

---

## Appendix A – Biography of Mathematicians and Statisticians

### Leonardo Pisano Fibonacci



Born: 1170 in (probably) Pisa (now in Italy)

Died: 1250 in (possibly) Pisa (now in Italy)

Fibonacci or Leonard of Pisa played an important role in reviving ancient mathematics and made significant contributions of his own. Leonardo Pisano is better known by his nickname Fibonacci. Fibonacci was born in Italy but was educated in North Africa where his father held a diplomatic post. He traveled widely with his father, recognizing the enormous advantages of the mathematical systems used in these countries.

Liber abaci published in 1202 after his return to Italy, is based on bits of arithmetic and algebra that Fibonacci had accumulated during his travels. Liber abaci introduced the Hindu-Arabic place-valued decimal system and the use of Arabic numerals into Europe.

A problem in Liber abaci led to the introduction of the Fibonacci numbers and the Fibonacci sequence for which Fibonacci is best remembered today. The Fibonacci Quarterly is a modern journal devoted to studying mathematics related to this sequence.

Fibonacci's other books of major importance are Practica geometriae in 1220 containing a large collection of geometry and trigonometry. In addition, in Liber quadratorum in 1225 he approximates a root of a cubic obtaining an answer, which in decimal notation is correct to nine places.

Mis practica geometriae in 1220 gave a compilation of the geometry of the time and introduced some trigonometry.

The portrait above is from a modern engraving and may not be based on authentic sources.

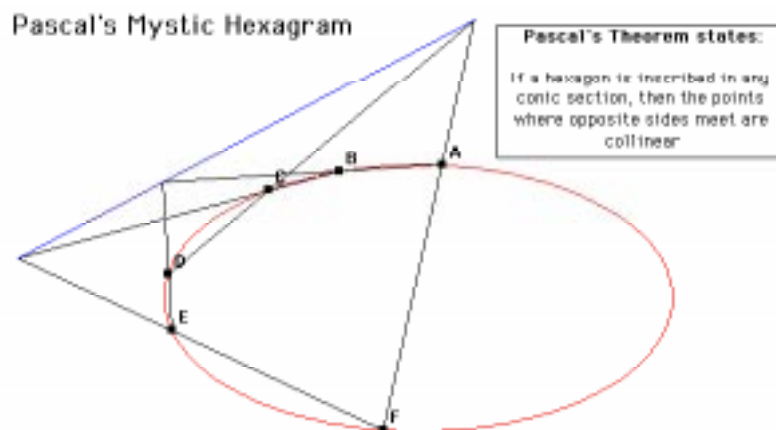


Pascal's father, Étienne Pascal, had unorthodox educational views and decided to teach his son himself. He decided that Pascal was not to study mathematics before the age of 15 and all mathematics texts were removed from their house.

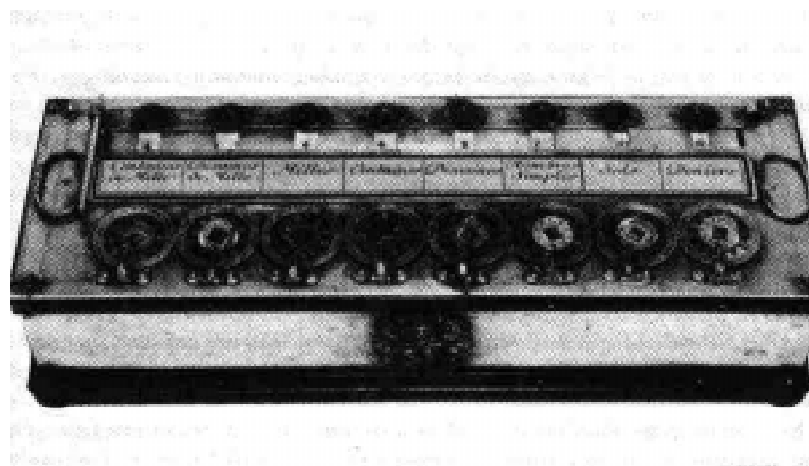
Pascal however, his curiosity raised by this, started to work on geometry himself at the age of 12. He discovered that the sum of the angles of a triangle is two right angles and, when his father found out he relented and allowed Pascal a copy of Euclid.

At the age of 14, Pascal started to attend Mersenne's meetings. Mersenne belonged to the religious order of the Minims, and his cell in Paris was a frequent meeting place for Fermat, Pascal, Gassendi, and others.

At the age of 16, Pascal presented a single piece of paper to one of Mersenne's meetings. It contained a number of projective geometry theorems, including Pascal's mystic hexagon.



Pascal invented the first digital calculator (1642) to help his father. The device, called the Pascaline, resembled a mechanical calculator of the 1940's.



Further studies in geometry, hydrodynamics, and hydrostatic and atmospheric pressure led him to invent the syringe and hydraulic press and to discover Pascal's law of pressure.

His most famous work in philosophy is *Pensées*, a collection of personal thoughts on human suffering and faith in God. 'Pascal's wager' claims to prove that belief in God is rational with the following argument.

If God does not exist, one will lose nothing by believing in him, while if he does exist, one will lose everything by not believing.

His last work was on the cycloid, the curve traced by a point on the circumference of a rolling circle.

Pascal died at the age of 39 in intense pain after a malignant growth in his stomach spread to the brain.

## Fermat



## Jacob (Jacques) Bernoulli



Born: 27 Dec 1654 in Basel, Switzerland

Died: 16 Aug 1705 in Basel, Switzerland

Jacob Bernoulli was the brother of Johann Bernoulli and the uncle of Daniel Bernoulli. He graduated with a theology degree from Basel in 1676. He received training in mathematics and astronomy against the wishes of his parents.

Between 1676 and 1682 Jacob traveled widely in France, England and the Netherlands. He met Boyle and Hooke in England.

Jacob returned to Switzerland and taught mechanics at the University in Basel from 1683. He was appointed professor of mathematics in Basel in 1687.

Jacob was the first to use the term integral in 1690. In 1691, he studied the catenary, the curve of a suspended string.

He was an early user of polar coordinates and discovered the isochrone, the curve along which a body with uniform vertical velocity will fall.

In a mathematical dispute with his brother Johann, he invented the calculus of variations. He also worked on probability theory. The Bernoulli distribution, the Bernoulli differential equation and the Bernoulli numbers are named after Jacob Bernoulli.

Jacob published many articles on infinite series

On his death, his chair at Basel was filled by his brother Johann Bernoulli.

## Abraham de Moivre



Born: 26 May 1667 in Vitry (near Paris), France

Died: 27 Nov 1754 in London, England

After spending five years at a Protestant academy at Sedan, De Moivre studied logic at Saumur from 1682 until 1684. He then went to Paris, studying at the Collège de Harcourt and taking private lessons in mathematics from Ozanam.

A French Protestant, de Moivre immigrated to England in 1685 following the revocation of the Edict of Nantes and the expulsion of the Huguenots. He became a private tutor of mathematics and hoped for a chair of mathematics, but this was not to be since foreigners were at a disadvantage. In 1697, he was elected a fellow of the Royal Society.

In 1710 de Moivre was appointed to the Commission set up by the Royal Society to review the rival claims of Newton and Leibniz to be the discoverers of the calculus. His appointment to this Commission was due to his friendship with Newton. The Royal Society knew the answer it wanted!

De Moivre pioneered the development of analytic geometry and the theory of probability. He published *The Doctrine of Chance* in 1718. The definition of statistical independence appears in this book together with many problems with dice and other games. He also investigated mortality statistics and the foundation of the theory of annuities.

In *Miscellanea Analytica* (1730) appears Stirling's formula (wrongly attributed to Stirling) which de Moivre used in 1733 to derive the normal curve as an approximation to the binomial. In the second edition of the book in 1738, de Moivre gives credit to Stirling for an improvement to the formula.

De Moivre is also remembered for his Stirling's for

$$(\cos x + i \sin x)$$

This took trigonometry into analysis.

Despite de Moivre's scientific eminence, his main income was by tutoring mathematics and he died in poverty. He, like Cardan, is famed for predicting the day of his own death. He found that he was sleeping 15 minutes longer each night and summing the arithmetic progression calculated that he would die on the day that he slept for 24 hours. He was right!

## Rev. Thomas Bayes



Born 1702

Died 1761

Thomas Bayes discovered an approach to statistical inference that was far more advanced than the traditional thinking of the mathematicians of the time. Up to the time of Bayes, the focus of mathematicians was on the behavior of samples from known population, but Bayes reversed the idea to determine the properties of a population based on a sample. In "An Essay Towards the Solving a Problem in the Doctrines of Chance," he presented as "Proposition 9," what is now known as *Bayes' theorem*. The essay is, perhaps, one of the least understood but most famous and controversial contributions in the history of science. In modern times, Bayes was rediscovered and his theorem has laid the foundations for modern decision making.

## Pierre-Simon Laplace



Born: 28 March 1749 in Beaumont-en-Auge, France

Died: 5 March 1827 in Paris, France

Laplace proved the stability of the solar system. In analysis, Laplace introduced the potential function and Laplace coefficients. He also put the theory of mathematical probability on a sound footing.

Laplace attended a Benedictine priory school in Beaumont between the ages of 7 and 16. At the age of 16, he entered Caen University intending to study theology. Laplace wrote his first mathematics paper while at Caen.

At the age of 19, mainly through the influence of d'Alembert, Laplace was appointed to a chair of mathematics at the École Militaire in Paris on the recommendation of d'Alembert. In 1773, he became a member of the Paris Academy of Sciences. In 1785, as examiner at the Royal Artillery Corps, he examined and passed the 16 year old Napoleon Bonaparte.

During the French Revolution he helped to establish the metric system. He taught calculus at the École Normale and became a member of the French Institute in 1795. Under Napoleon, he was a member, then chancellor of the Senate, and received the Legion of

Honour in 1805. However Napoleon, in his memoirs written on St H el ene, says he removed Laplace from office after only six weeks because he brought the spirit of the infinitely small into the government

Laplace became Count of the Empire in 1806 and he was named a marquis in 1817 after the restoration of the Bourbons. In his later years he lived in Arcueil, where he helped to found the Societe d'Arcueil and encouraged the research of young scientists.

Laplace presented his famous nebular hypothesis in Exposition du systeme du monde (1796), that viewed the solar system as originating from the contracting and cooling of a large, flattened, and slowly rotating cloud of incandescent gas.

Laplace discovered the invariability of planetary mean motions. In 1786, he proved that the eccentricities and inclinations of planetary orbits to each other always remain small, constant, and self-correcting. These results appear in his greatest work, Trait  du M canique C leste published in 5 volumes over 26 years (1799-1825).

Laplace also worked on probability and in particular derived the least squares rule. His Th orie Analytique des Probabilit s was published in 1812.

He also worked on differential equations and geodesy. In analysis, Laplace introduced the potential function and Laplace coefficients. He also put the theory of mathematical probability on a sound footing. With Antoine Lavoisier, he conducted experiments on capillary action and specific heat. He also contributed to the foundations of the mathematical science of electricity and magnetism.

## Johann Carl Frederick Gauss



Born: 30 April 1777 in Brunswick, Duchy of Brunswick (now Germany)

Died: 23 Feb 1855 in Göttingen, Hanover (now Germany)

Carl Frederick Gauss worked in a variety of fields in both mathematics and physics including number theory, analysis, differential geometry, geodesy, magnetism, astronomy and optics. His work has had an immense influence in many areas.

In June 1801, Zach, an astronomer whom Gauss had come to know two or three years previously, published the orbital positions of Ceres, a new "small planet" which was discovered by G. Piazzi, an Italian astronomer on 1 January, 1801. Unfortunately, Piazzi had only been able to observe 9 degrees of its orbit before it disappeared behind the Sun. Zach published several predictions of its position, including one by Gauss, which differed greatly from the others. When Ceres was rediscovered by Zach on 7 December 1801, it was almost exactly where Gauss had predicted. Although he did not disclose his methods at the time, Gauss had used his least squares approximation method.

## Siméon Denis Poisson



Born: 21 June 1781 in Pithiviers, France

Died: 25 April 1840 in Sceaux (near Paris), France

Poisson's most important works were a series of papers on definite integrals and his advances in Fourier series.

Originally forced to study medicine, Poisson began to study mathematics in 1798 at the École Polytechnique. His teachers Laplace and Lagrange were to become friends for life. A memoir on finite differences, written when Poisson was 18, attracted the attention of Legendre.

Poisson taught at École Polytechnique from 1802 until 1808 when he became an astronomer at Bureau des Longitudes. In 1809, he was appointed to the chair of pure mathematics in the newly opened Faculté des Sciences.

His most important works were a series of papers on definite integrals and his advances in Fourier series. This work was the foundation of later work in this area by Dirichlet and Riemann.

In *Recherchés sur la probabilité des jugements*, an important work on probability published in 1837, the Poisson distribution first appeared.

He published between 300 and 400 mathematical works including applications to electricity and magnetism, and astronomy. His *Traité de mécanique* published in 1811 and again in 1833 was the standard work on mechanics for many years.

His name is attached to a wide area of ideas, for example:- Poisson's integral, Poisson's equation in potential theory, Poisson brackets in differential equations, Poisson's ratio in elasticity, and Poisson's constant in electricity.

## Biddell Airy



Born: 27 July 1801 in Alnwick, Northumberland, England

Died: 2 Jan 1892 in Greenwich, England

Airy was an astronomer who was Astronomer Royal from 1835. He wrote the text "On the Algebraic and Numerical Theory of Errors of Observations and the Combinations of Observations." Although said at the time to be unreadable except by those already thoroughly acquainted with the subject, the book was used at Cambridge and influenced Pearson.

## Sir Francis Galton



Born: 16 Feb 1822 in Sparkbrook (near Birmingham), England

Died: 17 Jan 1911 in Grayshott House, Haslemere, and Surrey, England

Galton is best known for proving that a normal mixture of normal distributions is itself normal.

An explorer and anthropologist, Galton is known for his pioneering studies of human intelligence. He devoted the latter part of his life to eugenics; i.e. improving the physical and mental makeup of the human species by selected parenthood.

Although weak in mathematics, his ideas strongly influenced the development of statistics particularly his proof that a normal mixture of normal distributions is itself normal. Another of his major findings was reversion. This was his formulation of regression and its link to the bivariate normal distribution.

He also made important contributions to the fields of meteorology, anthropometry, and physical anthropology. Galton was an indefatigable explorer and an investigator of human intelligence.

Galton, the cousin of Charles Darwin, was convinced that pre-eminence in various fields was due almost entirely to hereditary factors. He opposed those who claimed intelligence

or characters were determined by environmental factors. He inquired into racial differences, something almost unacceptable today, and was one of the first to employ questionnaire and survey methods, which he used to investigate mental imagery in different groups of people.

His work led him to advocate breeding restrictions.

Galton was knighted in 1909.

## Pafnuty Lvovich Chebyshev



Born: 16 May 1821 in Okatovo, Russia

Died: 8 Dec 1894 in St Petersburg, Russia

Pafnuty Chebyshev is largely remembered for his investigations in number theory.

In 1847 Chebyshev was appointed to the University of St Petersburg. He became a foreign associate of the Institut de France in 1874 and also of the Royal Society.

His work on prime numbers included the determination of the number of primes not exceeding a given number. He wrote an important book *Teoria sravneny* on the theory of congruencies in 1849.

In 1845 Bertrand conjectured that there was always at least one prime between  $n$  and  $2n$  for  $n > 3$ . Chebyshev proved Bertrand's conjecture in 1850. Chebyshev also came close to proving the prime number theorem, proving that if

$(\pi(n)\log n)/n$  had a limit as  $n \rightarrow \infty$  then that limit is 1. He was unable to prove, however, that  $\lim (\pi(n)\log n)/n$  as  $n \rightarrow \infty$  exists. The proof of this result was only completed two years after Chebyshev's death by Hadamard and (independently) de la Vallée Poussin.

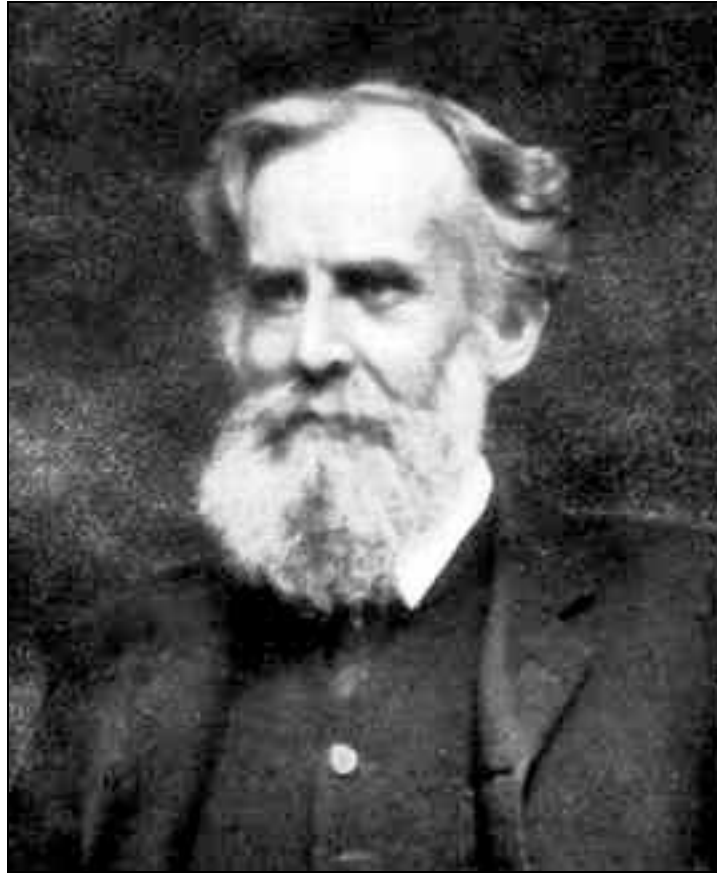
In his work on integrals he generalized the beta function and examined integrals of the form

$$\int x^p (1-x)^q dx.$$

Chebyshev was also interested in mechanics and studied the problems involved in converting rotary motion into rectilinear motion by mechanical coupling. The Chebyshev parallel motion is three linked bars approximating rectilinear motion.

He wrote about many subjects, including probability theory, quadratic forms, orthogonal functions, the theory of integrals, the construction of maps, and the calculation of geometric volumes.

## John Venn



Born: 4 Aug 1834 in Hull, England

Died: 4 April 1923 in Cambridge, England

Venn came from a Low Church Evangelical background. When he entered Gonville and Caius College Cambridge in 1853, he had so slight an acquaintance with books of any kind that he may be said to have begun there his knowledge of literature.

He graduated in 1857, was elected a Fellow in that year and two years later was ordained a priest. For a year, he was curate at Mortlake.

In 1862, he returned to Cambridge University as a lecturer in Moral Science, studying and teaching logic and probability theory. He developed Boole's mathematical logic and is best known for his diagrammatic way of representing sets and their unions and intersections.

Venn wrote *Logic of Chance* in 1866 that Keynes described as strikingly original and considerably influenced the development of the theory of statistics.

Venn published *Symbolic Logic* in 1881 and *The Principles of Empirical Logic* in 1889. The second of these is rather less original but the first was described by Keynes as probably his most enduring work on logic.

In 1883, Venn was elected a Fellow of the Royal Society. About this time, his career changed direction. He had already left the Church in 1870 but his interest now turned to history. He wrote a history of his college, publishing *The Biographical History of Gonville and Caius College 1349-1897* in 1897.

He then undertook the immense task of compiling a history of Cambridge University, the first volume of which was published in 1922. He was assisted by his son in the task, which was described by another historian in these terms:

It is difficult for anyone who has not seen the work in its making to realize the immense amount of research involved in this great undertaking.

Venn had other skills and interests too, including a rare skill in building machines. He used his skill to build a machine for bowling cricket balls, which was so good that when the Australian Cricket team visited Cambridge in 1909, Venn's machine clean bowled one of its top stars four times.

## Francis Ysidro Edgeworth



Born: 1845 in Edgeworthstown, County Longford, Ireland

Died: 1926 in Oxford, Oxfordshire, England

Francis Edgeworth came to study statistics after an education in classical literature.

In 1881, he published *Mathematical Psychics: An Essay on the Application of Mathematics to the Moral Sciences*. This work, really on economics, looks at the *Economical Calculus* and the *Utilitarian Calculus*. He formulated mathematically a capacity for happiness and a capacity for work. His conclusions that women have less capacity for pleasure and for work than do men would not be popular in the 1990's.

Edgeworth published *Methods of Statistics* in 1885, which presented an exposition of the application and interpretation of significance tests for the comparison of means.

In 1892, Edgeworth examined correlation and methods of estimating correlation coefficients in a series of papers. The first of these papers was *Correlated Averages*.

Edgeworth's work was to influence Pearson although bad feeling developed between the two and later Pearson was to deny Edgeworth's influence.

## **Andrei Andreyevich Markov**

Born: 14 June 1856 in Ryazan, Russia

Died: 20 July 1922 in Petrograd (now St Petersburg), Russia

Markov is best known for his work in probability and for stochastic processes especially Markov chains.

Markov was a graduate of Saint Petersburg University (1878), where he began a professor in 1886. Markov's early work was mainly in number theory and analysis, continued fractions, limits of integrals, approximation theory and the convergence of series.

After 1900, Markov applied the method of continued fractions, pioneered by his teacher Pafnuty Chebyshev, to probability theory. He also studied sequences of mutually dependent variables, hoping to establish the limiting laws of probability in their most general form. He proved the central limit theorem under general assumptions.

Markov is particularly remembered for his study of Markov chains, sequences of random variables in which the future variable is determined by the present variable but is independent of the way in which the present state arose from its predecessors. This work launched the theory of stochastic processes.

In 1923, Norbert Wiener became the first to treat rigorously a continuous Markov process. The foundation of a general theory was provided during the 1930s by Andrei Kolmogorov.

Markov was also interested in poetry and he made studies of poetic style, interestingly Kolmogorov had similar interests.

Markov had a son (of the same name) who was born on September 9, 1903 and followed his father in also becoming a renowned mathematician.

## Karl Pearson



Born: 27 March 1857 in London, England

Died: 27 April 1936 in London, England

Pearson applied statistics to biological problems of heredity and evolution.

Pearson graduated from Cambridge University in 1879, then spent most of his career at University College, London. He was the first Galton professor of eugenics, holding the chair from 1911 to 1933.

His book *The Grammar of Science* (1892) was remarkable in that it anticipated some of the ideas of relativity theory. It was wide ranging, and attempted to extend the influence of science into all aspects. Pearson then became interested in developing mathematical methods for studying the processes of heredity and evolution.

He applied statistics to biological problems of heredity and evolution. From 1893-1912, he wrote 18 papers entitled *Mathematical Contribution to the Theory of Evolution*, which contain his most valuable work. These papers contain contributions to regression analysis, the correlation coefficient and include the chi-square test of statistical significance (1900). His chi-square test was produced in an attempt to remove the normal distribution from its central position.

Pearson coined the term 'standard deviation' in 1893. His work was influenced by the work of Edgeworth and in turn influenced the work of Yule.

Pearson had a long dispute with Fisher. Pearson used large samples, which he measured and tried to deduce correlations. Fisher, on the other hand, followed Gosset in trying to use small samples and, rather than deduce correlations, to find causes. The dispute was bad enough to have Fisher turn down the post of Chief Statistician at the Galton Laboratory in 1919 since it would have meant working under Pearson.

He was a co-founder, with Weldon and Galton, of the statistical journal *Biometrika*.

## George Udny Yule



Born: 18 Feb 1871 in Morham (near Haddington), Scotland

Died: 26 June 1951 in Cambridge, Cambridgeshire, England

Yule developed his approach to correlation via regression with a conceptually new use of least squares.

After studying engineering and physics, Yule worked under Pearson from 1893. Some of his early work appears as examples in Pearson's papers. Yule worked at University College London where he was promoted to Assistant Professor of Applied Mathematics in 1896.

Yule's early work is on waves but as Pearson began to work on statistics Yule was increasingly drawn into that field. In 1912, he accepted a Lectureship in Statistics at Cambridge, taking a drop in salary but never regretting the move.

Yule's own work entitled *On the Theory of Correlation* was first published in 1897. He developed his approach to correlation via regression over the next few years with a conceptually new use of least squares and by the 1920's his approach predominated in applications in the social sciences.

During World War I Yule worked as a statistician in the army, then at the Ministry of Food. He was awarded a C.B.E. for this work.

In his later years he applied statistics to literary style and published a book *The Statistical Study of Literary Vocabulary* in 1944.

Yule did not develop any completely new branches of statistical theory but he took the first steps in many areas, which proved important in their further development by later statisticians.

## **William Sealey Gosset**

Born: 13 June 1876 in Canterbury, England

Died: 16 Oct 1937 in Beaconsfield, England

Gosset studied under Airy. He wrote under the name "Student". Gosset worked as a chemist in the Guinness brewery in Dublin and did important work on statistics. He invented the t-test to handle small samples for quality control in brewing.

Gosset discovered the form of the t distribution by a combination of mathematical and empirical work with random numbers, an early application of the Monte-Carlo method.

## **Richard von Mises**

Born: 19 April 1883 in Lemberg, Austria (now Lvov, Ukraine)

Died: 14 July 1953 in Boston, Massachusetts, USA

Von Mises was an applied mathematician who worked on fluid mechanics, aerodynamics, aeronautics statistics and probability theory. He gave the first university course on powered flight in 1913. In 1915 he made a 600-horsepower plane for the Austrian army and piloted it during the First World War. He was professor of applied mathematics at Strassburg (1909-18) and professor of applied mathematics in Berlin (1920-33). Forced to leave Germany in 1933 he went to Istanbul. Then in 1939, he went to Harvard University.

Von Mises contributed greatly to probability and statistics. He made considerable progress in the area of frequency analysis, which was started by Venn. He combined the idea of a Venn limit and a random sequence of events. His ideas in this area were controversial.

In his book *Positivism: A Study in Human Understanding* (1951) he expressed his views on science and life.

## John Maynard Keynes



Born: 5 June 1883 in Cambridge, Cambridgeshire, England

Died: 21 April 1946 in Firlie, Sussex, England

John Maynard Keynes was an economist making important contributions to probability theory and mathematical economics. He became a lecturer in economics at Cambridge, where he was educated, until the start of World War I when he worked for the government.

In 1921, his *Treatise on Probability* was published although it had been completed 10 years earlier. It was an attempt to put probability on a firm mathematical basis and Russell said

The mathematical calculus is astonishingly powerful ... the book is one that it is impossible to praise too highly.

Keynes was an advisor at the Paris Peace conference, but withdrew and attacked its conclusions. A conventional economist until the depression when he wrote *The General Theory of Employment, Interest and Money* (1935) he returned to favor and was the British representative in 1944 at the conference which set up the International Monetary Fund.

## Sir Ronald Aylmer Fisher



Born: 17 Feb 1890 in London, England

Died: 29 July 1962 in Adelaide, Australia

The contributions Ronald Fisher made included the development of methods suitable for small samples, the discovery of the precise distributions of many sample statistics and the invention of analysis of variance.

Fisher received a BA in astronomy from Cambridge in 1912. There he studied the theory of errors under Stratton using Airy's manual on the Theory of Errors. It was Fisher's interest in the theory of errors in astronomical observations that eventually led him to investigate statistical problems.

Fisher gave up being a mathematics teacher in 1919 to work at the Rothamsted Agricultural Experiment Station where he worked as a biologist and made many contributions to both statistics and genetics. He had a long dispute with Pearson and he turned down a post under him, choosing to go to Rothamsted instead. There he studied the design of experiments by introducing the concept of randomization and the analysis of variance; procedures now used throughout the world.

In 1921, he introduced the concept of likelihood. The likelihood of a parameter is proportional to the probability of the data and it gives a function, which usually has a single maximum value, which he called the maximum likelihood.

In 1922, he gave a new definition of statistics. Its purpose was the reduction of data and he identified three fundamental problems. These are

(i) Specification of the kind of population that the data came from

(ii) Estimation and

(iii) Distribution

The contributions Fisher made included the development of methods suitable for small samples, like those of Gosset, the discovery of the precise distributions of many sample statistics and the invention of analysis of variance. He introduced the term maximum likelihood and studied hypothesis testing.

Fisher is considered one of the founders of modern statistics because of his many important contributions.

## Jerzy Neyman



Born: 16 April 1894 in Bendery, Moldavia

Died: 5 Aug 1981 in Oakland, California, USA

Jerzy Neyman was originally named Splawa-Neyman, but he dropped the first part of his name at the age of 30. He studied at Kharkov University and wrote on Lebesgue integration. Sergi Bernstein influenced him, encouraging him to read Pearson's Grammar of Science.

In Warsaw he lectured in mathematics and statistics and received a doctorate in 1924. Receiving a fellowship to work with Pearson in London, he was disappointed to discover that Pearson was ignorant of modern mathematics.

In Paris, he attended lectures by Lebesgue and Hadamard but his interest in statistics was stimulated again by Pearson's son who sought a general principle from which Gosset's tests could be derived. Neyman went on to produce fundamental results on hypothesis testing. He worked in England from 1934 to 1938 when he immigrated to the USA working in Berkeley for the rest of his life. His work on hypothesis testing, confidence intervals and survey sampling revolutionized statistics.

## Andrey Nikolayevich Kolmogorov



Born: 25 April 1903 in Tambov, Tambov province, Russia

Died: 20 Oct 1987 in Moscow, Russia

Kolmogorov was one of the developers of probability theory.

Kolmogorov graduated from Moscow State University in 1925 and then taught on the staff, becoming a professor there in 1931. In 1939, he was elected to the Soviet Academy of Sciences. He received the Lenin Prize in 1965 and the Order of Lenin on six separate occasions.

His work on probability theory started with a major paper in 1933. He built up probability theory in a rigorous way from fundamental axioms in a way comparable with Euclid's treatment of geometry. One success of this approach is that it provides a rigorous definition of conditional expectation. Kolmogorov later extended his work to study the motion of the planets and the turbulent flow of air from a jet engine.

In 1941, he published two papers on turbulence, which are of fundamental importance.

In 1954, he developed his work on dynamical systems in relation to planetary motion. He thus demonstrated the vital role of probability theory in physics.

He had many interests outside mathematics, in particular he was interested in the form and structure of the poetry of the Russian author Pushkin.

## John von Neumann



Born: 28 Dec 1903 in Budapest, Hungary

Died: 8 Feb 1957 in Washington D.C., USA

Von Neumann built a solid framework for quantum mechanics. He also worked in game theory, was able to investigate spaces with continuously varying dimensions, and was one of the pioneers of computer science.

Von Neumann studied chemistry at the University of Berlin and received his diploma in chemical engineering from the Technische Hochschule in Zürich in 1926. He received his doctorate from the University of Budapest, also in 1926, with a thesis on set theory. He published a definition of ordinal numbers when he was 20, the definition is the one used today.

Von Neumann lectured at Berlin from 1926 to 1929 and at Hamburg from 1929 to 1930. In 1930 von Neumann became a visiting lecturer at Princeton University, being appointed professor there in 1931. He became one of the original six mathematics professors in 1933 at the newly founded Institute for Advanced Study in Princeton, a position he kept for the remainder of his life.

*Mathematische Grundlagen der Quantenmechanik* (1932) built a solid framework for the new quantum mechanics. During this time he also worked in game theory and proved the

minimax theorem. He gradually expanded his work in game theory, and with co-author Oskar Morgenstern, he wrote *Theory of Games and Economic Behavior* (1944).

The second half of the 1930's saw von Neumann working with F J Murray on 'rings of operators' that are now called von Neumann algebras. He was able to investigate spaces with continuously varying dimensions.

Von Neumann was one of the pioneers of computer science making significant contributions to the development of logical design. He advanced the theory of cellular automata, advocated the adoption of the bit as a measurement of computer memory, and solved problems in obtaining reliable answers from unreliable computer components.

During and after World War II, von Neumann served as a consultant to the armed forces. His valuable contributions included a proposal of the implosion method for bringing nuclear fuel to explosion and his participation in the development of the hydrogen bomb. In 1955, President Eisenhower appointed him to the Atomic Energy Commission, and in 1956, he received its Enrico Fermi Award, knowing that he was incurably ill with cancer.

## Samuel Stanley Wilks



Born: 17 June 1906 in Little Elm, Texas, USA

Died: 7 March 1964 in Princeton, New Jersey, USA

Samuel Wilks was a member of the mathematics department at Princeton.

He worked on mathematical statistics. His early papers on multivariate analysis were his most important.

One of his most important papers was certain generalization in the analysis of variance.

## **William Gemmell Cochran**

Born: 15 July 1909 in Rutherglen, Scotland

Died: 29 March 1980 in Orleans, Massachusetts, USA

After a Ph.D. from Cambridge, Cochran went to the Rothamsted Experimental Station where he worked for 5 years on experimental designs and sample survey techniques. During this time, he worked closely with Yates.

Cochran accepted a statistics post at Iowa in 1939, worked with Wilks at Princeton, then joined the newly created North Carolina Institute of Statistics. Later he was at Johns Hopkins and then Harvard and did much to promote statistics within the USA.

## Leonard Jimmie Savage



Born: 20 Nov 1917 in Detroit, Michigan, USA

Died: 1 Nov 1971 in New Haven, Connecticut, USA

Savage's doctoral thesis was on metric and differential geometry. In 1944, he joined the Statistical Research Group at Columbia University - this move into statistics was suggested by von Neumann.

Savage's book *The Foundations of Statistics* is important and shows von Neumann's influence and that of Ramsey. He also wrote *How to Gamble if You Must*.