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Analyse this

As key players on scientific teams, biostatisticians are in high demand. Kendall Powell sums up the situation.

Kendall Powell

Demand for statisticians is flourishing as biology embraces the large data sets provided by devices such as time-of-flight mass spectrometers.

SERONO GENETICS INSTITUTE

In the 1950s, Edwards Deming, a statistician known as the father of the Japanese industrial revolution, almost single-handedly reformed the country's economy by introducing a mathematical concept: set quality standards so high that the likelihood of failure is near impossible. That concept now pervades the biosciences. In industry, it is essential for monitoring the safety of drugs and, in basic science, it is necessary for drawing causal relationships conclusively, for instance, between multiple genes and a single disease.

Although familiarity with such ideas is vital, people who can handle them — and understand the problems their colleagues are trying to solve — are in short supply. As a result, they hold powerful positions in academic research, and the pharmaceutical and biotech industries. Today, biostatistics offers lucrative salaries and a variety of projects that go beyond simple 'number crunching'. And yet few people in the scientific community are aware of it.

The boom, say those in the know, can be attributed to the exponential growth in data sets: as biology becomes more of a quantitative science, those with solid foundations in statistics and mathematics are getting the pick of positions.

"Somebody with an interest in mathematics and science can be pretty sure to get a job," says Bradley Efron, a Stanford University statistician and president of the American Statistical Association (ASA). The combination of undergraduate work in biology or chemistry with a graduate degree in statistics is very attractive, agree industry statisticians.

Efron notes that having solid training in both biology and statistics is "an ideal only approached by a few people". But this may change as more science graduates turn to statistics programmes (see 'Stats after a science degree'), creating the next generation of analysts, who will tackle complex projects such as gene–environment interactions in cancer and personalized medicine.

social scientists

The image of a statistician toiling away in obscurity behind a computer after being handed a pile of data could not be farther from the truth. Almost every biostatistician plays a crucial role in a team of researchers — whether collaborating on an academic project or developing a clinical trial protocol. Introverts with limited people skills will find themselves struggling to do their job adequately. Biostatisticians have to be able to explain to others why they chose a particular analysis and how to interpret the analysed results.

"The more lingo you understand of the people you are working with, then the more efficiently you can operate," says Daniel Mowrey, a biostatistician with Elanco, the animal health division of Eli Lilly in Greenfield, Indiana. Mowrey, who has a BSc in maths and chemistry and a doctorate in statistics, says that communicating with field scientists lets him pinpoint variation in their studies and suggest changes to make experiments more precise.

"It is not at all 'crunching numbers', because we have powerful computers to do that," says Fabio Macciardi, director of biostatistics at the biotech company Serono Genetics Institute in Evry, France, and a professor at the universities of Toronto and Milan. Instead, he says, biostatistics is much more of an "innovative exploration" to find out what information can be extracted about diseases or treatments. And the collaborative nature of the work means that statisticians experience many types of projects.

Katherine Monti, a 27-year industry veteran who directs the Boston office of the contract research organization Rho, reports in ASA's *AmStat News* that her projects have ranged from optimizing Twinkie springiness to developing a breeding database for a colony of 11,400 cats and working on AIDS drug trials. "Sure, I have boring spells," she says, "but some new project always comes along to save the day."

Monti's experiences reflect the array of opportunities for biostatisticians in industry. Positions designing and analysing clinical data make up the lion's share of jobs. But biostatisticians can also be involved at all stages from discovery to the point at which the drug is submitted to regulatory agencies.

Top

experimental design on a dime

It is up to statisticians to give companies the most bang for their buck in experimental terms, by designing protocols that will generate the least amount of variation, Mowrey explains. When drugs are given to food-producing animals, any residues in meat or milk are meant to be proved safe for public consumption. So Mowrey ensures that the necessary safety studies are as comprehensive as possible.

Jerry Weaver, manager of statistics at Pfizer's research and development facility in Groton, Connecticut, discusses statistical strategies with clinical researchers. He and Mowrey both note that statisticians play a huge role in the 'go/no-go' decisions that decide a pharmaceutical company's direction. Although, Weaver points out, statisticians do often need to take on significant management or administrative duties to progress further in a drug company.

Other industry options include working on quality control of medical devices or diagnostic tests, or optimizing foods and fertilizers, all of which require quantification of biological variation. In these areas, where industry standards are already clearly defined, a statistician can succeed with on-the-job biology training.

But another burgeoning sector of biostatistics — genetic epidemiology and bioinformatics — requires a bit more background in the biomedical sciences. "Newer types of statistics are called for with devices such as microarrays and time-of-flight mass spectrometers," which can generate millions of data points per patient, says Efron.

Top

cross training

For these situations, a biostatistician needs to understand both statistical theory and the use of bioinformatic tools, says Macciardi. The bioinformation age will bring new challenges to cancer epidemiology, agrees Mitchell Gail, biostatistician in the Division of Cancer Epidemiology and Genetics at the National Cancer Institute in Rockville, Maryland. Gail helped create a statistical model to predict a woman's absolute risk of developing breast cancer during her lifetime. He says it will take new statistical methods to address how much of cancer is explained by specific genes.

Mitchell Gail (left) and Fabio Macciardi see biostatistics as an area in which innovation and exploration are key.

NATIONAL CANCER INSTITUTE/SERONO GENETICS INSTITUTE

Familiarity with handling scientific data and forming hypotheses "would be a distinct plus", says Gail, for anyone considering work at academic or medical centres. Although double degrees in science and statistics are not required for most of these jobs, an aptitude for mathematics is a must. But take heart, says Vicki Hertzberg, a graduate adviser in the biostatistics programme at Emory University's Rollins School of Public Health in Atlanta, Georgia: a year of calculus and linear algebra and high quantitative test scores would earn a biologist strong consideration for a place.

Michael Kutner, who chairs the Emory programme, explains that, unlike straight statistics courses, a biostatistics degree focuses equally on theory and applied statistics. The programme places students in research collaborations on campus with real, messy data, he says, to give them practical experience.

The rewards for statistics graduates in the biological sciences are at an all-time high. Half the job posters on the ASA's website are for biostatisticians, split almost evenly between industry and academic placements. According to the ASA's 2003 salary survey, biostatistics researchers started on about $75,000 and could make upwards of $166,000 as full professors. In industry, a master's level statistician might start at $65,000 and a PhD with 20 years' experience could pull in as much as $175,000. Couple those numbers with the high job satisfaction of ever-changing projects, and brushing up on your maths suddenly doesn't sound so bad.

Web links

American Statistical Association
→ http://www.amstat.org/

Rollins School of Public Health's Department of Biostatistics
→ http://www.sph.emory.edu/hpbios.html

National Cancer Institute's Division of Cancer Epidemiology and Genetics
→ http://dceg.cancer.gov/biostat.html

Serono Genetics Institute
→ http://www.genetics.serono.com/

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