

Transmission of probability theory into China

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Abstract

In spite of the occurrence of many uncertain events in human experience in different civilizations since antiquity, be it in the East or the West, a quantitative approach to probability was not developed until the sixteenth and seventeenth centuries in Western Europe. This peculiar "miss" is particularly notable in the history of Chinese mathematics, even though knowledge and skill in numerical calculation had long been well developed in ancient and medieval China. The first introduction of probability into China came in the form of a book *Jueyi Shuxue*, translated around 1880 through the collaboration of the British missionary John Fryer and the Chinese mathematician HUA Heng-fang from an article on probability written by Thomas Galloway for *Encyclopaedia Britannica*, which was published separately as the book *A Treatise on Probability*. This presentation is about this episode and related issues.

Keywords: *Jueyi Shuxue*, Western learning in Qing China

1. Introduction

This story is about how the theory of probability was first introduced into China in the late-nineteenth century through the translation of *A Treatise on Probability* by Thomas Galloway (1796-1851), which also formed an article in the seventh edition of *Encyclopaedia Britannica* in 1839. This Chinese translation, accomplished through the collaboration of the famous pair of translators of the time, the British missionary John Fryer (1839-1928) and the Chinese mathematician HUA Heng-fang (1833-1902), was given the title *Jueyi Shuxue* (with literal meaning: "mathematics to resolve uncertainty"). The book was first published in 1896 with some later editions, although it was already announced in *Gezhi Huibian* (with literal meaning: "compendium for investigating things and extending knowledge"), a Chinese magazine published by John Fryer from 1876 to 1892, that the translation had been finished by the autumn of 1880.

In a way this is not a story of success, but not one of complete failure either. It can be said that this first book on probability in China introduced this new branch of mathematics to the Chinese mathematicians and scientists towards the ending years of the old Imperial China, but seemed to have exerted little influence on the subsequent development of probability and statistics which took place in the Chinese Republic. The serious study of probability theory and mathematical statistics, in the modern sense of the subject, got underway in China in the 1930s, from which point onwards the development would be like what it was in the Western world (Bréard (2008); Wang, Bréard (2010)).

Why are we then interested in this "unsuccessful" attempt? A main reason is to look at the episode from the viewpoint of the incompatibility in the cultural, social and linguistic context when a certain scientific discipline from outside is implanted into the indigenous environment in which the concept and technical means are foreign and the communication is not helped by the scientific language of the time. Being confined to six

pages the present paper is to be regarded more as an extended abstract of the presentation than a full-length paper, which we plan to write after reaping the benefit from exchange of ideas with participants during the presentation in the World Statistics Congress 2013.

2. The book *JUEYI SHUXUE*

Several historians of mathematics had researched on the book *Jueyi Shuxue*, with the commonly acknowledged view that it is a translation based on Galloway's article in the eighth edition of *Encyclopaedia Britannica* in 1859 (see Bréard (2008); Guo (1989); Wang (2006); Wang, Bréard (2010); Yan (1990)). The translation was accomplished through the collaboration of John Fryer and HUA Heng-fang in the traditional way of those days, namely, the Western translator would explain the text in detail to the Chinese translator, who would then study the content to as much depth as possible and wrote out a Chinese text in consultation with the Western translator (see also Bennett (1967) and Horng (1993).)

Jueyi Shuxue faithfully reproduces the original English text. The content is basically a book on probability after the style of Laplace with the work of Poisson added in. The introduction begins with the sentence: "The doctrine of probability is an extensive and very important branch of mathematical science, the object of which is to reduce to calculation the reasons which we have for believing or expecting any contingent event, or for assenting to any conclusion which is not necessarily true." (Galloway (1839)) After some general discussion of the subject a historical account of the theory from the Pascal-Fermat discussion to the fundamental treatises of Huygens, Bernoulli and others to the works of Laplace and Poisson is given, with the work of De Morgan of 1837 mentioned at the end. By the end of the nineteenth century probability theory had developed beyond the dominance by Laplace's work (Schneider (1987)), but the translation indicates the enthusiasm the translators still held for Laplace's work.

It is interesting to note a passage in the introduction that says of probability and gambling: "In fact, most of the questions of this class to which the calculus can be applied, are connected with lotteries and games of hazard. The results obtained from the analysis of such questions cannot be considered as being of any great value in themselves, but they frequently throw light on subjects of far higher importance which present analogous combinations. It is true that the mathematical theory comes in aid of moral considerations, and demonstrates the ruinous tendency of gambling even when the conditions of the play are equal, mathematically speaking; but, unfortunately, those who indulge a passion for the vice are seldom capable of appreciating the force of such arguments." This expression of a negative attitude towards gambling perhaps has an appeal for the Chinese translator who was brought up in a Confucian tradition!

The translation of Western books on science and mathematics went on as a fervent activity in Imperial China in the latter half of the nineteenth century. One has to look at it in the historical context of what the country went through during that period, which the historian Immanuel Hsü (Hsü (1970/1995)) describes as a "search for a way to survival in the new world that had been forcibly thrust upon China by the West after the mid-19th century". The Chinese, "burdened by tradition and heritage, and as yet ignorant of the nature of the Western world, groped in the dark". Hsü maintains that "the dynamics of change suggests that modern Chinese history is not characterized by a passive response to the west, but by an active struggle of the Chinese to meet the foreign and domestic challenges in an effort to regenerate and transform their country from an outdated

Confucian universal empire to a modern national state, with a rightful place in the family of nations” (see also Chan, Siu (2012)).

Jueyi Shuxue was published in 1896, about fifteen years after it was translated! It was reprinted in 1909 by the Chinese mathematician ZHOU Da, who had great interest in the book but lamented that it was not given adequate attention so that circulation was not widespread. The fact that the book remained unpublished for fifteen years may reflect the doubt of the translators about its degree of acceptance by the indigenous scientific community. Or, it may reflect the lack of confidence of the translators in having a comfortable grasp of this new branch of mathematics themselves. This may explain why the book was not prefaced by an introduction written by Fryer nor by Hua, particularly when two other well-known and popular translated books by them contained such explanatory introductions. Those two translated books, *Daishu Shu* (Method of Algebra) of 1873 and *Weiji Suyuan* (The Origins of the Differential and Integral Calculus) of 1874, respectively translation of the articles on “Algebra” and “Fluxions” written by William Wallace for the eighth edition of *Encyclopaedia Britannica*, were influential to the transmission of two equally new subjects in China at the time, algebra and calculus (Hu (1998)).

It also turns out that most of the terms the translators (probably mainly due to the credit of Hua) coined in probability theory did not survive so that the Chinese terminology adopted in later textbooks were different. Besides *Jueyi Shuxue* we can only find one other mentioning of the subject at the time, in an article on “using mathematics to resolve uncertainty” published in the Spring issue of 1891 of *Gezhi Huibian*. A leading Chinese intellectual of that period, LIANG Qichao, compiled a recommended reading list of Western books in 1896 in which *Jueyi Shuxue* was included. However, the actual influence of the book seemed to be rather minimal and subsequent study and works on probability theory and mathematical statistics seemed not to have received direct impact from the book.

One argument for the lack of influence of the book has to do with the mathematical language adopted in the translation, which was not a complete symbolic format already commonly adopted in Western mathematical literature but was a hybrid between the Chinese format adopted in traditional Chinese mathematical text and some newly coined symbols with a Chinese flavour. In our modern eyes this would indeed look awkward and impede facility in computation or even ease in comprehension. However, with sufficient practice familiarity can still be attained. Thus, it seems that hindrance arose more from a cultural and social context, which is the subject of the next section.

3. Probability in pre-modern China

As Hua might have expected the concept of probability was not as readily received by the indigenous scientific community of his time. With algebra there was the tradition of solving equations in ancient and medieval China, in fact of a level quite advanced compared to that of the Western world in the corresponding period. With calculus there was the notion of infinitesimals used in the computation of area and volume as explained by LIU Hui in the third century. But the quantitative notion of uncertainty was totally absent in all Chinese mathematical classics up to that point. This peculiar “miss” in the history of Chinese mathematics is a baffling question on two counts. The first one is an “internal” issue, since the needed mathematical knowledge and skill in numerical calculation had long been well developed in ancient and medieval China. The second one

is an “external” issue, since probability theory has so many applications. It is commonly agreed that traditional Chinese mathematics paid much attention to demands on solving real world problems as an exemplification of a basic tenet of traditional Chinese philosophy of life shared by the class of *shi* (intellectuals), namely, self-improvement and social interaction (Siu (2009)). Had the Chinese mathematicians become aware of the fundamental significance and applicability of the notion of probability they should devote their effort to its investigation.

Perhaps this question has to be viewed not just in the Chinese scene by itself alone but in the full background of the West as well (see Bernstein (1996); Daston (1988); David (1962); Hacking (1975/2006); Maistrov(1974); Meusnier (1996); Plato (1994); Sheynin (1974); Stigler (1986)). In spite of the occurrence of many uncertain events in human experience in different civilizations since antiquity, a quantitative approach to probability was not developed until the sixteenth and seventeenth centuries in Western Europe. According to David (David (1962)) “the real problem which confronts the historian of the calculus of probabilities is its extremely tardy conceptual growth – in fact one might almost say, its late birth as an offspring of the mathematical sciences”. Elvin (Elvin (2002/2010)) points out that, according to what Crombie categorizes as six styles of scientific thinking in the European world (Crombie (1994)), probabilistic and statistical thinking was the last one that came to maturity, and is perhaps the least natural kind of scientific thinking which needs time to incubate, be it in the West or the East. Sambursky (Sambursky (1956)) points out an interesting feature of Greek philosophy in general and its mathematics in particular that caused their “miss” in understanding the intriguing and important concept of probability.

In the Chinese scene there were likewise instances in philosophy, in mathematics and in social practices that could have hinted at probabilistic thinking, but this had not germinated and bloomed into a mathematical theory as it did in the West. No recognizable mathematical account on the notion of probability appeared in the mathematical literature in China before its transmission from the West through *Jueyi Shuxue*. Mathematically speaking it is known that Chinese mathematicians developed much earlier than Pascal what is commonly known as Pascal’s triangle (of an origin earlier than Pascal even in the West), solved problems related to permutations and combinations, and for administrative reasons treated problems of a statistical nature since early times (Bréard (2008); Li, Mo (1993)). One problem in *Shushu Jiuzhang* [Mathematical Treatise in Nine Sections] of QIN Jiu-shao in 1247 even made use of the idea of sampling in collecting grains for taxation (Xu, Zhang (1995)). Folklore wisdom depicted in some anecdotes embraced an awareness of chance events. Games of chance were never unfamiliar to the Chinese, even though gambling practice was officially banned by different rulers throughout the long history of China (Guo, Xiao (1995)). Divination and fortunetelling may lead to probabilistic thinking (although it may also lead to the opposite by thinking that human affairs are destined by the deities so that it is meaningless to investigate the notions of chance and risk!) Physiognomy that had been practiced in China for long can be regarded as some kind of statistical thinking. In his very thorough analysis of the situation of probabilistic thinking in premodern China (Elvin (2002/2010)) Elvin points out that there may be more than what was found in writings. In another detailed and comprehensive study on probability and statistics in China (Bréard (2008)) Bréard suggests that further scrutiny is needed. Having mentioned all these factors we have to admit that in the history of Chinese mathematics the kind of probing into mathematical concepts, purely for the curiosity of intellectual pursuit, was not as marked as in the West. The axiomatic approach of geometry is one example; the

investigation of the solvability by radicals of polynomial equations instead of just obtaining highly accurate methods of solving them is another, and (probably!) the study of probability starting from games of chance is a third.

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