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STUDY WITH GEORGE STYAN

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Abstract

George Styan and I first met when he came to the University of Birmingham to study Mathematics. We both developed interests in Mathematical Statistics. Matrix theory is an essential component of such courses and we both excelled at it. Our paths have intersected on a number of occasions and George's insight and cooperation has been a great help in enabling me to carry out research in several areas. This article summarizes the value of George's presence and help in carrying out some interesting and complicated research projects.

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1. 1956–1989

In 1956, early in my second academic year in the University of Birmingham, in Great Britain, I sat with my fellow second year students awaiting the start of the first meeting of the undergraduate's Mathematical Society.

A noisy group of new first year students entered the room. Prominent amongst them was a tall young man who appeared to be in charge of the group. Later, I discovered the name of their leader. It was:

George Styan.

During George's first year we were a year apart in our studies. So we did not at that time attend any of the same lectures. At the end of the 1956–57 session I managed to fail the Physics courses I was attending in my second year for my degree in Mathematical Physics. Thus I had to withdraw from doing Mathematical

Physics and transfer to doing courses in Mathematics. So, in the 1957–58 session I had to take a course on statistics taught by a new Professor of Statistics at the University. This was Henry Daniels who had previously taught and carried out research at the University of Cambridge. Henry Daniels was born in 1912 and died in April 2000. A biography of him was published by his student, Professor Sir David Cox, see [4]. What was remarkable for me was that the first lecture that Henry Daniels gave was the most interesting I had received at the University of Birmingham up to that date, in my third year at the University. In this first lecture he demonstrated that the subject of Statistics was:

"The application of the Scientific Method for the investigation of any subject in which numerical data are collected".

Thus, statistics is essential in the study of all subjects including: Physics, Chemistry, Biology, Biochemistry, Medicine, Mechanical Engineering, Electrical Engineering, Civil Engineering, Social Science, Economics. Also, I discovered years later, one can include: Religion, Law.

It is also essential in its application in all subjects throughout their development in the real world.

So I became hooked on the subject. I did very well in the statistics examination at the end of that year and finished my undergraduate degree.

Then Henry Daniels asked me to see him to discuss my future. He offered to obtain finance for me to study at the university for another two years. This would be for me to obtain a postgraduate diploma in Mathematical Statistics which he was going to teach starting in the next academic year.

I leapt at the opportunity. So at the start of the 1958–59 academic year I had to do a number of courses in the final year of the Pure Mathematics degree which were also attended by George Styan in his final year.

These courses included Algebra, taught by a wonderful lady called Nora Calderwood. She was the one who taught us about determinants and matrices. How to solve matrix equations. How to compute the inverse of a matrix. It is important to point out that in those days for all practical purposes computers did not exist. As far as I recall we would start problems using 2×2 determinants and matrices containing small integers. At the most of dimension 3×3. These we could do easily by hand.

Nora Calderwood was a red haired lady from Scotland. She could totally dominate an entire class of 80 or more students. If any little group in the class had started to talk amongst themselves she would silence the entire room and threaten her students into silent submission. We all had great respect for her, and FEAR!

Without this background of determinants and matrices we would be lost in statistics in the discovery and application of methods for analysing large blocks of data.

George and I had different lecturers for the basis of Pure Mathematical Analysis. Peter Rogoskinsi was brought in to teach us Complex Variable Analysis. This was about the solution of equations with many complex variables which involve imaginary numbers. This subject is of course essential for deriving distributions of statistical data and inferences from them. Peter Rogoskinsi was extremely good and methodical. Very thorough in his development of the subject.

We also studied Group Theory which is so important for the Design of Experiments.

David Wishart taught us Stochastic Processes. In this the population dynamics of animals was a very popular and interesting subject. Effects of predators, carnivores on vegetarian species, are of course of great interest. Foxes hunting rabbits can easily be of interest to students. Applications to populations of sea fish are also valid.

Study of car traffic on roads was most illuminating in regard to showing why on very busy motorways the traffic at places and times all grind to a halt for no obvious reason. Where essential services such as Fire stations, Police stations, Hospitals and Ambulances should be located in cities and at all locations throughout the country.

Study of queueing theory has immediate application in deciding how the sequence of traffic lights can be organised to maximise the total flow through of motor traffic especially during rush hours. This is now done in many cities around the world. It of course also has many other uses including study of river flow and the necessary design and operation of dams on rivers to conserve and supply water throughout entire countries.

In connection with practical statistics classes organised by Henry Daniels the practicals were supervised by junior staff. Students did not have computers, we had mechanical calculators. With these machines we could calculate the sum and the sum of squares of a sequence of numbers. Thus we could solve simple linear regression problems in a reasonable time. The clackerty clack of these machines lasted for several years until electrical calculators came in. They were not computers either and only had limited storage capacity.

In 1959 George Styan graduated from the University of Birmingham and went on to the University of Oxford, Wadham College, and obtained a Certificate in Statistics, in June 1960. I continued on with the second year of my postgraduate diploma course at the University of Birmingham. In that 1959–60 session, spurred on by one of my new colleagues, I wrote my first computer program to solve an equation that required an iterative solution. This was written in C Autocode. This was punched onto paper tape and then posted to the only available computer center for universities in the country which was at the University of Manchester. A few months later I wrote another computer program which, with the speed of development in those days was written in K Autocode and was sent to University

College, London.

At the end of the 1960 session I got my postgraduate diploma in Mathematical Statistics and George Styan got his Certificate in Statistics at the University of Oxford. Then we were both looking for jobs as Statisticians.

My first professional job as a Statistician was working for Beecham Research Laboratories on the Great West road in Brentford, London. Here I was to design and analyse experiments connected with the manufacture of Penicillin. My course in Group Theory had been invaluable to construct the necessary designs. The amount of time and money these designs saved must have been considerable, together with the clarification and accuracy of the results.

Meanwhile, George Styan had obtained a job as a statistician working for another company on the other side of London. We kept in touch by telephone, discussing various statistical problems and appropriate methods for their solution. Then when possible we met in London with other colleagues to have meals in many different places. George enjoyed and was good at seeking out different interesting places to go to eat out at.

We discussed in general various statistical matters. Over time George became unhappy with the way that British companies operated. Possibly that also applies also to European companies.

George wanted to go to America. So, that is what he did.

2. 1990–2012

I next met George again when around 1990 he came to give a seminar at the University of Birmingham, UK. Our contact and friendship renewed I set my target on getting to visit him at McGill University in Montréal, Canada. So, I applied to get a grant to visit Montréal for three weeks to get George's advice on how to develop a matrix generalisation of unusual results that can occur when doing a linear regression analysis of variable y on two variables, x_1 and x_2. On this topic I had published a paper on with my colleague Roger Holder in the *The Statistician* in 1988, see [3]. Funding obtained I set off in 1992 for McGill.

At my first meeting with George's students at their weekly seminar George announced that I was there to do some research and in two weeks time would be giving the seminar and let them know about the results of my research. "Oh, my God!", I thought. "I have no idea how to do this at all!" After a very pleasant social evening I realised that the next day I had better settle down in George's library and write down the problem in matrix notation. So, that is what I did: I got the matrix equivalent of the problem. I had no idea at all, however, how to solve this in any sense.

Around lunch time I told George that I did not know what to do next.

"Sorry Bertie", he said, "I am just too busy sorting out teaching, exam papers, and admin work, to help you now. At the end of term there may be time for me to help you. In the meantime I shall see if I can get someone else to help you."

That afternoon I was sat in the library opposite George's office looking at my formula wondering what to do. Then a young man came in and introduced himself. This was Keith Worsley. He said he was interested in the work I was doing. So I showed him.

"Hmm", he said, "why not multiply both sides of that inequality by the inverse of that matrix and see what happens."

"My Gosh," I said, "it looks as if that will work!"

I did that and ended up with some results which made good sense. I had a solution!

Pleased, I had a coffee.

For I realised this unusual statistics situation can occur in many dimensions with as many variables as there may be.

Looking at the equation again I thought of a corollary to the solution! So worked that out.

Then I thought of another corollary!!

Then another!!!

I realised I had enough done to give a seminar in several days time. I had to tidy up this work, get it typeset and get it printed out.

So at the end of my visit I gave my seminar on this topic at McGill University.

Further work I wished to do on those results. I wanted to simulate data where this result would appear.

Discussing this with George Styan he was very helpful on this. "Go and read my 1983 paper on generalised inverses which is in the *Encyclopedia of Statistical Sciences*, volume 3," he said "and apply the methods there!" See: [5].

This I did, then together with a lot of other subsequent research led to the paper I published on "Constructing explained and explanatory variables with strange statistical analysis results" in *The Statistician* in 1998, [2].

I had enjoyed visiting Canada and McGill University in Montréal so on returning to Britain decided I had to try to find another way to get funding to visit again. A year later for some reason I kept receiving invitations to present a paper at a conference of the 4th International Symposium on Guanidino Compounds in Biology and Medicine to be held at the University of Montréal in September 1994. Not knowing what Guanidino compounds were I ignored this invite for some time. Later I received another invitation. So I went to the University library to find out what they were. They involved Cortisol and Creatinine. Substances concerning which I had carried out some statistics on in connection with my my biochemical colleagues in the Medical School.

So I studied some recent topics on these variables which suggested that the

ratio of the two would be more stable than looking at them separately. Then I did a statistical analysis to see if this was so. With the data available at that time my conclusion was that this would not be the case. The ratio of the two variables would be greatly inflated due to the large separate independent errors of measurement of both of them.

Then I put together a paper for that meeting and submitted it for presentation. The paper was accepted for presentation and I obtained funding to present my paper at that conference.

The conference was held at the Université de Montréal. At that meeting I had the pleasure of meeting many Biochemists including Samuel Natelson, a founder member of the American Society for Clinical Biochemistry. My paper [1] was published, Chapter 22, in the proceedings of that Conference. I was pleased to see that Samuel Natelson's paper was in Chapter 23 next to mine.

Since then I have visited George Styan in Montréal a number of times and met him at statistics conferences around the world. We have not yet published a paper together, but there is hope yet. I have since worked on this subject further and talked about "Statistical Quirks and Anti-Quirks" at meetings but not yet moved into submitting that work for publication. For I think work on this subject has only just started. We could perhaps generalize the results so far to time dependent correlated data. Then perhaps we can show how in the future we humans can avoid an international stock and credit market crash like that which we are still in and which appear to occur in human history about every 70 to 80 years.

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