The value of information as a verification and regret-preventing mechanism in algorithmic search environments

Madjid Tavana [a,b,#,*], Francisco J. Santos-Arteaga [c], Debora Di Caprio [d,e]

[a] Business Systems and Analytics Department, Distinguished Chair of Business Analytics, La Salle University, Philadelphia, PA 19141, USA
[b] Business Information Systems Department, Faculty of Business Administration and Economics, University of Paderborn, D-33098 Paderborn, Germany
[c] Faculty of Economics and Management, Free University of Bolzano, Bolzano, Italy
[d] Department of Mathematics and Statistics, York University, Toronto, M3J 1P3, Canada
[e] Polo Tecnologico IISS G. Galilei, Via Cadorna 14, 39100, Bolzano, Italy

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ABSTRACT

Information is a fundamental asset in any organization and as such is assigned a value reflecting its importance. We define information to be valuable if it either confirms the choice that a decision maker (DM) would make based on the information acquired on a given alternative or prevents him from making a regrettable choice, or both. We introduce a novel information acquisition algorithm where the value of information is used as a verification and regret-prevention mechanism determining the behavior of the DM. The proposed algorithm shows how the incentives of the DM to continue acquiring information on a given alternative are determined by his attitude toward regret and the relative spread exhibited by the domains on which the characteristics of the alternative are defined. Moreover, our model proves the existence of relative spread scenarios where indecision arises, leading the DM to behave randomly. The generality and flexibility of the model allows to easily develop extensions and applications to decision theory, psychology, economics and operational research.

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1. Introduction

1.1. Motivation and literature review

Information is a fundamental asset in any organization and as such is assigned a value reflecting its importance. Intuitively, the value of information could be defined as the price that a decision maker (DM) is willing to pay to reduce the uncertainty faced in a given decision environment. However, the value that a DM assigns to a piece of information, together with its subsequent effect on his information acquisition and decision processes, differs considerably across the different literature branches analyzing sequential search environments. Decision theorists [25], psychologists [15,28], behavioral

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economists [6] and operational researchers [2,21] each adapt the concept of value of information to their respective settings and define it based on their specific needs.

Moreover, the quantity and quality of information available to DMs in business organizations conditions the quality of their decisions [23]. From a knowledge management perspective, the way DMs use information determines the performance of an organization [4]. In particular, project managers tend to overestimate their decision-making abilities [19], and refuse considering any potential improvement in their quality [11], an attitude that can result in avoidable wrong judgments.

For example, Hallen and Pahnke [12] describe the importance that limited information and bounded rationality have for the misevaluation of potential partners when analyzing their track records. Indeed, the acquisition of information can be described as a strategic managerial process that requires the cooperation of managers and information specialists [40]. Managers must select the information considered to be more useful from the large amounts to which they have access [22]. This selection process is highly important from a strategic perspective and requires the addition of both reputation [10] and regret [39] considerations to the analysis.

The effects that large amounts of available information have on the information acquisition and choice behavior of DMs can also be observed in online shopping environments [5,33]. The paradox of choice identified by Schwartz [29] is the most relevant among these effects. Park et al. [24] perform several experiments to illustrate how DMs exert cognitive effort to minimize negative emotions such as regret in their online and offline decision making processes. Schwartz [30] argues that DMs should focus on robust satisficing, i.e. trying to guarantee a good enough outcome, following the basic precepts of bounded rationality defined by Simon [31]. In this regard, Zeelenberg [41] suggests that robust satisficing may take place via regret minimization in everyday decision making.

The interaction between regret and the value of information is particularly evident in medical environments. For example, Johnson [14] highlights the fact that DMs confronted with health problems engage in low levels of information seeking or even avoid seeking any information. Fels [9] elicits the value of information when DMs consider potential disappointments after receiving negative news and are loss averse to changes in their beliefs. The author shows that the emotional impact of information depends on whether or not it determines future decisions. That is, DMs account for the potential dynamic consequences derived from receiving a given piece of information when determining its value.

Lerner et al. [16] and Bagozzi et al. [1] review the literature on emotion and decision making and suggest that, given the regularities observed regarding the effects that emotions have on judgments and choices, decision theorists should include emotions as drivers of decision making. In particular, decision theoretical models should acknowledge the fact that DMs aim at anticipating potential regrettable choices when making a decision [1,27,37].

The remainder of the paper proceeds as follows. Section 2 describes the main contribution of the model introduced in the paper. Section 3 provides the basic notations. Section 4 describes the proposed information acquisition setting. Section 5 introduces the concept of value of information as a verification and regret-preventing mechanism, shows how the value of a new piece of information can be determined through two well-defined real-valued functions, and defines the selection criterion to identify the best information acquisition option. Section 6 introduces the concept of dynamic incentive and describes the stopping criterion of the algorithm determined by the beliefs of the DM. Section 7 presents several numerical examples relative to the main formal results. Section 8 implements the model to a sequential information acquisition environments similar to those generally found in online evaluation settings. Section 9 concludes and suggests potential applications.

2. Contribution

The information acquisition model introduced in the current paper accounts for the main features outlined above regarding the value of information, the regret-based incentives determining the behavior of the DM and the role played by emotions on his judgments and choices. To maintain notational consistency, we refer to choice objects as products throughout the paper.

Two important aspects relative to the structure of the information acquisition process must be emphasized. First, similarly to the operational research literature [20,32,36], the information acquisition process will be defined through a sequential algorithmic structure. However

- we do not focus our attention exclusively on the importance of search costs but on incrementing the number of characteristics of the products considered by the DM;
- we endow the DM with memory capacity so as to analyze the effect that the information acquired at any point through the process has on his subsequent behavior;
- different reference products both partially and completely observed will be defined and modified through the information acquisition process.

Second, information will not be valued using a purely economic approach [17], where, together with the utility derived from a given choice, a regret-rejoice function is defined to account for the differences derived from having chosen a given alternative over another. In particular

- we do not only consider the prevention of regret when determining the value of information but also its capacity to verify the suitability (or unsuitability) of a given product;
- we incorporate to the value of information the subjective importance assigned by the DM to the prevention of a regrettable choice relative to verifying its suitability;