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Joseph Mark Gani 1924–2016

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Joe Gani, as he was universally known, was born in Cairo, Egypt, on 15 December 1924 and died in Canberra on 12 April 2016. A visionary leader, mentor, and brilliant organizer, he created the *Journal of Applied Probability*, and was Chief of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Mathematics and Statistics. A distinguished academic career included posts at the Universities of Sheffield, Kentucky, California at Santa Barbara, and the Australian National University. His numerous research contributions are dominated by stochastic modelling, especially epidemic theory.

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Early life

Joe Gani was born into a comfortable middle-class Jewish family. His father, Marc Joseph Gani, was a businessman whose parents had emigrated to Egypt from Ioannina, western Greece, in ~1891. His mother was Lucie Gani (née Israel); her family had come to Egypt from the island of Corfu at about the same time, partly as a result of anti-semitic disturbances. The Ganis had three children, all boys. Joe was the oldest, followed by Maurice and then Robert. Joe recalled:

> Egypt was then a country of opportunity, lacking a developed native managerial and professional class, a gap filled by Europeans until the 1950's. … Although I learned to read and write Arabic, I was never fluent in it … With my mother's family, I spoke Italian whose Venetian dialect they had brought from Corfu, and with my father's French, the language of my schooling. … My recollections of school, the Catholic Collège des Frères de la Salle [Salesian Brothers], are none too happy … particularly [memorizing] the Catholic catechism whose relevance to our Judaism I could not comprehend.[1]

The years 1932–7 were spent in Kobe, Japan, near which Joe attended the Canadian Academy, where the language of instruction was English. He was in later life fond of recounting that he had learned English in Japan. Moreover, he continued to learn it in detail. Much of the editing of articles in the *Mathematical Scientist* (one of the journals that he founded) related to language expression. Returning to Cairo in 1937, Joe attended the English School as a day pupil. He continued:

> It was not till 1940 at the age of 15, when I was in fifth form at the English School, Cairo, that I discovered my interest in mathematics. Until then, mathematics teachers had stressed manipulative skills, various operations being carried out by rote with a minimum of explanation; but Douglas Whiting, our new headmaster, made our geometry and algebra lessons connected and interesting. I realized for the first time the logical coherence and finesse of mathematical reasoning; the wonderment has remained with me through a lifetime. Although I had been expected to follow in my father's export and import and leather goods business, I expressed the intention of breaking the family tradition with my mother's support, [and] received my father's reluctant consent to continuing my studies by becoming an engineer. Finishing school in December 1941, I enrolled at evening courses run by the British Council for the external Intermediate (First Year) Examination in Engineering of London University. These were exciting and anxious times: Rommel's army had reached El Alamein in June '42 and the large Jewish population of Egypt expected his final attack. Some were retreating to Palestine to fight with the British Army Jewish Battalion, others [were] fleeing to the Sudan. The majority, undecided [about] events, were [sound] by Montgomery's victory in October 1942.
>
> In the summer of 1942, Douglas Whiting found me a job at the English School as a mathematics and science student teacher. In September 1942 I joined the ES [English School] staff, thus becoming financially independent of my father; this job I retained until the end of the war in August 1945. When I had completed my Engineering Intermediate, it did not prove possible to continue my studies, as the BC [British Council] in Cairo did not [have] the necessary laboratories and engineering component. I therefore chose to continue in the London Intermediate in Science, concentrating on mathematics. Meanwhile Douglas Whiting, with the support of the BC, secured a university place for me at Imperial College London, and when the war ended, I boarded the troopship 'Franconia' in Port Said and sailed for England. So began an adventure as exciting as it was unexpected.

Whiting, a Canadian, was clearly one of the keystones in the direction that Joe's life was to take. Over the years Joe kept in touch with him, and visited him several times in the 1990s in Ottawa.

At Imperial College, London, Joe 'launched into the second year of the Mathematics degree'. From 1945 as an undergraduate he was influenced in the direction of statistics within his BSc studies by Emlyn Lloyd, George Barnard and K. D. Tocher. He was taught also by Hyman Levy and Leon Roth, the authors of one of the earliest textbooks in English on probability, which coincidentally influenced the present memoirist as an undergraduate at the University of Adelaide in 1962 towards a direction in mathematical statistics. Joe graduated in 1947 with First Class Honours in Mathematics following which he took the Diploma of Imperial College that he completed in June 1948 under Barnard's supervision.

Sadly, Joe's father Marc had died in 1947.

Australia

The Palestine (first Arab-Israeli) war broke out in May 1948, and anti-Jewish feeling in Egypt was high. Joe's younger brother,

[1] J. Gani, 'Some autobiographical notes by Joe Gani', 7 pp., undated, possibly 1987 or 1988. Title, transcription and typescript by D. J. Daley, 25 April 2016. The notes end with Joe Gani's sojourn in Canberra as PhD student in Pat Moran's department.

Maurice had apparently been arrested as a Zionist, and their mother Lucie wrote to ask Joe to get her and Joe's two brothers out of Cairo. The family applied for visas to English-speaking countries that were encouraging migration. One of Joe's fellow teachers at the English School in Cairo had been Grace Drummond, from Western Australia, who had since come to London to do a master's degree in education. She agreed to sponsor the family if they came to Australia. Joe approached Hyman Levy, the head of mathematics at Imperial College at the time, who wrote a letter to Thomas M. Cherry (Foundation FAA 1953, FRS 1954), the Professor of Applied Mathematics in Melbourne, who agreed to take Joe on as lecturer in applied mathematics. The visa to Australia came through, and Joe flew to Melbourne, while his mother and siblings took a ship from Port Said to Western Australia, and later came to Melbourne by train.

When Joe began at the University of Melbourne in 1948, the academic staff included Cherry as professor and head, E. R. Love, H. Schwerdtfeger and F. Behrend. Joe made friends with the department tutors, H. Bennett, later a professor of genetics at the University of Adelaide, and E. Bowen, later at the University of New England, Betty Laby who assisted Cherry with his calculations and kept in touch with Joe until her death, and, closest of all, Harry Levey, at the time a master's student under Cherry, later a professor at the University of Western Australia (UWA). Among the undergraduate students in the Melbourne department at the time, whose subsequent careers Joe followed, were Alan Boyle, later at UWA, Bruce Craven who continued at Melbourne, and A. G. Wilson of Sydney. In 1948, M. H. Belz formed a statistics department at Melbourne, the first in Australia. Through contact with this department, where Joe gave a few lectures, he met G. S. (Geof) Watson, later a professor and head of department of Statistics at Princeton University, and E. J. (Evan) Williams, who succeeded Belz on his retirement.

After two and a half years, Joe felt that the University of Melbourne did not offer him avenues of progress in his interests. He wanted to get a PhD in statistics, but because few Australian universities had begun to offer this degree he resigned his lectureship in December 1950 and returned to Britain. He began teaching at Birkbeck College from October 1951, but finding himself stateless, without papers, and with only a still-valid Australian immigrant visa, he returned in December 1951. Having acquired while at Melbourne a reputation as something of political radical, he failed to get any of the seven academic posts that he applied for over the next two years. Eventually, after repeated applications, he was accepted as a teacher by the Victorian Education Department, and sent to a school at Horsham, in the Wimmera, to teach maths, science and French. He recalled: 'I had moved gradually from labouring jobs, to clerical jobs to return finally to the teaching profession: … I retain an immense respect for those who can survive with good humour the brutalization of our industrial system'.

Having made his peace with Tom Cherry, Joe then applied for three academic positions and was offered all three. He accepted a lectureship in mathematics at UWA in the department of Larry Blakers, who in subsequent years, by allowing very generous periods of leave, helped Joe's career to flourish as he went from Lecturer to Senior Lecturer to Reader in mathematical statistics during 1952–60. Unusually for the times in Australia, Blakers was American-trained.

After one year at UWA, Joe took up an Australian Commonwealth Postgraduate Scholarship to do a PhD under P. A. P. (Pat) Moran (FAA 1962, FRS 1975), professor and head of the statistics department at the Institute of Advanced Studies, Australian National University (ANU), Canberra. The time was unproductive for Joe until Moran asked him to read a paper on provisioning by H. R. Pitt.[2] Moran had been working on the theory of dams, and Joe was familiar with this theory, and on reading Pitt's paper Joe realized that the problems were similar. This launched Joe on his research career, his first paper appearing in *Biometrika*.[3] He describes his opening of his research career in a 2008 interview:[4] 'Well, once I'd seen that research was about making connections, improving what had been done slightly differently before, ... I never looked back'.

The times were early part of a Golden Age in Australian statistics. As Joe later explained, 'I found the ANU an ideal environment for research; Pat Moran was enthusiastic about his new department, which G. S. Watson had joined as Senior Fellow. … I learned a lot of probability and statistics from Pat Moran, and for this and his guidance of my PhD project, I owe him a debt of gratitude'.[5]

In Moran's department Joe met E. J. (Ted) Hannan (FAA, 1970). They had both begun in 1953, and were the first two PhD graduates, completing towards the end of 1955. Gani writes 'Imbued with the Moran tradition, we later helped to influence statistical developments in Australia, both as researchers and organizers. We strongly encouraged students to pursue careers in Statistics, Hannan at the ANU and I at the CSIRO Division of Mathematics and Statistics (1974–1981)'.[6]

Joe had become an Australian citizen in a ceremony at the Albert Hall, Canberra, in 1954. The *Canberra Times* reported that he was 'the first Egyptian to seek naturalization in Canberra'. Australia was getting much, much more than that![7]

During the ANU years Joe met his wife to be, Ruth Stephens, also a scientist, a graduate of the University of Liverpool who had migrated to Australia to work as research assistant to (Sir) Otto Frankel (FAA 1954), chief of the CSIRO Division of Plant Industry. She later focused her research on human genetics. They were married on 3 September 1955, at University House, ANU, where Joe was living at the time. Ruth was born on 22 February 1927 in York, England. Her parents were Henry Stephens and his wife Margaret, née Edwards. On Joe and Ruth's marriage certificate, Joe's occupation is 'Research Student', and Ruth's 'Research

[2] Pitt (1946).
[3] Gani (1955).
[4] Seneta (2008).
[5] Gani, see footnote 1.
[6] Gani (2005).
[7] Moran (2016).

Assistant'. Her father's is given as 'Advertising Manager' while Marc Gani's (dec.) is 'Businessman'. One of the witnesses to the marriage was Pat Moran.

After Joe received his PhD in 1955 for a thesis entitled 'Some problems in the theory and applications of Markov chains', he and Ruth were in Manchester on a Nuffield Fellowship, 1956–7. There, under the influence of Maurice Bartlett, Joe became interested in the theory of epidemics that formed a large part of his subsequent research activity. Another one-year absence from Western Australia was spent as visiting associate professor, Columbia University, New York, 1959. A daughter, Miriam, was born during this time. In the period to 1960 Joe built up a strong group at UWA that was afterwards headed by N. U. (Uma) Prabhu (1961–4). Under Blakers' influence, Joe developed a strong interest in the development of mathematics in Australia, and was one of the founding members, with Blakers, of the Australian Mathematical Society in 1956. His first book had its genesis in his time in Western Australia.[8]

The striking evidence of Joe's activity in Western Australia led to an offer from Pat Moran of a position as senior fellow at ANU from 1961, where on account of the presence on the academic staff of Joe Moyal, Geof Watson, and Ted Hannan (at the nearby School of General Studies), the discipline of mathematical statistics (in its broad sense as encompassing applied probability) flourished,[9] and began to attract the cream of Australian students in the area, including C. C. (Chris) Heyde (FAA, 1977).

Applied probability and the Sheffield-Manchester School,[10] 1965–74

When it became clear to Joe that there was insufficient support in Australia for setting up his dreamchild, the *Journal of Applied Probability*,[11] he moved in 1964 to Michigan State University, East Lansing, where he was joined (1964–5) by Uma Prabhu, and then by Chris Heyde after Chris had finished his doctoral studies at ANU. The first issue of the journal appeared in 1964. Attempts to build up stochastic processes at Michigan State encountered difficulties, and in 1965 Joe left for Britain to become professor of statistics at the University of Sheffield, followed by Chris Heyde, who became Joe's right-hand man at Sheffield-Manchester before Chris returned to ANU in 1968 as reader in Ted Hannan's Department.

During the decade that Joe spent in Sheffield, it became, and remains to this day, the home of his creations: the Applied Probability Trust, and of its journals, the *Journal of Applied Probability* (*JAP*), *Advances in Applied Probability* (*AAP*) and the *Mathematical Scientist* (*TMS*). This period is associated with the creation of the strong Manchester-Sheffield School of Probability and Statistics, with notable Australian input. Due to Joe's editorial and organizational activity, applied probability became an internationally recognized and prestigious area of mathematical activity. His launch of *JAP* in 1964, followed by *AAP* in 1969, came at just the right time to catch the swelling activity in applied probability (in physical, biological, social, queueing and computing sciences) that hitherto had no clearly defined home in an appropriately dedicated journal. Nowadays several journals are similarly focused.

In the 2008 interview Joe recalled that: 'It was one of the happiest times in my life. Ruth bought a house in Riverdale Road, in West Sheffield … the western part is more rural, full of trees and very attractive. She made the house into a very warm, comfortable home. ... As a result of my connection with Australia, whenever an ANU PhD was ready I would hire them. … a lot of Australians came through Sheffield'.[12]

A partial list of Australians who were in Sheffield for a time includes Jim Pitman, Terry Speed (FAA 2001, FRS 2013), Sue Wilson, Malcolm Clark, David Scott, Ishwar Basawa, and Niels Becker. Sue Wilson had met Joe during her PhD time at ANU in 1972, when she accepted a two-year appointment from September of that year at Sheffield, after which she returned to ANU. Those two years were Joe's last at Sheffield. In a memorial presentation Sue recalled Joe's pastoral care of all in the department especially of the younger members, and his very organized running of the department, characteristically also, Joe did not bottle up his emotions. Her talk concluded with an expression of our debt: 'for all that Joe has left us'.[13]

There were many visitors to the Sheffield Department, mainly from Europe, and all were taken to departmental meal gatherings. During his Sheffield years Joe was active in the Royal Statistical Society, and in the European statistical scene, and for 1972–4 he was Chairman of the European Regional Committee (of the Institute of Mathematical Statistics). In 1975, this became the Bernoulli Society, a transition in which Joe was a key player.

Joe served as editor-in-chief of both *JAP* and *AAP* until 1989, and was followed by Chris Heyde, who served until his death in 2008. Joe was founder and editor of *TMS* from January 1976, and then editor-in-chief from 1988. Randall J. (Randy) Swift, later joint editor-in-chief with Joe, continues as editor-in-chief until December 2018, at which time *TMS* will cease publication.

Australia again: CSIRO, 1974–81

Joe's recollections of his time at the CSIRO occur as distinct and extensive sections of two recorded interviews.[14] Some additional detail below is from Ron Sandland's unpublished account presented at Joe's memorial session.[15]

[8] Gani (1963).

[9] Gani (2006).

[10] Seneta (2017). This obituary provides more detail on the Sheffield years; while the present Biographical Memoir focusses more on the Australian (Canberra) and USA (Kentucky, Santa Barbara) years.

[11] Heyde (1995). This interview concludes at the beginning of Joe's 'retirement' in Canberra, It contains detail additional to that in the present Biographical Memoir. It also contains a number of group photographs, meticulously captioned, from his youth up to Joe's CSIRO years.

[12] Seneta (2008).

[13] A Memorial Session was held on December 5, 2016, at the Australian Statistical Conference, Hotel Realm in Canberra. The speakers were Eugene Seneta (overview of life and career), Sarah Gani (on her father, and family life), Frank de Hoog (presenting Ron Sandland's account of Joe's time at the CSIRO), Sue Wilson (on Manchester-Sheffield), Gordon Smythe (on Santa Barbara), and Daryl Daley (Applied Probability and Joe's mathematical activity).

[14] Seneta (2008). Heyde (1995).

[15] See footnote 13.

Early in 1973, A. E. (Alf) Cornish (based in Adelaide), head of the-then Division of Mathematical Statistics, died. The division in those days was a distributed statistical consultancy to other CSIRO divisions, with some research being carried out in experimental design, and in the structures underlying the analysis of variance which led to the development of the statistical software GENSTAT. Some research problems arose from CSIRO consulting projects but research for its own sake played a minor role.

Joe, happy in Sheffield, and with not altogether happy memories of Australia, was not enthusiastic about applying for the position. After a time he was asked, as an Australian, to come and do a review of the division, and did so in about February 1974. He reported that the division needed to broaden its focus, hitherto confined to biometry and agricultural problems, to encompass operations research, mathematical modelling, applied mathematics, and computational mathematics. The CSIRO Executive accepted the report in full, and asked Joe to be the person to implement it.

Thus, from September 1974 to July 1981 Joe was back in Australia as chief of the Division of Mathematics and Statistics (DMS), where he was soon joined by Chris Heyde as assistant chief. The division was now based in Canberra and located close to ANU where Joe was able to renew friendships.

Leaving Sheffield was the most difficult decision in the family's life but they soon settled in Canberra. Joe bought a house in Deakin, in the same street as the house he had purchased when he joined the ANU, 1960–1. Ruth modified it extensively, and the family was happy there during the CSIRO years. It was their home in Australia to the end of both their lives, although intervening years were spent in the USA.

Joe had come with a clear agenda to bolster significantly the division's research. He made many outstanding appointments in both applied mathematics and statistics. These included Bob Anderssen, Noel Barton, John Blake, Richard Cowan, Frank de Hoog, Mark Diesendorf, David Gates, John Knight, Nick Stokes, Geoff Eagleson, Ian Saunders, Richard Tweedie, and Mark Westcott. Joe also enhanced the careers of young scientists who had been in the division before his arrival, encouraging and facilitating their progress to a PhD. The division's research, and its reputation, flourished. Joe set up a company, SIROMATH, to provide paid statistical consulting for industry and government outside the CSIRO. Under Richard Tweedie's dynamic leadership this company prospered. During his time as chief at CSIRO, Joe spent some significant periods overseas, in particular at the University of Waterloo where he was supported by National Research Council of Canada Research Grants, 1978–9.

The consensus is that in his years at CSIRO Gani's work went brilliantly, both achieving what had been promised in service and research, and fostering a strong visitor program that brought out celebrated statisticians such as Sir David Cox FRS, John Nelder and John Tukey. The impetus of those years also resulted in remarkable achievements after Joe's departure, recognized by the Sir Ian McLennan Prizes in 2000 (Tony Miller) and 2009 (Frank de Hoog), and the CSIRO Chairman's Medal in 2004 (Norm Campbell and his team).

At the end of seven years, as was usual at the CSIRO, there was a review of the division in 1981. J. P. (Paul) Wild (FAA 1964, FRS 1970) was at the time head of CSIRO, and very supportive of the division's achievements. J. R. (John) Philip (FAA 1967, FRS 1974), director of the Institute of Physical Sciences that contained Joe's division, was the head of the committee of review. In Joe's words 'the review, when it eventually came out, was schizophrenic'.[16] While praising the division's having become internationally renowned, the report said the government wanted 'a return to the more consultative aspects … I was told that I had to change policy'.

Joe resigned as chief of division, but stayed with the CSIRO on leave, explored a move to the US, and after a few weeks back home, retired honourably from the organization at age sixty. Chris Heyde was acting chief for a short time, 'followed for a couple of years by Terry Speed, … he was followed by Peter Diggle who lasted a full year'. Ron Sandland became chief of DMS in 1988. Terry Speed summarizes these upheavals as follows:

> the major changes which followed the appointment of Gani as Chief of Division related to the great broadening of the Division's range of activities beyond statistical consulting, collaboration and research. The Division was reviewed in 1981 and whilst applauding many of the developments of DMS since 1973, these broad objectives were seen by the Committee as unrealistic. Further, there was criticism of the extent to which the Division's research was unlinked with its consulting and collaborative work.[17]

Of Joe's time as Chief, Ron Sandland concluded his talk with the words, beloved of assassinated US President John F. Kennedy, whose presidency came to be known as 'Camelot':

> Don't let it be forgot,
> That once there was a spot,
> For one brief shining moment,
> That was known as Camelot

from the musical *Camelot,* derived from the Arthurian legends.[18]

University of Kentucky, 1981–5

From July 1981 to June 1985 Joe was professor and chairman of the Department of Statistics at the University of Kentucky in Lexington. The department there was well established, having just celebrated its twenty fifth anniversary. Joe succeeded the founding chair of the department, Dr Richard L. Anderson, and worked in parallel with him. Anderson's department was essentially statistical, with strong links to the College of Agriculture, as was characteristic in statistics departments in the United States in the times. In the interview with Chris Heyde, Joe recalled: '… what I tried to do in my … years there was to consolidate it [the department] and introduce some courses on stochastic processes and probability, as well as create a statistical laboratory. It seemed to go quite well, and I was reasonably happy with it'.[19]

Joe's vision was to create an active research group in applied probability. Throughout his life Joe loved to travel, and so often took short research visits to promote this vision. The department's colloquia series reflected this imprint with many international speakers in applied probability on the schedule. He also encouraged

[16] Seneta (2008).
[17] Speed (1988).
[18] See footnote 13.
[19] Heyde (1995).

graduate students to pursue careers in this area. In the summer of 1983 Joe secured funds from the Operations Research Society of America/The Institute of Management Sciences (ORSA/TIMS) to host an international conference in applied probability and engineering. Keynote speakers were M. S. Bartlett and E. Çinlar. He secured extramural funding for his research program in epidemic theory from the Office of Naval Research.

Joe was comfortable working with the departments of computer science and mathematics; he convinced each department to take on a project that would be of mutual benefit to the group and the campus. He recalled that he had a very cooperative dean of the College of Science, who agreed that all statistics must be taught by statisticians. This had been a contentious issue also in Australian universities.[20]

At the outset, he recalled, he was promised $50,000 in financial help from the university administration to start a statistical laboratory.[21] Dick Kryscio joined the department to help with the start-up and consulting. But the university administration was facing an austere budget situation at the state level and the university funding round of 1982–3 could not fulfill that promise. This was likely a factor in Joe's departure from the University of Kentucky for a similar position at the University of California, Santa Barbara in 1985.

Nevertheless the Statistics Department formed the Mathematical Sciences Consulting Laboratory to aid campus investigators with study design and data analysis. It received financial support from the Colleges of Agriculture, Medicine, and Nursing and some research centres on campus. Many young statisticians worked in the laboratory as interns during that period of time. Dick Kryscio (who became chair of the Statistics Department) wrote that after several iterations it then flourished as the Applied Statistics Laboratory and is self-supporting. Although during Joe's time at the University of Kentucky both Joe and Richard Anderson, who served as president of the American Statistical Association in 1982, worked tirelessly to encourage the university administration to support statistics, they were ahead of their time.

Joe and his wife Ruth enjoyed living in Lexington, which Joe described as a very lovely town. Ruth pursued a MS degree in microbiology and they are well remembered there. They hosted an annual department Christmas party at their residence but since this was a small apartment, they had to spread the invitations over two evenings.

University of California at Santa Barbara, 1985–94

After leaving the Department of Statistics at the University of Kentucky, Joe joined the Department of Mathematics at the University of California, Santa Barbara (UCSB) in July 1985. Just before his arrival, a proposal for forming a Statistics and Applied Probability Program (SAPP) at this time had been approved at UCSB. This SAPP was a semi-autonomous unit under the umbrella of the Mathematics Department, and was responsible for its own hiring and teaching programs. The permanent faculty (academic staff) at that time consisted of professors Milton Sobel, James Robertson and J. S. Rao (Sreenivas Jammalamadaka). James Robertson, from whom the invitation to Joe had come, held a joint appointment with mathematics. It was hoped that Joe would build up SAPP and that it would eventually become a separate department.

With his vast administrative experience, Joe led the SAPP very successfully during the period 1985–9. He worked enthusiastically toward introducing new degree programs (masters and PhD) in statistics, and toward forming an independent Department of Statistics and Applied Probability. During these four years of his chairmanship of SAPP, the statistics program grew in strength from the initial four academic staff to about eight, and Joe arranged for a stellar group of short-term visitors to the program that included James Durbin, Lennart Rohde, Soren Asmussen, Daryl Daley, Chip Heathcote, Des Nicholls, T. J. Rao, and P. Bhimasankaram. That brought the Program a great deal of visibility on the campus as well as outside the university.

An independent department was finally formed in 1989 with J. S. Rao as the first chair 1989–93. During 1990–1 when Rao was on a sabbatical leave, Joe again pitched in as the acting-chair for that year. Gordon Smythe, presently at Walter and Eliza Hall Institute of Medical Research arrived at Santa Barbara as a PhD student, and was at UCSB, 1985–94. He recalled this time as a masterclass on how to create and run a department. There were monthly meetings of academic staff, with a clear agenda and decisions to be made. Joe used to round everybody up for lunch, almost every day for three years. There were also formal dinners to honour visitors.

Daryl Daley, who later worked with Joe as a colleague at ANU, wrote in an email to the author:

> The spring quarter that I spent there in 1988 was the first time that I had really seen anything of Joe in action in the sense of almost daily contact with him. What impressed me most, had seemingly little to do with academic work (and I collaborated with him on a couple of writing projects in that period) … it was his care and concern for his staff irrespective of whether he was closely sympathetic to them as people. He maintained sociable interaction with them and fostered that between them by insisting that the department should have regular morning and/or afternoon tea/coffee, and by ensuring that when visitors (e.g. for seminars) were entertained at lunch, a good cross-section of the department should be included in the luncheon party (ditto for any post-seminar dinner).

Under a special arrangement with UCSB, until his retirement Joe lived in Canberra from 1991 and worked at ANU for nine months each year. He officially retired from UCSB as Professor Emeritus in July 1994, at age 70. Ruth preferred Lexington to Santa Barbara, which in her view was a city inhabited by retired millionaires. In Santa Barbara she and Joe lived in a high-rise apartment, in a building with a lot of wealthy widowed ladies who drove expensive American cars, and Joe and Ruth did not feel especially comfortable among them. They drove a second-hand Datsun Sunny. There was a black doorman, whom everybody else ignored. Joe as ever in his habitual role of good shepherd and egalitarian, tried to organize a Christmas gift for him from the residents.

Australia once again

Joe was a visiting fellow at ANU from September 1989 to December 1997 and then from 2001. He was primarily located within the Stochastic Analysis Group, headed by Chris Heyde.

[20] Seneta (2008).
[21] Seneta (2008). Heyde (1995).

At ANU Joe's weekday routine was as regular as clockwork. He drove in, arriving at ~8:45am. Then emails were answered, followed by editorial duties on the *Mathematical Scientist*; then mentoring young people; then research to which he dedicated one third of his time. Linda Stals, ANU PhD (1996) in computational mathematics, and new member of the Mathematics Department in 2002 as lecturer, had her office two doors from Joe's, and recalled that Joe was the social coordinator for the corridor. As well, he took her under his wing and they wrote six papers together, the first published in 2004, the last in 2013. Joe did the probabilistic modelling (aspects of epidemics), while she provided the computational expertise. At ANU Joe formed a morning Coffee Club that became an informal forum for people to exchange views on the world. It was also a forum for Joe's Jewish jokes, for which he was famous.

Sarah Gani said that Joe had always loved the movies. For Joe's four young children, visits to the movies were an important family time to be shared: 'there was nothing better than listening to him laugh till he cried at such films as the Pink Panther with Peter Sellers, or Monty Python'. After Ruth's death, he went regularly on Saturdays, often with a neighbour.

Until the end Joe maintained his academic activism in Australia arising out of innate interest in the social function of mathematics and his strong interest in its history, manifested by his continuing role as Editor-in-Chief of the *Mathematical Scientist*, his role in many selection committees, and indeed his own continuing research productivity, still significant well into his eighties.

Joe's very close friendship with Ted Hannan ended only with Ted's death on Friday 7 January 1994. The photograph (Fig 1) of the group of four was taken the day before. Joe read the eulogy from the pulpit of St Christopher's Co-Cathedral, Canberra, at Ted's funeral, and wrote several moving obituaries that reflected the depth of the relationship as well as the personality, achievements and life of his friend.[22]

Ruth, who had been an enormous source of support and influence on Joe, died in January 1997 after battling cancer for three years. The Ruth Stephens Gani Medal, first awarded by the Australian Academy of Science in 2008, was instituted in her honour. One of his favourite papers was written under her guidance and effectively in collaboration.[23] Her name as co-author is missing at her own insistence.

Chris Heyde, who had been as close family to Joe, died in March 2008.[24] Joe was too emotionally fragile to prepare the eulogy that was read by Eugene Seneta, with Joe in the front row of the congregation.

Research and publications overview

Joe's research interests in applied probability and statistics included these areas: theory of storage, queueing theory, epidemic modelling, biological models, statistical linguistics, and inference on stochastic processes. His research directions in these real-world-context areas, had been motivated by questions such as 'How can I use mathematics to understand what is going on?', and were influenced by a belief in the 'British method of serendipitous discovery', to quote Daryl Daley.[25]

Figure 1. From left: Chris Heyde, Ted Hannan, Joe Gani, and Eugene Seneta. ANU Canberra, 6 January 1994.

In his 2008 interview Joe said that his most influential papers were in epidemic theory.[26] A list headed 'Publications on Epidemics' was extracted from Joe's own total list of 351 papers (Supplementary Material) in his *Curriculum Vitae*.[27] This extracted list shows the continuity of the often collaborative (and doubtless Joe-stimulated) work on epidemics through the various periods: Michigan-Sheffield, CSIRO, USA, and ANU (1989–2016). I have selected two of these items on epidemics, published in 1967 and 1971, for the next section, to illustrate highlights of Joe's mathematical creativity.

Articles published from 1987—work roughly corresponding onwards from the latter part of his Santa Barbara period—are numbered 195 to 351, and indicate a period of intense productivity facilitated by his retirement. Publications from the year 1990 to 2000 display increasing focus on spread of HIV and collaboration in particular with Daryl Daley, Sid Yakowitz, and Gleb Haynatzki whom Joe had supervised for PhD at Santa Barbara.

History of mathematics and statistics was one of Joe's very strong interests. A special interest was Isaac Newton on whom he wrote in the *Mathematical Scientist* in 1982, and then in 1985 in the *Encyclopedia of Statistical Sciences*. He edited books, where individual statisticians wrote their life histories and creative philosophies.[28] In 2001 there were articles in *Statisticians of the Centuries*

[22] Gani (1994*a*). Gani (1994*b*).
[23] Gani's favourite papers were Gani (1967), a very strong mathematical paper, solving a hitherto unsolved equation; Gani (1975), written with Ruth; and Gani and Swift (2006), a paper from extensive late-career collaboration with Randall J. Swift.
[24] Gani and Seneta (2008). Seneta and Gani (2009).
[25] Daley's presentation at the 2016 Australian Statistical Conference (see footnote 13).
[26] Seneta (2008).
[27] J. Gani, '*Curriculum Vitae*. Joseph Mark Gani. (Version 3, June 2005).' 31pp. (Unpublished.)
[28] Gani (1982). Gani (1986).

on Daniel Bernoulli, Pyotr Dimitrievich En'ko (who formulated the first epidemic model), and Anderson Gray McKendrick, all of whom had worked in epidemic theory.[29]

Joe was very gratified by the response to the book (his second) that he co-authored with his ANU colleague Daryl Daley.[30] In Joe's words it 'contains a compendium of all the work we did in epidemic modelling'. It also includes history, and displays a great deal of the analytical apparatus, such as partial differential equations and generating function technology, used in the golden years of applied probability. This book was followed by a period of productive collaboration, in particular with Randy Swift: some twenty four joint publications beginning in 2005 and ending in 2016. Of these, six were published in the year 2008 and five in the year 2011. Additional papers with Randy Swift were being completed at time of writing, and are listed at the end of the Supplementary Material.

In an interview with Joe in 2008, Eugene Seneta remarked: 'You have a good publication rate for someone who's retired: about seven papers a year. In fact, not too many mathematicians would publish seven papers a year'. To which his response was: 'Well, what else have I got to do? [laugh]. They do say it keeps the brain active. …And it keeps me abreast of what's going on'.[31]

In Joe's own list of articles and publications of 351 items, a proportion is described by Joe 'as of general interest and expository' and indicated in his *Curriculum Vitae* by an asterisk. They testify to his continuing social activism is in the cause of mathematics and statistics.

A separate list of 'Books & Special Collections of Papers by J. Gani (Supplementary Material) displays these activist and historical diarist roles, and in particular his role as editor and publisher. This list precedes the list of articles and publications in the Supplementary Material.

In his *Curriculum Vitae* he listed as his graduate students: Manchester: N. U. Prabhu (M.Sc.); University of Western Australia: Boonserm Weesakul, B. R. Bhat (completed PhD at University of California, Berkeley); Australian National University: G. F. Yeo; Michigan State University: R. C. Srivastava; University of Sheffield: I. V. Basawa; Mohammed Sher Ali Khan, Niels Becker, K. Dietz (completed PhD in Germany), David Jerwood; University of Kentucky: Marie-Pierre Malice; University of California, Santa Barbara: Shahar Boneh, Steve Butler, Nadia Minicuci, Gleb Haynatzki.

Some mathematical highlights

The highlights occur within the context of stochastic modelling, which is the mathematical construction of a random process to reflect the evolution over time of a physical 'system' moving from state to state under random influences on the movements.

A random process over successive integer time $\{X_n,\ n \geq 0\}$, where X_n denotes the state after the n-th transition (that is, at time n) within the state-space S (that we shall assume to consist of a finite fixed number of possible states that we label $\{0, 1, 2, ...\}$ is called a finite Markov Chain (MC) if for all $n \geq 1$, and *all* $i_0, i_1, \ldots i_{n-1}, i, j \varepsilon S$

$$\begin{aligned}&\Pr(X_{n+1} = j | X_n = i, X_{n-1} = i_{n-1}, \ldots, X_0 = i_0)\\ &\quad = \Pr(X_{n+1} = j | X_n = i)\end{aligned} \tag{1}$$

Here Pr stands for Probability and the vertical slash | for 'given'. The above statement then reads: 'the conditional distribution of the random quantity depends only on X_n, the most recently known state value'. This specification of simple dependence structure of a discrete process $\{X_n,\ n \geq 0\}$ is called the Markov property. For example, if the evolution of a population is thought to consist of successive generations, the genetic structure of the population from generation to generation has the Markov property. More generally, successive time points $n = 0, 1, 2, ...$ mark successive epochs of some kind, without the successive unit gaps in the growth of n denoting actual equal time values.

When the quantity on the right of (1) is also independent of n, the MC is said to have stationary transition probabilities, or, equivalently, to be time-homogeneous. The quantity (1) is then denoted *by* p_{ij}. We shall consider only such finite MCs. If we now write $P = \{p_{ij}\}$, $i,j\ \varepsilon\ S$ for the finite matrix of transition probabilities, called the transition matrix, and Π_0^T for the row vector of initial probabilities $\{Pr(X_0 = i),\ i\ \varepsilon\ S\}$, then the probability-distribution - at - time - n row vector is given by

$\prod_n^T = \{Pr(X_n = i), i\,\varepsilon S\} = \prod_0^T P^n$ where P^n is the n-th power of the matrix P, that is in fact called stochastic since its row entries sum to one for each row. It is this expression of the Markov property over time in terms of matrix powers that enables the theory of Markov chains to be set within the matrix theory that is thus a fundamental tool in the analysis of long-term behaviour of MCs.

The other general random process that figures prominently in Joe Gani's mathematical highlights is the Markov process. This is basically a Markov Chain in continuous time (and indeed Joe continued to call it a Markov Chain). Such a (homogeneous) process $\{X(t), t \geq 0\}$ for $i, j, x(u) \varepsilon\ S$, where $S = \{0, 1, 2, \ldots\}$ is a finite set, satisfies

$$\begin{aligned}&P(X(t+s) = j | X(s) = i, X(u) = x(u), 0 \leq u \leq s)\\ &\quad = P(X(t+s) = j | X(s) = i) = p_{ij}(t)\end{aligned}$$

where if we write $P(t) = \{p_{ij}(t)\}, t \geq 0$, we have analogously to the MC framework,

$$\prod_t^T = \{Pr(X(t) = i),\ i\,\varepsilon S\} = \prod_0^T P(t).$$

Because of the Markov ('forgetting') property, the (random) time the process spends in state i once it enters it (if it is not an absorbing state), is negative exponential with some parameter $v_i > 0$, that is with the probability density function $f_i(t) = v_i e^{-v_i t}, t \geq 0$.

Next define for $i, j \varepsilon S$

$$\begin{aligned}q_{ij} &= v_i P_{ij}, i \neq j,\\ &= -v_i, i = j,\end{aligned}$$

[29] Heyde and Seneta (2001).
[30] Daley and Gani (1999).
[31] Seneta (2008).

and call the matrix $Q = \{q_{ij}\}$, $i,j \varepsilon S$ the intensity matrix. All its row sums are zero.

Since for $h = \delta t > 0$ small,

$$1 - p_{ii}(h) = v_i h + o(h) = -q_{ii}h + o(h)$$
$$p_{ij}(h) = v_i h P_{ij} + o(h) = q_{ij}h + o(h), i \neq j$$

we obtain $\frac{d}{dt}p_{ij}(t)|_{t=0} = q_{i,j}$ for all *i,j*, that leads eventually to

$$\frac{d}{dt}p_{ij}(t) = \sum_{k\varepsilon S} p_{ik}(t)q_{kj}, \quad (2)$$

the forward Kolmogorov equations. In some cases of a structured intensity matrix

Q, for example for some birth–and–death processes, it is possible to obtain, at least in transform form, explicit solution in terms of elementary functions for the probability distribution of the process $X(t)$ for arbitrary $t \geq 0$. From the beginning of mid-twentieth century, this was an achievement to aim at for a model formulated as a Markov process, even though important questions could still be answered without a time-dependent solution $p_{ij}(t)$.

The year that Joe spent at the Victoria University of Manchester (1956–7) was very research-productive for him in at least two directions. Here he met Uma Prabhu (born the same year as Joe), whose Manchester MSc (1957) he supervised. In collaboration with Prabhu he was able to reconsider in a specific setting the storage/dam problems of his original paper[32] as a Markov Process and to obtain a theoretical solution for its limiting-stationary distribution by solving the stable-state forward Kolmogorov equations, (2) above. Gani's work, individual and collaborative, on storage and dams was shortly after incorporated into a booklet by his PhD supervisor at ANU, P. A. P. Moran.[33]

Also at Manchester, under the influence of Maurice Bartlett, Joe became interested in the theory of epidemics that was to form a major part of his subsequent research activity. Within a few years this interest led to one of his outstanding mathematical achievements. The paper was written on the cusp of his move from Michigan State University to the University of Sheffield.[34] Both geographical addresses are given, separated by an 'and'. The 5th Berkeley Symposium, held at the Statistical Laboratory, University of California, 21 June −18 July, and 27 December 27 1965 − 7 January 1966, became the stuff of legend, encompassing the great and good in the field of theoretical statistics. There was a staggering number of ground-breaking papers, of which Joe's was one. His general model is a particular case of a Markov process on a finite state space where the states are pairs of non-negative integers (*r,s*). The intensity matrix Q is specified to reflect a stochastic epidemic model conceptualized as follows.

At time $t \geq 0$ there are in circulation in a closed population of size $n+a$, with $n, a \geq 1$,

(i) $0 \leq r \leq n$ uninfected susceptibles;
(ii) $0 \leq s \leq n + a - r$ infectives,

the remaining $n+a–r – s \geq 0$ individuals having been removed through immunity or death. At time $t = 0$, the population is known to consist of n susceptibles and a infectives. The probabilities of transitions in the interval $(t, t + h)$ are given by

$$\Pr((r,s) \to (r-1, s+1)) = rsh + o(h)$$

$$\Pr((r,s) \to (r,s-1)) = \rho sh + o(h)$$

$$\Pr((r,s) \to (r,s)) = 1 - (r+\rho)sh + o(h)$$

Here the usual pairwise infection parameter β has been set to one, and ρ denotes the removal rate. (More generally, the rate of infection would be β *rs*.) The distribution at time *t*, $p_{(r,s)}(t) = \Pr(X(t) = (r,s)|X(0) = (n,a))$, $(r,s)\varepsilon S$ satisfies the forward Kolmogorov equations (with initial 'state' fixed at (n,a)). Gani proceeds by an adaptation and mixture of transform methods: the Laplace transform, and the generating function.

He writes $F_r(w,u) = \int_0^\infty e^{-ut} f_r(w,t)dt$, $u>0$, where $f_r(w,t) = \sum_{s=0}^{n+a-r} w_s p_{(r,s)}(t)$ and forms, from the forward Kolmogorov eqns (2), a matrix differential equation:

$$A(w)\frac{\partial}{\partial w}F + uF = w^a E$$

where $F = F(w,u)$ is a column vector $\{F_r(w,u), r = n, n-1, ..., 0\}$, $A(w)$ is a matrix and E is a column vector. He is eventually able to obtain an explicit expression for the augmented column vector $\{F(w,u), \int_0^w F(v,u)dv\}$. This time-dependent solution, in transform form is illustrated for small *a, n* in Gani's Section 3. In Section 4 he points out that one of the advantages of the preceding analysis is the simplicity of resulting formulae for the total size of the epidemic. If *r,* $0 \leq r \leq n$, is the number of susceptibles remaining after the epidemic is over then the *size* of the epidemic is *n–r*. Put P_{n-r} for the probability that the epidemic is of total size *n–r*. Then the column vector P^* of the probability distribution $\{P_{n-r}, r = n, n-1, \ldots, 0\}$, is obtained, in matrix terms, as $\lim_{u\to 0} uF(0,u)$.

The paper is an outstanding technical achievement in its methodology, in achieving a time dependent-solution. Gani lists it as one of his three favourite papers.

This General Stochastic Epidemic model is an example of an absorbing Markov process. The states $(n–r,0), 0 \leq r \leq n$, are absorbing inasmuch once one of them is reached, no further changes of state can occur. The other states are transient in the sense that absorption into one of the absorbing states is certain. A question of interest for practical applicability of the model is the time taken to reach an absorbing state (that is, for the epidemic to end). Since in a Markov process the distribution of time until change of state is negative exponential, the model has a high probability of an epidemic having an exceedingly short duration, a general drawback of modelling by a Markov process. And this is exacerbated for this

[32] Gani (1955).
[33] Moran (1959).
[34] Gani (1967).

model by the hierarchical movement between transient states. Further, the probability distribution over the absorbing states, as expressed by the vector P^* above, can be relatively easily calculated from the MC imbedded at time points of actual changes of state, rather than from $\lim_{u\to 0} uF(0,u)$ as proposed.

After a time, Gani realized that absorbing MC models, *with discrete unit of time of the chain being the latent period of the disease*, would help overcome the 'drawbacks of the overly simple' (!) General Stochastic Epidemic model.

The infectives, S_t in number, newly present at time t would no longer be present at time $t+1$, all infectives at time $t+1$, S_{t+1}, having arisen from the susceptibles at time t. Denoting the number of uninfected susceptibles at time t by R_t, then $R_t = R_{t+1}+S_{t+1}$. The absorbing states (the states at which the epidemic terminates) are the states $(r, 0)$ of the state space (r,s) of the bivariate process (R_t, S_t). The epidemic will terminate at time $t = t$ when for the first time $R_t = R_{t-1}$.

Gani realized that the two discrete time models in common use, those of Greenwood and Reed-Frost, fitted, serendipitously, into this framework, and could in fact be expressed as MCs (as it turned out respectively univariate $\{R_t\}$ and bivariate $\{R_t, S_t\}$), and, presumably, that an encompassing generalization to simplify and unify their theory might be possible.

The first public appearance of these ideas is Gani's presentation at the International Statistical Congress, in London, 1969, and is summarized in its *Bulletin*.[35] The 'chain binomial' terminology of its title arises because the transition probabilities in both these models are of the form of a binomial distribution. Respectively for the Greenwood and Reed-Frost models:

$$\Pr(R_{t+1} = r_{t+1}|R_t = r_t) = \frac{r_t!}{r_{t+1}!(r_t - r_{t+1})!}p^{r_t - r_{t+1}}q^{r_{t+1}}$$

$$\begin{aligned}\Pr(R_{t+1} = r_t - s_{t+1}, S_{t+1} = s_{t+1}|R_t = r_t, S_t = s_t)\\ = \frac{r_t!}{s_{t+1}!(r_t - s_{t+1})!}(1 - q^{s_t})^{s_{t+1}}q^{s_t(r_t - s_{t+1})}.\end{aligned}$$

Here q, $0 < q < 1$, is the probability of no contact with the infection, and $P = 1–q$. In the Reed-Frost expression q^{s_t} is the probability of no contact with any of the s_t infectives. The subsequent paper, co-authored with his then-PhD student D. Jerwood, appeared in 1971.[36] Gani's research for this paper was completed at Stanford University with partial support of the US Office of Naval Research. Joe in fact spent five northern summers in the period 1967–71, as Visiting Professor at Stanford University, clearly time for research away from responsibilities and leadership at Sheffield.

The underlying generalized setting that appears explicitly in the 1971 paper is as follows. Let $\{X_t\}$ be a finite Markov chain (not necessarily univariate) with finite state space. (We retain the 't' for the discrete time setting for present consistency, even though we have used 'n' at the beginning of this section.) Denote the transition matrix M and the diagonal matrix Q and by:

$$\begin{aligned}M = \{m_{ij}\}, i,j = 0,1,\ldots,k;\ 0 \le m_{ij} \le 1, i \ne j;\\ 0 < m_{ii} \le 1.\ Q = diag\{m_{ii}\}.\end{aligned}$$

Now define the matrix $P = M – Q$.

The chain will be said to terminate at time $T = t$ when $X_t = X_{t-1}$ for the first time. This is a new concept for a general MC. The authors obtain the probability generating function (pgf) of the probability distribution of T in elegant matrix form:

$$\sum_{t=1}^{\infty}\theta^t \Pr(T = t|X_0 = i) = f_i'(I - \theta P)^{-1}\theta Q1,\ 0 \le \theta \le 1,$$

from which the moments of the termination time, such as its expectation (that is, mean value), are easily available. The final state X_T at which the process terminates is important in the epidemic application since it will give the size of the epidemic. Accordingly, the authors also derive the bivariate pgf of the pair (T, X_T), likewise in elegant matrix form, from which such information is easily available.

These results are clearly more general than (although as simple in structure as) the matrix results for absorbing MCs.[37]

Honours

Joe earned a DSc from London University in 1970. His honours included DSc degrees (*Honoris Causa*) from the University of Sheffield, (1989) and the University of Wollongong (1991).

He was elected Fellow of the Australian Academy of Science (FAA) in 1976; elected Honorary Fellow of the Royal Statistical Society in 1982, and Honorary Life Member of the Statistical Society of Australia in 1983. The Statistical Society of Australia presented Joe with a Festschrift in 1988,[38] and awarded him its Pitman Medal in 1994. The third number of the *Australian Journal of Statistics* for that year (volume 36) contains an excellent anonymous citation.

He was President of the Australian Mathematical Society 1978–80, and there is a fine obituary in that society's *Gazette* written by Daryl Daley in his honour.[39]

He was awarded the first Moyal Medal of Macquarie University, 19 June 2000.[40]

Joe was made Member of the Order of Australia (AM), on Australia Day, 26 January 2000, and awarded the Centenary Medal of the Australian Government in 2001.

[35] Gani (1969).

[36] Gani and Jerwood (1971).

[37] A Google search on 16 August 2018 yielded 57 citations of Gani and Jerwood (1971) paper (see footnote 36), truly a highlight of Gani's mathematical work. A further citation is in Möhle (2018). Gani (1967) has also had a large number of successors, 47 on Google listing as at 16 August 2018.

[38] Heyde (1988). Contributors include a large number of the great and good of probability and mathematical statistics of the time, of both Australia and overseas.

[39] Daley (2017).

[40] The medal, 'For distinguished contributions to Statistics', honours the memory of J. E. (Jo) Moyal, first Professor of Statistics at Macquarie University, Sydney. Moyal's distinguished academic career included supervision in Pat Moran's Department at ANU of the PhDs of C. R. (Chip) Heathcote and Peter Brockwell. Joe Gani also played a key role in ANU honouring Moyal during Moyal's long retirement in Canberra.

Epilogue

Joe Gani is survived by his children Jonathan (born 1957 in Perth, and now a well-known abdominal surgeon in Newcastle, Australia), Miriam (born 1959 in New York, now Associate Professor and Head of the Department of Law, ANU), Matthew (born 1962, in Canberra, an electronic engineer in Seattle, USA), and Sarah (born 1964 in East Lansing, Michigan, a GP and medical educator with an interest in Paediatrics and Adolescent Medicine, in Sydney), their families, and his brothers, Maurice and Robert. Joe's mother Lucie eventually become a teacher at the University of Melbourne's kindergarten, then migrated to England where she became established in the Surrey suburb of Sutton. She died in September, 1996. Maurice emigrated to Israel at about the time Joe had first come to Canberra in 1954. Robert completed Mechanical Engineering at the University of Melbourne, and eventually became an academic at Monash University. He retired in 1996, as Senior Lecturer.

A Memorial Service for Joe was held on 22 April 2016 in the Great Hall of University House, ANU. Joe, resolutely irreligious till the end, would have appreciated the coincidence of the date with the beginning of Passover.

Joe Gani was visionary leader, of indomitable physical and mental energy, who never faltered in making a decision. An indefatigable organizer, Joe lists some twenty two items including conferences and symposia, from 1960 to 2004, in his *Curriculum Vitae*. Something of a stormy petrel, he had a multiplicity of careers and activities, all executed with great efficiency, and in the face of frequently feeling 'mucked about'. He helped a great many people in their academic careers. Joe and the early *Journal of Applied Probability* could be seen as modern analogues of the mathematical activist A. V. Vasiliev, and the Kazan Mathematical Society's journal where Markov's foundational paper on chains was published in 1907.

The science of applied probability, Joe's adopted country Australia, and the mathematical world more generally, owe him much. Of him it can truly be said: 'I did it my way'.

Conflicts of interest

The author declares no conflict of interest.

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