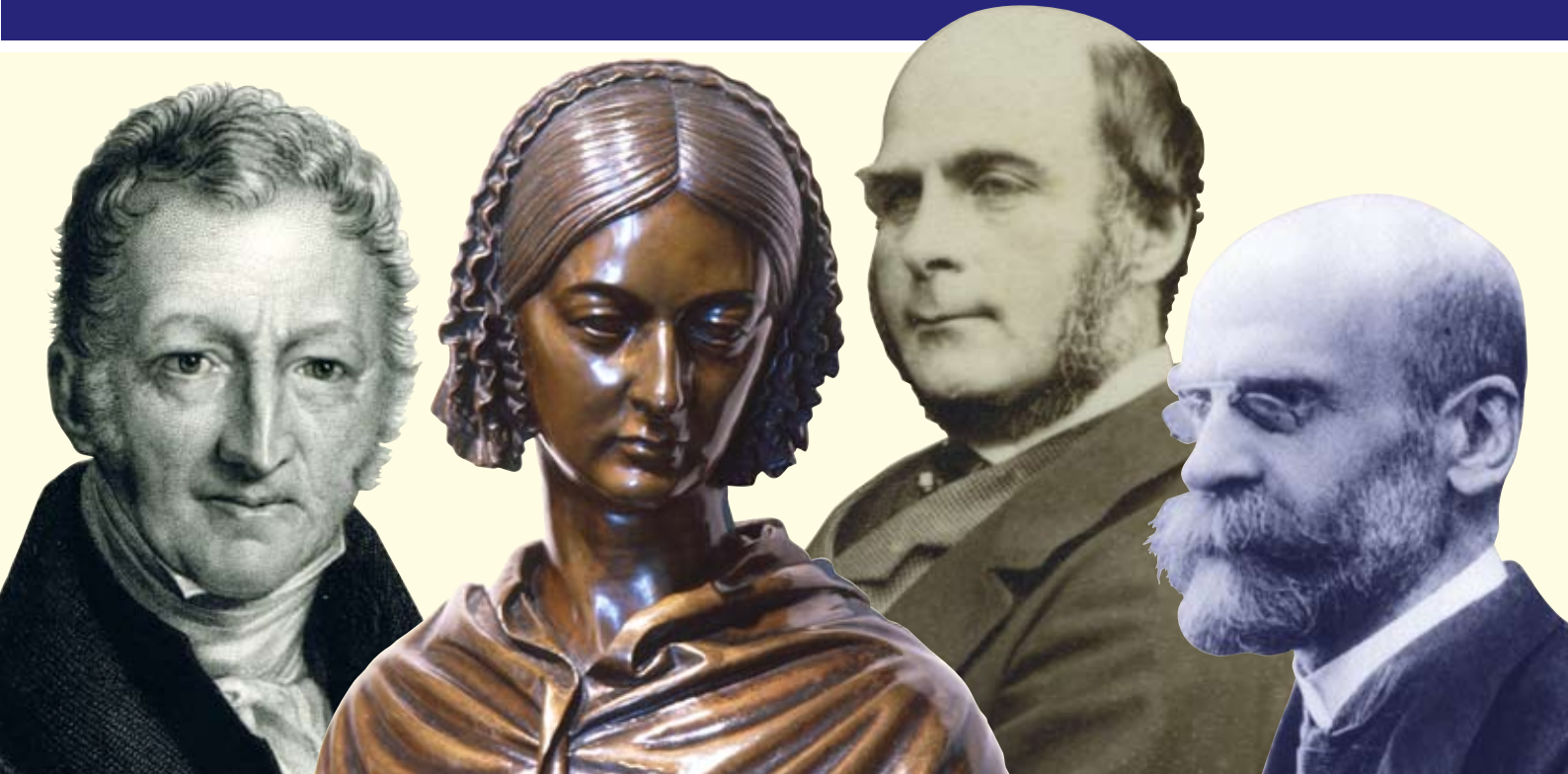


WHERE WOULD SOCIAL SCIENCE BE WITHOUT MATHS?

Landmarks in statistics



*Know then thyself, presume not God to scan;
The proper study of Mankind is Man.*

So said the 18th century poet Alexander Pope, and social scientists have been trying to take the measure of man and woman ever since. For more than 200 years, they have used statistics and other types of maths to find out about the nature of different groups of people and to try to make their lives better. Social reformers have used statistics to describe the stark reality of poverty – how little food some people had to eat, for example. Florence Nightingale used statistical charts of her own devising to prove that better sanitation and nutrition in hospitals saves many lives. In the late 20th century, computer technology escalated what could be done with numbers. Numerous aspects of whole societies could be measured in detail, and econometric modeling could describe

large national economies and predict the impact of a vast range of variables. The pioneering social scientists of the 19th century would be amazed at where their work has led.

Statistics (which has the same root as State) began as the counting of people and goods so that they could be taxed by the rulers.

Starting in the 17th century, concepts of probability and the study of variation transformed statistics into a mathematical discipline. Today, statistical methodology is important in the physical, biological and social sciences, engineering, economics and wherever measurements are made and interpreted.

This poster and the teaching notes trace some of the landmarks in the use of statistics in social science. It is far from comprehensive, but provides a brief sketch of their development.

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Landmarks in statistics in social sciences

Some leading figures

JOHN GRAUNT

British merchant
(1620-1674)

Graunt is credited as the founder of demography, the statistical study of human populations. A prosperous haberdasher until his business was destroyed in the fire of London in 1666, he began studying baptism and death records kept by the London parishes (the bills of mortality) while still a merchant. He noticed that certain phenomena occurred regularly, and wrote *Natural and Political Observations... Made upon the Bills of Mortality* in 1662.

Graunt observed that the urban death rate exceeded the rural, and attributed this to overpopulation. He found that although more males than females were born, there was a higher mortality rate for males, so the population was divided almost evenly between the sexes. Graunt is also seen as an early pioneer in public health and epidemiology.

He invented the life table, which predicted the percentage of persons who would live to each successive age and their life expectancy year by year. It was the start of actuarial statistics, so important to the insurance industry. Graunt was able to estimate roughly the number of men of military age, the number of women of childbearing age, the number of families and the population of London.

THOMAS ROBERT MALTHUS

British demographer and cleric
(1766-1834)

Malthus's *Essay on Population* put forward the idea that unchecked population growth always exceeds the growth of the food supply. Actual population growth is kept in check by events such as starvation, war and disease and by 'preventive checks' such as postponement of marriage.

Because of the tendency for the population always to push above the food supply, it would be fruitless to try to ameliorate the conditions of the poor, because the extra means of subsistence would immediately be absorbed by a boost in population. To maximise wealth, a nation had to balance 'the power to produce and the will to consume'. Known as 'Parson Malthus', he bequeathed us the adjective 'Malthusian', and helped to earn economics the reputation as 'the dismal science' because his argument went against popular ideas about progress.

Malthus has been criticised for failing to handle his factual and statistical materials with sufficient critical or statistical rigour. Later, the agricultural revolution increased the means of production and made prosperity possible for a larger number of people. But today, Malthus's concerns are becoming relevant again.

Though he was reviled by many as an enemy of the workers, his *Essay* can be seen as the first serious economic study of the welfare of the lower classes.

ADOLPHE QUETELET

Belgian statistician
(1796-1874)

Quetelet was one of the most influential social statisticians of the 19th century, and has been called the 'patriarch of statistics'. He was convinced that probability influenced the course of human affairs. 'Average' man could be described by graphically arraying sets of facts about many individuals as bell-shaped curves. The behaviour of individuals could then be assessed against how an 'average' man would behave.

He believed average characteristics of whole races or nationalities could be quantified by careful use of his methods, which he called 'social mechanics'. He devised improvements in census taking and today the Quetelet Index is an international measure of obesity.

Quetelet was the first to use the bell curve other than as an error law, and this had a powerful influence on Francis Galton's studies of intelligence. He was a pioneer in pointing to the existence of regularities in social phenomena.

“(Statistics are) the only tools by which an opening may be cut through the formidable thicket of difficulties that bars the path of those who pursue the Science of Man”

FRANCIS GALTON

FLORENCE NIGHTINGALE

English nurse

(1820-1910)

The Lady with the Lamp was a social activist who used statistical charts and diagrams as powerful arguments for social reform. Her idea that social phenomena could be measured objectively and analysed mathematically were influenced by Quetelet and her charts by William Playfair, who introduced the pie chart and the circle graph in 1801.

Nightingale was asked to oversee the introduction of nurses to military hospitals in Turkey during the Crimean War (1853-6). When she arrived in Scutari, she found desperately unsanitary conditions in the field hospitals. Nightingale collected data and organised a record keeping system. Her calculations showed that improved sanitary methods decreased the number of deaths.

Nightingale created graphical representations of her statistical data which she called Polar Area Diagrams, or 'coxcombs'. They showed that deaths in the British field hospitals reached a peak during January 1855, when 2,761 soldiers died of contagious diseases, 83 from wounds and 324 from other causes, making a total of 3,168. The army's average manpower for that month was 32,393. Using this information, Nightingale computed a mortality rate of 1,174 per 10,000 with 1,023 being from diseases such as typhus and cholera. If this rate had continued, and troops had not been replaced frequently, disease alone would have killed the entire British army in the Crimea.

On her return to London in August 1856, Nightingale discovered that soldiers during peacetime had twice the mortality rate of civilians. Using her statistics, she illustrated the need for sanitary reform in all military hospitals and gained the attention of Queen Victoria and Prince Albert.

FRANCIS GALTON

British anthropologist

(1822-1911)

The man who coined the term 'nature versus nurture' was Francis Galton, an explorer and anthropologist who became interested in heredity, in part through reading his cousin Charles Darwin's *Origin of Species*. He became convinced that people who were successful had acquired their superior intelligence through heredity.

He outlined his hypothesis in *Hereditary Genius* (1869), using data collected by analysing the obituaries of eminent men in *The Times*. His work sparked the eugenics movement, which called for improving the physical and mental make-up of the human species by selected parenthood. Galton went so far as to advocate human breeding restrictions so that the 'feeble-minded' would not have children.

Despite these highly controversial conclusions, Galton's contributions to social science are influential to this day. He developed the statistical concepts of correlation and regression to the mean, and was the first to use the survey as a data collection method.

EMILE DURKHEIM

French social scientist

(1858-1917)

In his youth Durkheim became convinced that advances in science did not necessarily lead to social progress. In his first major work, *The Division of Labour in Society*, he introduced the concept of 'anomie', a personal sense of rootlessness fostered by the absence of social norms.

His landmark *Suicide* (1897) was based on his observation that suicide appeared to be less frequent where the individual was closely integrated into a society; in other words, those without a strong social identification would be more susceptible. Thus, what looks like a purely individual decision to renounce life could be explained through social forces, such as religious affiliation, which he argued produced different rates of suicide among Protestants and Catholics.

This part of his argument has subsequently been the basis of much debate about how reliable suicide statistics are, because strong taboos around suicide in some cultures mean there is variation in which deaths come to be classified as suicides. Durkheim has also been criticised for committing the ecological fallacy in his analysis, misinterpreting correlations between suicide rates and the social characteristics of places, but despite these criticisms his study still stands as a remarkable pioneering work.

In his research for *Suicide*, Durkheim was one of the founders of the use of quantitative methods in the study of criminology.

“To understand God’s thoughts we must study statistics, for these are the measure of His purpose”

FLORENCE NIGHTINGALE

B. SEEBOHM ROWNTREE

British sociologist

(1871-1954)

Concerned about poverty, Rowntree conducted a survey of working-class homes in York in 1897–98 and published his findings in *Poverty: A Study of Town Life* (1901), which became a classic in empirical sociology. Several more surveys followed.

Born into the famous chocolate family, Rowntree was instrumental in getting the company to establish a pension plan, a five-day week, and an employee profit-sharing plan.

In his 1901 study, Rowntree distinguished between families suffering from primary poverty – lacking enough money for even the minimum necessities – and secondary poverty, where earnings were sufficient, but money was spent on other things (some ‘useful’, some – such as alcohol – ‘wasteful’).

Rowntree’s study provided a wealth of statistical data on wages, hours of work, nutritional needs, food consumed, health and housing. The book illustrated the failings of the capitalist system and argued that new measures were needed to overcome the problems of unemployment, old-age and ill-health. *Poverty: A Study of Town Life* did much to help those who went on to build the foundations of the welfare state.

GEORGE GALLUP

American pollster

(1901-1984)

Some 130 years after polling began, George Gallup did more than anyone to put this method of survey-taking on solid scientific ground. His work with public opinion surveys altered political campaigns and corporate marketing. Polling uses statistical methodology and probability theory for constructing appropriate samples and for calculating margins of error for the survey results.

Gallup is famous for one major triumph and one embarrassing failure. In 1936, he accurately forecast the re-election of Franklin Delano Roosevelt to his second term as US President. The leading pollster of its day, the *Literary Digest* magazine, drew samples from phone books and car registrations and predicted that Alf Landon, a Republican, would win. Gallup realised this approach biased the sample towards the wealthy, and used a smaller but more representative group.

In 1948, he wrongly predicted that the Republican challenger Thomas Dewey would defeat Harry Truman. It was a close race, but Truman won. Gallup learned from his mistake: he had stopped polling two weeks before the election despite the large number of undecided voters. Gallup concluded that undecided voters tend disproportionately to favour incumbents on polling day.

ROBERT FOGEL

American economic historian and scientist (born 1926)

The systematic application of economic theory and quantitative methods to economic history is called ‘cliometrics’ (Clio is the muse of history). A large stock of quantitative data and advances in computer technology made it possible to collect large historical samples. Fogel’s first major study involving cliometrics was *Railroads and American Economic Growth: Essays in Econometric History* (1964). His mathematical approach enabled him to rebut the assumption that railroads had made a huge difference to the US economy in the 19th century. Examining goods transportation costs, Fogel compared the actual 1890 economy to a hypothetical one in which transportation infrastructure was limited to wagons, canals and rivers. The difference in cost attributable to railroads was only about one per cent. This conclusion made a controversial name for cliometrics.

“The dark shadow of the Malthusian philosophy has passed away, and no view of the ultimate scheme of things would now be accepted under which multitudes of men and women are doomed by inevitable law to struggle for existence so severe as necessarily to cripple or destroy the higher parts of their nature”

JOHN GOLDTHORPE
British sociologist
(born 1935)

John Goldthorpe has made important contributions to the understanding of social mobility. People's actions are undertaken from a position of social power which is determined by the class they belong to. Therefore class position is a powerful predictor of many kinds of behaviour.

The internationally-used Goldthorpe Class Schema groups 11 classes of employees into three main clusters. Goldthorpe's analysis showed that the second half of the twentieth century saw significant upward mobility of sons relative to their fathers' positions, but that this did not mean that the UK was moving towards a classless society; rather, space for significant numbers of men from working-class backgrounds to develop middle-class careers had been created by the changing occupational structure. The picture is further complicated by the movement of increasing numbers of women into the labour force.

The class schema was one of the first classifications in sociology to be developed with reliability and validity always in mind.

Classifications and scales that allow counting and other forms of measurement - and in turn, statistical analysis - play a crucial role in social science. But they must have high levels of reliability (the capacity to be used by different researchers on the same data and give the same results) and validity (does what it says on the tin).

Because it has a clear theoretical basis which allows its validity to be tested, the schema has provided the basis for far more revealing statistical analyses than were previously possible of the relationships between social class and - for example - health and mortality, children's educational attainment, voting behaviour and sociopolitical attitudes, lifestyles and class mobility.

LAWRENCE KLEIN
American economist
(born 1920)

New technology has vastly extended what statisticians can do. Lawrence Klein's Wharton Econometric Forecasting model of the US economy contains more than 1,000 simultaneous equations. This and other econometric models can forecast economic conditions and estimate the impact of changes in government spending, taxes and other policies as well as fluctuations in business conditions such as investments, consumption and exports.

Econometrics is defined by *Encyclopedia Britannica* as 'the statistical and mathematical analysis of economic relationships, often serving as a basis for economic forecasting'.

After WWII Klein used econometric modelling to counter the conventional wisdom that the end of the war would sink the US economy into depression. Klein correctly predicted that the demand for consumer goods that had been unmet during the war, combined with the purchasing power of returning soldiers, would prevent a depression.

His earliest models were built on the work of Jan Tinbergen (1903-1994), a Dutch economist who pioneered macroeconomic mathematical modelling.

CATHIE MARSH
British quantitative sociologist
(1951-1993)

As a leading member of the Economic and Social Research Council Census Working Group, Cathie Marsh was instrumental in persuading the government to make census data available to researchers. *The Case for Samples of Anonymized Records from the 1991 Census*, by Marsh and others, demonstrated that census material could provide a wealth of social data for researchers to study. After her early death, the Cathie Marsh Centre for Census and Survey Research was established at Manchester University.

Marsh's work laid foundations for such publications as 2009's *'Sleepwalking to Segregation'?* by Nissa Finney and Ludi Simpson, which used census information to challenge both right-wing and left-wing 'myths' about immigration and racial segregation. It showed, for instance, that immigrants as a group are young, motivated and skilled, not benefits scroungers, as mythology has it. Migrants (who make up nine per cent of the UK population) contribute more in taxes than they use in public services and benefits.

The first British census was taken in 1801 amidst fears that the growing population might outstrip the food supply, as Malthus predicted. It asked five questions and counted 10 million people living in 2 million households. The 2001 census asked 40 questions, counted nearly 60 million people living in some 24 million households and informed more than £50bn of public spending each year.

“Treat social facts as things”

EMILE DURKHEIM

**RICHARD WILKINSON AND
KATE PICKETT**
British epidemiologists

It is too early to tell who will be the Durkheim of the 21st century, but Wilkinson and Pickett could well be in the running. Their book, *The Spirit Level: why more equal societies almost always do better*, shows statistically that in countries where there is a big gap between rich and poor, problems such as mental illness, drug abuse, obesity, crime and teenage pregnancy are more common.

The most equal societies, such as Japan and Sweden, have the best records of psycho-social health. Levels of trust and a sense of community are greater, children do better in school and there is more social mobility.

These trends affect everyone across the spectrum. In countries with the widest gaps, such as the US, Britain and Portugal, rates of mental illness are five times higher across the whole population than in the most equal societies.

Surprisingly, and contrary to the hypotheses of Durkheim, the authors found that while homicide was higher in unequal societies, those where the gap was smaller had a higher proportion of suicides.

Wilkinson and Pickett used international statistics to develop an index of health and social problems for 23 rich countries. In Japan and Sweden the richest 20 percent are less than four times as rich as the poorest fifth; but in Britain they are over seven times as rich, and in the USA, over eight times.

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WHERE WOULD SOCIAL SCIENCE BE WITHOUT MATHS?



1662
John Graunt, a merchant, publishes his Essay on Population, drawing attention to the potential dangers of population growth.

1798
Robert Malthus publishes his Essay on Population, drawing attention to the potential dangers of population growth.

1801
First comprehensive census in Britain.

1835
Adolphe Quetelet publishes A Theory of Man and devises Social Mechanics.

1855
Florence Nightingale's 'coxcomb' pie chart shows the number of soldiers who died of wounds, disease or other causes during the Crimean War.

1869
Francis Galton's Hereditary Genius investigates whether human intelligence is passed down through families. In the late 1860s, Galton invented 'correlation' and 'regression'.

1897
Emile Durkheim publishes his monograph on suicide.

1901
Seebohm Rowntree's Poverty: A study of town life was to influence much subsequent research.

1936
Gallup poll accurately calls US election for Franklin D.Roosevelt (above).

1964
Robert Fogel's Railroads and American Economic Growth, breaks the rise of cliometrics, the systematic application of economic theory and quantitative methods to economic history.

1980
John Galthorpe publishes Social Mobility and Class Structures in Modern Britain. Lawrence Klein wins Nobel Prize for creating computer model of national economies, which can estimate the impact of policy changes.

1991
Galis Marsh and colleagues publish The Case for Samples of Anonymised Records from the 1991 Census and open the way for a new strand of research, such as Finney and Simpson's 'Sleepwalking to Segregation' (2009).

2009
The Spirit Level by Richard Wilkinson and Kate Pickett uses statistics from around the world to explore the link between inequality and social problems.