Employment Opportunities for Statisticians

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What is job of a statistician?

Statistics may be considered as the science of decision making in presence of uncertainty. The Statisticians collect data, analyze them and using specific statistical tool they calculate results and draw valid conclusions to make decisions in the face of uncertainty. Statisticians use data from well-designed trials to discover results about a particular problem in a variety of fields. They combine their technical training skills with the knowledge of the field within which they are working to produce valuable results. Thus, statisticians are at times – educators, consultants and theoretical researchers. Some of the areas in which statisticians could get employment are briefly mentioned below.

1. Engineering:

Engineers work in a range of industries, such as electronics, chemicals, aerospace, pollution abatement, and construction. They may be responsible for leading large projects with significant costs, technical complexity, and responsibility. Statistical methods are 'powerful tools' for engineers and they need help of statisticians in the following day to day activities:

?***To make a consistent product when raw material quality varies:*** Engineers in the electronics industry needed to modify a process to make a new polishing pad product. They had to get to market rapidly, but raw material quality was not consistent. ***Statistical robust process design*** techniques allowed them to optimize the new process in just four weeks. The modified process yields high-quality pads despite variations in the raw materials.

?***To detect problems early and avoid false alarms*:** Engineers working with high-risk processes needed highly sensitive decision-making tools to tell them when conditions were significantly different from the normal operating state. ***Statistical process control*** *(SPC)* techniques provide them with early warning fault detection of equipment failure or process disturbances. Identifying impending failures early prevents safety problems and system damage.

? ***To minimize a chemical waste stream:*** Engineers in a chemical plant needed to minimize the amount of waste solvent from a biocide production line. ***Statistically designed experiments,*** completed in just two weeks, led them to discover that the process could be run with 100% recycled solvent. The environment near the plant is much improved, and the process is considerably less expensive to run.

?**To predict product life:** Engineers in the semiconductor industry needed to predict the failure times of printed circuit boards. ***Statistical reliability*** methods enabled them to predict the product life in actual use, based on experiments lasting for fewer than five weeks, with acceleration factors such as temperature and

humidity. As the pace of product development and quality improvement accelerates, statistical techniques become essential to the practicing engineer.

In brief, statistical methods allow engineers to consistent product detect problems to make a consistent product, minimize chemical waste and predict products' life. Statisticians who enjoy collaborating to design products, fix problems, and improve quality play an important role in industry today.

2. Manufacturing:

Industrial statisticians help build products and deliver services that satisfy customers and increase Company's market share and profit margin. Statisticians help design the best product, guide the transition from design manufacturing, ensure a consistently excellent product, help manage customer satisfaction and ensure a financially beneficial bottom line. Industry professionals use statistical methods for quality control and quality assurance in most of manufacturing goods.

In particular, statisticians become involved in the following:

? Helping design the best possible product by developing statistically valid studies of customer needs.

?Guiding the transition from design to manufacturing.

?Ensuring and building a consistently excellent product.

?Evolving an optimum servicing and problem-avoidance strategy.

?Leveraging the information on past failures to avoid future ones.

Eventually, statisticians help demonstrate that the product meets or exceed the customer's requirements.

We have described only a few of the areas in which today's industrial statisticians are involved, focusing on those that relate mainly to the successful introduction of a new product. There is much more. For example, in present times statisticians are participating in the following:

?Assessing the impact of a proposed programming change on TV viewing.

?Helping determine how to price long-term service warranties on locomotives.

?Understanding the root causes of variability in delivery times.

?Determining the optimum line of credit to be granted to consumer credit card holders, based on past performance and ability to pay.

?Planning a designed experiment to determine whether birds can tell the difference between jet engine noise and mating calls.

3. Marketing:

Statistics is used to quantify the extent variation in customers' needs and satisfaction. Statisticians design experiments for new products, conduct focus groups and sample surveys to gather customer feedback and perform field experiments in test markets to determine product viability and marketability. Statistics and data mining are also used to analyze sales data and future trends.

The goal of marketing is to create customer satisfaction profitably by building value-If everyone's needs, wants, desires, preferences, and expectations were the same, then marketing would be easy. Modern customers demand more from products and services, which must be customized to satisfy individual tastes and preferences. Statistics is used to quantify the extent of variation in customers' needs and wants.

Following are some marketing research methods for collecting information:

?**Focus Groups** - A small group of customers meets with a facilitator who leads a discussion about their needs and product features. Focus groups provide in-depth, unstructured information that is often used in designing more formal surveys or experiments.

?**Sample Surveys** - Sample surveys provide a structured method for collecting customers' needs, wants, and expectations by having participants respond to a battery of items. Surveys are conducted by mail, over the phone or Internet.

?**Designed Experiments** - Subjects experience new products or services under controlled, laboratory conditions.

? **Field Experiments and Test Markets** - Companies isolate a small city to test the acceptance of a new product or manipulate marketing variables, such as price or advertisements, to determine customers' response to a product and marketing effort.

?**Transaction Data** - Information technology provides the ability to record information at the point of sale. This information includes not only product features but also information about the customer. *Statistical methods are a critical component to understanding your customer.*

4. Statistical Computing:

Reliable and accurate statistical software is arguably the most important tool available to statisticians in every field. Developing code that is both users friendly and sufficiently complex is a challenging task, as it exploiting the rapidly occurring improvements in hardware platforms, graphics and algorithms. Opportunities in this field include software design and development, software testing, quality assurance, technical support, education, marketing and sales etc.

Computer science uses statistics in many ways to guarantee products available on the market are accurate,

reliable, and helpful. The following terms and definitions are a brief listing of areas in computer science that use statistics to varying degrees at various times.

Data Mining is the analysis of information in a database, using tools that look for trends or irregularities in large data sets.

Data Compression is the coding of data using compact formulas, called algorithms and utilities to save storage space or transmission time.

Speech Recognition is the identification of spoken words by a machine. The spoken words are turned into a sequence of numbers and matched against coded dictionaries.

Vision and Image Analyses use statistics to solve contemporary and practical problems in computer vision, image processing and artificial intelligence.

Human/Computer Interaction uses statistics to design, implement, and evaluate new technologies that are useable, useful and appealing to a broad cross-section of people.

Network/Traffic Modeling uses statistics to avoid network congestion while fully exploiting the available bandwidth.

Stochastic Optimization uses chance and probability models to develop the most efficient code for finding the solution to a problem.

Stochastic Algorithms follow a detailed sequence of actions to perform or accomplish a task in the face of uncertainty.

Artificial Intelligence is concerned with modeling aspects of human thought on computers.

Machine Learning is the ability of a machine or system to improve its performance based on previous results.

Capacity Planning determines what equipment and software will be sufficient while providing the most power for the least cost.

Storage and Retrieval techniques rely on statistics to ensure computerized data is kept and recovered efficiently and reliably.

Quality Management uses statistics to analyze the condition of manufactured parts (hardware, software, etc.) using tools and sampling to ensure a minimum level of defects.

Software Engineering is a systematic approach to the analysis, design, implementation, and maintenance of computer programs.

Performance Evaluation is the process of examining a system or system component to determine the extent to which specified properties are present.

Hardware Manufacturing is the creation of the physical material parts of a system, such as the monitor or disk drive.

Statistics is essential to the field of computer science in ensuring effectiveness, efficiency, reliability and high-quality products for the public.

5. Animal Health:

Statisticians have found productive, challenging and rewarding careers in animal health industry. Statisticians usually work in one of the following two components:

1. Companion animal - Animals such as dogs, cats, or horses with the main focus on their care and well-being.

2. Livestock - Animals such as swine, beef and dairy cattle, chickens, turkeys, lambs and goats with the main focus on making food healthy, safe and efficient to produce.

The livestock animal health statistician works with a diverse group of people with degrees in areas such as biochemistry, biology, virology, analytical chemistry, organic chemistry, physical chemistry, physiology, veterinary science, animal nutrition, meat science, computer science, business, marketing and sales. Some colleagues have nominal or moderate formal statistical training, but many have none. The animal health statistician must become familiar with the area in which he or she is working in order to give guidance and direction for the problem being investigated and assist in writing reports and formal papers and giving presentations.

The problems an animal health statistician encounters are diverse and challenging. In general, the statistician works with a team of colleagues to discover, develop and market compound. Rigorous tests and processes must be conducted to receive government approval and market the compound properly. The tests and processes occur in various phases of a company's research. The phases animal health statisticians are involved in depend on the company for which they work.

6. Biostatistics:

Biostatistics involves the development and application of *statistical techniques* to scientific research in health-related fields, including medicine, epidemiology and public health. From the beginning of this century, biostatistics has become an indispensable tool in improving health and reducing illness. More widely, biostatistics (sometimes called biometrics or biometry) involves statistical work in areas of environmental study, agricultural research and biology.

Biostatisticians play essential roles in designing studies and analyzing data from research problems. They help formulate the scientific questions to be answered, determine the appropriate sampling techniques, coordinate data collection procedures and carry out statistical analyses to answer those scientific

questions. Research problems are as diverse as the study of factors affecting heart and lung disease, testing new drugs to combat AIDS, assessing indoor air quality in schools, working with various cancer studies, evaluating dental health and dental procedures, evaluating psychiatric symptoms and drug and alcohol use, transplanting organs and bone marrow and studying inner ear infection.

Biostatisticians also help develop statistical techniques. Active areas of research include Bayesian methods, high-speed computing and simulation, survival analysis, analysis of geographical patterns of disease, longitudinal data analysis and methods for analyzing data from epidemiologic studies and clinical trials.

7. Clinical Trials:

A clinical trial evaluates the safety and effectiveness of a new treatment intervention or compares the effectiveness of a new treatment to that of current best practice or other control group. *Statistics* contributions to clinical trials affect every man, woman, and child in some way, whether now or in the future, as this type of research determines most options available for physicians to treat a patient. Clinical trials are required for every type of drug to treat every type of disease. A clinical trial is designed as a prospective study, which means it is thoroughly planned before any data are collected. This important, detailed design is developed in collaboration with a statistician. A clinical trial is an effective tool in determining whether a new treatment intervention really does have the beneficial results that have been proposed. This is where a statistician's input is vital. Given the variability of human subjects and the uncertain knowledge of the course of most diseases, it would be extremely difficult or impossible to determine the effects of a specific treatment on the outcome of the disease course if a study without a clearly defined hypothesis and an appropriate design to test this hypothesis.

8. Epidemiology:

Epidemiology has been defined as the study of the distribution and determinants of human health and disease. Both aspects of this definition rely heavily on *statistical methods.* To study the distribution of human health and disease, knowledge and proper application of survey sampling methods, as well as questionnaire design, quality control, and database management are needed. Statisticians whose work involves the characterization of the distribution of health and disease typically work for local, state, federal and international government institutions, such as state and local health departments, the National Center for Health Statistics and the World Health Organization. The data collected and analyzed in such efforts are used for the following:

?To calculate state and national *cancer incidence rates* and track them over time

?To calculate the *burden of disease* by large groups, such as chronic and infectious, or by smaller groups, such as cardiovascular, diabetes, etc.

?To monitor and report on acute *outbreaks of infectious disease*, such as HIV/AIDS.

?To monitor *changes in health-related behaviors*, such as cigarette smoking and physical activity to study the determinants of human health and disease, analytic epidemiologic methods are required. Methods are somewhat different, depending on whether chronic diseases or infectious diseases are under study. The latter group involves mastery of mathematical modelling techniques using differential and difference equations under deterministic and/or stochastic assumptions. The former group involves gathering knowledge and information by relying heavily on biostatistician methods such as logistic regression, Poisson regression and survival data analysis. Case-control, cohort and cross-sectional studies are the standard study designs for such endeavors. Recently, statisticians have been instrumental in moving the entire analytic epidemiology field forward with new work in causal inference, missing data and measurement error models.

Subject matter of topics include the following:

?**Nutritional epidemiology**, such as the study of the relationship, if any, between dietary fat intake and breast cancer incidence.

?**Environmental epidemiology**, such as the study of the relationship between air pollution and its various constituents and overall mortality.

?**Pharmacoepidemiology**, which studies observationally adverse effects and long-term benefits post-market of drugs and devices.

9. Genetics:

Traditionally, genetics has been used in the process of plant and animal breeding to produce desirable characteristics in offspring. Humans have long known that characteristics can be passed down through generations, but exactly how this is done is less clear. Though we say "like father like son," we also have observed that some children are very different from their parents. Because of this uncertainty, *statistics* has been used in human genetics as a tool since the very beginning of this science. It may be noted that many important traits that benefit humans, such as milk from a cow or sugar from sugar cane, are controlled by genes and the environment. When all factors are combined, how to select the most beneficial parents to breed the next generation is a challenging *statistical* problem. It turns out the best choice not only depends on the individuals, but also their parents, siblings, relatives, and the environments in which they live. Complex statistical models help sort out the environmental effects from the genetic, allowing sound decisions to be made about breeding.

One of the most important topics in modern genetics is locating the gene responsible for a disease or characteristic. Once a disease gene is found, we may discover what is lacking due to the abnormal function of this gene and consequently, have a clue as to how to treat the disease. Moreover, we may be able to replace the gene by gene therapy or genetic engineering. With intensive statistical effort, many disease genes have been found, such as those for cystic fibrosis and certain breast and colon cancers.

Modern genetics can no longer be handled by a few disciplines. In addition to the traditional biomedical sciences, chemistry, physics, and computer and information sciences are all key players. Statistics is only

one of them, but an indispensable one.

10. Pharmacology:

Statisticians in pharmacology work in pharmaceuticals, animal health and government research. They work in pre-clinical research, clinical trials, epidemiology, health economics and market research. Statisticians play a key role in the drug experimentation process leading to drug approval, particularly in determining the extent and complexity of the experiments and interpreting the results of those experiments. Statisticians are actually involved in the development of new drugs from the discovery of new drug chemicals through marketing approval and post-marketing surveillance for safety problems. Drug discovery begins in the laboratories of basic research scientists. Samples of natural substances are collected from the far reaches of the globe and run through screening experiments to identify drug chemical candidates with desired effects; these are referred to as active drug candidates. Each screening experiment is designed to reveal active chemicals for a specific targeted disease. Statisticians work with basic research scientists to design these experiments so they make the most efficient use of time and materials and to ensure the analyses of resultant data lead to appropriate identification of active drug chemicals (also called compounds). Once a natural substance is found to possess activity toward a disease target, chemists work to isolate the particular molecule responsible for the activity.

Statisticians work with chemists and use probability theory to ensure sufficient quantities of all combinations of molecules are produced for the screening experiments.

Statisticians work with scientists who study the drug's safety in lab animals to design these experiments and their analyses to identify unsafe compounds using minimal research animals. In addition, statisticians work with other scientists to design and analyze experiments that yield the best production processes for making the raw drug chemical.

Statisticians are key drug development project team members; they help plan the overall experimental strategy (sequence of clinical trials) and execute it. They coauthor the reports of the trials' results, which are assembled into volumes that are submitted to drug regulatory agencies worldwide for approval to sell the drug. Statisticians also make presentations at national and international scientific meetings and coauthor research journal articles; these presentations and articles summarize original statistical methodology and/or unique medical results for the worldwide research community.

Statisticians in regulatory agencies review the New Drug Applications (NDAs). Sponsor (i.e., Drug Company) statisticians meet with their counterparts in the regulatory agencies and other reviewers to address questions. The drug's labeling for prescribing physicians and patients contains information about the drug's proper use. Statisticians contribute to the design and content of the product's labeling. The labeling information is reviewed by statisticians for correctness.

Statisticians work with economists to document the drug's impact on costs compared to the costs of necessary treatment of the disease via alternatives that do not involve the drug. Market research involves statisticians who help assess the drug's potential financial impact on the company. Statisticians help

design strategies and interpret results for studies of drug safety during marketed use.

Statisticians are key collaborators in all aspects of drug discovery, development, approval, and marketing. In the pharmaceutical industry, statisticians work with research scientists in many fields, including biology, chemistry, pharmacology (i.e., the study of drugs' actions in humans), pharmacokinetics (i.e., the study of the drug's passage through the body), and clinical medicine (i.e., the drug's effect on the target disease). Opportunities for statisticians exist in all phases of pharmaceutical research: pre-clinical (i.e., laboratory) research, clinical trials (i.e., studies in humans), epidemiology (i.e., studies of the spread of disease), health economics, market research, and publication in scientific journals.

*Statisticians are essential in the drug development process because they ensure the validity and accuracy of findings at all stages of drug discovery, development, approval, and marketing***.**

11. Public Health:

Public *health statisticians* work on preventing disease, prolonging life and promoting health through organized community efforts. These include sanitation, control of contagious infections, hygiene education, early diagnosis and preventive treatment and adequate living standards. This requires understanding of epidemiology, nutrition, antiseptic practices and social science. In many states, especially in United States, public health is studied and coordinated on a national level by the centers for disease control and prevention. Internationally, the World Health Organization plays a vital role.

12. Census:

It is the agency that introduced scientific sampling methods into large scale surveys. It introduced methods to quantify and control measurement errors in surveys and it introduced the use of computers in large-scale data processing. True to its pioneering history, the Census bureau continues to develop methodology, making it an exciting place for statisticians to work. Statisticians often carry out theoretical research on such topics as the following:

* Time series * Estimation * Frame comparison * Treatment of nonresponsive * Statistical approaches to maintaining confidentiality of respondent data.

Apart from above, in census population, the statisticians also conduct surveys of the following:

* Housing * Manufacturing * Business *Transportation * Governments.

There are statistical issues for each of these censuses. Following are some examples:

?Estimating an undercount.

?Designing public use files with statistical procedures to prevent the inadvertent disclosure of

confidential data.

?Designing new ways of displaying data graphically.

For all the surveys, statisticians do the following:

?Develop sampling frames.

?Design the sample.

?Develop the most appropriate estimators.

?Decide what to do about nonresponse.

?Analyze data.

?Develop methodology for assessing measurement error.

?Assure the quality of the surveys.

Altogether, Census Bureau provides a stimulating environment for statisticians to work on a variety of surveys that affect the lives of all of us.

13. Ecology and the Environment:

An ecological/environmental *statistician* might encounter in some of the following jobs:

?How many fish are in a lake? What fishing limits would maintain current fish populations? Should fishing at the lake be restricted to catch-and-release? Should fishing be banned while the population rebuilds? Should the lake be stocked?

?Should farmers plant windbreaks (trees planted along the borders of fields) to increase the number of species and abundance of birds and insects? Would these increased numbers provide enough protection to the crop so chemical controls could be reduced or even avoided? Do windbreaks need to surround a field, or is one or two sides enough?

?Can fertilizer be applied at varying rates within a field depending on the changing levels of fertility within the field? Would such an approach decrease the amount of fertilizer removed by run-off or leaching and thereby reduce surface or underground water contamination?

?How do plants spread? Is a new species of weed that was accidentally introduced able to out-compete existing species? What are the best methods to control weeds without damaging other plants?

Statisticians play a major role in addressing each of these operations. First, they help establish methods for collecting data. They not only need to know whether the data can help answer the question, but also must consider whether it is physically possible to collect the data. Once the data are collected, the statistician helps analyze and interpret them. Because each question is unique, each requires careful thought for data collection, analysis, and interpretation. Opportunities for ecological/environmental statisticians have been increasing. Most states employ wildlife statisticians. Units of the federal government that deal with natural resources, such as the National Forest service and Environmental protection Agency also make use of statisticians. The same is true for companies that collect environmental data.

Increasingly, companies need statisticians to help assess how a new product or plant will affect the surrounding environment. Scientific researchers also work with statisticians, often at universities, to design experiments that will answer basic questions about the environment.

14. Forestry:

The role of the *forest statistician* is to link the forest and the trees through a scientific process of measurement, analysis and deduction. Following are some examples of ongoing biometrical research. Forest statisticians are studying the living history revealed by the growth rings of trees to see- whether growth differs from that of past decades and centuries. For studying -those forests provide nesting habitat for rare and endangered species scientists use statistical procedures to sample part of the forest, because they cannot study the millions of square kilometers of the province's forested landscape. From the information in the sample, they make estimates about the entire population in much the same way political pollsters forecast the likely outcomes of elections. Forest sampling, which dates back to 19th-century, is constantly evolving in response to new concerns about forest health and productivity by making use of technological advances.

15. Law:

Statistics are becoming more important as court cases address increasingly complex problems. Sometimes the statistician analyzes data that can help the judge or jury decide whether someone is guilty of a crime or must pay damages for causing injuries. A prosecutor who is offering hair fibers found at the scene of a crime as evidence may want to introduce testimony that a match with the defendant's hair would be *more than coincidental*. A person claiming a business discriminates on the basis of race or sex when paying its employees may introduce a *statistical study* of the factors related to salaries. In trademark cases, when one company uses another's trademark or something very similar to it, *surveys of consumers* may be done to see whether they recognize the brand name or are confused or misled by the competitor's advertising. ***Medical*** statistics are crucial in judging whether a drug or medical device has toxic effects and was the *probable cause of a disease* contracted by the plaintiff. Once negligence has been established, the amount of money the negligent party must pay may be based on statistical predictions. What would an employee have earned had there been no illegal discrimination? What would a company's sales have been had there been no unfair competition? As these examples indicate, attorneys need to retain statisticians (and other

professionals with statistical expertise) who may be consulted or asked to testify on a wide range of subjects. Such statisticians must know not only how to handle statistics, but also how to present their work effectively to lawyers, judges, and jurors who are not skilled in mathematics ***Forensic*** statistics is an especially challenging branch of applied statistics that draws on all kinds of statistical analyses and many areas of expertise.

16. National Defense:

As the world changes, the nation's leaders are faced with increasingly challenging problems involving defense and national security. What threat is the nation likely to face, and when? How should military personnel, weapons, facilities, and infrastructure be configured and used to counter this threat? Where should monies be allocated to ensure the nation continues to be safe and secure? Statisticians work with many other scientists, policymakers, and military personnel to address questions such as these. Activities can be applied-involving collecting and analyzing data-or more theoretical-including developing new methods and models. Statisticians with different degrees (e.g., B.Sc, M.Sc, M.Phil, & PhD) and application areas (e.g., physics, medicine, human factors, genetics and manufacturing and public policy) work in defense and national security. *Statisticians* who work in defense and national security help to do the following:

?Test and evaluate new systems.

?Budget scarce resources.

?Design experiments.

?Evaluate complex computer simulation models.

?Study the behavior of aging materials.

?Analyze experimental data.

?Interpret research findings.

A career as a statistician in defense and national security offers a chance to serve your country while doing challenging and interesting work.

17. Agriculture:

Statisticians have turned up with experts in agriculture in order to study a number of challenging problems including pesticides, hydrology, veterinary sciences, genetics and crop management. Statisticians are involved in studies ranging from small laboratory experiments to large projects conducted over many hundreds or thousands of square miles. They work on data from smallest scale of

organization, like viruses and bacteria, to plants, insects, animals and human. They work with scientists from field such as bacteriology, biometry, diary science, environmental sciences, entomology, plant sciences, rural sociology, wildlife, veterinary sciences and ecology.

18. Social Sciences:

Social research depends heavily on surveys, which can provide a snapshot or moving picture of social trends. In many instances, the only way to obtain information about behavior or opinions is to ask a representative sample of people. Political polls fall into this category.

A *survey statistician* might study the following:

?Question wording and design.

?Methods for follow-up of non-respondance.

?Deciding where to take samples in an archaeological dig.

?Analyzing survey data collected for another purpose.

19. Education:

Educational research and improvement of the educational system requires that performance and subsequent development be measured. A *survey statistician* might study the following:

?Designing surveys to include under-represented groups.

?Longitudinal surveys that follow a cohort of children to adulthood.

?How to sample from a population when no list of the population exists (e.g., the mosquitoes in a town/Village).

?Estimating sizes of wildlife populations (Avoiding bias in samples of wildlife e.g., because it might be easier to catch infected animals).

20. Risk Assessment:

Environmental risk assessment has grown in the last 30-40 years as people have realized their actions can have adverse effects on the environment. Risk assessment is the characterization of the potential adverse health effects resulting from human and ecological exposure to environmental hazards. The risk

assessment process, which includes the following steps, is complex:

Hazard identification is the analysis of an environmental situation to ascertain if there is the potential for exposure of an organism (including a human) or ecosystem to an environmental stressor that may cause harm.

Dose-response assessment is the process of characterizing the relation between the dose of an agent received by a receptor (organism or ecosystem) and the incidence of an adverse effect on that receptor.

Exposure assessment is the process of measuring or estimating the intensity, frequency, or duration of human or ecological exposure to agents currently in the environment or that may be present in the future.

Risk characterization is the process of estimating the incidence of an adverse effect under the conditions of exposure described in the exposure assessment. It also includes the narrative description of the meaning of the assessment, including uncertainties in the preceding steps.

Each of the steps requires the collection of data (e.g., lead concentrations in soil or water) and/or the use of *Statistical/mathematical models* (e.g., those that describe the movement of contaminants in the environment or define the cancer incidence from exposure to levels of uranium).

A successful environmental risk assessment requires the talents of many academic disciplines-chemistry, physics, biology, ecology, geology, hydrology, and engineering. Because of their skills in analyzing data and computations, statisticians can play a role in each of the steps above.

21. Econometrics, Commerce & Business:

In Econometrics, tools of economic theory, mathematics and *statistics* are indispensible. *Statistical* tools are essential in explaining most of the economic data. The Market research commonly relies on *Statistical* surveys and focus groups. Economic surveys such as those conducted by the Bureau of Labor *Statistics* may be used in making business decisions.

22. Government:

Statistical methods are used in Government regulations on topics such as – stock trading rules, air purity standards and new drug approvals. Statistics are cited in court proceedings, congressional hearings and lobbying arguments. Statisticians participate in Government agencies such as Food and Drug administration, the Census Bureau, the Bureau of Labor statistics, the Office of the Management and Budget, the Bureau of Transportation Statistics, the National Institution of Health, the Department of Agricultural Federal Agencies etc.

23. Surveys:

Statisticians work on surveys in-Government, Education, Social Science, Law, Agriculture, Biology, Medicine, Business, Economics and Commerce. A survey *statistician* might study efficient survey design, experimental methods or how to release data to pubic while maintaining confidentiality of the respondents. Other important issues include the question to design and to decide where and how to take sample that will include the non represented groups of people.

24. Medicine and Public Health:

State governments and medical researchers conduct numerous surveys to estimate prevalence of disease and cost to society.

A survey *statistician* might study the following:

?How to sample persons with rare disorders if no national registry exists.

?How to estimate effects of environmental toxins when comparing samples from neighboring cities.

?Methods for combining data from a specialized survey of AIDS patients with national survey data.

?How to profile and explain the extent of cardiovascular disease, back pain, and other chronic medical conditions.

?Methods to assess the impact of specific community programs to promote health through exercise, better eating habits, and other strategies.

In recent times, *Statistical Process Control* (SPC) tools are increasingly being used in health industries to aid in process understanding, assess process stability and identify changes that indicate either improvement or deterioration in health quality of a patient. They are used in hospital process improvement projects, by accrediting bodies, Government agencies and public health surveillance.

25. Chemistry:

Statistical methods are applied to a range of chemistry problems, from traditional laboratory experimentation to new techniques in molecular design. *Statisticians* contribute to chemistry problems in pharmaceuticals, electronics and semiconductors, paints and coatings, agriculture, food science, and many other interesting fields. Typical applications include the following:

?Collaborate with food scientists and test kitchen staff to optimize a recipe. The statistician must apply experimental designs for mixtures of ingredients, taste-testing using hedonic scales and numerical and graphical optimization techniques.

?Build response surface models to describe the performance of a chemical formulation in terms of its component levels. This may begin as a classic factorial study and then blend chemical knowledge with empiricism to develop meaningful models. Ultimately, nonlinear mechanistic models may be identified to describe the chemical kinetics.

?Predict the properties of compounds that have not yet been synthesized in any lab by supporting computer-aided molecular design based on molecular property descriptors. Statisticians develop optimum design strategies that minimize the number of syntheses required. Innovative modeling techniques enable continuous refinement of the molecular models to provide better predictions of the most promising compounds.

?High-throughput testing generates unprecedented volumes of data on both the synthesis conditions and evaluated performance of each compound. High-dimensional data visualization and mining techniques ensure that the valuable information in these data will be discovered.

?Analytical chemists often generate spectra instead of single-number results. Chemometric techniques draw upon multivariate statistics to reduce large sets of numbers to a meaningful few.

Statistical methods are well accepted in traditional chemical research. Statisticians today face the exciting challenge of developing design and modeling techniques to keep up with rapid developments in high-throughput testing, quantitative structure property relationship modeling, and rapid analytical testing.

26. Insurance: Insurance and Actuarial Sciences:

Insurance is a data-driven industry, and thus employs a large number of analysts to continuously monitor and analyze data. Analysts in the insurance industry have formal education in a variety of disciplines, including statistics, finance, economics, business, mathematics, and computer science.

Entry-level analysts require a bachelor's degree in one of these quantitative disciplines. Senior analysts may possess an advanced degree. In addition to technical skills, career success requires good project management skills and the ability to communicate effectively with both management and information technology specialists. Qualified individuals have opportunities to move into management roles.

There is much overlap between insurance statisticians and insurance actuaries. For instance, in Progressive Insurance Company, statisticians play a major role in setting the insurance rates, which is traditionally done by actuaries. Being an actuary consistently ranks among the most desirable jobs.

Functions requiring varying levels of statistical skills include the following:

?Pricing and product design.

?Multivariate statistical models are used to predict average losses versus driver characteristics (e.g., driver age, gender, marital status, driving record), vehicle characteristics, and geographic location.

?Multivariate models are necessary to separate the contribution of each of these inter-related variables. Such models are used to accurately set the relative price to charge particular segments of customers.

27. Reliability:

Product reliability provides a value to the customer. Reliability can distinguish products. Reliability means the product, service, or system will perform as expected now and in the future.
Statisticians provide the language to discuss product reliability. Statisticians and reliability engineers (often with significant reliability training) guide and perform critical reliability prediction, experiment, assessment, and assurance activities. Beyond the fundamental set of statistical tools, reliability has a set of specialized statistical techniques.

28. Customer Retention:

Statistical methods such as logistic regression or survival analysis may be used to identify variables that are predictive of how long a customer stays with the company. For example, such models are used to determine the impact of premium increases on whether a customer renews his policy. Designed experiments also may be used to efficiently test different strategies for retaining more customers. The results of such customer retention experiments may be used as the basis for actions implemented to increase customer retention.

29. Geology:

Geographers study how and why element differ from place to place. They use statistics in numerous ways:

?To describe and summarize spatial data.

?To make generalizations concerning complex spatial patterns.

?To estimate the probability of outcomes for an event at a given location.

?To use samples of Geographic data to infer characteristics for a larger set of geographical data.

?To determine if the magnitude or frequency of some phenomenon differs from one location to another.

?To learn whether an actual spatial pattern matches some expected pattern.

30. Science Writing and Journalism:

Science writers are employed by mass media, corporations and Universities to produce news brief, articles, news release and other reports. Writers with scientific backgrounds are especially in demand because of their ability to explain complicated statistical or scientific data in easy-to understand for non-statisticians and the general public.

31. Consulting:

Independent statistical consultants work on many projects. As the field of statistics is fast growing, statistical consultants are also specialized in some areas such as Quality Control or Agriculture etc. Consultants may be hired with grant of money to work on short or long term projects **Business**(Economics, Engineering, Marketing, Computer Science), **Health and Medicine**(Genetics, Clinical Trial, Epidemiology, Pharmacology),**Governmen**t(Census, Survey, Law, National Defence), **Environment**(Agriculture, Ecology, Forestry, Animal Population) and **Physical Sciences**(Astronomy, Chemistry, Physics, Geology etc).

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