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health science journals. We might choose a particular intelligence test and define the variable "intelligence" to be the score obtained on this test. 3.2 Using the data set entered in the previous problem, delete the P/E variable for the Dow Chemical company and D/E for Stauffer Chemical and Nalco Chemical in a way appropriate to the statistical package you are using. Following Fleming, researchers might want to go out and test an exploratory hypothesis in another setting or with new data. We will call such hypotheses exploratory. In this chapter, we define what a variable is in Section 2.2. Section 2.3 presents a method of classifying variables that is sometimes useful in multivariate analysis since it allows one to check that a commonly used analysis has not been missed. The investigators picked four areas of quite different types of air pollution and measured various demographic and other responses on all persons over seven years old who live there. 1.2 Examples of multivariate analyses The studies described in the following subsections illustrate various multivariate analysis techniques. Other programs allow you to transpose or flip your data file so the rows become the columns and the columns become the rows (Table 3.2). The risk factors are smoking tobacco (yes at present, former smoker, never smoked), drinking (yes, no), marijuana use (yes, no), and other illicit drug use (yes, no). Alternatively, for a company, the unit of analysis may be a sales district and sales made by different salespersons in each district are recorded. Factor analysis An investigator has asked each respondent in a survey whether he or she strongly agrees, agrees, is undecided, disagrees, or strongly disagrees with 15 statements concerning attitudes toward inflation. Clark Authors Abdelmonem Afifi, Ph.D., has been Professor of Biostatistics in the School of Public Health, University of California, Los Angeles (UCLA) since 1965, and served as the Dean of the School from 1985 until 2000. Of note, our definition of large data sets includes data sets such as those publicly available from the Centers for Disease Control and Prevention (CDC). Loan payers can be classified into several types: those who met all of the terms of the loan, those who eventually repaid the loan but often did not meet deadlines, and those who simply defaulted. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged. Imagine you are tasked with analyzing a large data set that includes a lot of data-preprocessing, statistical analyses, and creating graphics. This weight may be adjusted so that the sum of the weights equals the sample size. Note that income is given in thousands of dollars per year for the household; thus an income of 15 would be \$15,000 per year. Incorporating reproducible research techniques into your workflow not only provides a benefit to the analysts and their collaborators, but also the scientific community in general. xi xii PREFACE Part Two covers regression analysis, DATA VISUALIZATION 100 120 140 40 30 Frequency count 30 20 40 60 80 Frequency Brief Symptom Inventory Score 40 Histogram of parhiv\$bsi, overall 10 20 0 20 10 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 0 0 parhiv\$bsi, overall 1 2 0 3 (a) For your eyes only 1 2 3 BSI score bsi, overall (b) For an internal report (c) For publication Figure 4.1: Three Levels of Graphic Quality and Completeness Using Histograms as Examples. Repeat Problem 2.3 for the lung cancer data set described in Table 13.1. From a field of statistical application (perhaps your own field of specialty), describe a data set and repeat the procedures described in Problem 2.3. If the RELIG variable described in Table 3.4 of this text was recoded 1 = Catholic, 2 = Protestant, 3 = Jewish, 4 = none, and 5 = other, would this meet the basic empirical operation as defined by Stevens for an ordinal variable? Some of the physicians are still employed, but many have left. However, adjustments to the analysis must be made to account for the clustered nature of the sample, namely the possibility that patients within any one hospital may be more similar to each other than to patients in other hospitals. Analyses can also be performed via the file menu system with the option to save the commands generated. 7.3 Data example 7.4 Regression methods: fixed-X case 7.5 Regression and correlation: variable-X case 7.6 Interpretation: fixed-X case 7.7 Interpretation: variable-X case 7.8 Other available computer output 7.9 Robustness and transformations for regression 7.10 Other types of regression 7.11 Special applications of regression 7.12 Discussion of computer programs 7.13 What to watch out for 7.14 Summary 7.15 Problems 87 87 88 89 93 93 94 98 103 105 107 110 110 112 112 8 Multiple regression and correlation 8.1 Chapter outline 8.2 When are regression and correlation used? The manuals or HELP statements should be consulted so that you can match what they require with what you do. The second type of nonresponse occurs when the case, individual, or sampling unit is available but yields incomplete information. 1. A linear combination of the predictors is used to predict the outcome or response variable. When you are learning to use a package for the first time, there is no substitute for reading the on-line HELP, manuals, or texts that present examples. In contrast, people in most major countries have very different backgrounds and their opinions and genetic makeup can vary greatly. For example, for the variable "sex," if an investigator specifies 1 and 2 as possible values and the data entry person hits a 3 by mistake, the program issues a warning. An investigator may rename the categories, thus performing a numerical operation. Stata is similar to SAS and R in that an analysis consists of a sequence of commands with their own options. However, Chapters 11 and 12, on discriminant analysis and logistic regression, are somewhat interrelated, as are Chapters 14 and 15, covering principal components and factor analysis. The function cbind is available to "bind columns" of data, but it can yield unexpected results if the numbers of data points or data types are different in the data sets to be merged. Additional information that is sometimes given includes the number of cases that have missing values, how missing values are coded, the largest and smallest value for that variable, simple descriptive statistics such as frequencies for each answer for nominal or ordinal data, and means and standard deviations for interval or ratio data. We encourage readers to obtain data from either web site and frequently refer to the solutions given in the UCLA web site for practice. The first one is the CRC web site: If a data set included information on sex, age, and use of contraceptive pill, describe a consistency check that could be used for this data set. The choice between these two formats can be a matter of personal preference, but in general the spreadsheet is used for data sets with a small or medium number of variables and the form is used for a larger number of variables and for studies requiring detailed records of data entry and potential data changes. The second strategy is to use the data entry package or system provided by the statistical program you wish to use. Over the years, he taught well-attended courses in biostatistics for public health students and clinical research physicians, and doctoral-level courses in multivariate statistics and multilevel modeling. A multiple linear regression equation is computed, where cost is the outcome variable and the other factors are considered as candidates for predictor variables. This subset of observations is large enough to provide a good illustration of the statistical techniques but small enough to be manageable. These persons are given a score of 1 in variable 30, the CASES variable. That value should then be replaced within the software program, using an appropriate command, by that program's specific missing code. For example, using SAS one could state if sex = 9, then sex = . Section 1.5 then outlines the organization of the book. If the package available to you lacks needed features, then you may wish to perform these operations in one of the spreadsheet or relational database packages and then transfer the results to your statistical package. In SPSS the JOIN command with the keyword ADD can be used to combine cases from two to five data files, and in Stata the append command is used. By applying these limits, extreme or unreasonable outliers are prevented from entering the data set. If results are saved interactively (point and click), then it is recommended that multiple copies be saved along the way until you are perfectly satisfied with the results and that a memo facility or other program be used to document your steps. They also have information on age, sex, income, other indebtedness, length of residence, type of residence, family size, occupation, and the reason for the loan. Almost all graphics in this chapter are made using R, with Section 4.5 containing a discussion of graphical capabilities to create these graphs in other statistical software programs. The material in Chapters 2-6 was deliberately included to fill this gap in preparing investigators for real world data problems. The value in each cell is the number of records in the data set with that combination of factor levels. The scale must satisfy the basic empirical operation of preserving the equality of intervals. Now imagine that you find out that there were additional errors in the original data, or that additional data records are now available and need to be included in the analysis. In contrast, the Mohs Hardness Scale does not satisfy this condition since the intervals between successive categories are not necessarily the same. For example, in the treatment of a given disease a specific drug may be used. 2.3 Stevens's classification of variables In the determination of the appropriate statistical analysis for a given set of data, it is useful to classify variables by type. In the modified boxplots, outliers are typically denoted as points or dots outside the fences. ASCII (American Standard Code for Information Interchange) files are more commonly known as plain text files and can be created by almost any spreadsheet, data management, or word processing program. Dr. May has taught courses on introductory statistics, clinical trials, and survival analysis. 4.2.2 Continuous data Continuous data by definition can take on infinite possible values, so the above plots that display frequencies of records within a finite number of categories do not apply here unless the continuous data are categorized into distinct groups (e.g. income brackets). Several books are available which discuss statistical analysis using Stata; see Lalanne and Mesbah (2016), Hamilton (2012), Hills and Stavola (2012), or Cleves et al. The summary variables may later be used either as outcome or predictor variables. • For your eyes only (4.1a): Made by the analyst, for the analyst, these plots are quick and easy to create, using the default options without any annotation or context. In addition, many of the statistical packages also allow the user to import data from other statistical packages. Lung function study The purpose of this lung function study of chronic respiratory disease is to determine the effects of various types of smog on lung function of children and adults in the Los Angeles area. Only a subset of the factors measured on a subsample of the respondents is included in this book's web site in order to keep the data set easily comprehensible. Nevertheless, the investigators want to separate the patients into unique groups and to examine the resulting groups to see whether distinct types do exist and, if so, what their characteristics are. Depending on the defaults of the software program, the segments may start either at the 12 o'clock position or the 3 o'clock position. In general, as can be seen in Table 3.1, SPSS and SAS have extensive data entry features. The second way in which values can be considered missing is if the data values are beyond the range of the stated maximum or minimum values. One method for classifying variables is by the degree of sophistication evident in the way they are measured. This is referred to as double data entry and the resulting files are compared to identify data entry errors. The kernel density is a function, f(x), that is generated from the data set, similar to a histogram. The outcome variable may be a discrete variable classified as "cured" or "not cured." The outcome variable may depend on several characteristics of the patient such as age, genetic background, and severity of the disease. For example, in a survey it may be impossible to reach a potential respondent or the subject may refuse to answer. To summarize, there are three important considerations in data entry: accuracy, cost, and ease of use of the data file. Whichever system is used, the investigator should ensure that the data file is free of typing errors, that time and money are not wasted, and that the data file is readily available for future data management and statistical analysis. There are numerous ways to depict data using dots on a graph. It is important to note that sometimes making research data available to the scientific community or beyond needs to be done in such a way that confidentiality of participants are protected. 2. The effort then is reduced to a careful review and update of any written results. A more complete discussion of using weights for adjustment of unit nonresponse can be found in Groves et al. 14.3 Data example 14.4 Basic concepts 14.5 Interpretation 14.6 Other uses 14.7 Discussion of computer programs 14.8 What to watch out for 14.9 Summary 14.10 Problems 281 281 281 282 282 285 292 294 294 295 296 15 Factor analysis 15.1 Chapter outline 15.2 When is factor analysis used? It also includes a new chapter on graphics and data visualization and presents a rough guide to assist in the choice of an appropriate multivariate analysis. If X 1 is the mean for males and X 2 is the mean for females, then a weighted average could be computed as $X = w_1 X_1 + w_2 X_2$ $\sum w_i X_i = w_1 + w_2 \sum w_i$ Another common technique is to assign each observation a weight and the weight is entered into the data set as if it were a variable. For example, if the property we wish to measure is the cost of keeping the air clean in a particular area, we may be able to come up with a reasonable estimate, although different analysts may produce different estimates. In the rest of the chapters, we follow a standard format. 2) adding a violin plot to show the density (reflected around the mid-line of the boxplot, Figure 4.10a). Aggregate data on population size, income, educational level, proportion of population living in metropolitan areas, etc. From this plot one can get an idea of how the data are distributed and know the actual values (of ages in this example). Thus respondents who answered item C2, "I felt depressed," could respond 0-3, depending on whether this particular item applied to them rarely or none of the time (less than 1 day: 0), some or little of the time (1-2 days: 1), occasionally or a moderate amount of the time (3-4 days: 2), or most or all of the time (5-7 days: 3). Our deep gratitude goes to our spouses, Marianne Afifi, Bruce Jacobson, Ian Donatello, and Welden Clark, for their patience and encouragement throughout the stages of conception, writing, and production of the book. The file could be called "depress." Statistical packages commonly allow the user to designate the format and type of variable, e.g., numeric or alphabetic, calendar date, or categorical. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. Access allows entry using forms and provides the ability to combine different data sets. The first of the four methods listed above can only be used with a limited number of programs which use program or procedure statements, for example R, SAS or Stata. A large number of variables for each case can be seen on a computer monitor screen and they can be arranged in a two-dimensional array, instead of just the one-dimensional array available for each case in the spreadsheet format. Also, it may have occurred only at the start of the study or close to the end. The codebook, the variables used, and the data set are described below.

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