modeling assumptions of "stationarity," relate it to a combined view of geostatistics and geoinformation systems, and suggest that it be replaced by the term "generic stationarity" which greatly increases the application of geostatistics. The fundamental modeling assumption of (second-order) process stationarity is replaced by "generic" stationarity of the governing influence of the local geology on

the local semivariogram as stored in a GIS. A method to construct semivariograms accounting for additional spatial information such as smoothly varying geology or discontinuities imposed by geologcical faults has been presented. The method has been demonstrated to be useful to account for local anisotropies, i.e., locally changing anisotropy.

I completely share Gregoire Dubois' (owner of the ai-geostats web site) view published in his summary e-mail of IAMG'2001 at Cancun for those interested mainly in bridging GIS and geostatistics that Gerald van den Boogaart's approach "is a very promising work but you really need a tough background in statistics to understand it" and that his achievements open promising prospects and deserve the geomathematics community's attention. Hopefully, it will not take too much time before the geostats community will appreciate the results of Gerald's contribution to the subject. Finally, I would like to congratulate Gerald: may the incentive of IAMG's Vistelius Award be with you!

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