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ARTICLE

The Four-Quadrant Approach for Classification of Bias

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ABSTRACT

This paper introduces a Four-quadrant approach to categorize decision-making biases, based on the availability of information and time. Mapping these two factors on a Cartesian plane identifies how different biases emerge under varying conditions of time pressure and information complexity. The framework highlights key biases in four contexts: More Information - More Time, More Information - Less Time, Less Information - Less Time, and Less Information - More Time. This approach aids in understanding cognitive biases, promoting more objective, evidence-based decision-making, and suggests strategies to mitigate biases in management, policy, education, and research, thus facilitating the practice of scientific temper. This model interprets that anybody can be vulnerable to biases/superstitions depending upon the quality of information available to us, which further highlights the need of continuous institutional efforts for countering misinformation.

KEYWORDS: Bias, Scientific temper, Decision making, Four-quadrant approach

Introduction

Bias is defined as "the action of supporting or opposing a particular person or thing in an unfair way, because of allowing personal opinions to influence judgment" (Cambridge Dictionary, 2023). Biases can lead to prejudgments and, subsequently, discriminatory practices. The disproportionate emphasis on one perspective over another, without sufficient

scientific reasoning, results in prejudice, bigotry, and flawed choices. Identifying biases effectively is essential to avoid these pitfalls in decision-making, allowing for better, more objective decisions based on critical thinking and sound reasoning. Although we can never be rid of bias, the more we recognize and understand it, the more we can work to minimize any resulting effects (Nosich, 2012). Identifying biases effectively is essential to avoid pitfalls in decision-making, allowing for better, more objective decisions based on critical thinking and sound reasoning (Pennycook & Rand, 2019).

The identification of biases is closely linked to scientific temper, as both emphasize critical thinking, objective analysis, and a willingness to question assumptions. Scientific temper involves a disciplined approach to inquiry, where individuals employ systematic methods to gather evidence, formulate hypotheses, and test conclusions. Recognizing biases plays a crucial role in this process, as these biases can distort judgment and lead to erroneous conclusions.

By identifying biases, individuals cultivate awareness of their thought processes, which is essential for robust scientific understanding. The interplay between bias identification and scientific temper is fundamental in advancing rational thought and preventing dogmatic beliefs in both scientific inquiry and everyday life (Heard *et al*, 2020).

Background of the study

Previous studies highlighted that decision-makers often rely on mental shortcuts due to constraints in both time and information. Tversky and Kahneman explore cognitive biases in decision-making, introducing the concept of heuristics or cognitive shortcuts that simplify judgments but can lead to systematic errors (Tversky & Kahneman, 1974). Through various experiments, they illustrate how these heuristics influence people's evaluations and predictions, often deviating from statistical reasoning. The study highlights the implications of these cognitive processes for economic and psychological theories, suggesting that human judgment can be swayed by irrelevant information. Nickerson provides an in-depth review of confirmation bias and its linkage to information that confirms pre-existing beliefs, leading to biased conclusions

(Nickerson, 1998). Recent studies have continued to expand on the foundational theories of cognitive biases. Kahneman has elaborated on how biases like the planning fallacy and anchoring bias still affect decision-making, even in the context of significant information (Kahneman, 2011). Similarly, studies also indicate time pressure affecting decision-making processes and the likelihood of bias (Lerner *et al*., 2015). The specific influence of time pressure on decision-making in situations that require careful consideration and strategy, which can increase susceptibility to biases, has also been indicated (Ordóñez *et al.*, 2015).

Research on biases and heuristics has grown extensively, and a literature search indicates more than 250 types of biases which are classified depending upon their common generative mechanism (Hilbert, 2012). Dobelli categorized hundred common behavioural errors, while Baron identified 53 types of cognitive biases (Dobelli, 2013; Baron, 2008). Building upon the studies on such biases which are influenced by the information and time determinants, this paper attempted to categorize these biases based on time constraints and information availability, areas that have received less attention in traditional bias classifications in the earlier literature.

The Four-Quadrant approach is a strategic framework for categorizing information, decisions, or processes into four distinct categories based on two axes, often measuring varying dimensions. This method has been used in various domains of decision-making in strategic planning, evaluation, health care (Elder *et al.*, 2016), resource allocation (Henderson, 1970), time management (Covey, 2012), project management etc. The Four-Quadrant approach, based on an adaptation of decision-making models, to categorize decision-making biases based on the availability of information and time, can help to identify biases' origins and devise corrective actions and methods to mitigate them. This classification can facilitate the design of frameworks, policies, and strategies to reduce the prevalence of biased decisions, thereby promoting a more scientific and rational approach to decision-making.

The Four-Quadrant approach to Bias Classification

The different cognitive biases identified and studied in literature were enlisted and each one was examined to check its suitability to

be explained on the intersection of time and information. Through this detailed inquiry we were able to evolve the four-quadrant approach. This approach classifies biases based on two critical factors in decision-making: information and time. This framework suggests that bias arises from the interplay between the amount of information available and the time available to process it. By mapping combinations of these two factors- more or less information, more or less time- on a Cartesian plane, four situations emerge, each associated with specific types of biases. Each quadrant represents a different context for decision-making, helping us to pinpoint the origins of various biases and examine their underlying mechanisms. We propose that the intersection of information availability and time pressure provides a practical framework for understanding biases in decision-making. Time and information are fundamental components of decision-making that affect cognitive load. In this paper, though each quadrant has been illustrated by giving only three or four examples, the four quadrant approach can be used by the decision makers to test and identify all cognitive biases that can influence decision making (Figure 1).

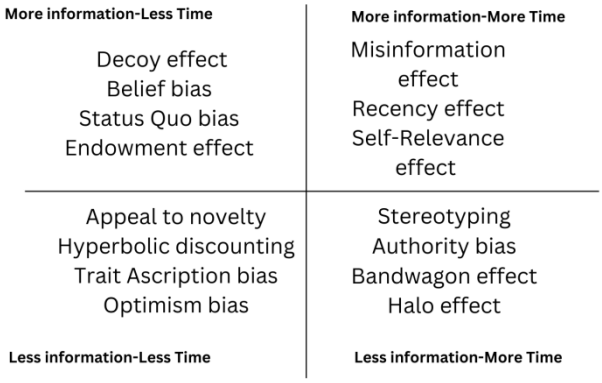

Figure 1: The Four-Quadrant Approach for Classification of Bias.

Quadrant 1: More Information - More Time

In Quadrant 1, biases arise from the complexity of processing and integrating a large volume of information, which can lead to overthinking and errors such as the Recency effect and

Misinformation effect. Here, having more time and information might still cause individuals to focus on the most recent or most striking information, skewing judgment.

In this quadrant, ample information and adequate time are available to make decisions. Despite these advantages, cognitive biases still arise, typically due to errors in reasoning, information overload, or how information is processed and stored. Key biases in this category include:

- Misinformation effect: This bias arises when memories are altered or influenced by misleading information provided after the event. This effect, documented by Loftus and Palmer, reveals how post-event information can distort memory, leading to inaccurate recollections (Loftus and Palmer, 1974).
- Recency effect: In this bias, the information presented most recently tends to be remembered more vividly, often overshadowing earlier data (Atkinson & Shiffrin, 1968). In contexts such as legal arguments or media presentations, the order of information can significantly influence decision outcomes.
- Self-Relevance effect: Individuals tend to remember information better when it relates personally to them. This bias shows how self-perception can skew the recall of certain facts over others (Symons & Johnson, 1997), which can impact objectivity in decision-making.
- Context effect: How prior information influences a person's response to subsequent data. It can lead to either assimilation (agreement with previous ideas) or contrast (opposition to previous ideas), depending on the framing of information (Schwarz & Strack, 1991).

Quadrant 2: More Information - Less Time

In this scenario, adequate information is available, but the lack of time pressures individuals to make quick decisions, leading to biases driven by haste and incomplete analysis. The stress of limited time can force individuals to rely on mental shortcuts, resulting in errors such as:

- Decoy effect: This bias describes how an additional, less appealing option (the decoy) can make another option seem

more attractive. The decoy effect influences choices under time constraints by simplifying complex decisions (Huber *et al*., 1982; Bateman *et al*., 2008).

- Belief bias: People are inclined to accept arguments that align with their beliefs, regardless of evidence. Under time pressure, people tend to default to preconceived beliefs rather than engage in thorough analysis (Evans *et al.*, 1983).
- Status Quo bias: Here, individuals prefer maintaining the current state, avoiding changes despite possible improvements. This bias is exacerbated by time constraints, as change requires additional effort and thought (Samuelson & Zeckhauser, 1988).
- Endowment Effect: This refers to valuing an item more simply because one owns it. Under time constraints, individuals may make irrational decisions to retain ownership (Kahneman *et al*., 1991).

Quadrant 3: Less Information - Less Time

In this quadrant, individuals have limited information and minimal time to make decisions, leading to biases that stem from incomplete understanding and rushed judgments. Without sufficient data or time to process it, people rely heavily on cognitive shortcuts, resulting in the following biases:

- Appeal to novelty: This bias leads individuals to favor new or modern solutions simply due to their novelty, often without evaluating their actual effectiveness. When information and time are scarce, this inclination can lead to premature adoption of new trends or ideas.
- Hyperbolic Discounting: This is the tendency to prioritize immediate rewards over future gains, even when future rewards are more beneficial (Ainslie, 1975). Lack of time or information exacerbates this bias, as individuals are less inclined to think long-term.
- Trait Ascription bias: Individuals view their own behavior as situational but see others' behavior as more predictable and consistent. This can lead to stereotyping, as decisions are based on superficial observations rather than comprehensive information (Krueger & Clement, 1994).

- Optimism bias: This is the tendency to overestimate the likelihood of positive outcomes, particularly in situations with little information. When pressured for time, people often assume the best-case scenario, leading to risky decision-making (Sharot, 2011).

Quadrant 4: Less Information - More Time

In situations where limited information is available but ample time exists, biases stem from assumptions, stereotypes, and reliance on pre-existing beliefs rather than a search for more information. Some of the biases in this category include:

- Stereotyping: With minimal information, individuals may rely on over-generalized beliefs about groups of people. Stereotyping occurs as a cognitive shortcut to compensate for missing details (Macrae & Bodenhausen, 2000).
- Authority bias: This bias is the tendency to trust and be influenced by the opinion of an authority figure. When time is not a limiting factor, authority bias leads people to accept information without questioning it (Milgram, 1963).
- Bandwagon effect: Individuals tend to adopt the beliefs or actions of others, particularly in the absence of their own data or information. The bandwagon effect, or "herd behavior," can lead to decisions based on popularity rather than critical evaluation (Asch, 1956).
- Halo effect: A positive impression of an individual's trait leads to a generalized positive assessment of their other qualities. In the absence of comprehensive information, people may form opinions based on limited positive (or negative) traits, affecting judgment (Thorndike, 1920).

We hypothesize that cognitive biases are exacerbated or mitigated depending on the availability of time and information. It is proposed that in situations of limited time or information, individuals are more likely to rely on cognitive shortcuts, leading to biases such as Hyperbolic Discounting (Quadrant 3) and Status Quo bias (Quadrant 2). In contrast, with more time and information, biases such as Misinformation effect (Quadrant 1) and Stereotyping (Quadrant 4) can emerge due to the complexities in processing large amounts of data.

Benefits of the Four-Quadrant Approach based model

The Four-Quadrant approach to bias classification offers several benefits across fields, including psychology, management, public policy, and education. By understanding the types of biases that arise in specific contexts, individuals and organizations can anticipate and correct for common errors. For instance, management decisions under tight deadlines can be approached with strategies to mitigate time-induced biases such as the decoy effect or status quo bias.

This approach is particularly useful in domains such as management decision-making, policy formulation, and educational assessment, where time pressures and the volume of information directly influence outcomes. For example, in crisis management, where quick decisions are often made with limited data, Quadrant 3 biases e.g., Optimism bias might dominate.

Policymakers can design training programs that address biases based on time and information availability. For example, emphasizing authority bias (Quadrant 4) training in areas like law enforcement can help professionals critically evaluate decisions rather than defer to perceived authorities.

Psychologists and behavioral experts can use this approach to develop cognitive training programs, aiming to improve individuals' awareness of biases based on situational factors like time pressure or information scarcity.

The most significant use of the Four-Quadrant approach is understanding biases in academic or scientific settings which can promote a culture of evidence-based reasoning. Researchers aware of quadrant-based biases can take corrective measures, such as prioritizing data collection over rushing to conclusions in low-information scenarios. In educational settings, promoting scientific temper through bias recognition can enhance students' analytical skills, encouraging them to evaluate information critically and approach problems objectively.

Consequently, it also highlights the indispensible need of continuous institutional and community efforts to counter misinformation because vulnerability to biases and superstitions increase if there is too much misinformation around. Thus enhancing the quality of information is one of the ways to prevent

cognitive biases. This model highlights that the quality of information in popular media is very important for maintaining the scientific temper of the society, thus validating the unrelenting, continuous efforts towards science popularization and refutation of myths/misinformation.

Conclusion

In conclusion, the Four-Quadrant approach to classify biases offers a structured, practical framework for understanding the role of time and information in decision-making biases and how different decision-making contexts foster specific cognitive biases. By identifying whether biases stem from high or low levels of information and time, individuals and organizations can better recognize the potential pitfalls and adopt strategies to mitigate, and correct for these biases. This approach serves as a valuable tool for anyone seeking to promote more rational, objective, and scientific decision-making across a range of fields. It also underscores the significance of continuous efforts to prevent the spread of misinformation in the community by providing evidence-based information. It is recommended that future research should explore the application of this model in real-world settings, especially in environments characterized by high pressure and uncertainty.

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