Indigenous statistical power

In 2002, Te Ropu Rangahau Hauora a Eru Pomare, at the University of Otago, wrote an influential paper about the need for equal explanatory power – the production of information for Maori health and development to at least the same depth and breadth as that obtained for non-Maori.

Discussing the NZ Health Monitor surveys by Statistics NZ, Bridget Robson (Ngati Raukawa) argued that good governance "compels us to ensure that data produced by the Crown is at least as productive for Maori as it is for non-Maori".

The simplest method for equal explanatory power is to recruit equal numbers of Maori and non-Maori responders to surveys. Random surveys include approximately 15% Maori and 85% non-Maori, and "will be more likely to meet Pakeha health needs". The end result is that health surveys "may have the unintentional effect of increasing health disparities".

Robson argued that implementing equal explanatory power in surveys of health and social determinants of health, such as unemployment, "will help to break this cycle of persistent inequalities".

See www.fmhs.auckland.ac.nz/ faculty/ tkhm/tumuaki/_docs/Equal_explanatory_ power.doc

Tasting applies with the Plant and Food Research sensory science team.

Tracking rat invaders

A Norway rat on Okahu Island, Bay of Islands. Photo: Stephen Cope.

Rodent Invasion Project member Associate Professor Rachel Fewster, of the University of Auckland, is regularly asked by Department of Conservation staff to identify the origin of rats found around the country. A few years ago she and others obtained genetic profiles for rat populations from many islands around Great Barrier and Stewart Islands, and the Bay of Islands.

"Since then they have been eradicated, but new rats have turned up. DOC or the Auckland Regional Council send us a sample and ask us where it came from." She was able to say recently about two rats from the Bay of Islands that one was almost certainly brought in by boat and the other might have been a swimmer from the mainland.

She examines 20 genes from each rat from DNA regions with a lot of variability. "We use microsatellites which don't code for anything or do any harm if they mutate. In isolated populations, rats will develop their own proportions of those genes. If I get a rat with Gene A, I think it is more likely to come from the island where Gene A is common. We take all 20 pieces of genetic information, and get a fairly clear idea of which island it came from."

Stats and the senses

Mark Wohlers one of 11 statisticians in Plant and Food Research around the country, working with scientists to ensure experiments have the statistical power to determine true treatment effects.

For example, he designs and analyses the results of blind tastings by the sensory science teams, which use panels of tasters to assess wine and fruit from New Zealand grapes and orchards. "They might be checking on length of storage or time of picking, or the effect of a different rootstock. Tasters sit in separate booths in front of a computer, ranking up to 15 variables about the taste and smell of the product.

"I determine, for example, the presentation order; they may not score the same thing similarly each time because of the tasting order. If they taste something very sweet first, the next one may be ranked lower. We might use different coloured lights to take away the effect of the colour of the fruit."

"I often use analysis of variance, sometimes multivariate analysis, and principle component analysis with bootstrapping techniques."

Census and death records

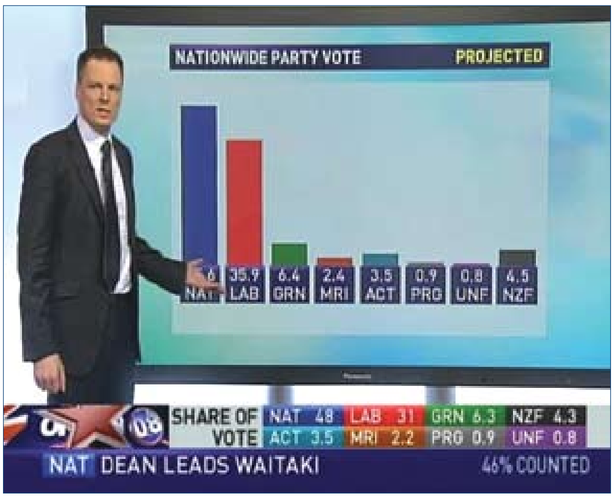
In 1998, death records were the first data set to the linked to the Census in what became the NZ Census-Mortality Study (NZCMS). "At the time," says NZCMS director Professor Tony Blakely of the University of Otago, "it was probably the biggest example of its kind in the English-speaking world."

The linkage was anonymous and probabilistic, enabling researchers to calculate death rates in the whole population for the three years after each census from 1981 to 2004.

"The NZCMS showed there was a great undercounting of Maori deaths in the 1980s and 90s. There was also little, if any, improvement in Maori mortality rates in the 80s and 90s at a time when non-Maori mortality rates dropped significantly. It's very tempting to ascribe that to the Rogernomics reforms and resulting high Maori unemployment rates."

The study also showed that relative gaps in mortality between high and low income groups widened in the 1980s and 90s.

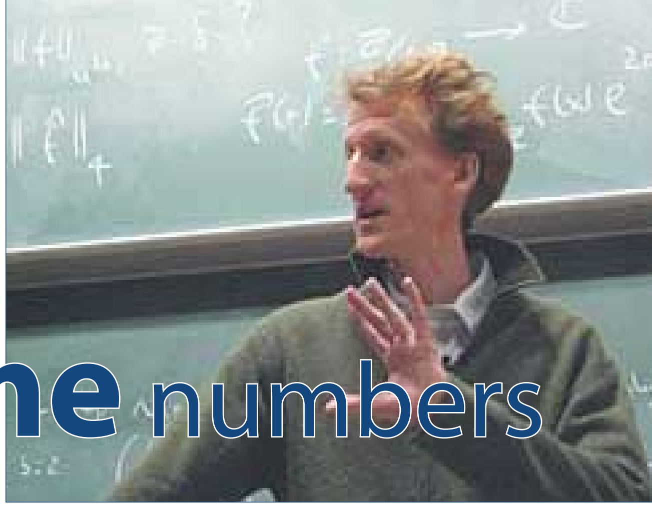
See www.uow.otago.ac.nz/academic/dph/ research/HIRP/index.html



Statistics on the telly

Dr Richard Arnold was the face of statistics during election night coverage on TVOne in 2008, and he got his predictions "bang on". His knowledge of the country's demographics from his time at Statistics New Zealand meant he was able to develop a statistical model to forecast the result.

"There is always an early preference for National on election night because the smaller booths that finish counting first tend to be rural, and more likely to go to National." He adapted and implemented a statistical forecasting method based on matching polling places between elections, which eliminated that early bias. Making sure that the prediction has a reliable margin of error was an important part of the process, because "a prediction without a margin of error is worthless".



Patterns in prime numbers

Ben Green's introduction to Aotearoa was a shaky one; his first night was 4 September in Christchurch. Luckily he was staying in a motel where nothing even fell off the wall, with a Californian colleague who knew what to do in a quake. He spoke with Jenny Rankine.

Green is Herchel Smith Professor of Pure Mathematics at the University of Cambridge, and gave the London Mathematical Society's Forder Lectures throughout the country in September. He particularly enjoyed learning about Henry Forder, the Chair of Mathematics at the University of Auckland whose endowment founded this lectureship, and whose Euclidian geometry tied in with Green's work.

Green works in additive combinatorics, an area related to number theory, analysis and combinatorics. He is best known for the 2004 Green-Tao theorem, that there are infinitely many arithmetic progressions of prime numbers of any specified length.

These progressions are sequences of primes that differ by a constant amount; for example 5, 17, 29, 41 and 53 step up by 12; and 13, 43, 73 and 103 go up in jumps of 30. Before then, the largest known arithmetic progression had 22 primes.

Green and Australian mathematician Terence Tao started with a 1975 result by Hungarian mathematician Endre Szemerédi, who showed that in any infinite set of numbers that does not thin out too rapidly, there will be arithmetic progressions of all finite lengths.

However, primes do thin out rapidly. So Green and Tao cleverly pruned some non-primes; they generated a pseudorandom infinite number set containing primes and non-primes with few divisors for their size, for which Szemerédi's result still held.

Their 50-page, non-constructive existence proof did not include any arithmetic progressions of primes or say how to find them; it used a combination of ergodic theory (about mixing or averaging) and number theory.

Since then, Green has worked with collaborators to find out more about prime number patterns and understand the mathematics behind them. He and Israeli mathematician Tamar Ziegler have developed an asymptotic formula for the number of arithmetic progressions separated by particular numbers. "For example, if you want to know how many progressions of primes there are separated by 100, we can find out. We didn't do that for the results, but for the structures underlying them; generalizing Fourier analysis."

Green has also worked with Tao on finding slightly more exotic patterns of primes. "If d is the spacing, d can be a square number or a cube."

"The famous problems about prime numbers seem open - the Goldbach conjecture that every even number is the sum of two primes, and the Twin Prime conjecture, that there are infinitely many pairs of primes differing by two. My career goal might be to say something about one or the other. It's very hard now, there's no sensible way of attacking those questions."

Green won silver medals at the International Mathematical Olympiad in 1994 and 1995.

"Maths is unique as a discipline," he says, "in that being naive can actually be very helpful. These days if I think of an idea, I know of too many reasons why it can't work, so I tend to give up."

"I like everything about it - you can see all these interconnections, beauty, symmetry, surprising things. It's also very social; I haven't written a paper by myself for over seven years. I'm always emailing and meeting collaborators. I have a lot of fun doing it."

Awards and honours

JOHN BUTCHER (an NZIMA founding principal investigator and director of an early programme) has been made a Fellow of the Society for Industrial and Applied Mathematics (SIAM), possibly the first New Zealand-based scientist to win this honour.

PETER HUNTER (a founding principal investigator) has been named an Honorary Fellow of the Institution of Professional Engineers New Zealand (IPENZ).

STEPHEN HASLETT (Massey University) has won the 2010 Campbell Award of the NZ Statistical Association.

PAUL MURRELL (University of Auckland) has been elected a Fellow of the American Statistical Association, one of only five outside the USA in 2010, in recognition of his "outstanding professional contributions to and leadership in the field of statistical science".

NZIMA Board Chair **LEN COOK** has been made a Life Member of the NZ Statistical Association.

MARSTON CONDER (NZIMA Co-Director) has been appointed one of three Moderators for the next Quality Evaluation round of the Performance Based Research Fund in 2012. Marston is one of the original founders of the PBRF. He was chair of the government-appointed committee that established the PBRF in 2001/02, and served on the Tertiary Education Commission's PBRF Sector Reference Group.

MARGARET WOOLGROVE, the NZIMA's Research Manager, won a University of Auckland General Staff Excellence Award for her work on the NZIMA's MathsReach website. Margaret managed the MathsReach project from the beginning, with help from co-awardees Neil Morrison and Robert Carter, of the University of Auckland Centre for Academic Development and Science IT group.

08 Allowing for wind power

Aucklanders may remember the power blackout in 2000 that closed businesses, and a ship in the harbour had to generate power for the central city. This was a reminder of how finely-tuned industrial power systems are, and how long it takes them to recover from rolling blackouts. New Zealand generates between five and ten percent of its power from wind, a high proportion internationally. Mathematicians are working out ways to deal with the uncertainty this power source adds to the national electricity system, to prevent future blackouts. Jenny Rankine investigates.

University of Auckland mathematician Golbon Zakeri explains: "The country's power system is regulated in 30-minute blocks. Market traders in Meridian, TrustPower and other generators submit offers every half hour to Transpower, which operates the national grid. The offers are made up of five quantities at different prices. And every 30 minutes, Transpower solves an optimisation problem to determine generation quantities from each supplier.

"So they say to Mighty River Power, which owns the Waikato River hydro chain, 'Generate this quantity or at this rate over the next 30 minutes'. So Genesis runs Huntly at a specific level, and Meridian provides a specific amount of hydro power from Lake Manapouri, and so on."

Transpower's optimisation software, called Scheduling Pricing and Despatch, aims to minimise the cost of electricity while meeting demand and satisfying transmission constraints.

The problem with wind power is that it is much more unpredictable than hydro or geothermal power, even over 30 minutes, and there is very little international research about how it can be efficiently integrated into national power grids.

Javad Khazaei's PhD is exploring ways of adding stochastic optimization, which takes into account uncertainty, to the deterministic optimization used by Transpower.

The current system copes with variability by using one generation station in each island to monitor the rate of demand, and feed in more or less power so that supply is maintained close to 50MHz. But it is too expensive to use more stations to regulate power in this way.

Khazaei used repeated simulations of past market data with stochastic optimisation that allows for high, medium, and low scenarios of wind during each half-hour.

In most cases this programming performed better and increased consumer and producer welfare. "It is a tuning, a natural extension, to enhance the current optimisation and cater for higher levels of uncertainty," says Zakeri. "It will also work for solar and photovoltaic power, which is similarly uncertain."

An implemented stochastic process would have more bids, more information within the 30 minutes, and include deviations with penalties if the wind isn't blowing. Khazaei's theoretical analysis also asks whether this mechanism is susceptible to power generators taking advantage of these penalties, as New Zealand's market is not highly regulated like those in other countries.

Golbon Zakeri, inset, and Javad Khazaei.
Background: Linkages between generating stations that make up New Zealand's electricity grid.

Notable maths problems

HODGE CONJECTURE

That for projective algebraic varieties, Hodge cycles are rational linear combinations of algebraic cycles.

Simply: Last century, mathematicians discovered powerful ways to investigate the shapes of complicated objects. They asked to what extent we can approximate the shape of such objects by gluing together simple geometric building blocks of increasing dimension. This technique was generalised in many ways, obscuring its geometric origins and sometimes adding pieces with no geometric interpretation. Cycles refer to Hodge's suggestion that all objects may be built from smaller parts being repeatedly projected. The conjecture asserts that certain complicated forms in algebraic geometry can be reduced to combinations of much simpler forms.

Originator: American mathematician William Hodge, 1903-1975, in 1950.

Discipline: Algebraic geometry.

Incentive: $US1million, one of the seven Millennium Prize Problems of the USA-based Clay Mathematics Institute.

Interesting aspects: The conjecture uses visualisation to investigate mathematical results and associated functions, which are studied as discrete objects.

Progress: The strongest evidence in favor of the Hodge conjecture is the 1995 algebraicity result of Cattani, Deligne and Kaplan. While mathematicians agree that the conjecture is important, they have not been able to find a resolution or even agree on the best way to do this.