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The division of labor between human and computer in the presence of decision support system advice

Donald R. Jones [a,*], Darrell Brown [b]

[a]*Department of Information Systems and Quantitative Sciences, College of Business Administration, Texas Tech University, Lubbock, TX 79409-2101, USA*
[b]*School of Business Administration, Portland State University, Portland, OR, USA*

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Abstract

Prior research suggests that decision support system (DSS) provide model advice and display non-modeled information for decision makers [4,13]. We investigate whether decision makers (1) delegate the processing of the modeled information to the model, (2) cognitively process the non-modeled information, and (3) decide based on the model's advice adjusted for the non-modeled information. Experimentally, decision makers were no more likely to execute normative strategies when they had requisite knowledge for the strategy than when they did not have the requisite knowledge. We observed alternative processing, including ignoring the advice altogether, and evaluating the advice. Our findings suggest that DSS builders must encourage decision strategies that capitalize on the relative strengths of human and computer in using those features.

Keywords: Decision strategies; Decision model reliance; DSS development; Human/computer interaction

1. Introduction

When a human decision maker is offered advice by a decision support system (DSS), how does the decision maker divide labor between human and machine in processing available information? Research in psychology and information systems has documented the relative strengths and weaknesses of human judgment and intuition compared to mechanical processing of information and the results are clear: formulas, algorithms, and decision rules are almost always superior to humans when processing the same information as humans, but humans can recognize when such mechanical advice should be adjusted because of additional information or extenuating circumstances (see Ref. [17] for a review). Hoch and Schkade [13] recommended a psychological approach to DSS that supports these relative strengths and compensates for these relative weaknesses of human and machine by providing model advice but also displaying potentially informative non-modeled information to the decision maker.

The question addressed by the current research is whether or not decision makers offered DSS model advice and a set of information, some modeled and some non-modeled, form strategies that capitalize on these relative strengths and weaknesses. That is, do decision makers construct "divide-and-conquer" strategies in which they delegate to the DSS the process-

* Corresponding author. Tel.: +1-800-742-1988.

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ing of information available to the DSS model while focusing their human effort on the information not modeled by the DSS to make adjustments to the model advice?

To address this question, we conducted a computerized process-tracing experiment. In choosing a university, participants had available DSS advice that recommended the highest-ranking university based on a linear model of a subset of the available information. Participants also had access to other non-modeled information that either supported or contradicted the model advice. Participants in a model-revealed condition had enough information to execute the divide-and-conquer strategy while those in a model-hidden condition and a no-advice control condition could not execute the divide-and-conquer strategy. This experimental design enabled us to detect whether decision makers, given the requisite conditions, would use the divide-and-conquer strategy to a greater extent than decision makers not given the requisite conditions. Computerized process data also enabled us to observe alternatives to the divide-and-conquer strategy.

In the remainder of the paper, we describe the divide-and-conquer strategy as well as other possible alternative decision approaches. We then explain our experimental method, describe our results and provide our conclusions.

2. The divide-and-conquer strategy and alternatives

2.1. Advice and non-modeled information

Given an array of information and a judgment or prediction task, most research has concluded that mathematical combination of the information is superior to human intuition or judgment [17]. Extensive early research in the contest of "heads" versus "formulas" concluded that heads almost never win [19]. Particularly persuasive in favor of formulas were findings by Goldberg [11] that a linear composite of personality scales outperformed the best from 13 clinical psychologists, and findings that the particular weights chosen for linear models had little effect on the models' ability to outperform human judges [9]. The advantage of formulas and algorithms is their ability to quickly perform consistent and accurate computations, while human intuition or judgmental combination of available data suffers from inconsistency and imprecision [17].

In these comparisons of human and model, the unaided human suffers from the limitations of bounded rationality, which results from the small amount of information that can be processed by the human brain at a time and the slow speed with which the information is processed [20,25]. In multiattribute choice tasks (similar to the task of our experiment), increasing the information set to only a fairly modest size makes the choice problem sufficiently complex to stimulate decision makers to shift from compensatory strategies (which allow high values of one attribute to compensate for low values of another attribute) to non-compensatory strategies (less accurate but easier strategies) such as elimination-by-aspect.[1] In contrast, mathematical approaches such as linear models embody compensatory strategies, and can be applied to much larger data sets so long as the data are properly structured (see Ref. [21] for discussion and extensive evidence concerning compensatory and non-compensatory decision strategies).

An advantage of human judgment over model computation is the human understanding of when the model advice should be adjusted or overridden. Meehl [18] observed that a model predicting Professor X had a 0.90 probability of going to a movie on a particular night would not hold if Professor X had just broken his leg. Thus, a model user could have other information, not incorporated in the model, that should lead to an adjustment of the model advice [18]. Other research has found that decision makers are influenced by informative non-modeled information when it is available [4,13,30].

2.2. The divide-and-conquer strategy and alternatives

DSS designers should take advantage of the aforementioned psychological findings and create DSS that provide model advice as well as display of informative

[1] In elimination-by-aspect, all alternatives that fail to meet a given threshold of some attribute are eliminated from consideration. This simplification reduces the amount of information that must be processed by the decision maker and makes the choice easier, but it also reduces accuracy since other potentially compensating favorable attributes are not taken into consideration.