

A lifetime in probability

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By Olav Kallenberg, 2021

Family and school years. My father came from a simple servant family that had remained poor for generations. Thus, his older brothers had to quit school at age 14 to take simple jobs, helping to support the family. The curse of perpetual poverty was magically broken when my grandfather *Otto Kallenberg* got employed as a trusted servant to the Swedish king, moving into an apartment across from the royal castle. With the improved economy, the family could afford to send their youngest son, my father, to a Latin school, where he became the first member of the family to graduate from high school. To support any higher studies was out of the question, which is why he enrolled in the military academy where the education was free, thus becoming an officer in the Swedish army reserve.

My mother came from a prominent Norwegian family of doctors, lawyers, and public servants, whose ancestry could be traced back at least 17 generations, well into renaissance times. The brothers of my maternal grandfather had extraordinary careers, one becoming a prominent lawyer, another a famous architect, a third a successful business man, and a fourth an outstanding scientist. Though my grandfather *Olaf Sund*¹ was said to be the smartest of the lot, he opted for a simple life as a *lensmann* in a rural island community north of the polar circle. My grandmother was sickly, staying for long periods at a sanatorium far from home, and so my mother was raised by her three older sisters. Since only the most elementary education was available in the local community, the children had to be sent for schooling to the nearest town, staying with friends and relatives. My mother must have been doing well in school, since she was the only daughter deemed worthy of a higher education, thus becoming the first girl of the family to graduate from high school.

I was born on 22 September 1939, shortly after the outbreak of World War II. Though Sweden managed to stay neutral through the war, these were still very challenging times, with extreme shortages of basic groceries in the stores and much of the work force tied up in the army. My mother's life was very lonely and difficult, since her entire family was living in Norway within occupied territory. On my two-years birthday, she got the message that her father had been killed, when traveling as a civilian on board a steamship, also used for German troupe transports, that was torpedoed and sank outside the Norwegian coast. My father was lying with his company at an undisclosed location along the Norwegian border, ready to fend off the Germans if they would decide to invade. I hardly knew him and would cry when he came

¹I was named after my maternal grandfather, thus getting a name that nobody knew how to pronounce (Uh-love), to my embarrassment all through school.

home for a short visit. Even after the war, he became the manager of a refugee camp far away from home.

Like all other Swedish kids, I started in first grade at the age I turned seven. (There was no kindergarten in those days.) My mother then took a simple job in an insurance company, and I became a "key child," with a key to our apartment hanging in a string around my neck.² The first couple of grades were totally boring and meaningless, since I already knew how to read and write, plus some elementary arithmetic. The simple calculations and algebra we learnt in school I found easy but extremely boring. Compared with other subjects, the advantage with math was that there was nothing to memorize, you could just figure things out if you were only smart enough. This suited a lazy person like me, with lots of other interests and passions. Somehow I always got the top grade A in math all through school, which was very unusual, since an A was hardly given except in the graduating class. Everybody in school knew that I was the guy who was good at math. From the teachers I got some contradictory advice. One thought that if you were good at math, you should focus on that, and all other subjects would take care of themselves. The opposite advice came from another teacher, who kept reminding me of the danger of a narrow specialization (becoming a *fackidiot*). He may have chosen a bad target, since I had probably broader interests than most kids of my age.

Math got more interesting when we started with Euclidean geometry, which was a subject I truly loved. Oddly enough, our textbook was a more or less literal translation of Euclid's original, with all the nonsense faithfully reproduced, such as "a line is that which has no width." But there were so many beautiful propositions, with short but clever logical proofs. I became an expert on the subject, and when the teacher raised a question, then 35 pairs of eyes were directed towards me (the class size was typically 36 throughout elementary school), since everybody knew that I could always find the answer.

The educational system in Sweden was both rigid and competitive in those days, with all students studying at the same pace. After four years there was a selection, and then another one after eight years for entry into high school. Traditionally, the only options were realities (math and science) and Latin, and if you had no talent or taste for math, then Latin was the only alternative. Soon a third, intermediate option was introduced. By the end of high school we started with some very elementary calculus, which again got quite interesting. Every year there was a math competition for Swedish high school students, where I submitted my solutions and won the first prize. The outcome was even publicized in a Scandinavian math journal.

Much of the basic school was just boring and tedious, but in the rigid Swedish school system there was no way of skipping classes or transferring to a more advanced school. In the rather socialistic Swedish society of those

²Leaving children alone was common in Sweden in those days. The country was very safe and peaceful, and crimes like kidnapping were unheard of.

days, the government (big brother) had simply decided once and for all what was best for everybody. As already mentioned, when I started in elementary school, I had already known for years how to read and write. I knew the basic arithmetic too, though with my usual stubbornness I resisted all kinds of memorization, and to this day I admit that I can never remember the multiplication table, and similarly with the "quadratic formula." Later on, as a math professor, I could always save myself anyway, since I knew how to find the answer at the speed of lightning.

After school we had a year of mandatory military service. For some reason, I became the target of constant harassment, for failing with shoe polishing or whatever. My head was too big for the helmet, and when we were diving down to the ground, it would always fall off, and the heavy rifle carried on the back would hit me in the head. Then the drill sergeant would mock me in front of everybody:

Hahaha, look at Kallenberg!

and I may have got the penalty of doing ten push-ups. How much I hated it all! And the purpose of the whole thing was to learn how to kill other human beings, which was so absolutely repulsive to me. After nine months of torture, including a bout of pneumonia that almost killed me, it was a relief to return to regular civil life. When going to the captain's office to get my exit slip, I was asked about my plans, and I replied that I was admitted to studies at the KTH (the *Royal Technical University* in Stockholm). I will never forget his answer:

Hahaha, forget it, you are never going to make it.

College years. My undergraduate studies at "Teknis" (KTH) were among the best years of my life. There were many divisions, and I was admitted to the division of *Technical Physics* (F), which was a kind of honors class, with the highest entrance requirements but also the most advanced courses. We were only 30 students, 29 boys and one girl, and because of the high entrance demands, most of my classmates were extremely bright, often with broad intellectual and other interests. In fact, among us 30 students, at least five or six eventually became professors in our own right.

From the end of my military service to my entry at Teknis I had five months free. Then I took a simple job at an insurance company in town (about 48 hours a week in those days), and in my spare time I studied calculus. In fact, on the suggestion of a friend in a higher class, I bought the two huge calculus volumes of Courant, about 600 pages each, where I worked through every section and did all the exercises. This was a great investment, since practically all our courses at Teknis were calculus based, and the studies became so easy.

In every subject, the teaching was divided into theory classes by the main professor and problem solving classes taught by teaching assistants. We were advised that the problem solving sessions we absolutely had to attend, whereas the theory classes of the professor we could safely skip. With my

usual stubbornness, I did the exact opposite. I can't recall that I ever studied during the semesters, except for producing the detailed lab reports that we often had to submit.

Every semester ended with finals in the various subjects (it could be up to five or six of them), and for preparation we got a bunch of tests that had been given in the course during the last few years. I remember that, between the finals, I would take my bike and perhaps a sketchbook and find a beautiful spot by a lake, where I would do the first test, then finding another nice spot for the second test, etc., until I had worked through all of them. In this way, the actual test the next day usually became a simple routine.

Here our grading scale was in numbers from 1 to 7, where 3 was required for passing. However, we could only get up to 5 on the regular course, and if we wanted a high grade we had to take an extra reading course with an oral exam for the professor, not too hard for a 6 but very challenging for grade 7. In this way, I took reading courses in abstract algebra, functional analysis, linear algebra, complex variables, probability, etc. For example, in complex variables I got to read the classical book by Ahlfors, where I was responsible for knowing every theorem and every proof. This is how I got a good foundation of basic mathematics. My assignment in probability was to read a portion of Feller's classical book, arguably the best math book ever written. The only problem was about the numerous errors, so that part of the challenge became to "fix" the proofs. I remember how the professor *Carl-Gustav Esseen* complimented me after the exam, addressing me formally in third person:

*Det här har teknologen gjort grundligt!*³

Already the first calculus lectures (held by professor *Hans Rådström* in the huge KTH auditorium) were fascinating, as he presented from memory complete proofs of all results, maybe up to the level of the Heine–Borel theorem. This was when I truly fell in love with mathematics. But then, in the famous book of E.T. Bell, I had read that all great mathematicians had been child prodigies. For example, Galois had revolutionized algebra before dying in a duel at age 21. Hardy said in his *A Mathematician's Apology* that "mathematics is a young man's game." When he was on travel, he covered all mirrors in his hotel room, so that he wouldn't see his aging. For me, I thought that I would have loved to become a mathematician, and it was only too bad that I was simply too old. I was only 19.

In order to graduate, I needed six months of internship plus doing a special project. I asked professor Esseen if he had a problem for me. As a former student of *Arne Beurling* (who moved to Princeton and inherited Einstein's old office), he was an expert on harmonic analysis and had written a famous dissertation years ago including the celebrated Berry–Esseen bound. The theses also contained an unsolved problem, and he proposed that I make some computer simulations that might suggest the answer. Using computers

³This the candidate has done thoroughly.

in those days was very complicated, using punching cards for the input and then studying carefully the similarly encoded output. Thus, I decided to see what I could do by some pure reasoning. After a few days I had solved Esseen's problem, and I wrote a short paper with my proof, which I handed over to Esseen. This was not quite what he had had in mind, and my paper ended up in Esseen's drawer. In any case, it was sufficient for the purpose, and I was approved to graduate as a civil engineer. Upon graduation I was selected as one of the two top students in my division, the other being *Anders Martin-Löf*, who also became a math professor.

I should add that, already from third year in college (in the US called the junior year) I became a teaching assistant, first in physics, then in numerical analysis, and finally in calculus. After some initial difficulties, perhaps due to my natural shyness, things were going very well. There were many parallel sections in calculus taught at the same time in adjacent classrooms, and the students would naturally choose to go to the one they liked best. My classroom ended up to be crowded, and the professor seemed very pleased with me.

Graduate studies. After my graduation as a civil engineer, it was natural to proceed with graduate studies, since at this point I truly loved all theoretical subjects and especially mathematics. But then I felt (fairly or not) that, if I would choose an area in classical math, I would end up doing some technical calculations and estimates in a very specialized area. Probability theory seemed to be so totally different. Here was a powerful emerging field of modern mathematics, where all the standard tools and techniques of classical math came into play, be it real or complex, functional, or harmonic analysis, occasionally even abstract algebra or differential geometry. So, I chose to go into probability theory. A contributing factor was that Carl-Gustav Esseen was known to be such a famous man with a world-wide reputation. In fact, when Kolmogorov (one of the world's leading mathematicians) visited Stockholm, then Esseen was the only one he wanted to see. What I didn't know was that, after writing his famous dissertation decades ago, he had published very little.

A complication, following me all through my career, was that for purely historical reasons, probability has been classified in Sweden and some other countries as part of mathematical statistics, thus belonging to a separate department. In fact, up to about 1950, probability and statistics were more or less the same subject, whereas today they are lightyears apart. To this day, many mathematicians are not aware of the distinction. If a statistician would come to our seminar, he wouldn't understand a word and we would never see him again, whereas conversely most probabilists I know have no interest in statistics (simply because it has no relation to what they are doing).⁴ Instead, modern probability theory has evolved into one of the major branches of real

⁴This is not meant as criticism: I deeply respect my statistical colleagues, many of whom are my close friends.

analysis, with close ties to subjects like functional and harmonic analysis, ordinary and partial differential equations, potential theory, abstract algebra, and topology. Besides, modern probability has important applications to many areas of physics and biology.

When beginning as a graduate student under Esseen, I became a GTA (graduate teaching assistant) in mathematical statistics, responsible for teaching two basic statistics courses a semester plus supervising the teaching and grading of hundreds of undergraduate students. We had no graduate courses, very few seminars, and only an extensive reading list of course literature. When I had mastered the material in one of the books, I made an appointment with the professor, who conducted an oral exam on the material. For the last and most difficult test, I was responsible for knowing every theorem and every proof in the book by Loève (3rd edition) plus half of Doob's book, totally about about 1,000 pages of theorem-proof, theorem-proof. Loève was regarded as the standard reference for theoretical probability in those days, purportedly containing everything worth knowing in the subject.⁵ I recall how I spent a whole summer studying for that exam. Since studying at home or in my office soon became too boring, I preferred to study in different parks around Stockholm, choosing a different bench for each proof. When the time of my appointment was approaching, I realized that I couldn't quite make it, and for the first and only time in my life I was cheating a little, skipping some of the last and most difficult sections of the book, in the hope that Esseen wouldn't ask me on that material. Fortunately he didn't, and I passed the exam.

Before graduating I also had to produce a master's thesis, and Esseen proposed that I do some work in the notoriously difficult area of convolution factorization of probability measures, leading into some hard problems in complex and harmonic analysis. Apart from the mathematical difficulties, some of the major literature in the area was written in Russian, and I remember sitting with a dictionary trying to make sense of some Russian papers. In fact, in those days mathematical papers could be written in any of the languages English, German, or French, and even papers in Italian, Spanish, or Russian were not uncommon. When it came to papers in Japanese, I just had to give up, or guess the contents by looking at the formulas. Similarly, conference or colloquium talks were routinely given in all those languages, sometimes with simultaneous translation into English. Personally, I have given talks in German a few times, but never in French. Nowadays the life of mathematicians is so easy, since English has become the *lingua franca*, and you never need to know any other languages.

After graduating with a master's degree, I could have stayed on at Teknis (KTH) if I wanted to, but I decided that it was pretty pointless and time to move on. As said before, we had no graduate courses or supervision of any kind, and I was essentially the only graduate student in the area. The profes-

⁵Today it is totally outdated, whereas especially the books by Feller still feel fresh.

sor (though very kind and extremely knowledgeable in classical analysis) was hardly active anymore and was not in touch with the more recent, dynamical developments of the subject. Based on the strength of my master's thesis, I got a position as a permanent lecturer at the university of Lund, with a formal appointment letter signed by the Swedish king. This was a full time job with a huge teaching load, about 14 hours a week of elementary statistics courses, plus some general supervision of all teaching and grading. After only two years on the job, I couldn't stand it anymore and got hired instead by a general consultant company in Gothenburg. The job was well paid, but my working load was enormous, with constant travel by car or train all around Sweden. Typically I had to board a night train in the evening, work for eight hours (breaks not included) for the client company, and then board another train in the evening for travel to the next client. On Saturdays we had endless meetings about business policy, held in a small room with dense tobacco smoke, and I would return home in the evening, exhausted and with bad headache. Don't blame me if I soon gave up again.

My years at Chalmers. Now at least I was in Gothenburg, the site of the famous *Chalmers University*, boasting a great math department. They advertised a temporary lecturer position in mathematical statistics (remember, probability always belonged to the department of mathematical statistics), and based on my credentials I got hired. The teaching load was again enormous, but already after one semester I got a special scholarship with a much reduced teaching load. Besides, this was an exciting environment with many outstanding graduate students. The main professor in the department, *Harald Bergström*, was close to retirement but still very active, though only in the classical area of the central limit problem, where the most general case had already been settled more than 30 years earlier, independently by Doeblin and Gnedenko. However, there was also the young, dynamic, and extremely clever postdoc *Peter Jagers*, who had managed all by himself to break away from the perpetual work on the central limit theorem, soon to become a leading expert on branching processes and related subjects. He was the one who had attracted all those brilliantly gifted graduate students (including *Torgny Lindvall*, *Olle Nerman*, and many others; *Hermann Thorisson* and *Tommy Norberg* joined us later).

Unfortunately, when I came to Chalmers in the fall of 1970, Peter Jagers was not there, since he was about to spend the academic year of 1970–71 on a sabbatical at Stanford University. However, when the fall semester of 1971 began on October 1, he was back and brought some lecture notes on random measures and point processes that he had written during his absence. We started right away with a seminar on the subject, and very soon I made some interesting discoveries. Already by the next April, I had so many new and interesting results that I decided to submit my paper as a doctoral dissertation, which I defended publicly in early May 1972. (All the course work I had already done under Esseen in Stockholm.) I still find it

quite amazing⁶ that I wrote my Ph.D. thesis from scratch in only six months, especially since this was the year when my father tragically died from cancer, and I took the train to Stockholm to see him every second weekend. It was truly terrible to see him slowly fading away, until he was thin like a chop stick apart for a bulging stomach, and greyish green in his face.

My paper was long, technical, and tightly typed, and I sent it to the ZW, one of the leading probability journals. Here the editor told me that they could possibly publish only a paper of about one third of the original size (down from > 50 to about 17), which essentially meant rejection. I was devastated, since I thought that my paper was filled with lots of important new results. However, I also sent a copy of my dissertation to *Klaus Matthes* in East-Berlin, the undisputed leader of the emerging field of general point-process theory, and then what a difference: More or less in return mail he sent me a nice letter, where he offered to publish my thesis in their monograph series and invited me for a visit. He even send me a photo copy of the entire manuscript of their famous point process book (German edition), which was just about to get published. I also sent my thesis to *Ross Leadbetter* in Chapel Hill, who invited me right away to spend a year as a visitor in their famous department.

I did spend a year in Chapel Hill, and to East-Germany (DDR) I was invited for visits more or less every year, until I left for the US. Matthes was the powerful director of the celebrated *Karl Weierstrass Institute* of the *Academy of Sciences* in DDR, and also a dynamic personality in his own right, inspiring a whole generation of graduate students in especially Berlin and Jena. This was during communist times, and I had endless political discussions with everybody, except with Matthes himself, who was also a boss in the communist party. On my visits I was always treated as a guest of honor. I recall an evening reunion with dozens of participants, where somebody proposed a guessing game: Somebody would think of a famous mathematician, and the others would ask questions, until they could guess who the person was. It turned out that the right answer was *Herr Dr. Kallenberg*, and I was blushing. Suddenly I was a famous man, at least in the DDR.

Already at this time I had very broad mathematical interests and was working on projects all across probability theory. During my visit to Chapel Hill I went to the library every day and scanned all the incoming math journals for papers in probability theory. In particular, I wrote a long paper (now obsolete) about stochastic integration, which I presented in a seminar and even at a local conference. Another visitor to the department was *Ildar Ibrabimov* from Leningrad, one of the first mathematicians allowed to exit the Soviet Union, leaving his wife behind as a hostage. Every day at lunchtime, I would join Ildar to a simple hamburger restaurant. He was immensely proud of his work, but was not impressed by what I was doing. In fact, when I met

⁶Please forgive me my immodesty after all these years.

him again years later, all he wanted to talk to me about was hamburgers.

Travel across the "Iron curtain" was very restrictive in those days, and in the train station there were people checking with mirrors that nobody was hiding under the cars. They would also remove all the pillows in the train compartments to check that nobody was hiding underneath. In the math institute of the Academy in Berlin, there was a lady sitting in an iron cage at the entrance, carefully checking my ID before letting me in. Matthes was kind but formally reserved, resisting any informal address by first names. On my last visit to the department, all formalities were suddenly abolished, the lady in the iron cage at the entrance was gone, and I was invited to Matthes' sanctum high up in attic, where he had a small office with only a desk and a pair of big speakers for his stereo. Like me he was a passionate music lover and an expert on especially chamber music. Klaus Matthes is one of the greatest mathematicians I have known, and I am proud to have been his friend, albeit on rather formal terms.

My next breakthrough came with my solution of the Rollo Davidson problem. Davidson was a math prodigy at Cambridge who died tragically in a climbing accident at the age of 25. He left behind his "big problem" about stationary line processes in the plane, where some evidence seemed to suggest that, under suitable regularity conditions, they would have to be Cox processes (mixtures of Poisson). He was a pioneer in the emerging field of stochastic geometry, and I was fascinated by those line processes, especially in their relation to certain infinite particle systems. For a couple of years, this general area had been one of my main interests, and after writing a couple of papers on such line and flat processes, it suddenly occurred to me that I could solve the famous problem. That was not my primary interest, and I thought it wasn't much more than a curiosity, when I noticed that Davidson's conjecture was actually false, and I could give a rather simple counterexample. This happened to be during the Christmas break, and I remember spending only about a week to write a short paper, explaining my argument. Though I wasn't sure whether it was of any interest, I submitted my note to a journal, and I also sent copies to a few colleagues interested in the area.

The reaction was surprising and absolutely overwhelming. *Klaus Krickeberg* called to invite me to spend a year at the *Sorbonne* in Paris, and from Berkeley I was invited to spend a year in their department, in a letter written by the famous statistician *Erich Lehmann*, who also said:

*I hope you can come. Kolmogorov will also be there.*⁷

From Cambridge I was notified that I had been awarded the prestigious *Rollo Davidson Prize*. When I came to Cambridge, few people cared about my regular colloquium talk about some recent work, but an extra seminar was arranged to discuss my solution to the Davidson problem, where the auditorium was filled to the last seat. It was a little embarrassing, since I

⁷Unfortunately, Kolmogorov was sick and couldn't come either

didn't even care to bring a copy of my Rollo Davidson paper. For personal reasons I couldn't go to either Paris or Berkeley, but a few years later I did spend a wonderful year in Vancouver, where I could go downhill skiing three times a week all through the long winter season.⁸

The several years I spent in Gothenburg on various postdoc positions were among the best years of my life, both professionally and privately. Already during my first year at Chalmers University, Harald Bergström suggested that I give a course on weak convergence theory based on the relatively recent book of Billingsley, and teaching this course became my first experience with a graduate course. During the following years I had complete freedom to choose the topics of my lectures, doing a new subject each semester. Those advanced probability courses were well attended and I think much appreciated, and they were also a great learning experience for me, since I would learn in depth all the basic parts of the subject, including ergodic theory, martingales, Markov processes, stochastic calculus, etc. A couple of times I lectured from Feller's wonderful book, Vol. II, where I faced the special challenge of correcting all the little errors in the proofs. One of the students took notes in the class and sent my corrections to the publisher, but there was little they could do about it since Feller was already dead.

Some friends in the general math department came and asked if I was willing to give some lectures on

Probability Theory for Mathematicians.

Few people could see what was so funny about the title: At least since Borel, probability theory had been an integral part of mathematics, just as much as algebra, topology, or differential equations. After some faint objections to the title, I gladly complied, and so I ended up teaching advanced probability courses for a general mathematical audience for several semesters, even doing a substantial series on stochastic calculus. Those lectures became very popular and were attended by dozens of mathematicians, professors and graduate students alike.

All my appointments at Chalmers were only temporary, and I was always nervous about the renewal of my scholarships. During my last year, I got a personal research position, financed by the Swedish national research council (corresponding to the NSF in the US), again with a very modest teaching load. The only caveat was that, whenever a chair of full professor was advertised in Sweden, I was obliged to apply, and presumably to accept the position if I got selected. Since there were very few such "chairs" in Sweden (in my case only those in mathematical statistics were relevant), in principle I might have to wait for years until somebody would retire or die. Now it so happened that, already after one year, three such positions were advertised at the same time, one at each of the universities in Uppsala, Lund, and Stockholm. Thus, I had to apply to all three, and since there was a common hiring committee, I was selected for all of them. Then I could just

⁸Hiking and downhill skiing have been among my passionate interests all my life.

choose where I wanted to go, and naturally chose Uppsala, the oldest and most venerable among Swedish universities. In this way, I was appointed to the Uppsala chair, again in a formal letter signed by the Swedish king, and at the same time I automatically lost my job at Chalmers.

All through my life there had been a crisis on the Swedish house market, and at this time it was worse than ever. I owned a simple row house outside Gothenburg, and because of various government regulations (big brother again), it suddenly had become impossible to sell a house without a substantial loss. In the newspaper I read about people who had to take out huge bank loans to afford selling their house. In Uppsala the situation was very much the opposite, where it was virtually impossible to get even the simplest apartment without a huge down-payment. The situation was compounded by my special family situation. I was newly married with a little baby child, but my wife was Korean and was not eligible for the social benefits that everybody else in Sweden would take for granted. To summarize, I was in a desperate financial situation, was stuck with a house that I couldn't sell, and was unable to find even the simplest apartment that I could afford in the place of my new employment.

In my desperation, I wrote to my friend *Ross Leadbetter* in Chapel Hill, asking for his advice. More or less in return mail, I got an offer to spend the next academic year at the *Center for Stochastic Processes*, where he was one of the managers (the others being *Stamatis Cambanis* and *Gopi Kallianpur*). This is how I decided right away to go to Chapel Hill.

Moving to America. I had visited Chapel Hill before, but with the new *Center for Stochastic Processes*, they had created a marvelous environment, with up to a dozen visitors from all over the world constantly coming and going. Every week there was a seminar, always followed by an intense discussion. All three people in the organizing team, all extremely generous and helpful, were specializing in different areas and attracting visitors accordingly. Especially *Gopi Kallianpur* influenced me the most, as he was following every word of the presentations and was leading the subsequent discussion with some penetrating comments and questions. If you gave a talk with him in the audience, you would feel that you were talking only to him, as he was sitting in the first row and would occasionally interject some quick comments, always exactly to the point. I soon became very active too, and the initial comments often led to an intense discussion between the two of us. After this first year at the Center, I truly loved the place and came back for long visits every summer. *Stamatis Cambanis* told me that I was welcome to visit as often as I wished, which presumably he didn't say to everybody. Unfortunately, he died tragically from a cancer tumour when he was only 50 years old, and soon *Kallianpur* also got sick and died as well. Then of the organizing trio there was only *Leadbetter* left, and this whole exciting activity soon faded out.

My visit at the Center gave only a temporary relief to my Swedish prob-

lems, and I realized that, for a permanent solution, I needed to look for a job elsewhere. In the Scandinavian countries I could get any academic position I wanted, and in many European countries I had a very high reputation as well. Thus, I thought it would be easy to get a job in the US too. Together with a young German visitor we applied to all open positions we could find in the ads. He got invited for interviews everywhere, but for me I just got a card saying;

Thanks for applying. We regret that we have no positions at this time.

I was getting desperate and started wondering what was wrong with me.

Then one day I got a phone call from Auburn University with an invitation to come over for a colloquium talk. Such invitations were not unusual, and I accepted right away. Since I had never heard of Auburn, I got a map of the US and found Auburn as a little dot far down in the south. When I came to Auburn to give my talk, I was told that

By the way, we have an open position in probability, and you might be interested.

Well, I am actually looking for a job, so please tell me about it.

After a few days I got an offer from Auburn, and I calculated that, with the offered salary, my living standards would improve by a factor five. I asked Leadbetter for his advice, and he went straight to the dean's office, since I guess the salary I was offered was higher than his. However, my excellent Jewish friend *Robert Adler*, visiting from Israel, insisted that

You shouldn't go to Auburn, you are too good for Auburn.

Well, I had no choice, I desperately needed a job, and so I accepted the offer, and in the fall I moved with my young family to Alabama. I had been hired by the math department at Auburn University, but when I arrived there were actually two math departments, and I ended up in the department of *Algebra, Combinatorics, and Analysis* (Math ACA). This may seem strange but was actually perfect for me, since I got to teach so many interesting courses, not only in probability but also in real, complex, and functional analysis. Moreover, we had some truly excellent graduate students in those days, and I really enjoyed the teaching. Soon our probability group of three was extended by the addition of *Jurek Szulga* and *Ming Liao*, superb experts even in functional analysis and differential geometry, respectively, so that totally we were now five. We started a regular probability seminar where we alternated to speak, which became quite rewarding for all of us.

Soon we got a very energetic dean, who thought that having two math departments didn't make sense, so he worked hard to reorganize everything. After all his efforts, things just got worse: We still got two math departments, but now with a different split, where the probabilists would join the combinatorists to form the core of a new statistics group. This was totally unacceptable to me, in view of the nature of probability theory as part of real analysis, without any ties to either statistics or combinatorics. Thus, it led to a split of the probability group, where I went with Jurek and Ming into the main math department.

With regard to teaching assignments, I told my colleague in charge that I would be happy to teach practically any courses in real math, but please don't give me a statistics course. Apart from some attractive probability courses, I liked especially the courses in abstract algebra, and Galois theory I taught many times. My true favorite was a course on the history of mathematics, which I designed myself and taught for many years. However, the attractive graduate courses in real, complex, or functional analysis I never got a chance to teach again. In addition to the routine teaching, I supervised many excellent graduate students through the years and was extremely proud of them all. At one point, I was even selected as the graduate lecturer of the year at AU.

I should end this section by telling about a dramatic incident, occurring when we first moved to Auburn. I was invited to give a plenary talk at a huge conference in Tashkent, then belonging to the Soviet Union but now a city in the autonomous country of Uzbekistan. It was a long journey via Moscow, and I had been planning to visit my mother in Stockholm on the way. My US visa was going to expire during my trip, but I got some documents from Auburn and was told that, when I come to Stockholm I should go to the American embassy, and they would give me the required extension. When coming to the embassy I got a form to fill out, where one of the questions was whether I intended to stay permanently in the US. Of course, the answer was yes: I had a permanent faculty position, had rented an apartment in Auburn where my family were waiting for me, and all our furniture were on the way across the ocean. I thought I had better tell the truth, since if I were caught with a lie, I might be expelled and would never be admitted to the country again. So, I answered yes and submitted my form under a thick glass screen. After a minute came the response:

Sorry Sir, we can't extend your visa. Next one please!

There was nobody to talk to, I just returned to my mother's apartment, and from there I called the vice president at AU who had advised me before. I will never know what happened next, but after one week of nervous waiting in my mother's apartment, I was notified that now I could return to the embassy, and I would get my visa.

Writing, service, and honors. My field is probability theory, but beyond that I never liked to specialize, and I love constantly to learn new things. On the question what is most important, to be deep or broad, my answer is that you need to be both. I have been working in most areas of modern probability, and the advantage of being broad is that I may see connections that others will miss. Two of my major areas of interest through the years have been *probabilistic symmetries* and *random measures*, and I have been fortunate to get the opportunity of publishing two massive monographs in those areas, both issued by Springer. (My earlier book on random measures, partly based on my dissertation from 1972, is today totally obsolete.)

Now Springer has just published a third, extended and thoroughly revised

edition of my *Foundations* book, which represents a huge project, initiated almost 30 years ago. My primary motivation is the urgency I feel, in these days of extreme specialization, to keep the subject together. Throughout my writing, I was also surprised to discover how much could be done to simplify proofs handed down through generations of textbook authors. I also strongly believe in the importance of getting a good overview, helping us to see the crucial relationships hidden beyond a forest of dense calculations. To me every major theorem should be a revelation, prompting us to explain

Wow, this is just amazing, how could it possibly be true?

and your studies are not finished until you can see the interplay between the sometimes intricate arguments involved in the proof. In this way, not only the statements of the theorems but also their proofs become an integral part of the exposition.

Throughout my career, I have attended countless of conferences and given numerous plenary and other talks, too many to enumerate here. I am especially proud of the opening lectures entrusted to me at two huge international conferences, first in Vilnius in 2006 and then in Gothenburg in 2018. But perhaps the high-point of my career was the special workshop to my honor, organized in 2013 by an international committee at the Mittag-Leffler Institute in Djursholm outside Stockholm. Apart from the organizing committee, led by my admirable mentor and friend *Peter Jagers*, the list of participants included some of the greatest probabilists of our time, including *John Kingman*, *David Aldous*, *Jean-François LeGall*, *Donald Dawson*, *Martina Zähle*, and so many others⁹, all giving superb talks. As an extra treat, my old friend *Per Enflo*, both a famous mathematician and an outstanding concert pianist, came and gave a memorable piano recital.

Through the years I have been a member of many editorial boards and certainly done my share of refereeing. For three years in the early 1990's, I was the main editor of *Probability Theory and Related Fields* (PTRF), then regarded as one of the two top probability journals in the world, which was one of the most difficult things I have ever done. A major problem was that the rate of submitted papers was much higher than the capacity of the journal, and we could publish only some 20–30% of all incoming manuscripts. This was hard to explain to the authors, many of whom felt offended that I had to reject so many formally correct but not outstanding papers.

The referees of the papers, supposedly experts in the respective areas and often friends of the authors, would normally accept some 70–80% of all papers, so there was always a need to find a second referee with stricter standards. In order to keep high and reasonably uniform standards, I ended up reading practically every submitted paper myself, which was very time-consuming, since during my three years of service we got about 1,000 sub-

⁹I was missing especially my excellent friend *Persi Diaconis*, who missed two crucial flight connections and couldn't make it, and also my special mentor and longtime friend, the infatigable *Kai Lai Chung*, who had died a few years earlier. I would also have loved to see *Fredos Papangelou*, whose work had been such a great inspiration to me.

missions. I think that few people who haven't been main editors themselves really understand the difficulties involved. A compounding problem was that I chose my wife as my editorial assistant, which happened to be during the time when we got our third child, and she had very little time for the editorial work. Thus, I ended up essentially doing her job as well. It was then a true relief to turn over the responsibilities to the next editor.

Arts and passions. My passion for art may have started with a study of Disney cartoons, in the Donald-Duck magazine my mother used to buy for me, when I was home from school with a cold or flu. A few years later, I became a passionate stamp collector. Most stamps are pretty boring, but the Swedish ones were exceptional, as they were based on the most marvelous engravings. Around age 13, I started with photography, making my own enlargements from the black-and-white negatives we used in those days. This somehow led me to become a passionate art lover, also triggered by some reproductions in the few art books we had at home, and I went alone to the great art museum in Stockholm, where I was especially intrigued by the famous Rembrandt collection. Saving my modest allowance, I bought a set of oil paint and some brushes and started learning oil painting on my own. We still have at home a couple of Rembrandt reproductions, which I made when I was 15 years old. A little later I started making pencil drawings, and for years I was going around on my bike, bringing my sketchbook and a couple of pencils. When the weather was nice, our art teacher in school used to send us out to make drawings in the neighborhood, and when I came back with mine at the end of the hour, he used to say:

Wow, that's a genuine "Kallenberg"!

From that time on, I always got an A in art, just as in math. He suggested that, with my talent, I ought to become an architect. Today I am not active in art anymore, but when I am out traveling, I won't miss any opportunity to visit the great art museums. I am also passionately interested in the great cathedrals in Europe, and when the Notre Dame cathedral in Paris almost burned down a couple of years ago, I literally cried.

My next big passion was for music. My father was very talented and played two instruments by ear, but oddly enough he couldn't stand classical music, and would always turn off the radio or television if something musical came up. My best friend in high school was taking piano lessons, and one day he asked me if I would like to join him for a piano recital with a famous pianist in the Stockholm concert hall. I agreed to go with him, just because he was my friend, and that decision changed my life. For days (or rather nights) I was dreaming of the music we had heard, and from that moment on (I was 16 at the time) I was taking every opportunity to attend concerts of every kind. The greatest revelation was to hear the famous pianist Arthur Rubinstein. I took by bike and got a ticket on the highest balcony right under the ceiling, where I couldn't even see him, and I will never forget the sound when he started playing. I felt how I was blushing and my hair was standing

right up. Since then I heard Rubinstein many times, and his concerts were the greatest musical experiences of my life.

We had an old piano at home, which was the pride of the family, since it was made by a distant relative and had the name Kallenberg on the fall board. But when a piano technician came over to tune it, he would just shake his head and say

Sorry, but this piano can't be tuned.

I started saving all my money, but it wasn't until I was 21 that I could afford to buy my own upright piano. I started taking piano lessons and even attended several summer camps with a famous piano professor. At one of these events I met an old lady, who said

I am sorry that you are a mathematician, but at least you have your musical interest.

That kind of comments are not uncommon, and as a mathematician you have to get used to them. I have met people telling me right in my face that

I hate math,

though most people would express their sentiments in a more polite form.

I soon became a passionate opera fan, and when dating girls I would bring them to the Stockholm opera, which was one of the leading opera houses in those days. The first time I visited Columbia University in New York, I was asked if I had any preference for hotel, and I replied

As close as possible to the Lincoln Center.

Now there happens to be a hotel right across the street, and upon arrival I threw in my bags in the hotel room, and after five minutes I was in the ticket line of the Metropolitan opera. Since then I have visited the Met countless times, often driving to New York with my wife or taking a flight from Atlanta over the weekend.

All our children are musically gifted and play one or two instruments, and especially my two youngest daughters have reached an almost professional level on their instruments. (The oldest has the most incredible artistic talent I have even seen.) We used to work together in the evenings, and for many years I used to practice the piano for three hours every day. I even had a few piano students, and we arranged with a little student recital at home. At one point I even supervised a string quartet of little kids, but it was a struggle to make them play in tune and listen to each other, and we had to rehearse many times before they were ready to perform in a recital.

Through the years we also got to know so many professional musicians, who were more than willing to perform in our living room, and we usually managed to assemble a good audience of some 30–40 people, including many graduate students from our department. Those were full-time concerts at the highest professional level, and my role was to organize the events, make some introductory comments, print out the program, and write some concert notes (about the music, not the performers). My wife, helped by some faithful friends of hers, prepared the refreshments to be served after the end of the program. I should mention that even my friend Per Enflo performed twice

in our home. The activity came to a sudden end when my wife started with her international business and was constantly away on travel.

A third passion of mine (apart from the art and music) is my constant reading. I am buying books all the time, mostly on cultural history and modern science, and at one point my wife told me

You can buy as many books as you want, but no more bookcases.

As a result, the books keep piling up everywhere in our house. For years we used to drive every weekend, the whole family, to a neighboring city, where I would go to a book or record store while my wife went fashion shopping. But soon the record stores disappeared, and nowadays the surviving bookstores are getting converted into toy stores.

I am often asked if I miss Sweden. The answer is that I am badly missing all of Europe, and whenever I come to Paris, Rome, Venice, ... (even Stockholm), I am taking a deep breath and saying to myself:

Wow, now I am back home again!

I have the same feeling when coming to New York and many other places, and I am especially fond of the oriental and Indian culture. I should add that I am also a passionate advocate of human (and animal) rights¹⁰, and feel strongly that people of all nationalities, religions, and ethnic groups are my sisters and brothers. To be honest, I am horrified by some recent events in the US and abroad, and I feel extremely worried about both the climate change and the rise of far-right extremism. Where are we heading? At least we have the consolation of the great math, music, art, literature, ...

¹⁰including the rights of women

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