Why distinguish between statistics and mathematical statistics – the case of Swedish academia

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Abstract

A separation between the academic subjects statistics and mathematical statistics has existed in Sweden almost as long as there have been statistics professors. The same distinction has not been maintained in other countries. Why has it been kept so for long in Sweden, and what consequences may it have had?

In May 2015 it was 100 years since *Mathematical Statistics* was formally established as an academic discipline at a Swedish university where *Statistics* had existed since the turn of the century.

We give an account of the debate in Lund and elsewhere about this division during the first decades after 1900 and present two of its leading personalities. The Lund University astronomer (and mathematical statistician) C.V.L. Charlier was a leading proponent for a position in mathematical statistics at the university. Charlier's adversary in the debate was Pontus Fahlbeck, professor in political science and statistics, who reserved the word statistics for "statistics as a social science". Charlier not only secured the first academic position in Sweden in mathematical statistics for his former Ph.D. student Sven Wicksell, but he also demonstrated that a mathematical statistician can be influential in matters of state, finance, as well as in different natural sciences. Fahlbeck saw mathematical statistics as a set of tools that sometimes could be useful in his brand of statistics.

After a summary of the organisational, educational, and scientific growth of the statistical sciences in Sweden that has taken place during the last 50 years, we discuss what effects the Charlier-Fahlbeck divergence might have had on this development.

Statistics is a science in my opinion, and is no more a branch of mathematics than are physics, chemistry and economics; for if its methods fail the test of experience – not the test of logic – they are discarded; (Tukey, 1953)

Statistics may have a more important role to play in technology than in science; it may itself best be considered as a technology rather than as a science; (Healey, 1978).

The naming of cats is a difficult matter, It isn't just one of your holiday games; (Eliot, 1939)

1 Introduction

By the end of the 19th century, the subject of statistics was starting to gain acceptance as an academic endeavour. In England, the polymath Karl Pearson (Pearson, 1895) was developing general approaches to fit probabilistic models to data; in Germany the economist Ladislaus von Bortkiewicz (Bortkiewicz, 1917, p. 177) was arguing that fitting models to data was not sufficient, one needed to develop a mathematical model for the data production; while in Denmark, the astronomer and actuary Thorvald Thiele (Lauritzen, 2002) came up with the idea of the likelihood function and a system for approximating distribution functions (both these ideas were later reinvented by R.A. Fisher).

Karl Pearson was a leading proponent of statistics as a universal science, to be generalised beyond social phenomena, political science, and demography, (Pearson, 1891). He reserved the use of the name statistics for a methodological science, "married with probability and couched in the abstract language of mathematics", (Klein, 1997, p. 199).

In Sweden, the first years of the new century saw a few signs which in different ways pointed at what would emerge on the statistical scene. To our knowledge, the first Swedish professorship with the word statistics in the title was awarded to Rudolf Kjellén (1864-1922) at Göteborg University College in 1901. In Lund 1902, Pontus Fahlbeck, professor in history and political science, had his chair changed to "political science *and statistics*". In 1903 Gustav Sundbärg (1857-1914) earned the title of docent in statistics at Stockholm University College. The same year, 1903, Filip Lundberg (1876-1965) published a deep treaty on collective risk theory, (Lundberg, 1903). Through the work of Harald Cramér (1893-1985), one of the few who understood Lundberg's text, the ideas in Lundberg's thesis became a key part of actuarial mathematics.

In 1907, the Chancellor of the Swedish universities declared that "Statistics, whose importance as an independent science nowadays is commonly agreed upon, and whose importance undoubtedly will grow in all future, in parallel with the development of societal and political sciences, demands, in my opinion, a much firmer position at our universities than it has henceforth been awarded. It is in particular of utmost importance for society that the opportunity for scientific study of statistics as a theoretical discipline is obtained for the steadily growing number of civil servants needing such education." (The 1907 statement was quoted in the government proposition 1914, (Kungl. Maj:t, 1914).)

2 Fahlbeck and Charlier

The actors and their environment

During the early years of the century, Carl Vilhelm Ludvig Charlier (1862-1934), astronomy professor in Lund, started to lecture on mathematical statistics and its use in empirical research, (Charlier, 1905b,a, 1906). Charlier and Fahlbeck were strong personalities – with direct and indirect influence on the statistical sciences in Sweden that has lasted a century.

Pontus Fahlbeck (1850-1923) became a professor of history and political science at Lund University in 1889, and C.V.L. Charlier became professor in astronomy in 1897. Both scientists were not only interested in but also actively using and developing statistical methods in their work. The use of statistical means to describe mass phenomena, in Fahlbeck's case masses of people or economies; in Charlier's masses of stars or galaxies, was key in their work. In fact, Charlier developed and industrialised the branch of astronomy named "Stellar statistics" (Kapteyn, 1906), in a sequence of papers, summarised in the book (Charlier, 1921).

Fahlbeck was a member of the first chamber of the Swedish parliament. He was, as most professors in Lund, a conservative. Charlier, on the other hand, while not politically active (Lundmark, 1935) was a radical liberal, who in Uppsala had been active in the student club Verdandi. The appointment of Charlier was unusually complicated, and he was not the first choice of the university (Petrén, 1955).

Fahlbeck: statistics as the only exact social science

Fahlbeck viewed statistics as purely a social science, dealing only with humans and their activities. Fahlbeck (1918) describes the subject matter of statistics as "counting and measuring the human things and find the regularity in their measures." In his view, statistics was the only exact social science. The use of the mathematics of mass phenomena "yields for statistics [...] an immeasurable area. Hardly anything exists between heaven and earth that can not be considered statistics. The absurdity of this is obvious, and is most evident if one recalls the historical and etymological meaning of statistics as 'statesmanship'."

Fahlbeck vigorously defended the definition of "statistics" as a social science only, not to be confused in any way with "statistical methods", which he preferred to describe as "numerical means to reach knowledge". In Fahlbeck (1918) he is seriously distressed by the usurpation of the term "statistics" to be used for methods to describe variation in any other field, be it astronomy, meteorology, medicine, or economy. He saw it as a deadly threat to statistics as a science.

Sigfrid Wallengren, Fahlbeck's successor as professor in political science and statistics, was respectfully cautious when he wrote, in the obituary (Wallengren, 1923), "To what extent he was too strict to limit the use of higher mathematics in statistics, is a different matter that must be left to the debate of the specialists."

Charlier: statistics as a tool to bring structure to data

The standard view of a theoretical astronomer at the turn of the 20th century was a person sitting alone in an office, maybe with some computational help from the occasional student, but producing research much as a mathematician, while the applied astronomer spent the nights at the telescope taking pictures of the sky.

Charlier operated in a very different fashion. He felt an astronomer must be able to handle very large data sets, as well as making complex calculations. In order to manage these task he decided that it would make sense to hire computational staff, people (usually women without astronomical training) fluent at using mechanical calculators. Computational problems were broken down into manageable chunks, and each chunk was handled by one of these computers. Big multivariate data sets, common in astronomy, required card catalogues, with one card for each observation. Of course, a similar method was used in the official statistics, being the data collection arm of Fahlbeck's view of statistics.

Charlier was not only an astronomer and a mathematical statistician but used his intellectual capacity also in public affairs. He argued for proportional representation in general elections, proposed a new system for rail transport tariffs, and presented a statistical characterisation of the eligible voters in Lund. In mathematical statistics he is well known for his contribution to series expansions of density functions (Gram-Charlier series). His broad scientific work meant that many scientists wanted to send their doctoral students to Lund to study with Charlier (Holmberg, 1999).

As a statistician Charlier shared Karl Pearson's view of statistics as a universal science, calling him "an outstanding scholar", (Charlier, 1910), even if he disagreed with Pearson on technical issues.

Their students

The opposing views of Fahlbeck and Charlier on statistics as a science did not have much consequences for their students. Writing dissertations on statistical topics while getting degrees in political science or astronomy, they ended up being very influential in society regardless of their basic training.

For example, Fahlbeck's student David Bergström (1858-1946) became a liberal minister of war (the first civilian one in Sweden), and did a lot to anchor the use of statistics in the Swedish civil service (Sjöström, 2002).

Charlier's student Josua Linders (1882-1938) worked with the Central Bureau of Statistics and the Central Board of School Planning, before spending several years at the Eugenics Institute in Uppsala and eventually getting the professorship in statistics in Uppsala in 1931 (Holmberg, 1999).

It is noteworthy that Charlier does not seem to have argued particularly around the statistical topic of the decade: how to handle and understand biological variation and evolution. A "Mendelian Society" was founded in Lund 1910, ten years after the revival of Mendel's genetic experiments. In Copenhagen, the Danish biologist Wilhelm Johannsen coined the name *gene* and explained how one could combine Mendelian inheritance with variation within population. Johannsen and Karl Pearson disagreed on fundamental statistical issues (Guttorp and Lindgren, 2009), but the contacts between Charlier and Johannsen seem to have concerned only the organisation of statistical teaching and research (Johannsen, 1908).

Sven Wicksell (1890-1939), son of the radical economics professor Knut Wicksell (1851-1926), was another Charlier student to whom we will return in the next section.

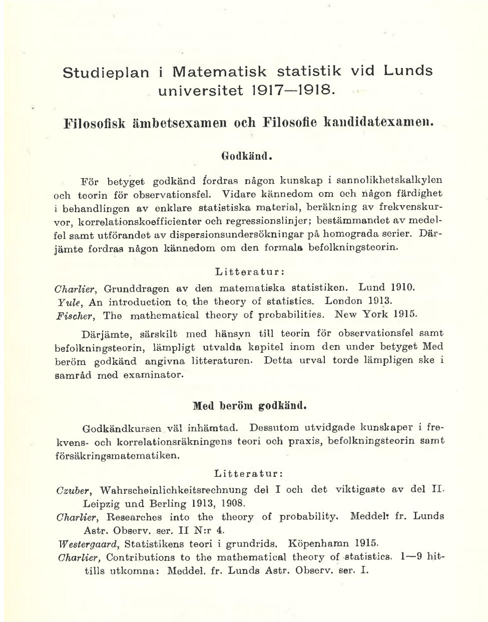
3 Statistics established

Shaping statistics education as an academic subject

In order that academic studies in the new and growing discipline of statistics could be accepted in an academic degree, a formal study plan had to be approved by the Chancellor of the Swedish universities.

The study plans for statistics at the different universities and colleges in Sweden could vary a fair bit. In 1912 Nils Wohlin (1881-1948), then docent (essentially reader) of statistics at Stockholm University College, developed a syllabus (Wohlin, 1913) that was based on the division of the subject into three parts: a theoretical, an administrative and an applied. The theoretical part requires some understanding of mathematics, and was inspired by G.U. Yule's text (Yule, 1913). The administrative part dealt with official statistics, while the applied part required understanding of the subject matter of the application, often economics. The Uppsala curriculum was similar, but did not contain the requirement of understanding some theoretical statistics.

In 1917, Sven Wicksell, then lecturer in mathematical statistics at Lund University, published his syllabus (Wicksell, 1917) for examining students in the subject.



Studieplan i Matematisk statistik vid Lunds universitet 1917—1918.

Filosofisk ämbetsexamen och Filosofie kandidatexamen.

Godkänd.

För betyget godkänd fordras någon kunskap i sannolikhetskalkylen och teorin för observationsfel. Vidare kännedom om och någon färdighet i behandlingen av enklare statistiska material, beräkning av frekvenskurvor, korrelationskoefficienter och regressionslinjer; bestämmandet av medelfel samt utförandet av dispersionsundersökningar på homograda serier. Därjämte fordras någon kännedom om den formala befolkningsteorin.

Litteratur:

Charlier, Grunddragen av den matematiska statistiken. Lund 1910.
Yule, An introduction to the theory of statistics. London 1913.
Fischer, The mathematical theory of probabilities. New York 1915.

Därjämte, särskilt med hänsyn till teorin för observationsfel samt befolkningsteorin, lämpligt utvalda kapitel inom den under betyget Med beröm godkänd angivna litteraturen. Detta urval torde lämpligen ske i samråd med examinator.

Med beröm godkänd.

Godkändkursen väl inhämtad. Dessutom utvidgade kunskaper i frekvens- och korrelationsräkningens teori och praxis, befolkningsteorin samt försäkringsmatematiken.

Litteratur:

Czuber, Wahrscheinlichkeitsrechnung del I och det viktigaste av del II. Leipzig und Berling 1913, 1908.
Charlier, Researches into the theory of probability. Meddel. fr. Lunds Astr. Observ. ser. II N:r 4.
Westergaard, Statistikens teori i grundrids. Köpenhamn 1915.
Charlier, Contributions to the mathematical theory of statistics. 1—9 hittills utkomna: Meddel. fr. Lunds Astr. Observ. ser. I.

Figure 1: Official study plan for studies in mathematical statistics at Lund University published by Sven Wicksell (Wicksell, 1917).

It is largely similar to Wohlin's syllabus, but also requires studies in probability theory. The topic could then be included in the academic degree Master of Philosophy (Filosofie magister). Texts by Charlier (1906), Czuber (1908), Westergaard (1916), and others are listed in the syllabus. Wicksell also anticipated the need for further studies in statistics, leading to a Licentiate degree, a pre-requisite for being a teacher at the university. The syllabus allows for specialisations, theoretical or more applied, in insurance, astronomy, biology (with a recommended text by Johannsen (1913)), or demography.

Arguments for splitting the Lund position into two

Already in 1907, five years after employing a professor in statistics and political science, Lund University started to advocate splitting the joint position into two, one in each scientific field. The argument that the growing subject of statistics needed the full attention of a professor also in Lund earned sympathy from the Minister of Education (1909), but he considered it wise to gain experience from the new statistics professorship in Uppsala before any expansion of the subject could be considered.

After a few failed requests for a statistics chair in Lund, the Larger Academic Consistorium (the board of the university), had a major debate in 1912. There were strong arguments for a separation of political science and statistics, and an important aspect was that Fahlbeck was nearing retirement. It was thought very unlikely that one could find a candidate with competence both in statistics and in political science. A special committee was appointed to investigate the areas of competence in a professorship in statistics, and to formulate the university's arguments to the government.

Naturally, Fahlbeck and Charlier were the leading members of the committee, and they expressed their individual opinions on what should be the responsibilities of a professor's chair in statistics and what competencies should be required. Their different views on the meaning of the word "statistics" and on the role of mathematics and mathematical statistics made it impossible for the committee to reach a consensus on the arguments. The history professor Samuel Clason, arguing that statistics was after all a social science, expressed worries that too strong emphasis on mathematics could jeopardise the recruitment. The suggestion from the humanities section to the university followed Fahlbeck and Clason.

At the university level, the economy professor Knut Wicksell complicated matters by suggesting that the title for the suggested professorship should indicate that it included mathematical statistics.Knut Wicksell had a university background in mathematics from Uppsala, but long before he obtained a Licentiate degree in mathematics (1885) he had switched interest to social problems and economy. In April 1913 the university decided to suggest to the government that statistics should be represented by a separate professorship without further specification.

The University Chancellor supported the request and a government proposition was sent to the parliament meeting 1914, (Kungl. Maj:t, 1914). The professorship was turned down by the parliament with the explicit motivation that there had been such a disagreement in Lund on its profile.

Fahlbeck retired in 1915 and was succeeded by Sigfrid Wallengren (1876-1927) as professor in political science and statistics. He was the only candidate who had any statistics at all in his CV; his main qualifications were in political science. We will return to the Lund scene after an excursion to Uppsala, where the future of the statistical science was at stake in a serious debate on the role of statistics.

The Uppsala debate

The first professor of statistics at Uppsala University, Gustav Sundbärg, did not last long because of illness. He was replaced in 1916 by Nils Wohlin, who in 1921 urged the government to change the professorship from one only in statistics to one in economics and statistics, partly since, as he argued, the fields are so similar. Wohlin, who between 1919 and 1942 was a member of the Swedish parliament, as well as holding positions as Minister of Trade and Minister of Finance, was not often available to perform his professorial duties in Uppsala. The teaching and examination was performed by a lecturer.

Uppsala University had been arguing for a professorship in Economics, but the University Chancellor had not approved this, and was now using Wohlin's suggestion to propose a solution. After a long discussion about this in the Faculty of Philosophy at Uppsala University (Andersson, 1922) and requesting advice from outside experts

(Pontus Fahlbeck, the retired Lund University professor, Eli Heckscher, economist at Stockholm University College, and Ludvig Widell, the director of the Royal Bureau of Statistics), the Faculty pointed out that the only satisfactory solution would be to maintain the professorship in Statistics and add a new one in Economics.

Fahlbeck argued against the similarity between statistics and economics, stating that "While economics is primarily deductive and reasoning, statistics equally clearly is inductive and numerical." Heckscher argued the opposite point of view, maintaining that "A student who studies statistics as his main subject, will hardly obtain any unified knowledge or thinking." He deduces that one should avoid professorships in statistics, "at least as long as one does not thereby mean mathematical statistics.'" The Larger Academic Consistorium accepted, with 12 votes to 4, the argument from the Faculty of Philosophy that statistics should be represented by a professorship of its own. The Chancellor of Universities was not convinced, and made no proposal to the government.

The first Swedish academic in "Mathematical statistics"

The discussion in the previous section highlighted the different views on the role of mathematics in statistics. The term "Mathematical statistics" (in German Mathematische Statistik) dates at least back to Wittstein (1867). In the introduction to his treatise on mathematical statistics (Charlier, 1910), Charlier writes: "Mathematical statistics is the tool that empowers the statistician to draw conclusions from his statistical material. ... mathematical statistics is just as necessary for the statistician as the knife is for the surgeon."

Charlier's perception of mathematical statistics and its relation to the wider field of statistics as defined by Fahlbeck is clear. But he also realised the generality of the statistical way to describe phenomena from different fields; besides astronomy, he mentions psychology, biology, economics. He concludes that *"mathematical statistics has, during the last decade, developed into an almost completely new science"*.

In 1915 Charlier proposed to the section of mathematical and natural sciences that his recently graduated Ph.D. Sven Dag Wicksell should be appointed as a docent in Mathematical statistics. The recommendation was sent to the Chancellor of the Universities, who appointed Wicksell on May 12, 1915. However, this was just a position, a "license to teach", and had no money associated with it. The Faculty of Philosophy had a six-year docent stipend available, and Wicksell was one of three candidates (the other two from the humanities section). After a considerable debate, Wicksell was awarded the stipend 1916, getting 9 votes out of 16. The renowned geneticist Herman Nilsson-Ehle supported Wicksell and emphasised the importance for all empirical sciences of the subject he represented.

To the best of our knowledge, the appointment of Wicksell as docent makes him one of the first academic teachers in mathematical statistics in the world, third only to Evgeny Slutsky in Kiev (lecturer in Mathematical statistics, 1913) and H.L. Rietz in Chicago (professor in Mathematical statistics, 1913). Rietz we will encounter again later as one of the founders of the Institute of Mathematical Statistics in the United States.

Wicksell quickly started to teach, and was soon awarded the right to examine students in statistics. That meant that the subject became a regular subject at the university. Until then students had needed to apply to the Chancellor in order to be allowed to include statistics in a degree program.

4 Statistics and/or Mathematical statistics

The professorship in Lund

As docent in mathematical statistics and with formal and paid appointment as teacher in statistics (1918 and 1920, respectively) Wicksell represented both statistics, with its regular syllabus, and mathematical statistics. Students wanting to use mathematical statistics in their degree program still had to apply to the Chancellor for permission. The reason that Wicksell (and not Wallengren, who after all was professor in the subject) got the examination rights was presumably that Wallengren had so many outside commissions that he frequently was not present in Lund. Sigfrid Wallengren was very appreciated for his ability to listen to different opinions, and much of his time was spent as mediator in labour market conflicts, (Erlander, 1972, p. 136). He did not do much science as professor, but he realised and supported the need for a separate statistics professorship. The request for a financed professorship at Lund University was finally approved by the parliament in 1926.

Wicksell was the natural choice as professor – he already had a solid reputation in all the different aspects of a statistics professor. His ability as a mathematical statistician was recognised, but he had also gained much experience in statistics as a social science. Actually, not only as a scientist but as an indispensable competence in society, taking part in a national committee on the organisation of the Swedish official statistics.

Lund University decided to investigate the possibility to summon Wicksell as professor, and invited Charlier in Lund, Westergaard in Copenhagen, and Wohlin in Uppsala to assess whether he was "superior to any Swedish man (sic!) who could reasonably be considered for the position." Wicksell was appointed professor of statistics in 1926, and a Department of Statistics was created in 1929.

Wicksell's main interests as professor went to demography, both of interest in its mathematical methods and by concern for the future of the Swedish population growth, or even decline.

Wicksell thus managed to fill two versions of the role as statistics professor – that designed by Charlier and that by Fahlbeck. One can only speculate on what had happened if the parliament had approved a professorship in statistics in 1914, one year before Wicksell earned his doctor's degree.

Wicksell has his name attached to the Wicksell corpuscle problem (Wicksell, 1925, 1926), which earned him a doctors degree Honoris Causa in medicine 1936, and to a bivariate gamma distribution (Wicksell, 1933). He also represented a link between Charlier and the next statistics professor in Lund from 1941, Carl-Erik Quensel (1907-1977): all three wrote on the representation of statistical distributions as series; see (Särndal, 1971; Cramér, 1972) for details on their work.

Elsewhere in Sweden

Once Wicksell became professor of statistics, the formal activities in mathematical statistics in Lund slowed down. Charlier retired in 1927 and died 1934. However, as mentioned, Wicksell and his successor Quensel included mathematical statistics as part of their duties as professors in statistics, both in their research and in their teaching.

The focus (and in fact, for a long time to come, the only locus) of the field of mathematical statistics in Sweden moved to Stockholm, where Cramér became the first professor in mathematical statistics (and insurance mathematics) in 1929. (According to Hagberg (2005), C.V.L. Charlier had already in 1916 argued for a professor in Stockholm in Mathematical statistics and Insurance theory. Stigler (1999, Ch.8) argues that 1933 is the birth year of mathematical statistics, based on events in UK and USA.)

Cramér's professorship was funded by the insurance industry and it was not unanimously welcomed by the mathematicians in th area, (Sundberg, 2013). The department became a hotbed for development of the theory and applications of stochastic processes, with long-term visitors like William Feller, Kari Karhunen and Ted Anderson, and students such as Herman Wold (1908–1992, professor in stastistics in Uppsala from 1942), Kai-Lai Chung, and Ulf Grenander (1923–2016).

The list of seminars at the new department shows a mixture of theoretical and applied topics with international speakers including, i.a., Anders Hald from Denmark, Leo Törnqvist and Gustaf Elfving from Finland, Olav Reiersöl from Norway, Frederic Riesz from Hungary, M.S. Bartlett from UK, P.C. Mahalanobis from India, Einar Hille and Jerzy Neyman from USA. Conny Palm, Swedish computer and telecommunication pioneer, was also an active participant.

A series of lectures by Cramér 1934–1935 founded on Kolmogorov's work became of particular importance for his students and for the future of the statistical sciences in Sweden. Of course, the textbook (Cramér, 1945) lay the foundation of modern mathematical statistics in combining tools from the Russian school of probability with methods from the British-American approach to statistics, thereby formalising theoretical statistics. The later research monograph by Cramér and Leadbetter (1967) on stationary processes is another international classic with great impact also on the Swedish scene.

Some international aspects

Our characterisation in Section 2 of Pontus Fahlbech and C.V.L. Charlier focused on their strong personalities and opinions. It is tempting to regard the Lund debate, as described in Section 3, as a belated echo of the discussion in Europe (outside Britain) of the soul of statistics as a social science, (Stamhuis and Klep, 2004). But, on the contrary, the support for Sven Wicksell and Mathematical statistics expressed by various members of the academy showed that the subject was already worthy of academic recognition on its own merits.

We first give examples from four European countries of similar size and culture as Sweden, where mathematical statistics existed without the formal academic recognition, and then finish the section by a reference to the creation of the Annals of Mathematical Statistics in the USA.

In Finland, since 1809 a part of the Russian Empire, a statistical office, Statistics Finland, was created in 1865, in the midst of the rise of a Finnish national identity. Life insurance was the first encounter with statistics for the mathematician Jarl Waldemar Lindeberg, who of course is best known for the "Lindeberg form of the central limit theorem", 1920 and 1922; (Elfving, 1981, Ch. 12). As Elfving states it, "Once Lindeberg had been known as an expert on probability, he was approached as consultant in various fields of application: biology, medicine, linguistics, and above all, forestry." He got an active interest in mathematical statistics, where he looked for methods that could be simply explained to the layman.

The relation between statistics and mathematical statistics in Norway in the beginning of the 20th century has been sketched by Schweder (1980). He prefers to describe it as a relation between two different professions: the "old statistical profession" and the "new statistical profession". Anders Nicolai Kiær, a statistician of the old profession, was the first director of the Norwegian Statistical office. In several Sessions of the International Statistical Institute, from 1895, 1899, and 1903, he explained and advocated the early ideas of survey sampling, or the representative method. At the ISI session in Berlin 1903, the representative method was recommended and survey sampling became an officially accepted method! Kiær stopped using his method after it had been criticized by a Norwegian actuary also trained in mathematical statistics. In a review paper, Schweder (2003) argues that this clash between the old and new professions delayed, not only the development of survey sampling as a reliable method, but also the introduction of mathematical statistics as an independent topic at the university level.

As Schweder (1980) points out, the development of mathematical statistics in

Scandinavia started before 1900 in Copenhagen with Gram, Thiele, and Westergaard. However, with Agner Krarup Erlang (1878–1929) as an exception, one had to wait until the 1930s to see a substantial new activity in mathematical statistics, when Georg Rasch (1901–1980) introduced Fisher's ideas in Denmark.

In the Netherlands, the astronomer Jacobus C. Kapteyn (1851–1922), who pioneered the statistical analysis of stellar photographs, also introduced mathematical statistical methods relevant for biologists. He and his astronomy colleague Charlier were two quite different characters. Kapteyn was the serious researcher, Charlier the radical man of action. Stamhuis and Seneta (2009) describe Kapteyn's struggle to explain, and criticise, i.a. Pearson's skewed frequency curves to a biological audience. He and Pearson had a heated exchange of publications, criticising each other. Charlier's critique agrees with Kapteyn's, but his words are more diplomatic, (Guttorp and Lindgren, 2009, p. 67).

The academic recognition of mathematical statistics in the Netherlands was quite early, when in 1913 Van Uven taught mathematics and statistics at the Agricultural University of Wageningen (Dornbos, 1985). The subject lay somewhat dormant until after World War 2 when David van Dantzig became the Director of Mathematical Statistics at the Mathematical Centre in Amsterdam, a centre funded jointly by the government and industry.

In the United States, the discussion about the need of mathematics in statistics training was the subject of two sessions at the American Statistical Association (ASA) meeting in 1925, The following year the discussion was summarized in the December issue of the *Journal of the ASA* (Glover, 1926; Hunter, 1996). The voices for inclusion of mathematics were H. L. Rietz and A. R. Crathorne, while other authors did not consider mathematics particularly important in statistics training.

In 1929 Henry Carver suggested to the ASA that there was a need for a journal that published mathematical statistics. His experience had been that it was very difficult to publish such material, as mathematical journals considered it too applied, and statistical journals too theoretical. For a few years, the journal, called *Annals of Mathematical Statistics*, was indeed partly funded by the ASA, but by 1934 the association found it too expensive. Instead, an Institute of Mathematical Statistics was formed (led by Carver and Rietz) in 1935, and decided eventually to take over the publication of the *Annals*. Thus there was sufficient number of mathematical statisticians in the US to form a viable professional society (Hogg, 1986).

5 Higher education needs more statistics

Mathematical statistics and engineering in the 1940-ies

"Why distinguish between statistics and mathematical statistics" – and why is that difference still upheld in Sweden? A partial answer can be found in the substantial expansion of the technical universities that took place in the late 1940s.

In the 1930s and early 1940s the statistical sciences lived together, in Lund and Uppsala, Carl-Erik Quensel and Herman Wold mixed the two sides. In fact, of eight scientific papers published in The Annals of Mathematical Statistics between 1930 and 1949 by Swedish authors, five came from statistics departments and three from mathematical statistics. In Stockholm, the Cramér group kept the social side living through the connection with insurance. But a new era was coming.

A very detailed and comprehensive official report of the Swedish government 1943, ("Statens Offentliga Utredningar", SOU 1943:34-37), proposed a more than 50% increase in higher engineering education, including many new professors chairs. The two technical universities, the Royal Institute of Technology (KTH) in Stockholm and Chalmers Institute of Technology (CTH) in Göteborg, were invited to express their opinion and, in particular, to motivate their needs.

At KTH, Alfred Liljeström (1882–1953) held a large course in mathematical statistics every second year for students in engineering physics. Liljeström, doctor in physics, was professor in Applied mathematics at KTH. He was a very good and versatile teacher who could give courses in theoretical physics as well as in mathematical statistics. His retirement in 1949 was approaching.

The board of governors of KTH had, as its top priority, a split of the professorship in applied mathematics into two, one for mathematical physics and one for mathematical statistics. It was absolutely necessary, teachers and board agreed, to replace the retiring professor in applied mathematics with two. The alternative, they argued, was like looking for a combination of "a Cramér and an [Oskar] Klein", the latter a world famous mathematical physicist, from 1946 member of the Nobel price committee in physics, both working at Stockholm university college. "To our knowledge, there is no person in this country, who is scientifically qualified in both these areas." It is clear that KTH really wanted a professor in mathematical statistics, even more so since it had been on their wish list for almost 20 years.

The Minister of Education, Tage Erlander (who in October 1946, became Swedish prime minister), who had studied for Wicksell in Lund 1928, was personally responsible for two propositions to the parliament 1946, one on natural science research and one on engineering. The latter included a professor at KTH, responsible for mathematical statistics, and a new professor in applied mathematics at CTH. The new professors were appointed 1949, Harald Bergström (1908-2001) in Göteborg and Carl-Gustaf Esseen (1918-2001) in Stockholm. Both positions were later changed to professorships in mathematical statistics; Bergström in 1960 and Esseen in 1962.

To understand the background to the positive words about mathematical statistics at KTH in 1945-46, it is necessary to rest on Conny Palm (1907–1951). He enrolled at the School of Electrical Engineering at KTH, worked with the Ericsson telephone company, and was an active participant in the probability group around Cramér and William Feller in the late 1930s; (Haugen, 1995). Palm defended 1943 a fundamental thesis on the probabilistic and statistical properties of telephone traffic systems, (Palm, 1943), expanding the work by Erlang, and laying the ground for modern queueing theory; (Khintchine, 1960). Palm acted as professor in applied mathematics for a period, but did not get the chair.

Stochastic control theory is another area which was greatly influenced by the lectures by Carl-Gustaf Esseen at KTH and in particular by the stochastic process activities around Ulf Granander, the successor of Harald Cramér at Stockholm university; (Åström, 2007).

Mathematical statistics reborn in Lund

At the time of the described expansions Lund University had already a new docent in mathematical statistics, Gunnar Blom (1920-2003), also a student of Cramér in Stockholm. There he had been a member of the Applied statistics research group, giving statistics courses for Swedish industry. He moved in the early 1950s to Malmö and started working as an industrial statistician in textile and sugar industries. At the same time he wrote his doctoral dissertation, which he presented in 1958.

Blom became docent at Lund university 1959; as Blom recalls, the docent position had been dormant since Wicksell's time! He started regular courses in mathematical statistics 1960. The interest in the courses was overwhelming, and after repeated student requests mathematical statistics became a regular subject in Lund 1961. The study plan for the first semester listed only introductions to statistical theory and probability. The new probability textbook by Feller (1957) set the style for the second semester, together with Cramér (1945) during the third. Experimental design and analysis of variance were trained through practical cases from Blom's industrial years. The fourth semester listed only very theoretical books, both in probability and statistics.

In the late 1950s the need for a reformation of higher education became clear. A government committee, (one member was Sven Moberg, Ph.D. in statistics under Carl-Erik Quensel in Lund), scrutinised most aspects of higher education and research. One of its conclusions was that a third technical university should be opened, and organised near, and with support from, an existing environment for mathematics and natural sciences. Lund was chosen as the best locale, and Lund Institute of Technology, LTH, was born by a decision in the parliament in 1960.

Mathematical statistics should be organised, together with mathematics and numerical analysis, in a department joint between the new LTH and Lund University. Gunnar Blom worked hard with the organisation of statistics courses for all the engineering programs, stressing the need for different focus and depth according to specialisation. Even the architect students got their own statistics course. A separate course in experimental design should be a necessary link between engineering practise and statistical theory.

Gunnar Blom was in 1963 appointed to the first professor's chair of mathematical statistics in Lund, with responsibility for statistical research and education both at Lund Institute of Technology and at the Faculty of Mathematics and Natural Sciences at Lund University. Part of Charlier's vision had materialised after almost 50 years.

A fresh new professor in mathematical statistics was Bertil Matérn (1917–2007), a student of Cramér. He had worked for many years at the Forest Research Institute when he in 1960 presented his now famous thesis Spatial variation (Matérn, 1960). He became professor in "Silvicultural mathematical statistics" at the new Forestry College in Stockholm in 1963.

Thus, the number of professorships in mathematical statistics increased, from one in 1959 to five in 1963. The entire expansion came from needs in application areas, engineering and forestry, respectively; for more details, see page 19.

Statistical sciences in an engineering environment

When mathematical statistics was introduced at the Swedish technical universities around 1960 it was in an environment where mathematics was the common language. Emerging new technologies, in telephone communication, control theory, reliability, computers, delivered challenges for mathematical statistics. A new group of engineering students was opened for recruitment to higher studies. Together, these conditions added a new facet to the identity of mathematical statistics.

On the basic educational level, statistics courses were designed to meet the different needs in different engineering programs. Stochastic processes were introduced to electrical engineers and engineering physics students, operations research - a topic of the day - was picked up for mechanical engineers, and experimental design for chemical and civil engineering. This diversification lead engineering mathematical statistics away from traditional Swedish statistics and mathematical statistics education.

Research topics for PhD students slowly started to be chosen with inspiration from engineering. Of about 75 PhD theses in mathematical statistics defended during 1970–1989 only 6 dealt with topics that emerged from concrete engineering problems, and had genuinely engineering interest. The rest can be classified as applied probability or theoretical statistics. Engineering statistics was virtually unseen by the Swedish statistical community, and mathematical statistics played its official role as the theoretical side of statistics.

The Institute of Applied Mathematics, ITM, was a joint venture between the state and the Swedish industry, 1971–2003. Its first director was Ulf Grenander. First of all, ITM helped to finance moderate sized PhD projects in applied mathematics, computer science, numerical analysis, and statistics. The projects were suggested by scientists, and judged to have industrial potential. A second type of activity was projects with direct industry support, for example, co-financing from pharmaceutical industry of a professor in Biostatistics in Göteborg 1993.

The first statistical projects dealt with stochastic load analysis and random fatigue, and they were followed by projects in reliability, quality assurance, energy optimization, biostatistics, telecommunication, and statistical finance. About 25 PhD students in mathematical statistics got some support from ITM during its 30 years of existence. The public support for ITM ended 2001, and the national ITM was replaced by the centralised Fraunhofer Chalmers Center (FCC) for Industrial Mathematics. Also FCC has statistics on its program.

Building on the experience from ITM, "Mathematics as technology" was used as a promotion line in a joint effort from mathematics and statistics to create a dedicated five year engineering program. Programs in Engineering Mathematics started 2002 in Lund, (Lindgren and Sparr, 2011), and 2008 in Göteborg, followed by similar programs at a few more places. The effect on PhD education has been considerable: about 40% of new enrolment for doctoral studies in mathematical statistics have a background in Engineering Mathematics.

6 Discussion

Little effect of the Fahlbeck-Charlier controversy

Many of the current views of statistics as a discipline were available in the discussions in the early 20th century. For example, the importance of a cross-disciplinary view of the field was clearly expressed by both Fahlbeck and Charlier. Fahlbeck (1918, p. 31) writes that "statistics treats these sides of human activities in its own fashion, in that it views them purely as societal phenomena, without regard to what they are or concern in themselves (in economics, exchange and production of valuable goods, in medicine, life and health processes, in ethics, evil and good deeds, etc.) and further join them together with other similarly treated aspects to an independent science about humanity." Similarly the need for mathematical (particularly probabilistic) tools to develop the methodology of the field seemed to be a point of agreement between the two sides.

On the other hand there was no agreement as to the scope of statistics as a science. Fahlbeck's view that it had to be limited to social science seems strange to us, although it is the foundation for the current division between statistics and mathematical statistics at Swedish universities. He argued (Fahlbeck, 1918, preface) that this was needed to defend the subject against a point of view which would reduce it from an independent science to a branch of mathematics. He admitted that there are cases where novel methodology has been developed by mathematically inclined statisticians, but claimed that these methods did not become *statistical* methods until they were routinely employed by statisticians in the field. Again, the argument that the scope of statistics does not (and should not) go beyond social science applications is puzzling.

Our conclusion is that the Fahlbeck-Charlier controversy was more formal than real. “Statistics” kept its connotation as mainly a social science and “mathematical statistics” was free to work on all other areas. Sven Wicksell and his colleagues in Lund were active in both fields, and the use of mathematics was not a controversial issue.

Mathematical statistics gets its identity

Two completely unrelated circumstances around 1930 gave Swedish mathematical statistics its special identity. First, the life insurance companies' desire and willingness to support a professor in insurance mathematics and mathematical statistics led to a new institution with Harald Cramér as professor 1929. Second, Kolmogorov's axiomatic probability 1933 gave Cramér the tools he needed for statistics. He lectured both on statistical methods in social security services, and on advanced probability and stochastic process theory. It was Statistics, not Applied mathematics.

In Section 5 we described how “Applied mathematics” (or “useful mathematics” as it was sometimes called) at the technical universities was transformed into Mathematical statistics and Mathematical physics. The profile from Cramér's institution was copied to KTH, CTH, and LTH, and later widened to general science and engineering. This was a viable profile, but only when it acknowledged the diversification of mathematical statistics.

Diversification

Modern statistics is multidisciplinary. It works across boundaries. One of the central roles of statistics, that neither of the two early Lund scientists really anticipated, has now become one of the leading themes of statistics. The multidisciplinary nature of statistics renders it particularly important for the statistical scientist to understand the subject matter from which a problem arises, This, on the other hand, both Fahlbeck and Charlier understood and emphasised.

But, to understand the subject matter means more than sole understanding – it means to take part in problem formulation. To help construct models that include randomness within the system as well as in the way one observes the system. Statistics is more of a systems science than a data science.

Multidisciplinary cooperative research defines conditions for higher statistical education. The subject matter must be allowed to take its place in theses and in publications. The statistical problem can no longer be isolated. Probabilistic epidemiological models have become public health issues, extreme value theory has entered car and truck manufacturing industry, random field models are developed for environmental and climatological purposes, stochastic process models and statistical extreme value theory combines with marine technology to increase shipping safety.

There was a time when it was considered necessary to maintain the difference between a theoretical Mathematical statistics and an applications oriented Statistics science. It has taken several decades to break those bonds. The process started more than a hundred years ago, the heritage from Charlier and Cramér has been respectfully cultivated, and now there is no scientific reason to keep the difference.

First professorships by institution

Location	Subject	Name	Year
Göteborg University College	Political science and statistics	Rudolf Kjellén	1901
Lund University	Political science and statistics	Pontus Fahlbeck	1902
Stockholm School of Economics	Economics with statistics	Eli Heckscher	1909
Uppsala University	Statistics	Gustav Sundbärg	1910
Stockholm University College	Actuarial mathematics and mathematical statistics	Harald Cramér	1929
Stockholm University College	Statistics	Sten Wahlund	1938
Chalmers Institute of Technology	Mathematical statistics	Harald Bergström	1960
Royal Institute of Technology	Mathematical statistics	Carl-Gustav Esseen	1962
Lund Institute of Technology	Mathematical statistics	Gunnar Blom	1963
Forestry College	Silvicultural mathematical statistics	Bertil Matérn	1963
Umeå University	Statistics	Ejnar Lyttkens, acting	1963
Umeå University	Mathematical statistics	Gunnar Kulldorff	1966
Uppsala University	Mathematical statistics	Carl-Gustaf Esseen	1967
Göteborg University	Biostatistics	Sture Holm	1993
Örebro University	Statistics	Bengt Swensson	1995
Linköping University	Statistics	Anders Grimwall	1998
Karolinska Institutet	Biostatistics	Juni Palmgren	1999
Linköping University	Mathematical statistics	Timo Koski	2000
Dalarna University	Statistics	Kenneth Carling	2003
Luleå Technical University	Mathematical statistics	Kerstin Vännman	2004

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