

# APPLIED PROBABILITY AS THEORETICAL SCIENCE: 50 YEARS IN THE APPLIED PROBABILITY COMMUNITY

BY PETER JAGERS

50 years ago I defended my thesis and then made my first trip as a full academic citizen. I had indeed travelled before this, but as a student. My graduate studies in Moscow 1966 made a lasting impact. Kolmogorov's, Prohorov's, Dynkin's and young Sinai's lectures, Sevastyanov's advices and Gnedenko's little tutorials with foreign students—altogether they shaped an open, vivid self-confident, but friendly intellectual community, in sharp contrast to the stagnant and narrow-minded Soviet dictatorship surrounding it. My office still exhibits a piece of underground art from that year, an icon style Archangel Michael, given to me by the artist on my 25th birthday which I celebrated in a dormitory of Moscow State University. The times, they are a-changin', indeed.

But those were student years. My first professional trip, by way of an invitation to give a lecture, was in 1968 to Sheffield, as proper for a fresh doctor of applied probability. I do not know how Joe Gani could be aware of whatever moved in the field, wherever it occurred, but he certainly was. Many others of my generation can bear witness to similar visits, including the subsequent dinner at the Ganis' home; in my case it was together with a neighbour, a retired colonel from the Imperial Indian army. Very British indeed—I cannot recall thinking of Joe's cosmopolitan background then, maybe an indication of how well adapted he seemed to be, or just that I closed my eyes or simply forgot, or possibly how good the times were, from that point of view.

The main content of my Sheffield–Manchester lecture (and my thesis) was the presentation of general branching processes, meaning, branching processes allowing individuals to have repeated bearings [3]. Like Kenny Crump and Charles Mode, who formulated the same type of models simultaneously (and independently) [1], [2], my main purpose was mathematically to describe more advanced populations than those mimicking physical particles or single-cell organisms that split just once (even though the models were first conceived [3] in order to catch something intrinsically human, the extinction of surnames). It was a bonus but not a main point that the advance of the theory of point processes and random measures at that time rendered an elegant mathematical formulation possible. The essence was a logically strict formulation of a basic pattern of nature; we might say 'theoretical science' in the same sense as physicists talk of theoretical physics.

All this was obviously close to the ideas of 'applied probability', even though at the bottom of my heart I never liked names like that, nor 'applied mathematics', for that sake, because they seem to convey the wrong impression of first comes the mathematics and then its applications. The truth is, of course, that first comes the chiselling of pure, beautiful, simplified patterns out of reality, then pondering those mathematics, in the lucky cases where this is feasible, and so application, possibly followed by new rounds of analysis (in the broad sense of the word). Maybe this was also the idea when the concept of 'applied mathematics' first appeared [5], in Crelle's famous *Journal für die reine und angewandte Mathematik* in 1828 or Liouville's

French counterpart. But words have power; the name conveys the idea of something ready-made being applied.

Applied probability to my mind is theoretical science, any theoretical science, relying upon the elegant tools of probability theory, developed from intuitive arguments in gambling into a fully-fledged mathematical body by Kolmogorov [6] just three decades before the creation of the Applied Probability Trust and Journal. (At this point, I cannot resist a more personal remark about youth and perception of time. When I went to Sheffield in 1968, I thought I visited the eternal Rome of applied probability. As a matter of fact its Pope, Joe, had settled there only three years earlier, and was about to leave after another six years.)

During the half century that has passed since then the applied probability journals have remained remarkably stable. A glance at the tables of contents reveals very much the same topics: the random movement of particles, the growth and extinction of populations, and genetics on the science side, spread of epidemics, queues and queueing systems in health and operations research. New concepts show up, like those of networks and percolation and the (self-fulfilling?) prophecies of financial mathematics. All this is in a period of explosive development of physics, chemistry, and molecular biology, as well as medicine, not to mention computer and data science.

This can be viewed in two ways. It is either a tribute to the strength of the original concept or an indication of rigidity that the adherence to a successful pattern has hindered ‘new’ forms of applied probability. Or have they shown up elsewhere? In physics, theoretical biology journals, or possibly computational science?

Be that as it may, let us hope for the best in the future, a probability theory in development and interplay with both traditional and path-breaking new contexts, ‘applications’ as many of us would have called them, even though it would be nice if they would abound in fresh ideas of content as well as mathematics.

On the personal side, as a probabilist with a focus on theoretical science rather than mathematical l’art pour l’art, and admittedly relying upon techniques I have learnt from the toolbox of applied probability, I have certainly always felt at home in the applied probability community and journals, from that very first encounter half a century ago, until today. Thank you all, and let’s go on trying to decipher the marvellous patterns surrounding us, and develop an applied probability for modern science.

## References

- [1] CRUMP, K. S. AND MODE, C. J. (1968). A general age-dependent branching process. I. *J. Math. Anal. Appl.* **24**, 494–508.
- [2] CRUMP, K. S. AND MODE, C. J. (1969). A general age-dependent branching process. II. *J. Math. Anal. Appl.* **25**, 8–17.
- [3] HEYDE, C. C. AND SENETA, E. (1977). *I. J. Bienaymé: Statistical Theory Anticipated*. Springer, New York.
- [4] JAGERS, P. (1969). A general stochastic model for population development. *Skand. Aktuarietiskr.* **52**, 84–103.
- [5] KINGMAN, J. F. C. (2014). Applied probability before 1964, and after 2014. In *Celebrating 50 Years of The Applied Probability Trust* (J. Appl. Prob. Spec. Vol. **51A**), eds S. Asmussen, P. Jagers, I. Molchanov and L. C. G. Rogers, Applied Probability Trust, Sheffield, pp. 5–9.
- [6] KOLMOGOROV, A. (1933). *Grundbegriffe der Wahrscheinlichkeitsrechnung*. Springer, Berlin.

PETER JAGERS, *Chalmers University of Technology and University of Gothenburg*

Mathematical Sciences, Chalmers University of Technology, Gothenburg, Sweden.

Email address: jagers@chalmers.se