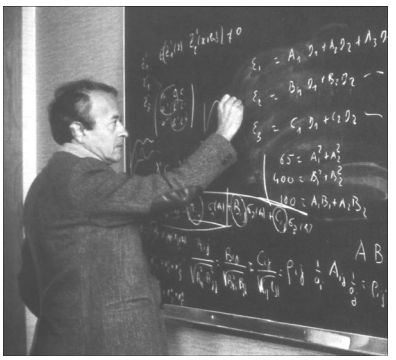
Adv. Appl. Prob. **32,** 1190–1192 (2000)
Printed in Northern Ireland

OBITUARY: *Georges Matheron*



Georges Matheron

The scientific community is saddened to learn of the death of Professor Georges Matheron on 7 August 2000. As a major figure in applied mathematics over four decades, he leaves an outstanding scientific heritage, covering a wide range of domains where probabilistic tools and models are implemented. He also trained more than one generation of researchers, engineers and teachers. In the fields of theoretical and applied random media and image analysis his work has inspired many researchers worldwide: mathematicians, statisticians, physicists, experimentalists, earth scientists, mining engineers and also users of image analysis and synthesis in all its applications (materials, biology, artificial vision, CAD, remote sensing, geophysics, biometry, image coding etc.).

We are indebted to Georges Matheron for the creation and development of geostatistics, of mathematical morphology, which he founded with Jean Serra, and for his contribution to the physics of random media.

In the 1960s, Matheron first devised the basis of geostatistics, strongly motivated by applications in the field of mining industry. A systematic and rational approach was taken to introduce probabilistic concepts for solving estimation problems connected with the global or local evaluation of resources from partial knowledge [1], [2], [3]. Working for the oil industry on the description of porous media and on the prediction of their permeability, he laid out the basic operations of mathematical morphology in its deterministic and random versions [4]. He conceived and studied one of the most famous models of random sets, the Boolean model, and developed a general methodology for the composition of permeability at different scales through a homogenization process [4], [5]. During the same period he moved to École des Mines de Paris, Fontainebleau, in 1968, where he created the Centre de Géostatistique et de Morphologie Mathématique (which was split into two research centres in 1986). A first version of the theory of random sets was devised at that time [6].

During the 1970s, Professor Matheron contributed to many courses at the École des Mines [7], which initiated applications developed by users. A general class of nonstationary models was created for geostatistical applications, namely the intrinsic random functions [8], and techniques of simulation (involving, among others, conditional simulation which respect available data) were initiated. The mathematical theory of random sets was completed and published in English [9]. This seminal book also contains a study of various classes of random sets

https://doi.org/10.1017/S0001867800010521 Published online by Cambridge University Press

(infinitely divisible, semi-Markov, stable for union), an axiomatic construction of the physical notion of granulometry, and a characterization of increasing set transformations. Nonlinear estimation models, termed disjunctive kriging, were proposed, based on bivariate distributions and inspired by multivariate statistical data analysis [10]. A theoretical study of the genesis of the permeability of porous media was made, proving the existence and the uniqueness of the solution of the Navier–Stokes equation for random closed sets, and providing useful upper bounds for some random media [12]. Important results were obtained concerning the dispersion of flows in random media. He published an epistemological work presenting his thoughts on the practical methodology that he progressively established, using probabilistic models, mainly in applications of geostatistics [11], [14]. Let us quote a key passage of this book:

> "Is probability subjective or objective?" In fact there is not, nor can there be, any such thing as probability in itself. *There are only probabilistic models.* In other words, randomness is in no way a uniquely defined, or even definable property of the phenomenon itself. It is only a characteristic of models we choose to describe it, interpret it, and solve this or that problem we have raised about it. [14, p. 4]

In the 1980s, the heuristic, but nevertheless rigorous, approach initiated in nonlinear estimation techniques was extended to models of change of support [13], which provide a prediction of distribution functions of phenomena observed at different scales. The theory of morphological filters was set out [17, Chapters 3 and 6]. Based on a combination of lattice algebra and topology, it gives the structure of new classes of nonlinear filters which are widely used in image processing. This approach was extended to a more general framework during the 1990s, with work on compact lattices [15], [16].

The power of the mathematical tools developed by Georges Matheron is the fruit of his immense talent, of his deep understanding of the physical background, which was always the starting point of his work, of a permanent interaction between theory and practice and of a strongly interdisciplinary approach. The fields of application continue to extend into many practical areas: image simulation and computer analysis enable us to obtain data on biological as well as inorganic materials; on a different scale, models are used to simulate mineral ore deposits, oil reservoirs, or even astronomical data; finally, they provide sources of textures to encode or generate artificial images. Illustrations and continuations of his work appear in many publications and in scientific meetings organized in geostatistics and in mathematical morphology.

As for all his colleagues, whether close or distant, it was for me a very stimulating experience of inestimable value to benefit from his help and advice. I will never forget long and exciting conversations with him in many fields of mathematics, physics, history or philosophy, reflecting his extensive interests, and I am deeply grateful to him for all his contributions.

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October 2000

https://doi.org/10.1017/S0001867800010521 Published online by Cambridge University Press