The Legacy of Jerzy Neyman

I am honored to write about Jerzy Neyman, a Polish-American mathematician and statistician whose contributions to statistics and whose many activities in the area of scientific planning, organization and collaboration between different disciplines were revolutionary. He was called "a principal architect of modern statistics." I had heard Jerzy Neyman's name for the first time many years ago at the applied mathematics conference with many statisticians among the participants in Zakopane, in Tatra, Polish mountains. I was too young to understand and recognize the pride Polish mathematicians spoke with about Jerzy Neyman. They spoke about two Polish-American mathematicians, Antoni Zygmund, who spent most of his life at the University of Chicago and about Jerzy Neyman, who spent most of his life at the University of California at Berkeley. Associated with Berkeley, there was also Czesław Miłosz, a Polish poet and Nobel Prize laureate. I have found that many mathematicians like poetry, and so did Jerzy Neyman. His favorite Polish poets were Adam Mickiewicz and Julian Tuwim. He often quoted them at social gatherings. I would probably not remember those early talks about Jerzy Neyman if I would not have taken an advanced statistics course. It was that course in which one day I learned about the Neyman-Pearson lemma and its importance in statistics. That was the time when I made connections to the wonderful stories about Neyman, which I learned a few years earlier in Zakopane. The Neyman-Pearson lemma is used to construct or find the uniformly most powerful level α hypothesis test. It provides a systematic method of determining a best critical region for testing one hypothesis versus another one. In that class, it was the only Neyman's contribution I learned and it was until the class of Professor Stigler "History of Statistics" that I learned about the power, beauty, importance, and excitement of Jerzy Neyman's contributions to statistics and beyond. What I call beyond, it is about his philosophy of statistics, its need and advantage of its applications. "Neyman used to say 'Statistics is the servant to all sciences'," Chiang, his former student and Professor at the University of California, Berkeley, wrote. "In many ways, Neyman had expanded the domain and improved the quality of the service."[1] Many probabilists and statisticians paid a tribute to Jerzy Neyman by writing papers about his contributions to statistics as well as about his family and career life.[2]

Jerzy Neyman was born on April 16, 1894, in a small town called Tighine, or Bendery as it is called in Russian, which used to be in the Ottoman Empire, then became part of the Russian Empire under Catherine the Great. It is just east of the Dniester River, about 150 km north of Odessa. After the collapse of the Russian Empire, in 1917, it became

[1] Statisticians in History: Jerzy Neyman, by Chin Long Chiang (the American Statistical Association)

[2] See `http://www-groups.dcs.st-and.ac.uk/history/reference/Neyman.html` for references concerning Jerzy Neyman

part of Romania, then the USSR. Now, it belongs to the region known as "Transnistria" which was established on July 22, 2005 as a separate territorial unit within the Republic of Moldova only by the Moldovian government. This independence is not recognized by any state or international organization.[3] Jerzy was the son of Czesław Spława-Neyman and Kazimiera Lutosławska. Czesław Spława-Neyman's father was a judge in Bessarabia and also a historian, a member of prestigious Polska Akademia Umiejętności (the Polish Academy of Learning), founded in 1872 in Kraków (Cracow) as a continuation of the Kraków Society of Learning (Towarzystwo Naukowe Krakowskie), established in 1816, it was the most important Polish learning organization in the nineteenth and twentieth centuries. Czesław met his wife when he was studying law in Kiev and rented a room in a house of Kazimiera's mother. Jerzy was the youngest of his parents' four children but two daughters died about the time Jerzy was born, and another son was already 16, so he was raised as the only child. Czesław Spława-Neyman's mother had one of the most difficult to pronounce name: Chrząszczewska. She had 12 sons and Czesław was the youngest among them. All of them except Czesław participated in the insurrection of Polish patriots against Russian occupation in 1863 and because of that they were sent to Siberia. Jerzy's father died suddenly of a heart attack when he was twelve. Jerzy Neyman used his father's name Spława-Neyman until he was 30 years old. His father and his family belonged to the noble class. It is rather surprising that he did not keep his noble name. Poles are rather proud of their names and from whom they descended. Spława is a coat of arms granted in 1773 to Mateusz Neyman, great-grandfather of Jerzy Neyman, by Stanisław August, King of Poland. In the book on Polish coats by J. Ostrowski ([8]), Spława has the following entry:

SPŁAWA: Nadany wraz z nobilitayą, Mateuszowi Neymanowi, właścicielowi dôbr Sierosław w poznańskim, 26 października 1775 roku przez Stan. August. krôla polskieyo	SPŁAWA: Granted together with nobility to Mateusz Neyman, the owner of the Sierosław land in the State of Poznań, 26 October, 1775, by Stanisław August, King of Poland

Witold Klonecki has first hand information about the family roots. He wrote ([2])

> I have been told by Barbara Neyman-Zoltt, a cousin of Jerzy Neyman, now residing in Wrocław, that Neyman's family came to Poland in the seventeenth century either from Germany or the Netherlands. They settled in the western part of Poland – called Wielkopolska. In the eighteenth century, during the Napoleon era, some of them bought real estates in the Ukraine. They started the eastern line of the Neyman family, to which Jerzy Neyman belongs.

Jerzy Neyman studied mathematics at the University of Kharkov (later Maxim Gorki University) in the Ukraine. Because of the political situation in that part of the world, at that time, Jerzy Neyman spoke fluent Polish, Russian, French, German, and Ukrainian.

[3] http://en.wikipedia.org/wiki/Transnistria

While at the university, he was fascinated by the work of Albert Einstein and Marie-Curie Skłodowska. He was deeply attracted again to mathematics after reading Lebesgue's paper "Lecons sur l'integration et la recherche des fonctions primitives." The paper fascinated him so much that he wrote a paper on Lebesgue integration and submitted it for the Gold Medal which he won later. While at the university, he took courses from very well known probablilists: Sergei Bernstein and C.K. Russian whom he truly admired. It was Bernstein who encouraged Jerzy Neyman to read Karl Pearson's "the Grammar of Science." Neyman read the book and the book inspired him to take an interest in statistical ideas. After completing undergraduate studies, Neyman became a lecturer at Kharkov University, teaching advanced algebra, integration and set theory. During the Russian Revolution, Neyman became ill with tuberculosis and was sent by the doctors south to a warmer climate to recover from illness. On his way to Crimea in 1919, he met a Russian girl, Olga Solodovnikova, whom he married in 1920. Almost at that same time, Poland and Russia were at war. Neyman was arrested and spent six weeks in a prison. After the treaty signed in Riga in 1921 that ended the war between Poland and the Soviet Russia, Poles living on the territory of Soviet Russia were allowed to move to Poland. Neyman's family took advantage of that offer and left for Poland. Neyman joined Wacław Sierpiński whose outstanding research attracted him to pure mathematics. Although he was close to Sierpiński and he published papers, he could not get a job at the Warsaw University and because he had to work for a living, he accepted a position at the Agricultural Institute in Bydgoszcz located about 200 km from Warsaw. During that time, he wrote important papers on statistical methods of treating agricultural trials and on modeling the agricultural experiments. His paper, written in Polish, which was still published under the name Jerzy Spława-Neyman "On the application of probability theory to agricultural experiments. Essay on Principles" ([10]) became a milestone in statistics.

In 1923, Neyman received a doctor's degree in mathematics at the Warsaw University. Neyman remembered that W. Sierpiński and S. Mazurkiewicz were the members of his Ph.D. examination committee. After receiving his Ph.D., he lectured on statistics at the Warsaw University, at Jagiellonian University in Cracow, and at the School of Agriculture in Warsaw. Soon, Neyman became the head of the Statistical Laboratory of the M. Nencki Institute of Experimental Biology. Neyman cooperated with many agricultural institutes. He also supervised many doctoral students, including S. Kołodziejczyk whose thesis on the general linear hypothesis opened the door for further research by other statisticians and W. Pytkowski who first asked the question how to characterize undogmatically the precision of an estimated regression coefficient that led Neyman to build the theory of confidence intervals [1].

Neyman received fellowships from the Polish government to study in London with Karl Pearson and a Rockefeller Fellowship to study mathematics in Paris. While in Paris,

he attended the lectures by Borel, Lebesgue, and Hadamard. Being fascinated by those lectures, his interests naturally went back to pure mathematics, in particular towards set theory, as well as measure and integration theory. His interests in statistics were reborn again after exchanging correspondence with Egon Pearson, a son of Karl Pearson. Egon Pearson mentioned about their starting point of an important collaboration in [9].

> Perhaps though talks about his own paper (1926b) in which he drew "attention to a method of judging whether a sample is likely to have been taken from a population whose distribution is supposed to be known," I spoke to him towards the end of his stay in London about a very general statistical problem which I had for some time been puzzling round. I suggested that if he was interested we might collaborate in going further with the investigation. It was clear that this would have to be largely by post, for at the end of the university term, in June or July, he left England. His second year's Fellowship was to run in Paris. During the next eight years, our communication was partly by letter – with occasions when a spurt of energy led to two or three letters a week, followed by long gaps when more demanding pressures intervened – partly in short holiday get-togethers when one or other of us crossed the Channel to meet in England, France, or Poland. It was only in 1934 that Jerzy came to London for a permanent appointment; by this time K.P. had retired and his Department of Applied Statistics had been split into two parts, under R.A. Fisher and myself. It was now my turn to be faced with administrative problems allowing much less time for doing freely what I wanted.

One of the reasons why Neyman decided to leave Poland was a lack of funding for research. Egon Pearson describes Neyman's frustration with the situation in Poland:

> It is clear that our progress would have been a good deal quicker had we been able to meet more often. From the research point of view, my life at University College in those days was what now seems ideal, with no administrative responsibilities and relative little teaching. K.P., however, imposed rather strict limits on the vacation time of his staff and I had to choose between a working holiday and other commitments with family or friends.
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> In comparison, Jerzy had to struggle against may difficulties. In 1928, he succeeded in getting a small Biometric Laboratory established in Warsaw at the Nencki Institute for Experimental Biology. But the continuance of funds depended on the financial prospects of his country. "Certainly it [the creation of the Laboratory] is not yet sure, especially as our loan in America is not yet signed" he wrote on June 4, 1927. And four years later, on March 7, 1931:
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> > In town I am terribly busy in getting some job for the Lab. You may have heard that we have in Poland a terrific crisis in everything. Accordingly the money from the Government given usually to the Nencki Institute will be diminished considerably and I shall have difficulties in feeding my pups [research workers in the Lab.]
>
> And again on June 23, 1932:
>
> > You seem to be a little annoyed with me: in fact you have some reasons as I do not answer properly your letters. This however is *really* not the result of carelessness or of anything which could be offensive. I simply cannot work; the crises and the struggle for existence takes all my time and energy. I am not sure that next year I shall not be obliged to take some job, I do not know where – in trade, perhaps, selling coal or handkerchiefs.

> However, Jerzy and his 'pups' did produce quite a large output of work, much of it in connection with statistical methods in agriculture. All this was collected in the five numbers of *Statistica*, 1929–34, in which separates of papers published elsewhere were issued annually bound together in a printed wrapper.

One of the most significant results on Neyman-Pearson collaboration was the Neyman-Pearson Lemma mentioned earlier. According to L.E. Lehmann in "The Neyman-Pearson Theory After Fifty Years" ([5]) "...the Neyman-Pearson paradigm formulated for the first time a clear program and provided a completely novel approach to hypothesis testing, the first 'exact' small-sample theory of its kind."

As I mentioned before, the Polish statisticians proudly speak about Neyman's contributions made in Poland. Witold Klonecki wrote proudly, to make sure that nobody will question the place of major contributions, that the moment of ground-breaking discovery in testing hypotheses took place in Warsaw. The following is his quote:

> A fact that seems to be not known so well to a broader audience is that it is possible to identify the exact place in Warsaw where Neyman discovered the correct way of formulating the problem of testing a simple hypothesis against a simple alternative. To quote Neyman's own account from paper, quoted already a few times, *A glance at some of my personal experiences in the process of research,* which appeared in the Festschrift in honour of Herman Wold in 1970, it happens thus:
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> > I can point to the particular moment when I understood how to formulate the undogmatic problem of the most powerful test of a simple statistical hypothesis against a fixed simple alternative. At the present time, the problem appears entirely trivial and within reach of a beginning undergraduate. But, with a degree of embarrassment, I must confess that it took something like half a decade of combined effort of E.S.P. and myself to put things straight. The solution of the particular question came on an evening when I was sitting alone in my room at the Statistical Laboratory of the School of Agriculture in Warsaw, thinking hard on something that should have been obvious long before. The building was locked up and, at about 8 p.m., I heard voices outside calling me. This was my wife, with some friends, telling me that it was time to go to a movie. My first reaction was one of annoyance. And then, as I got up from my desk to answer the call, I suddenly understood: for any given critical region and for any given alternative hypothesis, it is possible to calculate the probability of error of the second kind; it is represented by its particular integral. Once this is done, the optimal critical region would be the one which minimizes this same integral, subject to the side condition concerned with the probability of the error of the first kind. We are faced with a particular problem of the calculus of variation, probably a simple problem.
> >
> > These thoughts came in a flash, before I reached the windows to signal to my wife. The incident is clear in my memory, but I have no recollections about the movie we saw. It may have been Buster Keaton.

What Neyman describes here was the beginning of what is now a core concept in elementary statistics textbooks. Jointly with the younger Pearson, Neyman developed a groundbreaking and controversial theory of testing hypothesis.

In 1934, Neyman moved to London College to continue working with Egon Pearson and in 1938 he accepted the professorship at the Mathematics Department of the University of California at Berkeley. He soon established the Statistical Laboratory within the Mathematics Department.

Neyman had been always devoted to students, and Neyman's teaching was deeply integrated with research. There is the famous story of Dantzig's "homework problem" in Jerzy Neyman's statistics class at Berkeley. In Dantzig's own words:

> I was a grad student at Berkeley working on my Ph.D. I wasn't very good at getting to class on time. Neyman had a habit of putting homework assignments up on the blackboard at the start of class. When I came in late, I'd copy the problem, take it home and work on it.
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> On this particular day, there were two problems. They seemed more difficult that usual. When I handed in the assignment, I apologized for taking so long. Neyman told me to throw the paper on his desk. If you know Neyman, you knew his desk was always covered with a huge pile of papers. I threw the paper on the top of the pile and left, never expecting to hear about it again.
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> One Sunday morning a couple of weeks later, he came running over to my house and banged on the door. We lived upstairs. I came down and opened the door. He rushed in and said he had written an introduction to the problems I had solved and was going to submit the paper for publication. It turns out that those two problems were two very well-known, unsolved statistical problems. I had solved them both.[4]

In the Foreward to Festschrift for J. Neyman (1966) F.N. David wrote that " Jerzy Neyman's most significant work, in our eyes, was done either in Poland (in contact with University College), or in England as a Reader of the University of London." Stigler ([11]) provides an important additional recognition for Neyman:

> But, his great achievement of the post-war years was his success in building the Berkeley program into the foremost mathematical statistics program in the world. Already in the spring of 1945 when the end of the war was in sight he made plans for the first of what would become an influential series of quinquennial Berkeley Symposia in Mathematical Statistics and Probability, held in August 1945. From then and for the next decade or so, he was tireless in inviting the best statisticians and probabilists in the world to Berkeley; some for visits, some to stay. He developed an energetic teaching program, pestered the university administration without cease for resources, and overcame all manner of obstacles, including an extremely divisive controversy between the university and its board of regents over a loyalty oath that had been imposed upon the faculty.

In the Foreward to the Proceedings of the First Symposium, Neyman writes

> During World War II, the majority of statisticians were working on problems of defense which frequently bore the imprint of immediate practical importance. The purpose of the Symposium was to mark the end of the war and to stimulate the return to theoretical research.

[4] http://www2.informs.org/History/dantzig/in_interview.hml

In the Preface of the Proceedings of the Second Symposium, he writes

> For a symposium to be successful, it is necessary that its proceedings be published and, furthermore, that they be published soon. It is most sincerely regretted that various unavoidable difficulties delayed the publication of the Proceedings of the First Berkeley Symposium for more than three years. In connection with the present Symposium, strenuous efforts were made to arrange that the voluminous Proceedings would appear within the shortest possible time. On this section of the organizational work, hearty thanks are due the Editorial Committee of the Academic Senate of the University of California for the academic year 1950–1951 for speedy action and for a very substantial sum to help cover the cost of publication.
>
> There was a period in the autumn of 1950 when it was feared that publication of the Proceedings would be seriously delayed or, even, prove to be impossible. The reason was that the estimated cost of printing was so large that it was doubtful if funds could be found to cover it. The Statistical Laboratory, and indeed all the participants of the Symposium are indebted to Mr. August Frugé, Acting Head of the Publishing Department of the University of California Press, for finding ways and means to reduce the estimate substantially, thus making the publication possible without further delay.

What is the most impressive is that Neyman, while dealing with organizational and publication difficulties, was still doing research, contributing to almost every symposium he organized. I have been particularly interested in one of those titled "Struggle for existence, the Tribolium model: biological and statistical aspects" co-authored with T. Park and E. Scott. This paper can serve as a guide for collaborative research. The first part of the paper is devoted to the report of biological aspects of the experimental work done by the Hull Zoological Laboratory of the University of Chicago and the second part is devoted to stochastic modeling of the biological phenomena using Markoff chains and random walks and their properties to establish a broad pattern of the complicated ecological phenomena. Neyman wrote:

> In any cooperation of a group of biologists and a group of statisticians, there must be phases for which only one of the two groups is responsible. However, there is also an important phase in which the responsibility is shared. The latter is concerned with establishing a bridge between the various elements of statistical theory of the given phenomena and the phenomena themselves. In consequence, this paper is divided into two parts.

He was a master of collaboration. He was an amazing leader and a team player. Neyman's broad interests in applications of statistics are the most impressive. His communication skills must have been superior if he had collaborated with so many researchers representing so many different disciplines including health and astronomy from so many countries. He carefully selected invited speakers from the best centers around the world to Berkeley. Neyman reported ([3]): "With the help of advisory committees and of particular scholars, the participants of the Berkeley Symposia are recruited from all countries of the world, hopefully to include representatives of all significant schools of thought." He believed in collaborative effort in research. Neyman was a strong advocate for diversity. When the time was difficult for Russians to travel

abroad, he knew how to bring all those best from the Eastern Europe. With his well-defined clear vision and mission for Symposia: "The purpose of the Berkeley Symposia is to stimulate research through the lectures of the carefully selected speakers and by providing opportunity for personal contacts extending over several weeks spent in Berkeley for scholars from different centers, and by publishing the *Proceedings*." To achieve this purpose, he needs to reach for the best researchers from the countries which were classified as economically at risk with difficulties for getting research support for traveling abroad. But, Neyman has never given up on making efforts to make his dreams come true. One of his dreams was to publish the *Proceedings* in English even though many presentations were submitted in a different language. He talked about these issues, and many related problems including the cost of the *Proceedings*:

> The *Proceedings* are intended to represent a comprehensive cross section of contemporary thinking on problems of probability and mathematical statistics. Although completeness is difficult to achieve, the Statistical Laboratory is gratified by the gradual increase in the number of intellectual centers throughout the world represented at the successive Symposia. In particular, the present *Proceedings* are much richer than those of the earlier Symposia because of the several contributions from members of the great Russian school of probability.
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> The growth of the Symposia is naturally accompanied by the corresponding growth of the *Proceedings*, from about 500 pages for the First Symposium of 1945/46 to about 2000 printed pages for the Fourth. Speedy publication of this amount of scientific material naturally presents a number of problems. This is particularly true when a substantial part of the material is originally written in foreign languages and requires translation into English. This is even more particularly true when it is desired to produce books at a relatively low price which will make them accessible to young scholars.

Neyman's "inductive behaviour" as a basic concept of philosophy of science is fascinating. In the paper [7], he provides arguments and analogies between "behaviouristic" approaches in statistics and what we would call these days neuroscience, a very fast growing area of science, in which I have a strong interest and in which statistics finds a very demanded service. He argues that " the content of the concepts of inductive behaviour is the recognition that the purpose of every piece of serious research is to provide grounds for the selection of one of several contemplated courses of action." In his philosophical arguments for inductive behaviour, he refers to illustrative examples ranging from insurance to physiology. Neyman defines philosophy of science as an empirical scientific discipline. He has an impressive ability of making connections of speaking to and reaching a broad audience. The beginning of the article makes a reader curious about the whole content, and makes a reader outside of the discipline want to read the paper.

He believed in discussions so he organized breaks from lectures to take participants away from the classrooms to the beautiful parks for informal, intellectual discussions and then brought them back to the classrooms again to lecture. Neyman was a master of thoughtful planning of those meetings ([3]):

> In order to stimulate fruitful cross-fertilization of ideas, efforts are made for the Symposia to last somewhat longer than ordinary scholarly meetings, up to six weeks during which days with scholarly sessions are combined with excursions to the mountains and other social events. The record shows that, not infrequently, novel ideas are born at just such occasions.

Neyman describes one of those gorgeous places for excursions with the purpose of intellectual interactions in a stimulating and relaxing environment ([6]):

> To facilitate such personal associations, after three weeks of intensive lectures and discussions, a trip was made to the Sierra. There, animated discussions of stochastic processes and of decision functions were interspersed with expressions of delight at the beauty of Yosemite Valley, Emerald Bay, and Feather River Canyon. After this vacation, there was another period of intensive lecturing.

The last meeting he organized jointly with L. Le Cam, a short Cancer Study Conference, took place in July 1981. The purpose of the conference was to improve communication between statisticians and scientists studying cancer in the laboratory or in real life.

In the Dedication to the Proceedings of the Conference ([4]), Le Cam wrote:

> As already mentioned, the organizational task appeared difficult to impossible. In order to insure some impact on other workers in the field, Proceedings should be prepared and published. There was no time to secure Federal funds and our University dragged its administrative feet. Neyman proceeded along, with vigor, and made from his personal funds a grant to cover all expenses. The conference turned out to be an unqualified success. However, shortly thereafter, Neyman was stricken, and, after a short hospitalization, passed away. As was characteristic of him, he worked in the hospital to the very last hour before his demise.
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> He has left us with a monumental scientific heritage. His death marks the end of a remarkable era in the subject of statistics itself, an era marked by the names of Neyman, Pearson, Fisher, and Wald, whose contributions constitute the very basis of our science and methodology. But Neyman's legacy extends far beyond ordinary statistical methodology. He always insisted on the construction of stochastic models of natural phenomena, based on the available knowledge in the field. This meant delving into the subject itself and coming up with formulas with at least some semblance of relation to reality. In all of this he was great and was an inspiration to many.
>
> We regret that he did not live to see the publication of the present Proceedings. However, we would like, fondly and respectfully, to dedicate them to his memory.

Jerzy Neyman was highly recognized in Poland, England, America, and in the world. In Poland, he was elected an honorary member of the Polish Mathematical Society, a Foreign Member of the Polish Academy of Sciences, and a member of the Polish Statistical Association. Neyman received an honorary doctoral degree from the Warsaw University. In 1974, an International Symposium to honor Jerzy Neyman's eightieth birthday was organized in Warsaw and the Proceedings of that Symposium were published by PWN-Polish Scientific Publishers, in Warsaw in 1977.

While being in America, various honors were awarded to Jerzy Neyman. Those include being a plenary speaker at the International Congress of Mathematicians in

1954 in Amsterdam where he spoke on "Current Problems of Mathematical Statistics." In 1966, Neyman received the Royal Statistical Society Guy Medal in Gold which is named after the distinguished statistician, William Guy FRS. The medal is:

> ...intended to encourage the cultivation of statistics in their scientific aspects and promote the application of numbers to the solution of important problems in all the relations of life in which the numerical method can be employed, with a view to determining the laws which regulate them.

Fellows of the Royal Statistical Society who have made innovative contributions to the theory or application of statistics are considered for Gold Medals.[5] In 1968, he received the Samuel S. Wilks Award of the American Statistical Association. The award is given

> ...based primarily on statistical contributions (either recent or past) to the advancement of scientific or technical knowledge, ingenious application of existing knowledge, or successful activity in the fostering of cooperative scientific efforts that have been directly involved in matters of national defense or public interest.[6]

His 1968 citation states:

> ...whose extensive contributions to both the theory and practice of statistics have led to fundamental changes in the thinking and methodology of scientists all over the world. He has inspired and led more than a generation of students and his continued leadership is effective today. Both by precept and by example, he is one of the foremost statisticians in the entire world.[7]

In 1974, he was elected an Honorary Member of the London Mathematical Society, and in 1979 Neyman became a fellow of the Royal Society. Polish, British, American, and International Mathematical and Statistical communities recognize him as "a scholar, teacher, and pioneer of statistical mathematics and probability." In 1968, Jerzy Neyman received the President's National Medal of Science, "for laying the foundations of modern statistics and devising tests and procedures that have become essential parts of the knowledge of every statistician." The award was presented by President Johnson at a White House ceremony on January 17, 1969.[8]

References

[1] D. G. Kendall, M. S. Bartlett, and T. L. Page. Jerzy Neyman: 16 April 1894–5 August 1981. *Bull. London Math. Soc.*, 16(2):160–179, 1984.

[2] W. Klonecki. Jerzy Neyman (1894–1981). *Probab. Math. Statist.*, 15:7–14, 1995. Dedicated to the memory of Jerzy Neyman.

[5] http://www-groups.dcs.st-and.ac.uk/~history/Societies/RSSGuyGold.html
[6] http://www-groups.dcs.st-and.ac.uk/~history/Societies/Wilks_award.html
[7] http://www.answers.com/topic/jerzy-neyman
[8] http://www.nsf.gov/od/nms/recip_details.cfm?recip_id=256

[3] L. M. Le Cam, J. Neyman, and E. L. Scott, editors. *Proceedings of the Sixth Berkeley Symposium on Mathematical Statistics and Probability*. University of California Press, Berkeley, Calif., 1972. Held at the Statistical Laboratory, University of California, Berkeley, Calif., June 21–July 18, 1970, April 9–12, June 16–21 and July 19–22, 1971, Vol. VI: Effects of pollution on health.

[4] L. M. Le Cam and R. A. Olshen, editors. *Proceedings of the Berkeley conference in honor of Jerzy Neyman and Jack Kiefer. Vol. I*, Wadsworth Statistics/Probability Series, Belmont, CA, 1985. Wadsworth Advanced Books and Software. Held in Berkeley, Calif., June 20–July 1, 1983.

[5] E. L. Lehmann. The Neyman-Pearson theory after fifty years. In *Proceedings of the Berkeley conference in honor of Jerzy Neyman and Jack Kiefer, Vol. I (Berkeley, Calif., 1983)*, Wadsworth Statist./Probab. Ser., pages 1–14, Belmont, CA, 1985. Wadsworth.

[6] J. Neyman, editor. *Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability. Vol. III: Contributions to Astronomy and Physics*. Held at the Statistical Laboratory, University of California, December 1954, July and August 1955. University of California Press, Berkeley, 1956.

[7] J. Neyman. "Inductive behavior" as a basic concept of philosophy of science. *Revue Inst. Int. de Stat.*, 25:7–22, 1957.

[8] J. Ostrowski. *Księga herbowa rodów polskich*. Warszawa, 1897–1906.

[9] E. S. Pearson. The Neyman-Pearson story: 1926–34. Historical sidelights on an episode in Anglo-Polish collaboration. In *Research Papers in Statistics (Festschrift J. Neyman)*, pages 1–23. John Wiley, London, 1966.

[10] J. Spława-Neyman. On the application of probability theory to agricultural experiments. Essay on principles. Section 9. *Statist. Sci.*, 5(4):465–472, 1990. Translated from the Polish and edited by D. M. Dą abrowska and T. P. Speed.

[11] S. Stigler. Jerzy Neyman. *American National Biography*, 16:368–370, 1999.