Web Based Factorial Survey and Statistical Analysis Software

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Abstract:
Virtually anyone seeking information from a given group of people faces this dilemma: as one asks for more information, potential participants become more reluctant to provide all the information. Such reluctance is as likely to be on the basis of time and trouble as on grounds of sensitivity. Factorial surveys, however, permit researchers to sample different combinations of information from different respondents, thus allowing different respondents to contribute data to a subset of the full survey. To date, existing factorial survey software does not allow a researcher naïve to programming to design a survey and sampling protocol, and gather data (via internet) under the same umbrella.

e4Xchange Corporation, a software development organization and a NASA Industry Partner, has developed an intuitive and user friendly software solution to address the end–to–end needs of researchers conducting factorial and non-factorial surveys for the Centers for Disease Control and Prevention. e4Xchange has completed the Phase I proof of concept and has moved on to Phase II, full scale development. Proof of concept entailed developing factorial algorithms such that the survey designer could specify dimensions and levels of dimensions, which would then be sorted into all possible combinations and randomly presented.

Phase II is being built around four functions: design, web publishing, response, and analysis. Design is the cardinal function, with the user able to develop "static" survey questions with varied response options, as well as factorial questions with varying numbers of factors and levels of factors. The designer simply writes a story (vignette) in a text box and names factors directly within that vignette. The designer then defines and names levels of factors, earmarks invalid combinations for partial factorial designs, and lets the program do the rest. Eligibility criteria and block randomization, if needed, can be built into the design, and the designer can specify or randomize the order of questions (or even just some of them), as well as denote skip patterns. Notably, the software is unique in that the user need not have to be a computer programmer to build complex factorial surveys.

Respondents log on, anonymously or confidentially, and either as a convenience sample or according to user-designed sampling protocols. The output is readable in a spreadsheet format, and therefore via common statistical programs (e.g., SPSS or SAS). Potential statistical analysis of output ranges from descriptive statistics to experimental frameworks from the General Linear Model (e.g., analysis of variance/regression, curve estimation). The program has web publication functions: when to publish surveys on the web, for how long, and for how many respondents. Survey access can be web-based, email, or hard copy.

In sum, the software is designed to accommodate the needs of data-gathering and statistical analysis requirements of government, educational, and private industry.

Introduction

Virtually anyone seeking information from a given group of people faces this dilemma: as one asks for more information, potential participants become more reluctant to provide all the information. Sensitivity is certainly one issue, but time and trouble is another. When the test taker is remote from the administrator, the issue is exacerbated – anyone who has administered a web-based survey will have had people drop out simply by shutting down the browser. To persevere with a lengthy survey stuffed with detailed questions costs more money and risks enrollment and retention rates, not to mention sample bias. Thus, one often has to reduce the number of dimensions assessed (e.g., topic areas or domains of content) and to sample them more crudely.

Public health contains many examples of such reductions in sampling and sampling complexity. One example lies in health care-seeking: a questionnaire asking about clinical assessment of a sexual history will typically have a basic yes/no question: Do you take a sexual history from your patients? Ongoing research, however, suggests that many who answer yes to this question answer no when they are asked if they assess particular elements of a sexual history. (1)

Factorial surveys, however, permit researchers to sample numerous different levels of numerous dimensions while maintaining their ability to examine interactions between the different dimensions. In a factorial survey approach, each respondent receives at least one stimulus question (typically a vignette) that contains one combination of systematic variations in the levels of each dimension included in the survey.

The Details of Factorial Survey Sampling

Let us observe the process in more detail. The sample material that follows is drawn from one of the author's previous work on clinical assessment of patients with a possible sexually transmitted infection. (2) First, we show the requirements for a standard survey in this area that covers the necessary dimensions and sampling level of detail. The dimensions included symptoms, patient characteristics, physician characteristics, sex partners and partner management, with the intention of assessing the individual effects (i.e., main effects controlling for the effects of the other dimensions) and the interactions of these factors. A non-factorial survey maintaining the necessary detail would rapidly become a very complex instrument. The problem is exacerbated further if each dimension has several levels (e.g., several different types of patient reported symptoms). If a survey was confined to three symptoms, two levels of every other dimension mentioned above, and asked about only one potential physician response (e.g., whether to order an STD test), then respondents would have to answer 24 questions (3 x 2 x 2 x 2 x 1) where each question would differ in only a small degree from the one before. Each question would essentially constitute a small case study. Asking about two behaviors would require 48 questions and asking about four behaviors would increase the number of questions to 96, quickly exhausting respondents' patience and probably reducing survey participation. In the research from which this example is drawn, the authors were interested in 13 possible clinical actions! One solution to this problem of exponentially increasing numbers of questions is to ask about each dimension separately (e.g., would you be more likely to order an STD test if the patient was male?), but this eliminates examination of the interactions between the identified dimensions. When, as in this example, the interactions are relevant to clinical practice, to lose the ability to measure interactions reduces the applicability of the research.

Factorial surveys permit researchers to sample different levels freely while maintaining their ability to examine interactions between the different dimensions. In a factorial survey approach, each respondent receives a vignette that systematically varies the levels of each factor included in the study. The survey's creators ensure that they have covered every possible hypothetical combination and that they have enough respondents to yield adequate statistical power. Taking the 96-combination version from the previous paragraph as an example, a researcher who wanted 10 responses per combination, and who was willing to give two combinations (i.e., case vignettes) to each respondent, would need only 480 respondents in total. What one gives up with the factorial approach is the advantage of collecting complete data for each respondent on all possible variations of the vignette, so the factorial approach is most useful when variables, rather than individuals, are the primary item of interest.

In the study of clinical responses to patients presenting with possible sexually transmitted infections, (2) the authors chose to include patient symptoms, as they are theoretically the primary determinant of the clinical encounter. They also included the health status of the patient's sex partner(s) (if known) and the patient's risk behavior(s), which are indirect, but important, diagnostic tools that identify cues that a given patient may have an inflated STD risk. Finally, when discussion of sex and sexuality is concerned, current literature suggested the sex of the physician and the patient may affect the course and comfort of discussions about sensitive behaviors during a patient visit. Consequently, we chose patient sex as one dimension for the factorial survey and physician sex as the final dimension. In total, five dimensions were assessed. Four could be embedded in the vignettes, and the final dimension was the sex of the responding physician. By comparing physicians' reports of what clinical actions they would take in response to a given vignette, it becomes possible to construct a portrait of physicians' reactions to different hypothetical patient presentations.

Practical Issues Pertaining to Devising a Factorial Survey

Based on the description above, one might expect that factorial surveys pervade the literature, but they do not. The survey noted above required substantial contract funds, and over a year to construct. There are computer-based algorithms for generating combinations, but these are generally either ad hoc or require programming language skills. What is needed is a user-friendly construction tool, with user-friendly entailing no need for programming language skills and an output that can be analyzed with the same statisitcal tools as are used for other surveys.

In San Jose, CA, e4xchange corporation has completed a Phase I proof of concept and has moved on to Phase II, full scale development. Proof of concept entailed developing factorial algorithms such that the survey designer could specify dimensions and levels of dimensions, which would then be sorted into all possible combinations and randomly presented. The design component was accessible via a web server, respondents could log on, and the data output was readable in a spreadsheet format, and therefore via common statitical programs (e.g., SPSS or SAS).

Phase II is being built around four functions: design, administration, response, and analysis. Design is the cardinal function, with the Phase II software including the addition of static questions (e.g., "Table 1" items) and the ability to simply write a vignette in a text box and name the dimensions directly within that vignette. The designer then defines and names levels of dimensions, earmarks invalid combinations for partial factorial designs, and lets the program do the rest. Eligibility criteria and block randomization, if needed, can be built into the design, and the designer can specify or randomize the order of questions (or even just some of them), as well as denote skip patterns. Response categories can be categorical, ordinal, interval, or ratio, captured via numbers or text. The designer can create a qualitative measure as well as a quantitative measure, or mix and match.

The program will also have full administrative functions: when to publish surveys on the web, for how long, and for how many respondents. The administrator can permit people to fill out the survey once or multiple times, choose whether to allow the respondent to exit and return to the survey, and whether to allow non-responses (IRBs will naturally insist on the latter for research). Survey access can be web-based, email, or hard copy. Response functions are as above, as constrained by the administrator. The most efficient use of analysis seems to be to produce data that is readable in CDC's most common analysis programs, such as SPSS, SAS, and Epi Info. A generic spreadsheet is readable in these formats, but Phase III versions may permit one to save directly into one of those program formats.