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The Role of Induction and Probability in the Development of Science and Philosophy

Función de la inducción y la probabilidad en el desarrollo de ciencia y filosofía

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Abstract

This paper addresses the process of consolidating the inductive method and the support provided by the development of probability to satisfy formal validation requirements. The discussion on the limitations of induction considering the prevailing deductive method in philosophy and science has a long tradition, attention is paid to key concepts of inductive methodology and its probabilistic support with ranges of occurrence that contrast with the criteria of deduction based on certainties, such as the criteria of truth or falsehood. It is argued that probabilistic induction is the mechanism that enables the increase of philosophical and scientific knowledge and prevents us from falling into absolute and often dogmatic principles. Among the main findings is that induction does not adhere to the canons of knowledge from the deductive point of view, but introduces the concept of uncertainty, thereby breaking the Aristotelian tradition prevailing until Modernity. Additionally, it is observed that probabilistic induction expands the understanding of knowledge by shifting the discussion from absolute certainty to the realm of possibilities, thus presenting a diversity of possible worlds without deviating from real data collected by the researcher.

Keywords

Induction, Probability, Epistemology, Philosophy of science, Statistics, Mathematics.

Resumen

El presente trabajo aborda el proceso de consolidación del método inductivo y el soporte que brinda el desarrollo de la probabilidad para que aquel satisfaga los requisitos formales de validación. La discusión por las limitaciones de la inducción a la luz del método deductivo imperante en filosofía y ciencia tiene larga tradición, así se presta atención a los conceptos clave de la metodología inductiva y de su soporte probabilístico con rangos de ocurrencia que se anteponen a los criterios de la deducción basada en certezas, como el criterio de verdad o falsedad. Se argumenta que la inducción probabilística es el mecanismo que posibilita el aumento del conocimiento filosófico y científico, y nos cuida de caer en principios absolutos y, en muchas ocasiones, dogmáticos. Entre los principales hallazgos se tiene que la inducción no responde a los cánones del conocimiento visto desde la deducción, sino que inserta el concepto de incertidumbre, rompiendo así la tradición aristotélica vigente hasta la Modernidad. Además, se aprecia que la inducción probabilística abre la comprensión del conocimiento al desplazar la discusión desde la certeza absoluta para ubicarla en el plano de las posibilidades, presentando así diversidad de mundos posibles sin que estos se aparten de los datos reales recopilados por el investigador.

Palabras clave

Inducción, probabilidad, epistemología, filosofía de la ciencia, estadística, matemáticas.

Introduction

Throughout the history of philosophy and the subsequent emergence of science, there has been an ongoing debate over which method provides the best approach to knowledge, a discussion centered primarily on two methodologies: deduction and induction. The criteria underwriting these two methods are fundamentally different, if not contradictory; deduction is grounded in the criterion of certainty, whereas induction operates within the realm of probability. This paper focuses on the consolidation of the inductive method and the vital support that probability provides to this

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process. It argues that probabilistic induction is the mechanism that enables the expansion of philosophical and scientific knowledge, preventing us from falling into absolute—and, in many cases, dogmatic—principles.

When discussing the inductive method, it is common to hear that it proceeds from the particular to the general, or from the simple to the complex; however, these definitions are rudimentary and provide only a vague outline of the inductive process. To define induction simply, one could state that it proceeds from particular instances of knowledge to universal structures of knowledge. Another, less debated definition would characterize it as a form of reasoning in which the truth of the premises—or facts—does not strictly entail the truth of the conclusion,[1] but rather provides compelling reasons for the conclusion to be accepted as true (Black, 1979). It is worth clarifying that induction lacks absolute certainty in its argumentation and inherently incorporates uncertainty into knowledge. This does not imply that induction should be dismissed for failing to postulate certain or true criteria (Lamarre and Shoham, 1994; Peat, 2002; Pérez Ilzarbe, 2004; Rosmini, 1991); rather, it invites us to understand that certainty is not the ultimate goal of this method. Instead, its objective is to provide the rational grounds that allow us to accept the likelihood of postulated theoretical assumptions.

The objective of this paper is to defend probabilistic induction as a valid mechanism for generating knowledge in both science and philosophy, highlighting its relevance in overcoming the limitations of deduction. Furthermore, we will analyze how the probabilistic approach broadens the horizon of epistemological understanding through the evaluation of potential scenarios grounded in empirical data.

The central problem lies in the persistent lack of consensus regarding the validity of induction versus deduction. Historically, deduction has enjoyed greater prestige due to its association with logical certainty, while induction has often been viewed as an inferior method because of its reliance on probability and uncertainty. This perspective has limited the appreciation of induction as a valuable tool in the production of knowledge. This study argues that probabilistic induction, rather than being a deficient method, is fundamental to scientific and philosophical progress. Through an analysis of probability as a methodological foundation, this paper posits that the inductive approach offers a more flexible and realistic framework for validating theories, particularly in contexts where absolute certainty remains unattainable.

The significance of this study lies in the fact that probabilistic induction expands the frontiers of scientific knowledge and provides a

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robust methodological alternative to more rigid, deduction-based approaches. By treating probability as an integral part of the inductive process, it becomes possible to address complex issues from a perspective that acknowledges the uncertainty inherent in reality. The discussion of induction and probability remains highly relevant today, especially in a context where scientific advances in areas such as quantum mechanics and artificial intelligence rely heavily on probabilistic models to make predictions and validate theories. Indeed, the understanding and acceptance of uncertainty as a constituent part of knowledge is an increasingly mainstream trend across various disciplines.

To develop this analysis, a comprehensive review of the philosophical and scientific literature related to induction and probability will be conducted. A comparative approach will be adopted to examine deductive and inductive theories, analyzing how the incorporation of probability into the inductive method can resolve traditional problems associated with the lack of certainty in this approach. Likewise, the contributions of pivotal thinkers such as Bacon, Hume, and Bayes—who laid the foundations of probabilistic induction—will be explored.

The paper is structured as follows: first, the historical and philosophical context of the debate between induction and deduction is presented, highlighting the evolution of the inductive method. The second section examines the consolidation of this approach from Aristotle through the Modern Era, considering Hume's critiques and Bacon's contributions. Next, the third section analyzes the role of probability in supporting the inductive method and how this perspective allows for the expansion of scientific understanding. The fourth section delves into the Bayesian model and its impact on the validation of hypotheses in science and philosophy. Subsequently, the epistemological and metaphysical implications of probabilistic induction are explored. Finally, the main findings are summarized, and the relevance of this approach to the contemporary development of knowledge is defended.

Consolidation of the Inductive Method

Induction can be traced back to classical thinkers such as Aristotle, who, while advocating the use of deduction as a systematic framework, did not rule out the existence of cognitive processes based on induction rather than deduction (Aristotle, 1995; Franklin, 2009; Llano, 1991; Mosterín, 2006). This approach explicitly accounts for the information received

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through the senses. For induction, the senses represent the initial step in signaling the existence of objects; this is why, when we speak of experimentation, it is understood fundamentally in terms of observational data—data obtained through sensory perception that nourish knowledge and allow us to corroborate reality. The senses thus serve as the bridge connecting the real world with rational structures.

Although Aristotle recognized induction, he did not devote a detailed study to it comparable to his treatment of deduction in his syllogistic logic (Aristotle, 1995; Cárdenas Marín et al., 2017; Copi and Cohen, 2014; Gamut, 2002). Consequently, his classical and medieval followers showed little concern for any method other than the deductive one. This neglect stemmed from the belief that the senses and reason are designed to perceive macro-level magnitudes that exhibit continuity and progression, whereas probability serves to challenge or refute the data provided by these large-scale magnitudes. Interest in induction reemerged centuries later, during the Scholastic period, with the studies of Grosseteste (1942), as noted by Rivadulla (1995a), who revived interest in a method that takes experience into account and allows for the corroboration of theory in light of sensory data. Although his thinking remained rooted in Scholasticism, it is vital to recognize that by considering the value of numerous cases, Grosseteste employed a process akin to statistics, which allowed for approximations toward a reliable explanation.

Ockham (1986 and 1988) also offered an alternative perspective on the nature of science, since alongside *episteme* one must also consider *doxa*, which—while not constituting deductive logic—serves as a precursor to being guided by empirical data. In this sense, opinion introduces a psychological doubt into deduction. In this way, Ockham introduced the idea that alternative, non-deductive pathways can be considered in the construction of knowledge; while these do not invalidate deduction, they raise crucial questions about it based on an understanding of reality that provides data that must be accounted for.

In the Modern era, more compelling contributions regarding induction emerged. As Rivadulla (1995a) notes, Bacon (2011) asserts that science derives directly from experience through induction, thereby establishing the inductive method as a necessary path to knowledge. Drawing on empiricism, he shifted the understanding of truth to the realm of objects through his conception of truth as correspondence rather than mere coherence (Rogers, 1985)—i.e., beyond the simple logical consistency of postulates.

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According to San Martín (2005), the understanding of knowledge as correspondence conceives of truth as the product of two dimensions —one objective and one subjective— since truth originates from a subject who makes a statement about something outside that subject, which is the object. Conversely, coherence implies that the truth of statements depends on their internal connections within a totality from which there can be no separation from the true, a view that constitutes ontological monism.

In Bacon's view, the true is that which maintains a verifiable connection to what exists in reality and from which something is predicated that captures that reality as objectively as possible. Deduction, by contrast, is akin to entering a whirlpool that spins around itself without taking diverse data into account. Deductive logic does not operate with existing things, but with mental representations of existence; induction, on the other hand, works directly with existing entities rather than their mental surrogates. What Bacon lacked—and what remains relevant today—is a methodological correspondence: the formal link between existence and logic, which is captured in a single word: probability.

Exactness is an inherent component inferred by deduction with or without existing entities, and if hypotheses and facts lack a rigid logical framework, they run the risk of collapsing into psychologism. One must be careful not to fall into a conception of probability along purely psychologistic lines. How can this be resolved? Through frequency calculation—i.e., by considering the totality of a domain where the existent varies in its properties. The presence of higher occurrence rates denotes the probability of the majority at the expense of the minority, so that the probable does not constitute a haphazard form of psychologism, but rather a rigorous calculation based on existents.

Baconian empiricism proposed new tools for formulating theories, utilizing the procedure of induction through the experimental elimination of mutually competing hypotheses by means of the so-called "tables of being or presence" (Rivadulla, 1995a). This aspect entails a logical understanding of *modus tollens* (Copi and Cohen, 2014; Gamut, 2002; Suppes and Hill, 1988), given that the negation of an expected effect logically leads to the negation of its possible cause.

The elimination method constituted a significant advance in how the inductive process is conceptualized. Induction had previously been understood merely as the collection of data and the passive acceptance of hypotheses based on those findings; however, this approach fell prey to the problem of hasty generalization—understood as the fallacy of insufficient sample size—making it impossible to maintain a fully rigorous

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framework. When Bacon introduced the criterion of elimination, the approach to hypothesis acceptance shifted fundamentally.

In the Baconian method, when there was insufficient data to support a hypothetical approach, one would proceed to consider a competing hypothesis for which fewer data points had been eliminated.[2] This might superficially resemble a form of falsificationism (Popper, 1980 and 2007; Pérez, 2004) —since it could be misconstrued as a kind of psychologism lacking a formal logical foundation— but it does not include the specific theoretical elements required to be considered as such. For Bacon, it was necessary to actively manipulate the world to scrutinize its secrets (Hacking, 1996).

This points to the process that Bacon had to clarify for a better understanding of reality: in experimentation, the researcher can move beyond passive sensory data and manipulate reality to yield data that either support or contradict hypotheses. However, this thinker's inductive process is insufficient to claim that probability emerged as a guiding principle, since Bacon still placed his trust in the ultimate attainment of certainty (Black, 1979). Thus, his advances should not be understood as paving the way for probability, because at that time exact classical physics was developing, dominated by contributions to gravity and electromagnetism. It was not until the twentieth century that probability as we understand it today fully emerged, preceded by the Bayesian postulates of the eighteenth century. For Bacon, certainty remained a criterion that had to be met. In this light, we understand that although there was a close connection to experimental data, these data remained anchored in rational necessity—in the certainty derived from deduction (Stadler, 2004; Wilson, 1985). This implies that probability, even in modern induction up to the seventeenth century, was not viable because the overarching approach relied on the criteria of exactness and relationships involving large quantities.

In other, simpler forms, induction appeared as a guiding principle, but it concealed a highly pronounced deductive framework, indicating that the foundation of inductive methodology—at least in the theorizing of that era—always rested on a deductive scaffolding. This was evident in various forms of experimentation. Even today, it can be observed when, for example, a professor in a laboratory sets the conditions for conducting an experiment, but before the experiment is carried out, students perform mathematical calculations. Thus, once the results are available, the values the experiment will yield can be determined with highly accurate approximations; it is even possible to set aside the real or material component, since events can be analyzed rationally, and if the causal premises or conditions are appropriate, the effect must occur. This example does

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not imply that deduction is abandoned entirely, but it highlights that the traditional understanding of induction that has persisted to the present day maintains a deeply deductive foundation.

At this point, the problem of probability must be properly contextualized. It so happens that this problem does not arise from the deduction of large quantities, although it is related to it, since standard induction is grounded in deduction and in the criterion of exactness. It is crucial to understand probability in terms of the fact that matter and energy are not comprehensible as independent and progressive realities, but rather as correlated entities that advance in irregular steps.

Induction emerged as an empirical foundation, and the method gradually took shape through the contributions of various thinkers; however, there was not always a consensus on how the method should be applied to support the scientific theories outlined (San Martín, 2005). The alternative facet of induction is to focus strictly on phenomena, such that deduction is set aside to make way for observation as the primary source of data. Although observation has long been part of the natural sciences, it was not always at the center of the scientific method (Nagel, 1991). However, one should not generalize that everyone who conducts experiments tests theories exclusively in light of observed data, or that such observations always substantially contribute to knowledge (Hacking, 1996). In other words, there are postulates that, while appearing to consider data obtained inductively, remain tethered to a deductive component.

In this regard, one can consider Galileo (Galilei, 2010; Camilleri, 2015; Drake, 1975; Fehér, 1982; Fischer, 1986; Jardine, 1976), who, through his thought experiments, brought observational data and the deductive criteria of mathematics into play —i.e., he generated an inductive innovation that made it possible to understand the vitality of data and incorporate it into theoretical quantification (Rogers, 1985).

To understand the consolidation of induction, one must bear in mind that it is not a process derived from a single thinker; rather, it followed an evolutionary path marked by fluctuations, requiring constant refinement to withstand various attacks against its logical structure.

The ongoing tension or return to deduction that occurred in the search for the method best underpinning scientific knowledge is evident, but it cannot be denied that the rise of induction set a vital precedent in the acquisition of knowledge, despite the objections raised by various thinkers. One of these detractors was David Hume, who, although he framed his thought within the tradition of empiricism, also highlighted the profound difficulties of validating knowledge through induction.

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Hume mentioned the origin of the term "induction" as used by Aristotle, which relates to the generalization of particular cases that fall under specific considerations (Hume, 1984; Black, 1979)—i.e., induction consists of elevating observed and experienced events to a general theory, provided that similar conditions are accounted for in the collection of that data. It must be clarified that this always applies to macro-scale phenomena, since the comparison between macro- and micro-atomic calculations is fundamentally different, as they operate with entirely distinct concepts.

While deduction consists of starting from principles of reason—principles provided by the human intellect, which are known *a priori*—induction involves an unknown aspect of knowledge. It leads the mind into a realm of non-knowledge, of non-certainty, and of profound uncertainty regarding what might be encountered. It is this criterion of uncertainty that lacks logical foundation from a deductive standpoint, yet it highlights the importance of observational data in the structuring of scientific and philosophical theories.

Later, Mill focused on the study of induction and posited that this method consists of seeking causes, in a manner closely aligned with Hume's idea. As a methodological tool, he employed a system adapted from the induction by elimination proposed by Bacon, formalizing the methods of agreement, difference, joint agreement and difference, concomitant variations, and residues (Mill, 1973 and 1974; Black, 1979). As can be seen, the methods for verifying inductive postulates became increasingly rigorous, allowing for greater control over the experimental process. The methods proposed by Mill made it possible to categorize observational data and filter them to retain those offering the greatest explanatory certainty. Although it could be argued that Mill's method restricted or reduced explanations, it must be borne in mind that all these methods dealt with data that added novelty to knowledge and were applied directly to observation; thus, they did not constitute a restriction but rather an expansion characteristic of what has come to be established as the inductive method (Mill, 1973 and 1974).

The inductive method, which is expected to serve as the stepping stone to understanding probability, was eventually grounded in the use of mathematics. It should be recalled that Euclidean geometry previously dominated mathematics; thus, the common denominator was the syllogistic logical method, and deductive logic does not give way to probability but only to the demonstration of validity. If syllogistic logic were probabilistic, then the task would consist solely of drawing conclusions from premises. Since there was no connection to the empirical, the need

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arose to employ mathematics, which enabled the process through abstraction: by considering singular cases and, based on those cases, moving toward the probable, thereby introducing the concepts of uncertainty and indeterminacy.

For his part, Black (1979) made a clear distinction from what is generally known as induction, and his postulates include terms such as "eduction" (arguments that proceed from particulars to particulars, such as stating that a specific *a* is *b* without having previously observed that all *a* are *b*) and "adduction" (the most general case of non-demonstrative argumentation, corresponding to the classical notion of induction). By using these terms, he indicated that induction is not a subsidiary part of deduction. In addition to his postulates separating induction from deduction, he outlined the most common types of inductive arguments, along with one type of deductive argument:

- Elaborate induction: variants of induction by simple enumeration (the selection of individuals named in the premises).
- Proportional induction: inference from the frequency of occurrence of a certain characteristic in a sample to the frequency of occurrence of the same characteristic in the original population.
- Proportional abduction: reasoning from one sample to another based on premises of the same type.
- Proportional deduction: a statistical syllogism that proceeds from "*m/n* of *C* are *B*" (where *m/n*is greater than 1/2) and "*A* is a *C*" an "*A* is a *B*." Some authors consider simple enumeration to be, in a certain sense, the most fundamental form (Black, 1979).

As seen, the arguments presented highlight the inductive methods used in the formation of theories structured under this methodology—methods fundamentally based on enumerating observational data.

It should be noted that the inductive method evolved from simple enumeration processes to more advanced models that required the use of alternative tools for validating information; one such tool was statistics, which paved the way for a probabilistic understanding of the inductive method.

According to Bird (2011), when referring to induction, it is commonly understood as a path that starts from the observed to reach the unobserved; however, this is a misconception, since the premises of inductive inferences may themselves result from previous inductions. The author made this clarification to help readers understand that just because a procedure is assumed to be inductive does not mean that purely inductive processes are always being applied. Rather, it must be clear that there

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are certain structural nuances in the methodological considerations that must be considered when formulating theories. Furthermore, it should be noted that there are no purely isolated methodological programs—i.e., those that adhere strictly to a single methodology, whether deductive or inductive. Instead, there are instances in which a theory has empirical support and others in which it has rational support, reflecting a cooperative framework within the methodology of science.

It must be understood that when the term "premise" is used in inductive logic, it does not refer to postulates identical to those used in deduction, but is simply used as a synonym for an assertion, without this assertion being grounded in absolute truths of reason. When one has data that are more or less established, the path of science—which is formal knowledge—begins, and this involves nothing more than conceptualizing the data and, at that precise moment, arriving at a deduction. The mind typically draws deductions from data that have already been accepted, whereas dynamic science constructs new knowledge precisely from the uncertainty of the data.

In addition to the enumeration of data obtained through experimentation, induction must possess an inferential structure. Induction provides data that nourish mental states in the observer, such that it would not be possible to understand it through reference alone (Kuipers, 2004). Mental states are nourished by induction and allow theories to be developed from observation, provided that methodological guidelines are respected. Furthermore, it should be emphasized that theories derived from observational induction can, without restriction, serve as a foundation for new inductive theories. This introduces a novel aspect to the understanding of induction, since inductive theories can be sustained in a chain-like manner—something that is rarely possible in other frameworks, given that the historical foundation of induction typically included some underlying deductive component.

One author who structured his postulates around a methodological system alternative to deduction was Peirce, who maintained that inductive inference has the capacity to generate hypotheses that move from effects to causes (Peirce, 1957; Niiniluoto, 2004). This provides an understanding of induction as a system that allows one to infer an explanation whose hypothetical postulates possess sufficient inferential soundness to support the explanation based on the observed data.

This must be understood in terms of probability, which constitutes the condition of instability in data that are not immediately assimilated into a rigid mental program; there is a state of asymmetry, an asynchrony of data that do not fit. In the physics of large-scale phenomena, such data

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fit immediately, but at the micro-level, they do not align. The solution is probability, which gives meaning to the mutability of data and the flexibility of the mind. Thus, it is understood that induction is not a minor methodological framework derived from deduction—one rooted in it and whose scope is validated solely by the limitations of necessity or sufficiency established by rational principles. Instead, it is structured as an alternative methodology that transcends deductive criteria and takes data from reality as a starting point to infer theories that expand the scope of knowledge, in such a way that they expand mental states rather than being restricted to the researcher's *a priori* rational conditions.

Although induction has a structure that can be independently sustained, one of the problems that often arises is that it is routinely analyzed through deductive categories; one such category is the truth inherent in a deductive criterion of certainty. But even when doubt is raised about the truth of inductive inferences, scientific realists defend the position that even the best theories must approximate the truth (Niiniluoto, 2004).

Prediction is a combination of propositional data capable of being deduced; in effect, predicting is nothing more than the application of deduction based on the reliable stability of data. In probability, on the other hand, one cannot predict in an absolute sense, but rather calculate the likelihood of occurrence, which leaves a margin of error and room for managing the data itself. Mathematics provides a significant aid in lending some structural certainty to probability.

The understanding of approximately true theories calls for a principle upon which induction is based and which provides the rational foundation that for centuries was required to sustain a rational, mathematical counterpart—and that principle is probability.

So far, induction has been approached as the methodology that gives rise to probability. It is true that probabilities cannot be calculated from pure deduction, as that would be conceptually absurd; however, such probabilities can be obtained from induction without contradiction—but only when one moves into the infinitesimal realm, which, ultimately, is what underlies reality. Induction is the gateway to probability, but not the induction of large quantities; rather, it is that which is deeply rooted in infinitesimal calculus.

Inductive Probability as a Methodological Principle

The inductive method has undergone extensive revision over the centuries and has been subjected to tests and critiques that have made it possi-

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ble to revise and refine its criteria. Understanding the inductive approach did not necessarily involve conceiving of knowledge in terms of probability; this suggests that induction and probability did not emerge together as a single method, but rather that the process of theoretical revision allowed researchers to incorporate probabilistic criteria into the inductive method, thereby enabling it to gain ground and achieve validation.

Dealing with probability involves working with statistics, and working with statistics entails understanding the principles of mathematical calculus. For this reason, the following analysis will take these concepts into account to understand how the principle of probability aids the inductive method in advancing philosophical and scientific knowledge.

The concept of probability is not a recent one; rather, attempts to establish statistical indices can be traced throughout human history—even as far back as ancient Egypt—in connection with the creation of numerical censuses designed to enable the definition of various courses of action (Maistrov, 1974). In other words, the core concept of probability has been part of human understanding for a very long time.

The concept of probability emerged in the distant past of humanity, and the term was not initially coined as we know it today; rather, it was linked to randomness along with mathematical categories that made it possible to understand the greater or lesser likelihood of certain events occurring, based on observed repetitions (Rivadulla, 1995b). Probabilistic calculation emerged with the application of mathematics to observed cases, in which repetitions made it possible to establish a trend. The application of mathematics to observed data enabled humans to predict events, measure greater and lesser probabilities, and, based on those measurements, make informed decisions across various fields.

According to Maistrov (1974), in the fourteenth century, several merchant ship insurance companies were established in Italy and the Netherlands, which were responsible for insuring cargo transported between continents. These companies performed probability calculations regarding the risks associated with it. This approach to the use of probability calculations helps us understand that, as in many aspects of human life, certain tools emerged from practical needs rather than from the requirements of scientific knowledge; however, their applications opened up a field that made it possible to establish principles applicable to the acquisition of knowledge in general. Probability theory, as noted, developed out of practical human needs, but in the seventeenth century it became established as a scientific process—though it should not be forgotten that

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several of its tools emerged from the fields of chance and gambling, providing valuable data for the development of science.

Maistrov (1974) posited the enriching role of games of chance in the early development of probability theory, and even today, using games of chance as a starting point for understanding probabilistic theories remains a valuable teaching resource. It is important to understand that these games spurred the development of a more detailed theory of probability, which made it possible to describe a greater number of phenomena and solve various problems, although the theory of probability applicable to science is not limited solely to games but has advanced to a different level of understanding.

Pinpointing the exact starting point of probability theory within the scientific method is somewhat complex due to its close connection to the practical aspects of human life, but it can be argued that Descartes (2006) paved the way for skepticism, while Pascal (2014) positioned God not as a certainty in the Cartesian style, but rather within a framework of probability: God is the best bet, the best possible probability (Hájek and Hartmann, 2010). These constitute two distinct ways of thinking that broke with the idea of absolute certainty and introduced doubt, possibility, and the constant refinement of human knowledge—a system of probabilities.

The model based on certainties, while providing rational security and finding validation in criteria of necessity, began to show limitations when it came to obtaining data from reality; the filters were different, and new mechanisms were required to record that data. Consequently, there was a gradual shift away from the pursuit of absolute certainty (Rogers, 1985).

It is worth noting that although the Copernican revolution in science took place in the sixteenth century (Copernicus, 1987) and the end of Aristotelianism—which was the dominant mindset throughout the West—was declared, albeit with only partial justification, the new science remained Aristotelian in its consideration of large-scale phenomena. Thus, gravity and electromagnetism are scientific consequences of Aristotelianism due to their high degree of certainty and determinism. The definitive end of Aristotelianism and the entire classical paradigm came with the birth of quantum theory, which paved the way for uncertainty and indeterminacy: science, in its definitive form, became probabilistic in the twentieth century with Schrödinger's wave mechanics (Restrepo Echavarría, 2024) and Heisenberg's matrix mechanics (1975). When these scientists shook the foundations of certainty, they established that scientific knowledge requires empirical and rational pillars to be better sustained (Hacking, 1996).

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The criteria of reason and experience are not inherent in traditional science; reason applies to independent and progressive elements related to experiments that possess that quality. Reason became a matter of probability when it could not grasp hidden reality and had to hypothesize; indeed, the hidden is conjectured because it cannot be experimentally verified, and thus remains indeterminate —Schrödinger's cat serves as a prime example.

By subjecting certainty to doubt, the way was paved for uncertainty; however, this does not mean that all knowledge fell into the category of the uncertain, but rather that researchers began to seek mechanisms to understand it in a more or less plausible, probable way. In this regard, Hacking (1991) and Black (1979) note that probability is not just any mathematical discipline, but rather embodies one of the most notable achievements of modernity by enabling the study of metaphysics and epistemology through a unified methodology.

The process of consolidating probability in science occurred gradually, and it is evident that thinkers, step by step, directed their studies toward strengthening this theory beyond the context of games of chance. It is worth noting that the term "probability" had not yet been formally coined by these authors, appearing only a few times in the writings of the period (Rivadulla, 1995a).

As can be seen, recurring terms remained rooted in the tradition of using statistical calculations and had not yet managed to establish themselves as a cohesive theory of probability. The definitive origin of the term "probability" is attributed to Bernoulli in his work *Ars Conjectandi* (1713; Rivadulla, 1995b); with this author, it is possible to mark the emergence of probability theory as a scientific discipline. Bernoulli's advances in the field of probability laid the foundations upon which modern and contemporary thinkers structured their theories. Bernoulli's proof demonstrates the relationship between the number *n* of observations tending to infinity and the constancy of the probability *p* (Bernoulli, 1713; Rivadulla, 1995b), as follows:

$$\lim \mathrm{P}\left(\mathrm{p} - \varepsilon \leq \mathrm{f}^0 \leq \mathrm{p} + \varepsilon\right) = 1$$

$$\lim \mathrm{n} \to \infty$$

This probability formula establishes the mathematical and epistemological foundations necessary to initiate various forms of validation within probability calculus, helping to emphasize that the nature of probability stems from both mathematical and empirical perspectives.

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Although terms characteristic of induction—such as observation, data, and empirical basis—are evident, probability did not emerge alongside induction but rather within the practical world of human experience, later finding its specific path as a mathematical discipline. In this development, the value of statistics in consolidating probability theory must be recognized (Maistrov, 1974). In addition to proposing a statistical framework for knowledge, Bernoulli sought to provide an epistemological foundation for the principle of probability by arguing that it must be measurable in terms of proportion (Rivadulla, 1995b, p. 56)—a concept that remains central to all probabilistic formulas.

Later on, probability theory found new ways to define itself as a mathematical discipline. Alongside the consolidation of probability theory, an inductive methodology emerged that, while facing difficulties in its formal foundation, called deductive certainties into question. At that point, thinkers realized that probability could provide the necessary logical framework for induction, allowing for the expansion of the horizons of understanding regarding both the inductive method and the principle of probability. It is through this process of reconciling induction and probability that criteria began to be established to understand knowledge from a new perspective (Black, 1979).

As long as probability is viewed merely as a mathematical concept, it remains irrelevant to philosophy; but when it becomes part of an epistemological debate—i.e., in the construction and validation of scientific theories—probability enters fully into the realm of philosophy. In this sense, the issue is not only epistemological but also metaphysical, since it allows for an understanding of the modalities of being, moving far beyond the realm of exactness and certainty proposed by Aristotelianism. If one were to divide the horizon of science, only two overarching possibilities would emerge: the Aristotelian and the probabilistic.

Probabilistic induction established a new way of understanding scientific theories and allowed for the exploration of new ways of formulating hypotheses, while setting aside the need for absolute certainty in theories to make way for the possibilities of occurrence.

Later, Peirce (1957) sought to provide a foundation for probability in its support of the inductive method, locating this in a mediation between statistical deduction and abduction (Black, 1979). Probability lies between reason and the empirical—between mathematics, which has an undeniable deductive component, and the empirical, which is based on the collection of observational data. This is why, for Peirce, it is vital to understand that inductive hypotheses and theories, while possessing

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specific tools, must rely on statistical support of a rational nature. When one lacks knowledge of the structure of a phenomenon—both its functionality and its consequences—probability comes into play. Something remains probable as long as the behavior of the data and their combinations is unknown; indeed, probability is a theory in which common combinations are insufficient and further combinatorial possibilities are explored. Thus, the field of probability represents the extension of logic into its potential variations.

For Peirce, probability found a firmer foundation in statistics than in individual cases. This was because, according to him, deterministic views lacked validity, and it was preferable to ground knowledge in constant values (Hacking, 1991)—values rooted in the numerical constants established by statistics—from which his understanding of induction arose. His deterministic understanding of probabilistic induction was based on the mathematical formulations he reviewed (Black, 1979), which seemed to impose a deterministic framework on the way scientific explanations are understood.

The consolidation of probabilistic induction occurred later with authors interested in providing greater structure to a relatively young and evolving method. Carnap (1969) sought alternatives to logically ground induction, and among them found in probability a viable path by understanding it as rational credibility and as the limiting relative frequency of occurrences (Black, 1979). However, this was an incomplete or exclusive attempt, since there are insufficient grounds to recognize completely distinct senses of probability: one *a priori* and the other empirical. Yet, the inconsistency in Carnap's attempt to differentiate between *a priori* and empirical probability does not preclude the recognition we must grant the author for his advances in probability theory.

The system of probability calculus introduced the idea that observed data can expand knowledge to the extent that observation frequencies increase. Although the observer lacks the capacity to capture all events of a given class, as observational records grow, the likelihood of a hypothesis being true increases. The versatility of probability lies in the fact that it is not anchored in the researcher's mind as *a priori* principles of reason but rather expands the perspective to record facts; and these facts are not abstracted *a priori* but rather provide the benefit of recording objective information.

Logical elements are inherent to the mind, synchronized with facts. Events cannot be deemed "probable" in themselves; they simply occur. Yet the mind seeks not only answers but also meanings. Sometimes

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we have the answers, but they immediately become part of a network of meanings—and this is a product of the mind. Meanings do not exist in isolation but only in relation to one another. Probability is not merely a response to indeterminate phenomena but the attribution of meanings. Mathematics, together with statistics, opens the door to probabilistic answers, but philosophy is called upon to open itself—through logic—to the meaning of probability, which is what leads to the construction of theory, i.e., of epistemology. Herein lies one of the contributions that inductive probability makes to the construction of philosophical theories.

With the incorporation of the principle of probability into the inductive method, a new field of research into reality was opened up—a way of understanding knowledge and explaining the world not only from the researcher's perspective, but also by recognizing that data provide valuable information that can be categorized, allowing for the expansion of scientific explanation (Rivadulla, 194). This constitutes the basis of probabilistic induction, which, although it does not allow for the immediate determination of whether something is true or false—as is the case with deductive principles—provides a progressive approach to better explanations.

In probability, the same criterion applies as in the science of large quantities: it is not the experiment that decides, but the argument. This indicates that probability does not derive its persuasive power solely from data, since data only provide the variation and possibility within that specific experiment, leaving other possibilities aside. Thus, scientists and philosophers are not mere verifiers of experiments but rather defenders of theory, and this opens up a wide range of meanings.

One traditional criticism of induction concerns its lack of logical structure; however, probability emerged precisely to provide the logical support that was required of it. Given the consolidation of the link between induction and probability, it is a mistake to think of the inductive method as separate from this mathematical discipline. Keep in mind that the inductive method is not always followed when calculating probabilities; deduction can also make use of them (Hacking, 2009). Probability has a statistical—and therefore mathematical—structure, and it is understood from the outset that mathematics is the quintessential example of deduction. This does not imply that probabilistic induction borrows a methodological approach from deduction, but rather that the framework for calculating probabilities has a logical foundation that allows for the validation of the inductive approach.

The essential difference between induction and deduction does not lie in the logical system they follow to validate themselves, but rather in

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the primary source of knowledge: data or reason. In probabilistic induction, observations serve to inform a hypothesis that will be more or less accepted in accordance with the empirical data collected. The recording of data for probability allows observations to be formalized as propositions—statements open to evaluation—that serve as the basis for argumentation and arise from controlled experiments (Bunge, 1980).

It is evident that scientific theories arise to explain reality only partially, and when it comes to probabilistic induction, one must recognize that the process is inherently progressive. It would be a mistake to assume that the observations and hypotheses that emerge immediately rise to the level of universal laws. Rather, they remain at a specific level—singular statements that can form general systems of explanation as more data are systematically incorporated.

The arguments in favor of probability's contributions to inductive methodology are varied. The development of probabilistic reasoning involved several thinkers who gradually shaped the tools used, with the aim of modeling a more reliable system that would allow for better approximations to acceptable theories. Among the various probabilistic approaches developed in defense of inductive methodology, one in particular was more widely accepted and subject to ongoing refinement: the Bayesian approach, which made it possible to explore different ways of validating empirical data in relation to their statistical compilation.

Contributions of Bayesian Probability

In the previous section, we noted that probability has both an informal history—during which the term was not employed as it is today—and a formal history, when the term began to be used in its current sense. Amid this back-and-forth of theoretical adjustments, several contributions helped shape its formal structure.

Among the authors who proposed foundational probabilistic theories is Bayes (1763), who draws researchers' attention because his formal proposal incorporates categories that provide rigorous criteria for defending induction and for supporting hypotheses within probability calculus. It is necessary to analyze Bayesian approaches because his perspective underpins what is known as his inductive logic—a conception that suggests a robust way to confer validity on a system that was previously criticized for lacking such a structural foundation (Pinto, 2002).

The Bayesian system is important to the study of probabilistic induction, since the author was not only concerned with theoretically sup-

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porting the inductive method but also sought a probabilistic formulation that would allow for the definition of validation criteria for that methodology. Bayes' logical system posits various theses regarding probability. Notably, this system explicitly involves individuals' belief systems, and probability calculus serves to measure the degrees of these systems.

At this point, a common range emerges in probability calculus that involves measuring degrees of confidence between 1 and 0. This framework is notable for its proximity to mathematical logic; however, despite sharing a certain relationship with it, Bayes incorporated the space between states of absolute certainty to indicate the greater or lesser degree of confidence that a belief system can provide. It should be noted that probability does not allow for degrees of belief greater than 1 or negative values, because there are two absolute extremes that cannot be exceeded: either a belief approaches the maximum value of a true state, or it moves to approach the maximum at the opposite extreme—toward a state of falsity regarding the assertion made.

In this method of grading beliefs, Bayes found a mechanism for establishing verifiable criteria that made it possible, procedurally, to set values that could be tested against data obtained through induction (Bird, 2011). Viewed in this way, Bayesian probability does not postulate fixed or static states of affirmation but rather possesses an inherently incremental nature; it increases the likelihood of a belief in accordance with new data as they are obtained. In this manner, Bayes accounted for the fact that the inductive process is structured around the researcher's mental states when observing facts, and that each new piece of data collected directly influences the observer's belief.

When discussing the observer's degrees of belief, there is a risk of interpreting probabilistic induction as something merely subjective. However, it must be borne in mind that it is not subjective insofar as the assertions do not arise purely from the individual's intellect, but rather stem from the collection of data and, from that point, are elevated to the researcher's understanding; thus, they serve as an objective argument for defining the gradation of beliefs established in the hypotheses. Bayesian postulates leave the field of understanding reality open; i.e., theories are not restricted solely to nourishing a static body of beliefs and marking it as definitive, but rather allow for the systematic reconsideration of theories as data collection expands (Chalmers, 1999).

It must be borne in mind that Bayesian epistemology is not merely passive data collection, as this would lead to an Aristotelian-style referentialism—unconsciously implying that data alone construct probability,

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and thus that the experiment, rather than the theory, is the deciding factor. This interpretation contradicts the principle already stated; therefore, it will be maintained that it is not the experiment that decides, but the argument. If it is not merely the data, but rather the interpretation and meaning of the data resulting from logical analysis, then interpreting is not reproducing the data, but rather seeking structural meanings that involve the use of logical connectives. From a logical perspective, data can be combined in as many ways as possible until a contradiction is reached, which constitutes the boundary of all science and philosophy. The limit of probability is contradiction—not the data themselves, but the combinations that have been made of them. This opens up a new perspective on the understanding of induction, supported by Bayesian probability. Induction does not consist of immediately elevating a particular collection of data to a general postulate, but rather comprises a series of processes that gradually refine assertions and even allow for the correction of previous statements based on the data obtained from experimentation.

Probabilistic induction establishes a relationship of inquiry that proceeds from effect to cause, unlike deduction, which is concerned with defining the necessary causes to explain effects. Bayes' theorem clearly articulates this inductive premise as follows:

> We have an event (the data) and want to know whether it was caused by one of the causes A1, A2, (...) (a series of competing scientific hypotheses; these are the possible causes of B). The probabilities P(A1), P(A2), (…) P(An)—i.e., the prior probabilities of each of the rival hypotheses—are known, as are the probabilities P(B/A1), P(B/A2), P(B/An) or the likelihood of obtaining the data B depending on which of the hypotheses is true. Therefore, the probability P(Ai /B) (the final probability that hypothesis Ai is true, once we have obtained the data B) is given by the following expression (Díaz, 2007, pp. 12-13).

The calculation of probabilities within the Bayesian approach does not merely detail the likelihood of a single hypothesis arising from the data; rather, it involves a much more detailed analysis. Based on the observed data, several hypotheses will emerge that could explain the cause of that effect, each of which is supported by the collected data—i.e., they are never hypotheses disconnected from the events.

The practice of moving from the conditioned to the conditions was present in Hume (1984) and Kant (2004); however, this does not indicate that it is an inherently probabilistic endeavor, but rather an element of critique. At the level of mathematical probability, there will be many possibilities precisely because of the proliferation of hypotheses; but it

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is at the philosophical level that probability assumes the role of critique. Deduction and referentialism are not critical ways of presenting science, given their frequent absence of empirical data and reliance on reason alone, which can lead to dogmatism in science; indeed, such an approach could scarcely be called science—at best, it is dogmatic philosophy. Criticism is probabilistic because it brings logical elements into dialogue with facts, presenting alternatives that are not limited to a single point of view or a unique criterion of truth but open themselves to possibilities. From this perspective, one could say that critique is the philosophical version of what is probable.

The probability of hypothetical explanations is reinforced as reality provides data that offer greater or lesser evidence, and one can distinguish between these hypotheses in accordance with the values presented in the mathematical formulation. Thus, Bayes' theorem serves as a criterion for distinguishing between competing hypotheses—a system that employs statistical values but is thoroughly informed by experimental data. Bayes' formula (1763) is formulated as follows:

$$\mathrm{P}\left[\mathrm{A_n}/\mathrm{B}\right] = \frac{\mathrm{P}[\mathrm{B}/\mathrm{A_n}].\mathrm{P}[\mathrm{A_n}]}{\sum \mathrm{P}[\mathrm{B}/\mathrm{A_i}].\mathrm{P}[\mathrm{A_i}]}$$

This formula helps us understand that whether the probability of a cause or hypothesis *n,* is higher or lower depends on the ratio of the relationship between the effect and hypothesis *n*, to the sum of the probabilities of the effect across the initial causes. We understand that in the process of validating new theories, each hypothesis *n* will, in the subsequent step, replace hypothesis *i*.

What Bayes' theorem introduced into inductive probability involves a statistical approach that moves from the particular to the general—i.e., from the sample to the population—but not directly by bypassing rules of reasoning; rather, it is progressively consolidated through the repeated refinement of competing hypotheses, in which a hypothesis *n* may be accepted as more or less probable, or even rejected, as the data provide supporting or contradictory evidence.

There have been several followers of the Bayesian approach to inductive probability; among them is de Finetti (1972), for whom reasoning inductively is nothing more than calculating *p (h, e),* the probability of *h* given the observation of e, according to Bayes' theorem (Rivadulla, 1995a), where *e*, is given by empirical evidence or experimental data—the effects. Understanding the probability range of a hypothesis between the values 1 and 0 leads to the realization that no possible explanation can be

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ruled out *a priori*; rather, observational evidence *e*, is required to support or rule out that explanation as a possible cause of the effect.

Empirical evidence or data constitutes a compelling argument in probabilistic induction; unlike the irrelevance of data in deduction, in this methodology its value is high, since it has the capacity to increase the degree of acceptance of a hypothesis based on observations. These observations must follow patterns that allow for the establishment of statistical boundaries; otherwise, there would be hundreds of data points without rational categorization (Labastida, 158). Researchers who employ Bayesian approaches must clearly understand that cases must be collected objectively and that their occurrence will not always be constant; this is why the frequency criterion was introduced (Díaz, 2007). This clarification highlights the essential distinction between induction and deduction.

The concept of hypotheses exists in deductive methodology, but their justification depends on rational arguments—such as laws or corollaries—that allow a truth value to be attributed to the hypothetical statement. In probabilistic induction, on the other hand, there is no primary foundation based on laws, because there is no establishment of initial laws, only data collection; thus, inductive hypotheses lack a stable criterion of truth, and their acceptance is directly proportional to the frequencies derived from experimentation.

This is due to the category of precision within which macro-level phenomena operate. Indeed, probability, even today, does not enter into macro-scale phenomena because it is not needed there, as the laws of classical physics govern that realm. One must not succumb to the need to resort to probability when human beings are sensory beings who require stability. The problem will be even greater when a similar effect to that seen in Modernity occurs: when the influence of mathematical physics shaped the theory of knowledge, shifting toward a more subject-centered approach, yet one that includes explicit references to objects.

This results in a duality in the probabilistic conceptualization of a hypothesis: a probability derived from the hypothesis itself and one derived from the data (Díaz, 2007). This dual concept helps us understand that, in the application of induction, although we seek a starting point from the object, the subject possesses mental states that help them orient themselves toward what they wish to investigate; it is not a blank mind. This does not imply that probability is a matter more of the subject than of the object; one must be careful not to make that confusion because, for example, the physics of microparticles can be studied only through probability—this is neither subjectivity nor a psychological burden. This

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might seem like a critique of the structure of probabilistic induction, but all it does is situate the criteria by which probability is employed within inductive methodology. As noted earlier, Bayes' theorem never establishes certainty regarding a hypothesis; its purpose is not to provide deductive support but rather to calibrate beliefs. Its focus is on providing empirical support for hypotheses based on the collected data.

One of the issues that might cause unease for the researcher is the use of the concepts of subjectivity and objectivity, since it appears that the reviewed literature tends to frame induction in terms of the individual's subjective, almost psychological states. However, a careful review of the mechanisms used in both methodologies—deductive and inductive—will show that the purpose of probabilistic induction is to consolidate the mental state of a subject—in this case, the researcher—in light of objective data, statistical measurement, and the comparison of statements about reality. Based on this, Bayes' theorem at no point deals with rules for accepting the truth or falsity of a hypothesis based on the data—no matter how high the probability obtained—but rather seeks to continue increasing probabilities through the updating of data (Psillos, 2004), thereby elucidating the inferential chain structured by the information gathered.

Probabilistic induction provides a process-oriented understanding of knowledge construction. The support for a hypothesis within a probabilistic system does not lead to establishing its truth or falsity, but rather to connecting it to the probability of a subsequent hypothesis. This constant updating is possible thanks to the continuous collection of data from experience, which further shapes scientific explanations.

When considering chains of data—an endless stream of information gathered from reality—one might envision an infinite path of probabilistic calculations; and, in fact, it opens the door to understanding an unfinished science, one that can always renew its explanations. But this should not be understood as a regression to infinity or an absurdity; rather, with each advance in the probable acceptance of hypotheses, scientific knowledge and explanation expand.

The path of expansion of scientific knowledge based on Bayesian postulates can be understood when one considers the need for constant updating of theories, and this is made possible by recent data obtained by the researcher, while also making room for data collected by other researchers (Hájek and Hartmann, 2010).

Viewed in this light, the Bayesian probabilistic inductive model combines elements that have allowed it to establish itself as a comprehensive vision of knowledge. Meaning, memory, and testimony are key to the

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construction of knowledge and constitute mutually supportive building blocks; the goal of this integrative vision is the constant improvement of our explanation of the world. This understanding of theories as a quest for an ever-improving explanation is relevant to the researcher's work, since knowledge does not arise solely from the reasons established by the subject but is open to new empirical findings. It is evident that for this progressive construction of knowledge to be possible, inductive inferences take on a generalizing character (Kuipers, 2004); however, there is a limit to these generalizations, namely that their scope is restricted to the level of the hypothesis undergoing probabilistic evaluation, and they will suffice to establish the degree of belief in that hypothesis. In other words, the generalization obtained is not immediately elevated to the status of a law; there is no such broad rational leap due to the risk of committing argumentative fallacies.

Probabilistic induction in the Bayesian model does not provide states of truth or falsity for statements; what is obtained is a progressive approximation to the truth, although within these criteria it will not be possible to establish an absolute truth based on observational evidence (Kuipers, 2004). Although the notion of truth is not ruled out in this system, its function is not the same as that attributed to it in the deductive model of certainty; rather, it becomes a point of reference—a kind of nominal truth (Kuipers, 2004)—from which statements are formulated based on the data.

It should be clarified that truth in probability cannot be attained through reference, since that would constitute Aristotelianism, and probability is not Aristotelian. The data show how the world is presented, but it is through probability that ontology is reframed. So, is the world the one that truly appears to be? For Aristotelians, yes, but for probabilists, the answer is different. Therefore, if truth-falsehood is related to exactness, then the false will be the probable, precisely because it is indeterminate; but if truth-falsehood is relative, the exact is nothing more than the assessment of a categorical state of large magnitudes—that is, the brain was canonizing things according to categories based on the laws of larger magnitudes; for example, where matter ends, energy begins. On the other hand, at the relative, uncertain, and probabilistic level, it is discovered that categories must also change when one enters the world of fundamental and constitutive elements: what appeared separate at the macroscopic level, as categories, was, at the elementary constitutive level, a tangle of relationships, for which there was no capacity to unravel that inner world. Thus, truth value lies in flexibility rather than in exactness.

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The novelty of the methodological advance represented by Bayes' theorem lies in the ability to approximate the truth provided by probability calculus (Kuipers, 2004)—something that is irrelevant in deduction and, consequently, limits assertions to the researcher's rational process, setting aside—or relegating to the background—observational accounts of reality.

Conclusions

The inductive method has been subject to centuries of analysis, defense, and refutation. It has been shown that many thinkers have valued its scope, but at the same time, it has had to overcome various methodological limitations to meet the theoretical requirements that establish it as a valid method for justifying knowledge.

The key methodological element for the emergence of induction was probability, since it fulfills the formal mathematical requirements that cannot be overlooked in science—namely, the mathematical foundation of theories. In this regard, it has become evident that induction will never satisfy the concept of certainty; this is because certainty belongs to a different methodological field—deduction. In fact, much confusion and many refutations have arisen because philosophers of science analyzed probabilistic induction through the lens of deduction based on certainty, leading to a profound methodological incommensurability.

Induction and probability did not share similar origins; it would be a mistake to assume that probability belongs inherently to induction and vice versa. As we have seen in the course of this argument, probabilistic calculations had rather informal beginnings in recreational fields such as games of chance, whereas induction has been connected from its very outset to philosophy and, more specifically, to the branch known as epistemology. Furthermore, probabilities are not restricted to exclusive use within the inductive method, since probabilistic calculations can also be successfully employed in deductive theories; this is due to the mathematical and statistical framework involved in measuring the likelihood of occurrence.

What makes probability unique to induction is that its starting point is not contingent on concepts preestablished by the researcher, but rather is grounded in the systematic collection of factual data—of occurrences—and this is precisely what begins to inform knowledge. It is acknowledged that this approach could lead to a fallacy of hasty gener-

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alization, but if probability calculations are used properly, they actively prevent this error. Furthermore, this fallacy is ruled out by understanding that the ultimate purpose of the calculation is not to arrive at absolute certainty regarding what is true or false, but rather to determine what is more or less probable; thus, a probability value will never be exactly 1 or 0 (true or false in its deductive logical counterpart), but rather ranges fluidly between these two values.

Bayes's application of the principle of probability to inductive methodology helped clarify the path this method should follow to identify better validation criteria, and paved the way for its development and acceptance thanks to the statistical support that guides data collection. However, despite the warm reception given to Bayesian postulates and the advances made by his followers in revising formulas to ensure improved validation criteria, induction and its probabilistic foundation remained the focus of methodological observations and criticisms. Nevertheless, the current consensus in epistemology is not that science possesses true or absolute theories, but rather that probable theories are embraced, and it is probability that has enabled the development of groundbreaking theories over the past century. This does not imply that deduction is sidelined or no longer considered a valid method today, as it remains highly relevant, but it does not overlook the rich possibilities offered by probabilistic induction. Understanding philosophy and science through these criteria allows us to extend our reasoning to possible worlds. The enduring contribution of this method to knowledge has been that it allows us to break away from absolute or dogmatic understandings in order to move toward flexible, argumentative possibilities without ever abandoning the bedrock foundation of reality.

Notes

1. It is important to note that when it comes to induction, the starting point is not premises but facts; however, in logical theory, the term "premise" is used to refer to the relationship within the structure of the inductive argument.
2. "Competing hypotheses" are assumptions that seek to explain a reality from two conceptual perspectives that are not necessarily similar.

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Statement on the Use of Artificial Intelligence
The authors, William Orlando Cárdenas Marín and Rómulo Ignacio San Martín, of the article titled "The Role of Induction and Probability in the Development of Science and Philosophy," declare that the preparation of this document did not involve the use of artificial intelligence (AI).

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