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A Festschrift for Adrian Baddeley

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Summary

This article introduces a special issue of the Australian and New Zealand Journal of Statistics, being a Festschrift for Adrian Baddeley on the occasion of his 65th birthday.

Key words: bibliography; spatial statistics; spatstat; stereology

1. The Making of a Statistical Research Star

Adrian Baddeley was born on 25 May 1955, in Melbourne. His father Arthur was an engineer, and his mother Patricia a school teacher. Adrian recounts that he took an enormous dislike to mathematics at the age of 7, when it was presented as rote learning of multiplication tables. Remedial tuition was recommended for young Baddeley (a distinction shared by the first author [hereafter MH] at a similar age). Adrian's mother responded by presenting him with a set of Cuisenaire blocks, from which he began to understand arithmetic and see mathematical patterns.

Adrian's first childhood hero was Yuri Gagarin. He wrote fan letters to the American astronauts, and received a reply from the Apollo 1 crew (Gus Grissom, Ed White and Roger Chaffee) which he cherished. He was devastated when they were killed in a fire on 27 January 1967. A year previously his youngest brother, David, had died aged two years, an event that naturally traumatized the family. Through all these sad events, Adrian's father was a voice of calm and reason. He acknowledged Adrian's grief and explained that people can die of illness or accidents because we do not yet know how to protect them. Medicine and technology are not 'finished', but are continually improving, and making the world a safer and better place. This had an enormous influence on Adrian.

Adrian received his secondary education from Eltham High School. He began to outstrip his classmates in mathematics, so his teachers kept him occupied with a variety of challenges and books. Of these, Adrian particularly enjoyed *Facts from Figures* by M. J. Moroney. It

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painted statistics as a universal tool for solving problems for the good of humanity. Adrian was smitten, and decided that he wanted to be a statistician.

In 1972 Adrian matriculated and won a National Undergraduate Scholarship to the Australian National University (ANU), where he studied Mathematics and Statistics. He was brilliant as an undergraduate and his potential was recognised by the probabilists and statisticians at the ANU, including Chris Heyde, Richard Tweedie and Eugene Seneta, who all taught Adrian. Adrian did his honours thesis with Roger Miles on geometrical probability, setting the general path for his future research career. He graduated from the ANU in 1976 with a BA (Hons) double major in Pure Mathematics and Statistics, and received the University Medal.

Adrian's next step was a move to the University of Cambridge, to study for a PhD under the supervision of David Kendall. He won the Smith-Knight prize for PhD students, and was elected a Prize Fellow of Trinity College at the end of the second year of doctoral study.

After graduating from Cambridge in 1980, Adrian was appointed as a Lecturer in Statistics at the University of Bath. While there he worked on spatial point processes, and on stereology. He made many trips to Denmark to visit collaborators Eva Vedel Jensen and Hans-Jorgen Gundersen in Aarhus.

Adrian returned to Australia in 1985, taking up a job as a research scientist in the Division of Mathematics and Statistics (DMS) at CSIRO. He worked on image analysis, proposing a new metric for measuring errors in binary images which continues to prove useful in a variety of settings (Baddeley 1992a,b). Adrian also developed a software package 'Z' for interactive image analysis which was later used to support early research on microarray data analysis. It was in this role that the second author [hereafter RT] first came into contact with Adrian. RT notes that it took him an unconscionably long time to realise the extent of Adrian's brilliance. Part of the reason for this is that Adrian is a very humble and self effacing person. He never brags or extols his own (extensive) talents. In keeping with his charming humility is the fact that Adrian is an extremely patient and quietly spoken individual. He has a remarkably tactful and diplomatic nature. RT recalls accompanying Adrian on one occasion, early in their acquaintance, to visit a scientist in one of the "client divisions" of CSIRO, to which DMS provided mathematical and statistical advice. The person whom they were visiting was interested only in lauding the work that he was doing, and made numerous gratuitously disparaging remarks about the study of statistics, saying that it had essentially nothing to contribute. RT was seething, but Adrian displayed complete equanimity in the face of this short-sighted disparagement. As they were driving back to DMS Adrian explained, cheerfully, that he had encountered this sort of deliberate obtuseness in the past and knew that it was pointless to try to enlighten such people.

CSIRO was reorganised in 1988, changing its mission from research to service. In one of the many resulting meetings Adrian resigned, in front of 250 people and a video camera. The show of principle is characteristic. The very next day he received an email from Richard Gill, offering him a job at the Centrum Wiskunde & Informatica (CWA) in Amsterdam. He worked there from 1988 to 1994, before returning once more to Australia to take up the position of Professor of Statistics at the University of Western Australia (UWA) in Perth. MH's first contact with Adrian came through MH's appointment as a Lecturer in Statistics at UWA in 1997. The UWA Statistics Group at that stage was going from strength to strength, providing a fertile environment for a green young researcher to grow. At the centre was Adrian. His enthusiasm, crystal clear thinking and huge generosity in sharing ideas made a deep impression on MH, and was like a steroid shot for his nascent research career.

Adrian rejoined CSIRO on a part-time basis from 2006, leaving UWA and becoming full-time from 2010. In 2013 he received a Discovery Outstanding Researcher Award from the Australian Research Council to work on statistical problems in geological prospectivity analysis, and joined the Centre for Exploration Targeting (CET) at UWA. Two years later Adrian was appointed Professor of Computational Statistics at Curtin University, and honoured as Distinguished Professor the following year. After his 65th birthday in 2020 he moved to a half-time position.

2. An Overview of Adrian Baddeley's Research

Adrian's research career has focussed primarily on stereology and spatial point processes. He has also made substantial contributions to the general theory of stochastic geometry and random sets. Adrian has published more than 100 refereed journal articles, and a number of books and reports. While these publications include an array of landmark novel research contributions, he has also written several expository articles and tutorial papers. It is very much in keeping with the man that Adrian is not satisfied with finding general solutions to statistical problems: he also wants those solutions to be understood and used by others.

Adrian possesses, somewhat unusually, deep insight into both the theory and practice of statistics and has made enormous contributions to the development of methodology to be used in statistical application as well as to the theoretical underpinnings of the methodology. His insight into, and understanding of, statistical theory is immense. As a consequence, Adrian has the ability to see how established statistical principles can be applied in non-standard situations. This is nowhere better illustrated than through the contributions that he has made to stereology and methods for analysing spatial point patterns through the application of foundational ideas from survey sampling.

Figure 1. Distinguished Professor Adrian Baddeley, FAA.

Adrian's contributions to stereology (the process of learning about three dimensional properties of a sample based on two dimensional slices) are ground breaking. The paper Baddeley, Gundersen & Cruz-Orive (1986) has had a particularly significant impact on practice, showing for the first time how to obtain unbiased estimates of surface area through appropriate choice of sampling scheme. With others he has demonstrated the role of the Horvitz-Thompson weighting principle and the Rao-Blackwell theorem in stereological sampling.

Turning to spatial statistics, Adrian is a true world leader in the development and application of statistical methods for spatial point process data. His contributions are often theoretically profound, yet clearly connected to real-world problems. Examples include his work on clustering in Markov point processes (e.g. Baddeley & Van Lieshout 1995); his second-moment summary statistics for non-stationary processes (e.g. Baddeley, Møller & Waagepetersen 2000); and his extension of tools for planar processes to point patterns observed on linear networks (e.g. Ang, Baddeley & Nair 2012). His suite of diagnostic tools for spatial point process models led to a read paper for the Royal Statistical Society (Baddeley et al. 2005).

Adrian's research is marked by clarity and mathematical sophistication, but is always aimed at solving real problems and to seeing the solution through to practical implementation. His `spatstat` package (available from CRAN) is a masterpiece in the realm of software development and makes extremely powerful techniques in point process analysis readily available to scientists in applied disciplines (Baddeley & Turner 2005). It makes what were previously Herculean tasks straightforward to accomplish, almost to the point of being routine.

Adrian's research contributions have led to a variety of honours and awards. In addition to those early career awards mentioned earlier, he received the Australian Mathematical Society Medal in 1995, and was elected a Fellow of the Australian Academy of Science in 2000 (the Australian equivalent of Fellowship of the Royal Society). Adrian received an Australian Government Centenary Medal in 2001. In the same year he was also awarded the Hannan Medal in the Mathematical Sciences by the Australian Academy of Science. Adrian was awarded the Pitman Medal by the Statistical Society of Australia in 2004, and was the 2008 Georges Matheron Lecturer, a distinction bestowed by the International Association for Mathematical Geosciences.

3. Contributions to the Festschrift

The articles in this Festschrift nicely mirror Adrian's own contributions, both in subject area and also in his belief that methods based on established statistical principles are generally to be preferred over more ad hoc approaches. The first four papers are concerned with stochastic geometry and stereology. They include a beautiful (and beautifully illustrated) review of some recent work in stereology (Jensen 2021); two papers on specific applications which speak to the maxim that "there is nothing so practical as a good theory" (Stoyan, Beněs & Seitl 2021; Christoffersen, Møller & Christensen 2021); and some novel methodology for detecting outliers in random sets (Cascos, Li & Molchanov 2021).

The next set of articles are concerned with spatial statistics. In keeping with Adrian's own approach, the contributions address significant practical issues for the analysis of point pattern data. These include the use of conditional intensity (Diggle 2021); a new method for estimating the inhomogeneous K-function and the pair correlation function (Shaw, Møller & Waagepetersen 2021); a pair of papers about information criteria for point process models, and in particular how to measure the effective sample size when computing the Bayesian information criterion (Choiruddin, Coeurjolly & Waagepetersen 2021; Renner, Warton & Hui 2021); and work on spatially adaptive kernel estimation of the intensity function (van Lieshout 2021).

The special issue concludes with a pair of delightful articles that promote ideas of which I am sure Adrian will approve: the central role of statistical principles in data analysis, and the importance of clear thinking in the face of deceptively complex probability problems. Cressie (2021) offers some advice to data scientists seeking statistical principles, while Gill (2021) wrestles with the classic 'Two Envelope Problem' in a characteristically entertaining manner.

We thank all the contributors for their articles, and all the reviewers and editors for their work behind the scenes. Happy birthday, Adrian – enjoy your Festschrift!

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