SUSTAINING COMMUNICATION OF THE VALUE OF STATISTICS IN THE HUMANITIES

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The value or utility of statistical inference has not been well-understood among researchers in the humanities. To clarify, the approaches and methodologies of the humanities[1] are primarily interpretative. With appropriate emphasis on interpretation, I argue that a good starting point[2] for effective statistics education in the humanities is in highlighting controversy that continues to exist, such as investigating when statistical inferences are valid, and how to interpret results from statistical methods. Specifically, I present one way of defining a genuine principle of evidence, as well as reasons why principles of evidence are far-reaching. The import of evidence as a concept is accepted in the humanities, and the humanities are similar to sciences in that both involve the analysis and interpretation of evidence.

INTRODUCTION

For many years, statistics has typically been taught as a branch of mathematics, in a way that emphasizes performing computations and memorizing formulae. Though, it is worth noting that there has been much effort recently to focus attention on developing students' capability to think statistically. For example, the current GAISE College Report acknowledges the "importance of giving more people a sounder grasp of the fundamental concepts needed to use and interpret those tools intelligently" (American Statistical Association, 2010). Thus, there is a growing emphasis in statistics education on providing appropriate resources for advancing *statistical reasoning*: "the way people reason with statistical ideas and make sense of statistical information" (Garfield & Gal, 1999). In other words, there is a recent call to implement a "Statistical Reasoning Learning Environment" (Garfield & Ben-Zvi, 2008): a *learning environment[3]* that aids students in developing their ability to think and reason statistically.

In responding to that call, this paper offers one way to extend statistics instruction to a relatively neglected group, namely humanities majors. Even though students take statistics courses for different reasons, I think it is safe to infer that the most popular reason for taking a statistics course is to satisfy requirements for various science majors, as little to no humanities or arts majors requires statistics courses. Having said that, the formulation of statistics as involving "distinctive and powerful ways of thinking" (Moore, 1998) aligns well with the humanities – broadly defined as the study of the numerous ways in which people process and document the human experience. "The humanities remind us where we have been and help us envision where we are going. Emphasizing critical perspective and imaginative response, the humanities – including the study of languages, literature, history, film, civics, philosophy, religion, and the arts – foster creativity, appreciation of our commonalities and our differences, and knowledge of all kinds" (Commission on the Humanities and Social Sciences, 2013).

For this reason, relating statistics to the humanities requires concentrating on the rationale and interpretation of the well-known statistical tools, rather than on computations and formulae. To make clear how such a task is to be accomplished, the outline for this paper is as follows: in section 2, I provide some general remarks on the relation between "natural sciences"[4] and humanities, with the intention to highlight the similarities between statistics and humanities; lastly, in section 3, I propose specific questions, and the consequential concept of evidence, as a useful step toward establishing meaningful connections between statistics and the humanities. With appropriate emphasis on interpretation, this paper argues that a good starting point for effective statistics education in the humanities is in highlighting controversy that continues to exist in scientific/statistical practice.

THE RELATION BETWEEN NATURAL SCIENCES AND HUMANITIES

There has been very little interaction between scientists and humanities scholars, largely due to the widespread perception that the humanities and the more technical fields (e.g.,

engineering, physics, statistics) are discordant or incompatible with each other. In contrast, the view I endorse, which emerged from Wilhelm Dilthey's "Introduction to the Human Sciences," advocates a closer relation between natural sciences and humanities (or "human sciences", Dilthey, 1991). Accordingly, this section seeks to illuminate the relation between statistics and the humanities, which forms the basis for section 3.

Even though approximately two centuries have passed since Dilthey's writing, much of it still applies today. To begin with, "The relation to be clarified consists first of all in the fact that these natural conditions determine the development and distribution of human life on the face of the earth, and secondly in the fact that the purposive activity of man is bound by the laws of nature and is thus conditioned by his knowledge and use of them." (1991, vol. 1: Introduction to the Human Sciences, bk. 1 chapter 3). From this passage, Dilthey distinguishes the humanities from the natural sciences in the following way: the humanities concern the development of human life, our relation to society, and our capacity to acquire and use knowledge; whereas the natural sciences constitute an accumulation of facts about the material world, as it exists without human beings or civilization. Natural sciences without humanities largely take for granted the knowledge we are able to gain without questioning how we do so, and neglect those critical aspects that make us human beings. On the other hand, humanities without natural sciences is incomplete because it does not take into account the results derived from scientific theories and experiments that form a considerable portion of knowledge we are able to obtain. Hence, both humanities and natural sciences are needed, in order to fully make sense of the environment we live in. At this point, it is worth noting that the humanities are similar to natural sciences in that both involve the analysis and interpretation of evidence – information indicating whether a hypothesis is true or valid. Therefore, the natural sciences and humanities are closely related to each other.

In relating the above discussion to the more specific relation between statistics and the humanities, statistics is often treated as a natural science when it also has close ties to the humanities. As Dilthey says, "statistical studies permit a quantitatively based insight into those social data which they can encompass, though only for that limited time-span and narrow range of countries within which they have been applied; they make it possible to give a precise basis to information about the present state of those societies" (1991, vol. 1: Introduction to the Human Sciences, bk. 1 chapter 5), which is pertinent to the development of human life. Then, the study of statistics is interdisciplinary, in the sense of connecting and integrating several disciplines (e.g., philosophy, history, mathematics) – along with their specific perspectives. To give a better sense of how statistics relates to the humanities, the four principal tenets of core curricula in the humanities are: "1. great books; 2. major historical periods or junctures; 3. overarching themes, ideas, and motifs; and 4. ways of knowing" (Klein, 2005, 210). If we regard statistics as involving thinking, in a way similar to (Moore, 1998), then statistics fulfills the fourth principal tenet listed above, and can be directly relevant to the humanities. This is because statistics is about finding out what really is the case in all contexts involving uncertainty and variation, including the complexity of human culture. Having indicated a proximate relationship between statistics and humanities, I offer suggestions in the next section on how to extend statistics instruction to humanities majors.

THE UTILITY OF STATISTICAL INFERENCE IN THE HUMANITIES

Fortunately, there already has been some effort in advocating the study of statistics to the humanities in (Mayo, 1980). However, the value or utility of statistical inference has not been well-understood among researchers in the humanities, and this section intends to further motivate why statistics should be extended more to humanities majors. For one thing, inadequate attention to foundational questions in statistics has raised much controversy and confusion about which methods to use and how to interpret them, both among philosophers and those that apply statistics (e.g., sociologists, political scientists) (Mayo, 1980). Highlighting this controversy that continues to exist in scientific/statistical practice then gives humanities majors a profitable opportunity to contribute to the study of statistics with minimal knowledge of the underlying mathematics. To highlight such controversy, I suggest asking the following open questions: What is the role of probability in uncertain inference? (to assign degrees of confirmation or belief? to characterize the reliability of test procedures?) Are there principled grounds for selecting from among model selection techniques (e.g., Akaike, Bayesian information)? When are statistical inferences valid?

What enables particular statistical methods (e.g., significance tests, confidence intervals) to perform valid and informative inferences when they do?

Also, getting clear on the reasoning behind different types of inferences is relevant to problems concerning public policy involving statistics, which concern our relation to society – a component of the humanities. Questions about the justification of such policy (e.g., banning substances claimed to "have been determined to cause cancer in rats") are very much dependent upon being able to analyze the validity of the reasoning on which they rest (Mayo, 1980). As mentioned in section 2, the humanities are similar to natural sciences in that both involve the analysis and interpretation of evidence. With this similarity in mind, few would dispute the fact that the import of evidence as a concept is accepted in the humanities. Regardless of the discipline and the type of data collected – whether in the humanities or natural sciences, there is a pressing need to determine what information counts as strong evidence in favor of a hypothesis – broadly construed as any provisional conjecture to guide investigation.

Using the common interest in interpreting evidence as a bridge between humanities and statistics, I recommend introducing genuine principles of evidence when educating humanities majors about statistics. The reason for this suggestion is statistical inference has become an indispensable tool for obtaining evidence in all situations of partial or incomplete information. Appropriately, the enterprise of supplying genuine principles of evidence is becoming urgently pressing in today's debates connecting statistical inference, and data analysis, because even those largely concerned with applications of statistical methods remain interested in identifying general principles that underlie and give grounds for the procedures they respect on practical grounds. Furthermore, I propose that a principle of evidence counts as being genuine by giving us reasons for how we are to obtain desirable properties in constructing excellent estimators or hypothesis tests, especially reasons for indicating strong evidence for or against a statistical hypothesis.

That is, such genuine principles of evidence should go beyond the properties (e.g., performance of a hypothesis test or an estimator) themselves, and equip us with suitable tools to help justify how we are able to obtain such properties (e.g., excellent performance, compelling evidence) in the first place. Put in another way, felicitous genuine principles of evidence should provide concrete guidelines for either interpreting results from statistical techniques, or for following a correct logic of an entire inquiry from designing an experiment to drawing a conclusion. Such guidelines are material for fulfilling the goal of making an inference about what exactly is the case regarding a particular phenomenon (i.e., gaining accurate knowledge about (aspects of) a phenomenon), and yet are clearly lacking in the currently used frameworks of statistical practice. Nevertheless, I think that the most constructive way to evaluate a principle is in assessing it on how well it aids in fulfilling the goals or aims of the inquiry at hand.

Having defined a genuine principle of evidence, here are some reasons why such principles are far-reaching. Without genuine principles of evidence, it is easy to get caught up in the mathematics or more technical components of the experiment, which often leads to losing sight of the goal of performing the inquiry in the first place. For any mathematical entity (e.g., posterior probability, p-value), the question isn't getting the formal definition down, but rather the relevance of such a computation for the case at hand. Many researchers might think they want a posterior simply because they do not see how to use error probabilities (i.e., probabilities that quantify a method's capability to avoid various errors) in appraising evidence in the case at hand. But lacking a suitable definition of the prior and posterior probabilities, this leaves researchers very puzzled about the justification of statistical methods as evidence. Thus, genuine principles of evidence highlight the need to consider the rationale behind using these statistical tools – not just the mathematics underlying those tools. The output of a genuine principle of evidence – in the way I defined it – is deciding what does or does not count as evidence in favor of an hypothesis, and a rigorous account of why that should be the case.

To sum up what I take to be the defining characteristic of a genuine principle of evidence, if we are to take seriously this contribution to better apprehension of the actual processes behind successful application of statistical methods, then the appropriate conceptualization of evidence should supply us with a systematic but not necessarily fully formalized way of evaluating whether there is strong evidence for or against a hypothesis. As argued in my forthcoming Master's thesis, one genuine principle of evidence that meets my expectations is Deborah Mayo's severity

assessment or evaluation. Essentially, the intuition behind requiring severity evaluations is: if a test would very probably lead to an agreement between hypothesis *H* and the observed data, then finding such an agreement is poor evidence for *H*. The rationale behind severity is that error probabilities may be used to make inferences about the data gathering process by enabling assessment of how well probed hypotheses are. Moreover, the severity assessment is a useful tool in scrutinizing when statistical inferences are valid. Consequently, I urge that extending statistics instruction to humanities majors includes an introduction to both genuine principles of evidence and the severity assessment.

CONCLUSION

In this paper, I have offered one way to extend statistics instruction to humanities majors, who rarely get exposed to statistics due to the historically strong emphasis on the mathematical or technical aspects. I have also indicated a closer relationship between the natural sciences and humanities in general, with the intention of emphasizing the proximate relationship between statistics and the humanities. With the recent movement in statistics education toward focusing more attention on developing students' statistical reasoning, I suggested that statistics fits well with the humanities, and is not only a natural science. I also offered several open questions that could be used to motivate productive study of statistics in the humanities. Using the common interest in interpreting and analyzing evidence as a bridge between statistics and humanities, I introduced genuine principles of evidence as a useful way of scrutinizing when statistical inferences are valid, which would make much needed progress in resolving current debates in statistical practice. Informing students about genuine principles of evidence aids them in grasping the reasoning behind the usage of statistical tools, by highlighting the rationale for applying statistical methods in the first place.

ENDNOTES

[1] academic disciplines that study human culture, using methods that are primarily analytical/critical ("Humanity", 2013) – distinguished from the mainly empirical approaches of the sciences.

[2] utilizing aspects of (Mayo, 1980).

[3] "the combination of text materials, class activities and culture, discussion, technology, teaching approach, and assessment" (Garfield & Ben-Zvi, 2008).

[4] includes physical sciences, life sciences, and mathematical sciences (including statistics) – disciplines that rely primarily on quantitative methods.

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