INTRODUCTION TO THE STATISTICAL ANALYSIS OF DATA pdf

1: Introduction to Statistical Analysis - Wikiversity

The power of p valuesÂ¶. Statistics provides the answer. If we know the distribution of typical cold cases - roughly how many patients tend to have short colds, or long colds, or average colds - we can tell how likely it is for a random sample of cold patients to have cold lengths all shorter than average, or longer than average, or exactly average.

We will learn how statistics and probability work together. The subject of statistics involves the study of methods for collecting, summarizing, and interpreting data. Statistics formalizes the process of making decisionsâ€”and this course is designed to help you cultivate statistic literacy so that you can use this knowledge to make better decisions. Note that this course has applications in sciences, economics, computer science, finance, psychology, sociology, criminology, and many other fields. Every day, we read articles and reports in print or online. After finishing this course, you should be comfortable asking yourself whether the articles make sense. You will be able to extract information from the articles and display that information effectively. You will also be able to understand the basics of how to draw statistical conclusions. This course will begin with descriptive statistics and the foundation of statistics. You will then learn about probability and random distributions, the latter of which enables us to work with several aspects of random events and their applications. Finally, we will examine a number of ways to investigate the relationships between various characteristics of data. By the end of this course, you should have a grasp on what statistics represent, how to use them to organize and display data, and how to test the data to make effective conclusions. Define the meaning of descriptive statistics and statistical inference. Distinguish between a population and a sample. Explain the purpose of measures of location, variability, and skewness. Explain the difference between how probabilities are computed for discrete and continuous random variables. Recognize and understand discrete probability distribution functions, in general. Identify confidence intervals for means and proportions. Explain how the central limit theorem applies in inference. Calculate and interpret confidence intervals for one population average and one population proportion. Conduct and interpret hypothesis tests. Compute regression equations for data. Use regression equations to make predictions. The links below will direct you to the navigation page for each unit of this course. Data And Descriptive Statistics[edit].

INTRODUCTION TO THE STATISTICAL ANALYSIS OF DATA pdf

2: Inferring From Data

An introduction to the statistical analysis of data Hardcover -

Because practitioners of the statistical analysis often address particular applied decision problems, methods developments is consequently motivated by the search to a better decision making under uncertainties. Decision making process under uncertainty is largely based on application of statistical data analysis for probabilistic risk assessment of your decision. Managers need to understand variation for two key reasons. First, so that they can lead others to apply statistical thinking in day to day activities and secondly, to apply the concept for the purpose of continuous improvement. This course will provide you with hands-on experience to promote the use of statistical thinking and techniques to apply them to make educated decisions whenever there is variation in business data. Therefore, it is a course in statistical thinking via a data-oriented approach. Statistical models are currently used in various fields of business and science. However, the terminology differs from field to field. For example, the fitting of models to data, called calibration, history matching, and data assimilation, are all synonymous with parameter estimation. Your organization database contains a wealth of information, yet the decision technology group members tap a fraction of it. Employees waste time scouring multiple sources for a database. The decision-makers are frustrated because they cannot get business-critical data exactly when they need it. Therefore, too many decisions are based on guesswork, not facts. Many opportunities are also missed, if they are even noticed at all. Knowledge is what we know well. Information is the communication of knowledge. In every knowledge exchange, there is a sender and a receiver. The sender make common what is private, does the informing, the communicating. Information can be classified as explicit and tacit forms. The explicit information can be explained in structured form, while tacit information is inconsistent and fuzzy to explain. Know that data are only crude information and not knowledge by themselves. Data is known to be crude information and not knowledge by itself. The sequence from data to knowledge is: Data becomes information, when it becomes relevant to your decision problem. Information becomes fact, when the data can support it. Facts are what the data reveals. However the decisive instrumental i. Fact becomes knowledge, when it is used in the successful completion of a decision process. Once you have a massive amount of facts integrated as knowledge, then your mind will be superhuman in the same sense that mankind with writing is superhuman compared to mankind before writing. The following figure illustrates the statistical thinking process based on data in constructing statistical models for decision making under uncertainties. The above figure depicts the fact that as the exactness of a statistical model increases, the level of improvements in decision-making increases. Statistical data analysis arose from the need to place knowledge on a systematic evidence base. This required a study of the laws of probability, the development of measures of data properties and relationships, and so on. Statistical inference aims at determining whether any statistical significance can be attached that results after due allowance is made for any random variation as a source of error. Intelligent and critical inferences cannot be made by those who do not understand the purpose, the conditions, and applicability of the various techniques for judging significance. Considering the uncertain environment, the chance that "good decisions" are made increases with the availability of "good information. The above figure also illustrates the fact that as the exactness of a statistical model increases, the level of improvements in decision-making increases. Knowledge is more than knowing something technical. Wisdom is the power to put our time and our knowledge to the proper use. Wisdom comes with age and experience. Wisdom is the accurate application of accurate knowledge and its key component is to knowing the limits of your knowledge. Wisdom is about knowing how something technical can be best used to meet the needs of the decision-maker. Wisdom, for example, creates statistical software that is useful, rather than technically brilliant. For example, ever since the Web entered the popular consciousness, observers have noted that it puts information at your fingertips but tends to keep wisdom out of reach. Almost every professionals need a statistical toolkit. Statistical skills enable you to intelligently collect, analyze and interpret data relevant to their decision-making. Statistical concepts enable us to solve problems in a diversity of contexts. Statistical thinking enables you to add substance to your decisions. The appearance of computer software, JavaScript Applets , Statistical Demonstrations Applets , and Online Computation are the most important events in the process of teaching and learning concepts in model-based statistical decision making courses. These tools allow you to construct numerical examples to understand the concepts, and to find their significance for yourself. The course is tailored to meet your needs in the statistical business-data analysis using widely available commercial statistical computer packages such as SAS and SPSS. By doing this, you will inevitably find yourself asking questions about the data and the method proposed, and you will have the means at your disposal to settle these questions to your own satisfaction. Accordingly, all the applications problems are borrowed from business and economics. Greater and Lesser Statistics. Greater statistics is everything related to learning from data, from the first planning or collection, to the last presentation or report. Lesser statistics is the body of statistical methodology. This is a Greater Statistics course. There are basically two kinds of "statistics" courses. The real kind shows you how to make sense out of data. These courses would include all the recent developments and all share a deep respect for data and truth. The imitation kind involves plugging numbers into statistics formulas. The emphasis is on doing the arithmetic correctly. These courses generally have no interest in data or truth, and the problems are generally arithmetic exercises. If a certain assumption is needed to justify a procedure, they will simply tell you to "assume the It seems like you all are suffering from an overdose of the latter. This course will bring out the joy of statistics in you. Statistics is a science assisting you to make decisions under uncertainties based on some numerical and measurable scales. Decision making process must be based on data neither on personal opinion nor on belief. It is already an accepted fact that "Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write. Gives probability of exactly successes in n independent trials, when probability of success p on single trial is a constant. Used frequently in quality control, reliability, survey sampling, and other industrial problems. What is the probability of 7 or more "heads" in 10 tosses of a fair coin?

3: Introduction to Statistics and Data Analysis - Free Course by University of Michigan on iTunes U

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Overview[edit] In applying statistics to a problem, it is common practice to start with a population or process to be studied. Populations can be diverse topics such as "all persons living in a country" or "every atom composing a crystal". Ideally, statisticians compile data about the entire population an operation called census. This may be organized by governmental statistical institutes. Descriptive statistics can be used to summarize the population data. Numerical descriptors include mean and standard deviation for continuous data types like income , while frequency and percentage are more useful in terms of describing categorical data like race. When a census is not feasible, a chosen subset of the population called a sample is studied. Once a sample that is representative of the population is determined, data is collected for the sample members in an observational or experimental setting. Again, descriptive statistics can be used to summarize the sample data. However, the drawing of the sample has been subject to an element of randomness, hence the established numerical descriptors from the sample are also due to uncertainty. To still draw meaningful conclusions about the entire population, inferential statistics is needed. It uses patterns in the sample data to draw inferences about the population represented, accounting for randomness. These inferences may take the form of: Inference can extend to forecasting , prediction and estimation of unobserved values either in or associated with the population being studied; it can include extrapolation and interpolation of time series or spatial data , and can also include data mining. Sampling[edit] When full census data cannot be collected, statisticians collect sample data by developing specific experiment designs and survey samples. Statistics itself also provides tools for prediction and forecasting through statistical models. The idea of making inferences based on sampled data began around the mids in connection with estimating populations and developing precursors of life insurance. Representative sampling assures that inferences and conclusions can safely extend from the sample to the population as a whole. A major problem lies in determining the extent that the sample chosen is actually representative. Statistics offers methods to estimate and correct for any bias within the sample and data collection procedures. There are also methods of experimental design for experiments that can lessen these issues at the outset of a study, strengthening its capability to discern truths about the population. Sampling theory is part of the mathematical discipline of probability theory. Probability is used in mathematical statistics to study the sampling distributions of sample statistics and, more generally, the properties of statistical procedures. The use of any statistical method is valid when the system or population under consideration satisfies the assumptions of the method. The difference in point of view between classic probability theory and sampling theory is, roughly, that probability theory starts from the given parameters of a total population to deduce probabilities that pertain to samples. Statistical inference, however, moves in the opposite directionâ€" inductively inferring from samples to the parameters of a larger or total population. Experimental and observational studies[edit] A common goal for a statistical research project is to investigate causality , and in particular to draw a conclusion on the effect of changes in the values of predictors or independent variables on dependent variables. There are two major types of causal statistical studies: In both types of studies, the effect of differences of an independent variable or variables on the behavior of the dependent variable are observed. The difference between the two types lies in how the study is actually conducted. Each can be very effective. An experimental study involves taking measurements of the system under study, manipulating the system, and then taking additional measurements using the same procedure to determine if the manipulation has modified the values of the measurements. In contrast, an observational study does not involve experimental manipulation. Instead, data are gathered and correlations between predictors and response are investigated. While the tools of data analysis work best on data from randomized studies , they are also applied to other kinds of dataâ€"like natural experiments and observational studies [15] â€"for which a statistician would use a modified, more structured estimation method e. Experiments[edit] The basic steps of a statistical experiment are: Planning the research, including finding the number of replicates of the study, using the following information: Consideration of the selection of experimental subjects and the ethics of research is necessary. Statisticians recommend that experiments compare at least one new treatment with a standard treatment or control, to allow an unbiased estimate of the difference in treatment effects. Design of experiments , using blocking to reduce the influence of confounding variables , and randomized assignment of treatments to subjects to allow unbiased estimates of treatment effects and experimental error. At this stage, the experimenters and statisticians write the experimental protocol that will guide the performance of the experiment and which specifies the primary analysis of the experimental data. Performing the experiment following the experimental protocol and analyzing the data following the experimental protocol. Further examining the data set in secondary analyses, to suggest new hypotheses for future study. Documenting and presenting the results of the study. Experiments on human behavior have special concerns. The famous Hawthorne study examined changes to the working environment at the Hawthorne plant of the Western Electric Company. The researchers were interested in determining whether increased illumination would increase the productivity of the assembly line workers. The researchers first measured the productivity in the plant, then modified the illumination in an area of the plant and checked if the changes in illumination affected productivity. It turned out that productivity indeed improved under the experimental conditions. However, the study is heavily criticized today for errors in experimental procedures, specifically for the lack of a control group and blindness. The Hawthorne effect refers to finding that an outcome in this case, worker productivity changed due to observation itself. Those in the Hawthorne study became more productive not because the lighting was changed but because they were being observed. This type of study typically uses a survey to collect observations about the area of interest and then performs statistical analysis. In this case, the researchers would collect observations of both smokers and non-smokers, perhaps through a cohort study , and then look for the number of cases of lung cancer in each group. Types of data[edit] Main articles: Statistical data type and Levels of measurement Various attempts have been made to produce a taxonomy of levels of measurement. The psychophysicist Stanley Smith Stevens defined nominal, ordinal, interval, and ratio scales. Nominal measurements do not have meaningful rank order among values, and permit any one-to-one transformation. Ordinal measurements have imprecise differences between consecutive values, but have a meaningful order to those values, and permit any order-preserving transformation. Interval measurements have meaningful distances between measurements defined, but the zero value is arbitrary as in the case with longitude and temperature measurements in Celsius or Fahrenheit , and permit any linear transformation. Ratio measurements have both a meaningful zero value and the distances between different measurements defined, and permit any rescaling transformation. Because variables conforming only to nominal or ordinal measurements cannot be reasonably measured numerically, sometimes they are grouped together as categorical variables , whereas ratio and interval measurements are grouped together as quantitative variables , which can be either discrete or continuous , due to their numerical nature. Such distinctions can often be loosely correlated with data type in computer science, in that dichotomous categorical variables may be represented with the Boolean data type , polytomous categorical variables with arbitrarily assigned integers in the integral data type , and continuous variables with the real data type involving floating point computation. But the mapping of computer science data types to statistical data types depends on which categorization of the latter is being implemented. Other categorizations have been proposed. For example, Mosteller and Tukey [18] distinguished grades, ranks, counted fractions, counts, amounts, and balances. Nelder [19] described continuous counts, continuous ratios, count ratios, and categorical modes of data. See also Chrisman , [20] van den Berg Whether or not a transformation is sensible to contemplate depends on the question one is trying to answer" Hand, , p. A statistic is a random variable that is a function of the random sample, but not a function of unknown parameters. The probability distribution of the statistic, though, may have unknown parameters. Consider now a function of the unknown parameter: Commonly used estimators include sample mean , unbiased sample variance and sample covariance. A random variable that is a function of the random sample and of the unknown parameter, but whose probability distribution does not depend on the unknown parameter is called a pivotal quantity or pivot. Between two estimators of a given parameter, the one with lower mean squared error is said to be more efficient. Furthermore, an estimator is said to be unbiased if its expected value is equal to the true value of the unknown parameter being estimated, and asymptotically unbiased if its expected value converges at the limit to the true value of such parameter. Other desirable properties for estimators include: UMVUE estimators that have the lowest variance for all possible values of the parameter to be estimated this is usually an easier property to verify than efficiency and consistent estimators which converges in probability to the true value of such parameter. This still leaves the question of how to obtain estimators in a given situation and carry the computation, several methods have been proposed: Null hypothesis and alternative hypothesis[edit] Interpretation of statistical information can often involve the development of a null hypothesis which is usually but not necessarily that no relationship exists among variables or that no change occurred over time. The null hypothesis, H0, asserts that the defendant is innocent, whereas the alternative hypothesis, H1, asserts that the defendant is guilty. The indictment comes because of suspicion of the guilt. The H0 status quo stands in opposition to H1 and is maintained unless H1 is supported by evidence "beyond a reasonable doubt". However, "failure to reject H0" in this case does not imply innocence, but merely that the evidence was insufficient to convict. So the jury does not necessarily accept H0 but fails to reject H0. While one can not "prove" a null hypothesis, one can test how close it is to being true with a power test , which tests for type II errors.

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4: Introduction to Statistical Analysis of Laboratory Data - CfPIE

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5: Introduction to Statistics | Wyzant Resources

Introduction to Statistical Data Analysis Statistics is the science (and art) of making inferences and decisions given uncertain information. Given a problem, how should we proceed?

Does one medicine work better than another? Do cells with one version of a gene synthesize more of an enzyme than cells with another version? Does one kind of signal processing algorithm detect pulsars better than another? Is one catalyst more effective at speeding a chemical reaction than another? Much of statistics, then, comes down to making judgments about these kinds of differences. Your new medicine promises to cut the duration of cold symptoms by a day. To prove this, you find twenty patients with colds and give half of them your new medicine and half a placebo. Then you track the length of their colds and find out what the average cold length was with and without the medicine. Perhaps the average cold lasts a week, but some last only a few days, and others drag on for two weeks or more, straining the household Kleenex supply. If we know the distribution of typical cold cases â€” roughly how many patients tend to have short colds, or long colds, or average colds â€” we can tell how likely it is for a random sample of cold patients to have cold lengths all shorter than average, or longer than average, or exactly average. Intuitively, we can see how this might work. The common statistical tests used by scientists produce a number called the p value that quantifies this. The P value is defined as the probability, under the assumption of no effect or no difference the null hypothesis , of obtaining a result equal to or more extreme than what was actually observed. Obviously, the p value depends on the size of the effect â€” colds shorter by four days are less likely than colds shorter by one day â€” and the number of patients I test the medication on. A bigger difference, or one backed up by more data, suggests more surprise and a smaller p value. But there are limitations. The p value is a measure of surprise, not a measure of the size of the effect. Statistical significance does not mean your result has any practical significance. Similarly, statistical insignificance is hard to interpret. A statistically insignificant difference does not mean there is no difference at all. The revised and expanded Statistics Done Wrong , with three times as many statistical errors and examples, is available in print and eBook! An essential book for any scientist, data scientist, or statistician.

INTRODUCTION TO THE STATISTICAL ANALYSIS OF DATA pdf

6: An Introduction to Statistical Methods and Data Analysis - Ebook pdf and epub

"The book presents a detailed discussion of important statistical concepts and methods of data presentation and analysis. -Provides detailed discussions on statistical applications including a comprehensive package of statistical tools that are specific to the laboratory experiment process.

This section of the course will detail the basic and intermediate statistical concepts that are essential for professionals in the field. The first day emphasizes the principles of descriptive and inferential statistical applications and focuses on actual study examples, problem solving and interpretation of results. Throughout the course the participants are encouraged to ask questions and discuss examples relevant to their own work. Topic areas to be discussed include, but are not limited to: Basic statistical terminology including simple statistics as well as geometric e. Bartolucci, Karan Singh and Sejong Bae Advanced Topics Day Two. This section of the course will go beyond the basics and cover more complex issues in laboratory investigations with examples. Association studies including correlation and regression analysis with laboratory applications Analysis of robustness and ruggedness Method comparison using more accurate alternatives to correlate analysis and other pair-wise comparisons Outliers, limit of detection and limit of quantitation Statistical quality control for process stability and capability Who Should Attend This course is designed as an introduction to the statistical principles of laboratory data analysis and quality control that form the basis for the design and analysis of laboratory investigations. Where applicable, topics are presented with relevant regulatory requirements. This training will concentrate on the philosophy and understanding of the statistical principles required in conducting sound scientific investigations of laboratory processes and validation, including design and sample size issues. It will not simply present statistical formulae and the lectures are oriented toward professionals having minimal formal training in statistics or mathematics beyond basic algebra. However, for those with more formal training in statistics wishing to actually apply the techniques, appropriate time and references will be given for the procedures involved. Central tendency average or mean, median, mode , dispersion measures such as range, variance, standard deviation, coefficient of variation, unbiased estimates, measurement summary and precision. Histograms, bar charts, scatter plots. Graphical representation of lab results. Distributions and Formal Statistical Laboratory Tests: Normal, t-distribution one sample, two sample, paired , one way ANOVA to assess effect and necessity of replication, skewed distributions with applications to experimental results with alternative statistical comparison methodologies. Point and interval estimates, accuracy, precision. Further concepts of method validation such as sensitivity, specificity, selectivity, linearity. Second Day Defining Robustness and Ruggedness: Design selection criteria, calculations, interpretation, effects of repeated experimentation, multiple lab results. Applications to method comparison and interpretation. Examination of outliers in exploratory analysis of assay results. Alternative Strategy to Linearity: Alternative advanced method for assessing agreement between two methods of laboratory measurements. Limit of detection, limit of quantitation. Techniques involving crude and precise methodologies and measurement of bias. Validation Using Statistical Process Control: Use of quality control charts to determine laboratory process stability and capability. Learning Objectives Those completing the course will have an understanding of the concepts of statistical design, analysis and graphing methods required in laboratory data analysis and reporting. Attendees will be able to interpret and report results related to design and analysis issues as presented in the scientific literature concerning laboratory data analysis, as well as, quality control methods. Testimonials "Excellent presentation in statistical measurements techniques that can be applied to many disciplines and projects. He is great at explaining the concepts.

7: Statistics - Wikipedia

This course is designed as an introduction to the statistical principles of laboratory data analysis and quality control that form the basis for the design and analysis of laboratory investigations.

GO Introduction to Statistics Statistics is a branch of mathematics that deals with the collection, analysis and interpretation of data. Data can be defined as groups of information that represent the qualitative or quantitative attributes of a variable or set of variables. An example of data can be the ages of the students in a given class. When you collect those ages, that becomes your data. A set in statistics is referred to as a population. Though this term is commonly used to refer to the number of people in a given place, in statistics, a population refers to any entire set from which you collect data. Data Collection Methods As we have seen in the definition of statistics, data collection is a fundamental aspect and as a consequence, there are different methods of collecting data which when used on one particular set will result in different kinds of data. Census Data Collection Census data collection is a method of collecting data whereby all the data from each and every member of the population is collected. For example, when you collect the ages of all the students in a given class, you are using the census data collection method since you are including all the members of the population which is the class in this case. This method of data collection is very expensive tedious, time consuming and costly if the number of elements population size is very large. To understand the scope of how expensive it is, think of trying to count all the ten year old boys in the country. That would take a lot of time and resources, which you may not have. Sample Data Collection Sample data collection, which is commonly just referred to as sampling , is a method which collects data from only a chosen portion of the population. Sampling assumes that the portion that is chosen to be sampled is a good estimate of the entire population. Thus one can save resources and time by only collecting data from a small part of the population. But this raises the question of whether sampling is accurate or not. The answer is that for the most part, sampling is approximately accurate. This is only true if you choose your sample carefully to be able to closely approximate what the true population consists of. Sampling is used commonly in everyday life, for example, all the different research polls that are conducted before elections. History has shown that these polls are almost always close to accuracy, and as such sampling is a very powerful tool in statistics. Experimental Data Collection Experimental data collection involves one performing an experiment and then collecting the data to be further analyzed. Experiments involve tests and the results of these tests are your data. An example of experimental data collection is rolling a die one hundred times while recording the outcomes. Your data would be the results you get in each roll. The experiment could involve rolling the die in different ways and recording the results for each of those different ways. Experimental data collection is useful in testing theories and different products and is a very fundamental aspect of mathematics and all science as a whole. Observational Data Collection Observational data collection method involves not carrying out an experiment but observing without influencing the population at all. Observational data collection is popular in studying trends and behaviors of society where, for example, the lives of a bunch of people are observed and data is collected for the different aspects of their lives. Sign up for free to access more statistics resources like. Wyzant Resources features blogs, videos, lessons, and more about statistics and over other subjects. Stop struggling and start learning today with thousands of free resources!

8: An introduction to data analysis â€” Statistics Done Wrong

teaching of statistics, and over the years has evolved into an excellent system for data analysis. You can start MINITAB by finding the program within the Program menu or.

9: Data and statistics | 6th grade | Math | Khan Academy

Introduction to Statistical Analysis Pawel Skuza Statistical Consultant An introduction to modern missing data analyses.

Journal of School Psychology, 48(1),

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