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Original Article

Providing information for decision making: Contrasting description and simulation

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ABSTRACT

Providing information for decision making should be like telling a story. You need to know, first, what you want to say; second, whom you are addressing; and third, how to match the message and audience. However, data presentations frequently fail to follow these simple principles. To illustrate, we focus on presentations of probabilistic information that accompany forecasts. We emphasize that the providers of such information often fail to realize that their audiences lack the statistical intuitions necessary to understand the implications of probabilistic reasoning. We therefore characterize some of these failings prior to conceptualizing different ways of informing people about the uncertainties of forecasts. We discuss and compare three types of methods: description, simulation, and mixtures of description and simulation. We conclude by identifying gaps in our knowledge on how best to communicate probabilistic information for decision making and suggest directions for future research.

1. Introduction

Upon arriving in continental Europe in the early 13th century, Fibonacci convinced people that the Hindu-Arabic numerical system was superior to Roman numerals for making calculations, maintaining quantitative records and conveying information. His work essentially transformed the language in which analyses were conducted and communicated and thereby contributed significantly to both science and everyday life (Savage, 2009). Better understanding of quantitative analyses eventually led to better judgments and decisions.

We propose that providing information to help people make decisions can be likened to telling stories. First, the provider – or story teller – needs to know what he or she wants to say. Second, it is important to understand characteristics of the audience as this affects how information is interpreted. And third, the provider must match what is said to the needs of the audience. Moreover, when it comes to decision making, the provider should not tell the audience what to do. Instead, the latter should draw its own conclusions. That is, as in a well-crafted story, the audience should be free to interpret the outcomes without being told the "message" directly (i.e., what to do).

In this paper, we argue that our story telling metaphor does not capture how information is typically presented for decision making in applied settings. However, the metaphor captures principles that can improve decision makers' understanding of the situations they face and their satisfaction with the alternatives they select.[1] Our aim is to highlight and provide a perspective about these principles, given possible methods of communicating information for decision making. We consider the standard method of description and use it as a benchmark to discuss the benefits and weaknesses of an alternative approach: providing experience through simulations. Finally, we reflect on possible hybrid techniques that merge descriptions and simulations. To make our ideas concrete, we concentrate here on the presentation of information about uncertainty associated with taking different actions. However, we believe that the principles apply across a wide range of types of problems.

Our interest in this issue was stimulated by a survey we conducted of how economists interpret the results of regression analysis (Soyer & Hogarth, 2012). In this study, academic economists from prestigious universities answered questions about making decisions in light of the results of a simple regression analysis. The economists were given the outcomes of the regression

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[1] We emphasize that we use the term "story" in a metaphorical manner. Most forecasts are, of course, not stories in that they lack characters and plots that evolve across time. However, both forecasts and stories require transmitting information in an accessible manner.

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analysis in a typical, tabular format and the questions involved interpreting the probabilistic implications of specific actions given the estimation results. Hence, the participants had available all the information necessary to provide correct answers, but in general they failed to do so. Although their answers were influenced by the uncertainties concerning the model's regression coefficients, they tended to ignore the uncertainty involved in predicting the dependent variable conditional on values of the independent variable. As such they vastly overestimated the predictive ability of the model. Our survey also involved another group of similar economists who only saw a bivariate scatterplot of the data. These economists were accurate in answering the same questions.

Now academic economists typically do not use the results of regression analysis for decision making purposes and thus perhaps our survey was "unfair". However, since these economists were statistical experts (econometricians), their poor performance raises the issue of what people really understand when they consult data provided for decision making. Second, that one group made accurate answers after only seeing a scatterplot suggests that such displays could be used for better decision making. However, it is not clear that this suggestion would be accepted because, despite the accuracy of their answers, members of this group complained bitterly that they did not have enough information to answer the questions adequately.

As an exercise in providing information for decision making, our survey was a failure. The story did not match with the audience. In particular, the story in this case (regression results) was engineered by the analyst, whose principal aim is typically not to be understood (in terms of improving judgments and decisions) but just to be heard (published). If nothing else, our study showed that different *descriptions* of the same information, lead people to draw different conclusions – a phenomenon that has been documented many times in the literature (Hogarth, 1982).

2. Probabilistic forecasts – issues and challenges

In this paper, we consider the communication of probabilistic forecasts. In essence, this means that the analyst provides the decision maker with a probability distribution over possible future outcomes of a variable of interest. These can cover many different types of applications. Consider, for example, simple forecasts involving the weather (e.g., "Will it rain tomorrow?") as opposed to more complicated issues such as effects of climate change (Budescu, Por, & Broomell, 2012). In the economic domain, one can envisage forecasts involving sales and inventories, as well as outcomes of investments. In politics, probabilistic forecasts can cover elections, trading disputes, and so on.

We emphasize this range of applications because analysts and decision makers may have quite different conceptions when they consider a description of a decision making situation. In particular, the meaning of probability is not clear to many in that it does not necessarily map into people's experience. For example, imagine that a decision maker is told that the probability of rain tomorrow is 0.3. Now, let's assume it does not rain the next day. How should she interpret the meaning of the forecast? Was it correct or incorrect? Our bemused decision maker is not sure because rain could only occur or not occur and a single trial cannot reveal whether a 0.3 probability estimate is appropriate (Lopes, 1981). On the other hand, for a statistically sophisticated analyst, the 0.3 estimate can be interpreted as a personal "degree of belief" (supported intellectually by a Bayesian betting paradigm) or as the limit of a long-run relative frequency (imagining many days when the weather conditions were identical, i.e., as a frequentist statistician).

Given these issues, should analysts simply forget about numerical estimates and instead use verbal statements that describe feelings of uncertainty? Indeed, several studies show that verbal expressions of probability (e.g., phrases such as "unlikely", "almost certain", and so on) can be relatively effective (see, e.g., Budescu & Wallsten, 1985). However, verbal expressions do not have exactly the same meaning for different people and it is problematic to generalize from these results.

A further problem in providing forecasts in the form of probabilities to statistically naïve decision makers is that the latter may make assumptions of which the analysts are unaware. In a revealing study, Gigerenzer, Hertwig, van den Broek, Fasolo, and Katsikopoulos (2005) asked people what they thought was meant by weather forecasts of the form "the probability of rain tomorrow is 30%". There was a wide range of different interpretations including the possibility of having rain during 30% of the day and 30% of the region receiving rain during that day.

At one level, these interpretations are amusing. However, it can be argued that the statement the respondents were asked to interpret was ambiguous. What is missing is clarification of how one would know whether or not it had rained on the morrow. Lacking this insight, it is possible for people to have several interpretations even if statistical experts would not think of them. Statements of probabilities of events should be accompanied by operational definitions such that the occurrence or non-occurrence of the events cannot be disputed. For example, if a person makes a bet conditional on the occurrence of the event, he or she should not subsequently be able to avoid responsibility by changing the definition of the event.[2]

Finally, people may differ not only in statistical expertise but also expertise concerning the issue at hand, e.g., meteorologists know much more about the weather than non-meteorologists. What is unclear is whether such substantive expertise affects the ability to interpret probabilistic forecasts.

3. Human information processing: strengths and weaknesses

We assume that, prior to providing probabilistic forecasts, the analysts have made the appropriate analyses. This being said, we now consider some human strengths and weaknesses in information processing since it is important to understand the factors that help and hinder people in the task of interpreting information.

Although research in psychology and neuroscience can lead one to marvel at the capacity of the human mind, from our perspective, there are limitations. In particular, limits on processing capacity restrict our ability to "take in" all the information that may be relevant to a problem. At any point in time, we can only perceive a small fraction of what is actually in our visual field. Thus, anything that attracts attention is important and the reality in which we operate is bound by this attentional filter. Indeed the literature is replete with examples of how minor shifts in the presentation of information can change a person's conclusions (Einhorn & Hogarth, 1981; Hogarth, 1982). To overcome such problems, through experience people have developed skills in seeking specific information in particular situations so that attention can be guided appropriately. Indeed, this lies at the heart of expertise (Ericsson & Smith, 1991).

A second limitation is that people often fail to consider relevant information precisely because it does not form part of the information presented and they lack the ability to recognize this fact. Consider publication bias (Ioannidis, 2005). Academic publications make information part of the public domain; easily reachable by all consumers of knowledge. If certain analyses (those that find

[2] This betting criterion was originally suggested by Bruno de Finetti.