Delegating Agency among Researcher, Biostatistician and Computer Machinery: Modeling in Biostatistics

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Abstract: Medical researchers exercise and delegate agency for making inferences or for making claims. In the biostatistical consultations discussed here, they encounter three key knowledge-producing agents in the "epistemic culture" (Knorr Cetina, 1999) of biostatistics: themselves, biostatistician and computer machinery. Who or what does what occurs amidst a "dance of agency" among the participants (Pickering, 1995). These interpretations provide support for recent reforms employing modeling approaches in science and mathematics instruction in K-16 settings.

Introduction

Broadly speaking, medical researchers and biostatisticians in consultations recognize each others' differences in expertise. Medical researchers defer to the biostatistician for a suitable model that, once employed, will justify inferences that attribute observable patterns in data from a sample as indicative of some true characteristic of a population. Likewise biostatisticians rely on the medical researcher to turn measures obtained in the laboratory or medical setting into data suitable for statistical analysis. Both human agents rely on computer machinery to do a tremendous amount of computational, graphical, and tabular work that becomes the basis of further analytical work to be delegated among the human agents. They also rely often on computational machinery to provide menus of options for building a statistical model and subsequent graphical outputs. Thus the overall task of selecting, building and running a statistical model is a joint task involving the coordinated expertise of medical researchers, biostatisticians and the computer machinery. For the "agency" of computer machinery, I mean this in the sense employed by Pickering (1995), who underscores that only humans employ the kind of intentionality that we normally attribute uniquely to humans. Nevertheless, scientists must adopt a passive stance as they observe what their investigative machinery, and the unknown features of the material world they interact with, will actively accomplish. Machines have agency in the sense that once built and "run", only they can determine what heretofore had been indeterminate.

This paper reports from a multi-year study of learning and teaching in a biostatistics department associated with a medical school in the United States. Field data come from two main lines: (1) Audiorecordings, videorecordings and notes from several public lectures, attended mostly by biostatisticians, and (2) Videorecordings of several biostatistical consultations (meetings between biostatistician and researcher(s) for advice on interpreting data or designing a study), as well as follow-up interviews focusing on selected episodes as the basis for questioning. The field data from line (1) provides a framework for a "practice account" (Schatzki, Knorr Cetina & von Savigny, 2001) of biostatistical research, an opportunity to describe the "epistemic culture" (Knorr Cetina, 1999) of biostatistics. I use this practice approach with the intention of understanding the activities of this community dedicated to knowledge creation. Field data from line (2) provides an opportunity to examine from an ethnomethodological standpoint (Garfinkel, 1967) the local activity of learning to conduct medical research. The learners, for my purposes here, are medical researchers who seek advice on how to turn their data into defensible claims in research journals. Learning is here characterized by those local interactions responsible for acclimating these researchers to the epistemic culture of biostatistics. Here I foreground the question, *As participants attempt to create characteristics within a population from observable patterns within a sample of data, how do medical researchers learn to exercise and delegate agency among themselves, biostatisticians and their machinery?* By wording the question this way, I do not mean to suggest that they produce knowledge out of whole cloth. The patterns they observe in samples are real, but only by means of inference can these patterns be made to pertain to populations. They are all too aware of the contingent nature of findings. It is as if medical facts reside a liminal space between the status of the inherently provisional and the status of the statistically significant result.

Learning in Biostatistical Consultations

Learning biostatistics might be characterized as the process of inserting oneself into and acclimating oneself to the epistemic culture of biostatistical research. The videorecordings of consultations provide an opportunity to study the dynamics of such learning as participants interact. Such consultations are institutional responses to the need to reorganize future work (Hall, Wright & Wieckert, 2007). They therefore represent a unique opportunity to examine how local activity might bear on the greater epistemic culture. In the interactive poster session, I will present video episodes from one biostatistical consultation and will highlight some key

aspects of episodes where participants exercise or delegate agency to others. The poster itself will provide a synoptic view of other consultations in an attempt to convey the prevalence of these following aspects: (1) The import of a claim is reflexively bound to the legitimacy of the agent to make such claims. This self positioning may take on various forms, from more provisional stances that invite others to join in the task of claim-making, to more resolute and definitive stances that arrogate the task of claim-making uniquely to oneself. Furthermore, participants may position others as having agency and/or responsibility for making claims about data. (2) Outlines of agency. When things go smoothly, participants tend to exercise and delegate agency in mutually consistent manners, along the lines of a harmonious distribution of labor. Researchers tend to delegate model selection to biostatisticians (who in turn sometimes rely in part on computer machinery), but exercise agency to generate the research question of interest. These humans delegate to the computer machinery the task of computation (far from trivial), the production of summary tables and graphs and the reporting on any contrasts or significant trends. The computer machinery also solicits information by way of graphical user interfaces that pop up. However, things do not always go smoothly and when they do not, participants reveal where the bounds of their presumption of agency are. (3) Biostatistical consultations are often quests to determine an appropriate, workable and defensible statistical model, and to make it articulate with the data at hand or potential future data. Participants rely on the computer machinery to compute estimates of values and to display summarizes of these data in tabular and graphical form. Because these displays in turn become useful for analysis and for the generation of knowledge claims, they do more than simply illustrate the statistical model – they become models themselves and serve as "epistemic artifacts" (Knuuttila, 2003).

From Learning in Epistemic Cultures to Learning in Schools

Other recent work in the learning sciences has explored agency in educational settings (Charles & Shumar, 2007) and this paper too explores agency in similar, temporally emergent terms, but with the added feature of machinic agents. Interpretation of biostatistical modeling as a collaborative dance of agency among humans and machines provides support for modeling in mathematics and science education. The modeling movement has directed our attention to teaching students to experience the feel of scientific research, both on a personal level and on a collective level of collaboration with others (Lesh & Doerr, 2003; Lesh, Hamilton & Kaput, 2007), consistent with notions of learning as participation (Lave & Wenger, 1991). From this perspective, modeling provides first hand experience with knowledge production within a culture devoted to the cultivation of people. For these modeling activities, competency for delegating or assuming agency are just as relevant (Scardamalia, 2002), especially with the advent of more sophisticated computer machinery in schools (Borba & Villarreal, 2005).

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