The Generality-Observability Principle: A Gödelian Two-Criterion Model for Axiom Reliability

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Abstract

The foundations of knowledge rely on axioms, yet not all axioms are equally valid. This paper introduces the Generality-Observability Principle (GOP), a model for assessing axiom reliability based on two key criteria: Generality, the ability of an axiom to consistently apply across multiple systems, and Observability, the requirement that an axiom be empirically verifiable. By examining various scientific frameworks, we explore how some models remain useful despite limitations, while others collapse under broader scrutiny. The principle also reveals why certain belief system axioms lack epistemic strength, failing to meet the necessary criteria for reliability. This model provides a structured approach to evaluating knowledge, distinguishing between incomplete yet functional knowledge and those that are fundamentally invalid.

PART I— The Era of Information

Introduction

In an era where information is abundant yet often contradictory, the ability to critically assess knowledge has become an existential necessity (Bostrom, 2014). Human survival, both individually and collectively, has always depended on our ability to navigate truth and falsehood, and to distinguish between valid knowledge and unreliable speculation (Harari, 2015). From early survival strategies to the modern complexities of science, philosophy, and belief systems, the human mind has evolved to seek patterns, assign meaning, and establish frameworks for understanding reality (Dennett, 1995). However, while our cognitive instincts drive us to form axioms—fundamental assumptions about reality—not all axioms are equally valid. Some are internally consistent yet fail empirical scrutiny, while others may seem intuitive but collapse when applied across different domains. This paper introduces the Generality-Observability Principle (GOP), a structured method for assessing the reliability of axioms, distinguishing between those that are incomplete but functional and those that are fundamentally flawed.

The Need for a Formal Framework

Discussions about the validity of belief systems and theoretical frameworks have long been fragmented and arbitrary. People instinctively challenge ideas in everyday debates—questioning the logic of religious doctrines, doubting scientific claims, or debating the realism of economic models. However, such discussions often lack a structured method for evaluating axioms beyond subjective intuition. Even in philosophy and science, epistemological models such as coherentism, rationalism, and falsifiability attempt to provide evaluation criteria but fail to integrate both generality and empirical observability (Popper, 1959; Quine, 1951).

This results in knowledge hierarchies that are either too rigid or too permissive, allowing speculative frameworks to persist alongside empirically sound theories without clear distinctions.

The Generality-Observability Principle (GOP) formalizes these everyday discussions into a coherent, structured model. It provides two fundamental criteria for axiom reliability:

1) Observability – An axiom must be empirically verifiable, ensuring it is grounded in measurable reality.
2) Generality – An axiom must apply consistently across different systems, ensuring it is not merely domain-specific.

By applying this model, a hierarchy of knowledge reliability can be established, identifying frameworks that remain functional and valid, despite being incomplete (e.g., Newtonian mechanics) versus those that fail to meet epistemic rigor (e.g., unfalsifiable belief systems).

The Role of Critical Thinking in an Uncertain World

The ability to assess the validity of axioms is not just an academic exercise but a fundamental aspect of human survival and intellectual evolution. The process of testing ideas, refining theories, and discarding invalid frameworks is the foundation of both scientific progress and philosophical inquiry (Kuhn, 1962). Without structured epistemic models, knowledge becomes susceptible to bias, dogma, and stagnation, leading societies to hold onto invalid or outdated axioms. History has demonstrated that dogmatic adherence to unreliable axioms has real

consequences, from scientific stagnation in the Middle Ages to modern disinformation crises (Boghossian, 2006).

GOP is not merely a theoretical tool; it is a pragmatic necessity for navigating the complexity of modern knowledge. In a world where misinformation spreads faster than verified knowledge, the ability to distinguish between partially valid, fully reliable, and epistemically weak axioms is crucial for scientific integrity, rational discourse, and informed decision-making. This paper will demonstrate how GOP can be applied to a range of scientific, mathematical, and belief-based systems, offering a structured method for evaluating knowledge in a world where epistemic reliability is more critical than ever.

PART II— Defining Axiomatic Validity

The Generality-Observability Principle (GOP)

Axioms serve as the foundation of all knowledge systems, yet their reliability varies significantly. While some axioms function as universally applicable truths, others are domain-specific, and some fail entirely under scrutiny. The GOP provides a structured method to assess the epistemic strength of axioms by requiring them to satisfy two fundamental criteria: Observability and Generality. This dual-criterion model ensures that axioms are not merely logically coherent but also empirically and systematically valid across different contexts.

Axiom Validity Criteria

For an axiom to be considered epistemically strong, it must satisfy the following conditions:

1) Observability – Empirical Verifiability

An axiom must be grounded in empirical evidence, meaning it should be testable and verifiable through direct or indirect observation. This criterion ensures that knowledge claims are not merely abstract constructs but have a basis in measurable reality. Scientific theories that lack observability, such as String Theory in its current state, remain speculative until empirical validation is possible (Dawid, 2013). In contrast, fundamental mathematical axioms like 1+1=2 are observable both conceptually and in real-world applications (Russell, 1910).

2) Generality – Cross-System Applicability

A strong axiom must extend beyond a single, isolated framework. The ability to generalize across multiple systems ensures that an axiom is not just a useful approximation but reflects a deeper underlying truth. Newtonian mechanics, for example, is observable in classical physics but fails generality at relativistic and quantum scales, making it a domain-specific approximation rather than a universal axiom (Einstein, 1916). In contrast, the laws of thermodynamics apply across physics, chemistry, and biology, making them highly generalizable (Schroeder, 2000).

Generalizability and Classification

The classification of scientific theories often overlooks the degree of generalizability, treating incomplete theories as equally limited when in reality, their scope of applicability varies. GOP refines this classification by introducing a tiered generalizability system to account for varying levels of domain applicability:

Generalizability Level 3 (Universal Generalizability) – The theory or axiom generalizes across all known systems without exceptions.

Generalizability Level 2 (Broadly Generalizable) – The theory applies across all but one known system.

Generalizability Level 1 (Restricted Generalizability) – The theory applies only within specific systems, failing to generalize across multiple domains.

Using this classification, frameworks are further categorized into four epistemic classifications:

1) Fully Reliable – Frameworks that satisfy both observability and universal generalizability (Level 3), making them fundamental.
2) Partially Reliable – Frameworks that satisfy observability but are broadly generalizable (Level 2), failing in only one known system.
3) Weakly Partially Reliable – Frameworks that satisfy observability but have restricted generalizability (Level 1), failing in multiple domains.
4) Epistemically Weak – Frameworks that fail both observability and generalizability, making them unreliable as sources of knowledge.

Why These Two Criteria?

Axioms must satisfy both generality and observability because:

Internal consistency alone is insufficient – A system can be logically coherent but fail in real-world application.

Empirical data without generality is limiting – Some observations are accurate only under specific conditions but break down elsewhere.

For example, Euclidean geometry is internally valid but fails at cosmic scales, where Riemannian geometry better describes curved space (Hawking & Ellis, 1973). Likewise, many metaphysical claims may be internally logical but fail empirical verification, placing them outside the realm of strong axiomatic knowledge. The GOP framework ensures that axioms withstand broader scrutiny, forming the foundation for a more reliable epistemology.

PART III— Applying GOP to Scientific Frameworks: Why Some Theories Are Useful Despite Incompleteness

Newtonian Mechanics: Reliable but Not Fundamental

Newtonian mechanics has historically served as the basis for classical physics, describing motion, planetary orbits, and macroscopic interactions (Newton, 1687). However, under the GOP framework, it is best categorized as weakly partially reliable due to its limited domain of validity.

Observability – Newtonian mechanics is empirically verified within classical physics, accurately predicting planetary motion, forces, and macroscopic interactions (Mach, 1893).

Generality (Level 1 – Restricted Generalizability) – Newtonian mechanics fails in multiple known domains:

1) Relativity – At velocities approaching the speed of light, Newtonian mechanics provides incorrect predictions, requiring the relativistic corrections introduced by Einstein (1905).

2) Quantum Mechanics – Newtonian mechanics fails to describe atomic and subatomic behavior, where wave-particle duality and quantum indeterminacy dominate (Bohr, 1928).

Classification Under GOP: Newtonian mechanics is weakly partially reliable, as it is empirically valid but exhibits restricted generalizability (Level 1), failing in multiple known systems. It remains useful within classical mechanics but is not a universal theory.

Quantum Mechanics: A Valid Yet Incomplete Model

Quantum mechanics is one of the most empirically verified scientific frameworks, explaining subatomic interactions with high precision. However, due to its incompatibility with gravity, it remains partially reliable rather than fully fundamental.

Observability – Quantum mechanics has been experimentally validated through wave-particle duality, quantum entanglement, and superposition, as demonstrated in the double-slit experiment (Feynman, 1965) and Bell's theorem violations (Aspect, Dalibard & Roger, 1982).

Generality (Level 2 – Broadly Generalizable) – Quantum mechanics applies to most known physical systems but fails in one major domain:

1) Gravitational Systems – Quantum mechanics does not integrate with general relativity, making it incomplete in describing gravity at the quantum scale (Penrose, 2004).

Classification Under GOP: Quantum mechanics is partially reliable, as it is empirically verified but broadly generalizable (Level 2), failing in only one known system. While it remains an essential framework, its lack of integration with gravity suggests that a deeper theory—perhaps quantum gravity—may eventually replace it.

Euclidean Geometry: Contextually True

Euclidean geometry has historically provided the foundation for understanding shapes, distances, and spatial relationships in two and three dimensions. It serves as the mathematical framework behind architecture, engineering, and classical physics. However, under the Generality-Observability Principle (GOP), Euclidean geometry is not universally fundamental due to its limitations in curved space.

Observability – Euclidean geometry is empirically verifiable in daily applications, including construction, cartography, and classical mechanics. The axioms of parallel lines, right angles, and geometric transformations are consistently observed in flat-space environments (Kline, 1972).

Generality (Level 2 – Broadly Generalizable) – Euclidean geometry applies to most spatial frameworks but fails in one major domain:

1) Non-Euclidean (Curved) Space – Euclidean postulates do not hold in curved spacetime, where general relativity describes gravitational warping of space

(Hawking & Ellis, 1973). Riemannian geometry replaces Euclidean geometry in these contexts, showing that parallel lines can converge or diverge depending on curvature (Gauss, 1828).

Classification Under GOP: Euclidean geometry is partially reliable, as it is observable and broadly generalizable (Level 2) but fails in curved space. While it remains valid for flat-space applications, it does not represent a fundamental geometric truth in all physical contexts.

Mathematical Axioms: The Highest Form of Reliability

Mathematical axioms form the epistemic foundation of logic, computation, and formal systems. Unlike scientific theories, which depend on empirical observations and are subject to refinement, mathematical truths are self-evident, internally consistent, and universally applicable across logical systems. Under the Generality-Observability Principle (GOP), mathematical axioms are classified as fully reliable, making them the most fundamental category of knowledge.

Observability – Mathematical axioms are empirically reinforced through direct observation and application:

1) Direct Observation – Basic arithmetic axioms, such as 1+1=2, are directly measurable and observable in reality. If one object is placed next to another, the total quantity demonstrably increases, validating the axiom (Russell & Whitehead, 1910).

2) Empirical Reinforcement – While mathematical truths are abstract, their consistency with physical measurement, engineering, and computational models further reinforces their reliability (Tegmark, 2014).

Generality (Level 3 – Universally Generalizable) – Mathematical axioms apply across all known logical and empirical systems without exception.

1) Cross-System Validity – Arithmetic, algebra, and number theory function in all mathematical frameworks, making them independent of specific domains (Peano, 1889).

2) Foundational to Applied Sciences – Mathematical structures are essential to physics, engineering, computation, and logic, providing a universal foundation for measurement and scientific inquiry (Hardy, 1940).

Classification Under GOP: Mathematical axioms are fully reliable, satisfying both observability and universal generalizability (Level 3). Their applicability across all known logical and empirical systems places them at the highest level of epistemic validity. Should a system emerge in which 1+1≠2, mathematical axioms would no longer be fully reliable under the Generality-Observability Principle (GOP) and would instead be classified as partially reliable or weakly partially reliable, depending on the extent of their failure across different domains. While this remains a theoretical possibility, some alternative mathematical frameworks, such as non-standard arithmetic and paraconsistent logic, explore deviations from classical axioms (Priest, 2006).

PART IV— Non-Scientific Systems

While scientific and mathematical systems often meet at least one of these criteria, belief-based systems—such as metaphysical, ideological, and religious frameworks—frequently fail both. Their reliance on internal coherence rather than

external validation places them in the epistemically weak category under the GOP framework.

A key epistemic weakness in belief-based axioms is their lack of observability. Unlike scientific hypotheses, which are tested through empirical verification and falsification (Popper, 1959), many belief-based claims remain immune to direct testing. This is particularly evident in metaphysical concepts such as vitalism, the historical idea that living organisms possess a "life force" that cannot be reduced to physical or chemical processes (Driesch, 1914). Vitalism was widely accepted in the 19th century but ultimately failed observability when advances in biochemistry and molecular biology demonstrated that biological functions could be fully explained through physical laws (Crick, 1966). The inability to provide empirical evidence for a distinct "life force" led to its decline as a credible scientific framework.

Similarly, in the realm of psychology and cognitive science, Freudian psychoanalysis presents a case of an internally coherent system that lacks empirical rigor. Developed by Sigmund Freud in the late 19th and early 20th centuries, psychoanalysis posits that much of human behavior is driven by unconscious processes, repressed desires, and unresolved childhood conflicts (Freud, 1900). Freud proposed that these unconscious forces shape personality, influence emotional responses, and manifest in behaviors that individuals are often unaware of. This framework introduced several key concepts, including the id, ego, and superego, the Oedipus complex, and repression, all of which attempt to explain personality development and psychological distress.

One of the foundational claims of psychoanalysis is that unconscious desires and conflicts—especially those formed in early childhood—continue to influence thoughts and behaviors throughout life. Freud suggested that the mind operates on different levels of awareness, with the unconscious mind containing repressed memories and desires that individuals cannot access directly but that shape their actions. According to his structural model of the psyche, the id represents instinctual drives and operates on the pleasure principle, the ego mediates between desires and reality, and the superego internalizes societal norms and morality (Freud, 1923). Psychological distress, in this view, arises when these components are in conflict, leading to anxiety or neurosis.

Freud's theory of repression is central to psychoanalysis, proposing that the mind actively suppresses distressing memories and desires, which then manifest in disguised forms through dreams, slips of the tongue ("Freudian slips"), and neurotic symptoms (Freud, 1915). Because these unconscious elements cannot be accessed directly, Freud developed techniques such as free association, in which patients verbalize thoughts without censorship, and dream analysis, where he interpreted symbols and latent content as reflections of repressed desires (Freud, 1900). He also introduced the Oedipus complex, the controversial idea that young boys experience unconscious sexual attraction to their mothers and hostility toward their fathers, which is later resolved through identification with the father figure (Freud, 1910).

While psychoanalysis became widely influential in the early 20th century, it has been heavily criticized for its lack of falsifiability and empirical support (Crews, 1998). Unlike behaviorism, which bases its findings on observable behaviors, or

cognitive neuroscience, which studies mental processes through measurable brain activity, Freud's theories rely on interpretations that are highly subjective and difficult to test scientifically. Karl Popper (1959) specifically argued that psychoanalysis is unfalsifiable, meaning that it cannot be subjected to conditions that could prove it wrong. If a patient represses trauma, it confirms Freud's theory; if they recall a trauma, it also confirms the theory, leading to a system that cannot be empirically refuted. This stands in contrast to scientific psychology, where hypotheses are tested through controlled experiments and reproducible observations (Eysenck, 1985).

Additionally, many of Freud's claims lack cross-cultural generalizability and appear to be influenced by the Victorian-era norms in which he developed his theories (Maccoby, 1983). The Oedipus complex, for instance, has been challenged by anthropologists who have found that family structures and childhood development differ significantly across cultures, making it unlikely that Freud's model represents a universal truth about human psychology (Mead, 1928). Moreover, Freud's reliance on case studies of a small, non-representative sample—many of whom were upper-class European women—raises concerns about selection bias and the lack of rigorous scientific methodology in his work (Crews, 2017).

The GOP framework classifies Freudian psychoanalysis as epistemically weak because it fails both observability and generalizability. It lacks empirical verification, as its core claims cannot be systematically tested, and it does not generalize well across different cultures or psychological frameworks. While Freud's ideas have had a lasting impact on fields such as literary criticism,

philosophy, and psychotherapy, they do not meet the standards of scientific reliability required for a framework to be classified as epistemically robust. Over time, much of Freudian theory has been replaced by more empirical approaches, such as cognitive-behavioral therapy (CBT) and neuropsychology, which emphasize observable, measurable psychological processes rather than speculative unconscious forces.

Beyond observability, belief-based axioms often fail generalizability, meaning they do not consistently apply across different domains or cultures. This issue arises in subjective moral frameworks, which vary significantly between societies and traditions. Ethical claims such as "murder is always wrong" or "justice requires retribution" may be internally consistent within a particular moral system but fail to generalize across all cultural or philosophical perspectives (Mackie, 1977). In contrast, scientific principles such as Newton's laws apply universally, regardless of cultural context, because they are derived from objective, repeatable observations (Newton, 1687). The failure of belief-based axioms to extend beyond their originating framework further weakens their epistemic reliability.

Religious axioms exemplify both epistemic weaknesses—they are neither empirically observable nor universally generalizable. Many religious claims, such as the existence of an afterlife or divine intervention, lack empirical validation and are often insulated from falsification (Hume, 1748). Additionally, different religious traditions propose conflicting theological axioms, suggesting that these principles are culturally dependent rather than universally applicable (Dennett, 2006). While religion serves various social and psychological functions, its foundational axioms do not meet the GOP criteria for epistemic reliability. However, this critique is not

limited to religion—many secular ideologies also fail under GOP analysis. Political ideologies that claim absolute economic or social truths often rely on axiomatic principles that do not generalize well outside of their specific theoretical frameworks (Berlin, 1969).

The implications of these epistemic weaknesses are significant. Belief-based systems that do not rely on external validation tend to resist correction, making them static rather than progressive (Lakatos, 1970). In contrast, scientific frameworks evolve when new observations refine or challenge existing theories. This dynamic process allows science to move toward greater epistemic reliability, whereas systems based purely on internal coherence remain vulnerable to subjective interpretation and dogmatism. While belief-based axioms may serve psychological, cultural, or ideological purposes, they do not function as reliable knowledge frameworks under GOP classification.

Under the GOP framework, systems that fail both observability and generalizability are classified as epistemically weak. If belief-based frameworks were to gain epistemic strength, they would need to incorporate empirical verification and broader applicability—an adjustment that is fundamentally at odds with their structure.

PART V— Theoretical Gaps

String Theory

GOP reveals that many established scientific frameworks, while useful, exhibit theoretical gaps that prevent them from achieving full epistemic reliability. These gaps arise due to a lack of observability, a lack of generalizability, or both. In many

cases, theories that lack one criterion remain partially reliable under GOP, whereas those failing both fall into the epistemically weak category.

However, the history of science demonstrates that theoretical gaps do not necessarily imply invalidity. Many once-speculative theories gained empirical verification over time and became fundamental. Conversely, some frameworks have persisted in an epistemically weak zone, unable to meet the necessary criteria for reliability.

String Theory attempts to unify quantum mechanics and general relativity by postulating that fundamental particles are not point-like but rather tiny, vibrating strings (Green, Schwarz & Witten, 1987). While its mathematical formalism is highly sophisticated, it currently lacks direct empirical validation due to the extreme energy scales required for experimental testing (Smolin, 2006).

Observability – No direct experimental evidence supports String Theory's predictions, making it untestable within current technological constraints.

Generality (Level 2 – Broadly Generalizable) – String Theory applies to most fundamental physics domains, unifying quantum field theory and gravity at a theoretical level.

Classification Under GOP: Due to its lack of observability, String Theory is epistemically weak despite its strong generalizability. However, this classification is not permanent. If future experimental methods confirm string-like structures or extra dimensions, its epistemic reliability would increase, potentially elevating it to partially reliable or higher.

Gödel's Incompleteness Theorem: The Limits of Formal Systems

After discussing String Theory's lack of observability and Quantum Mechanics' lack of generalizability, it becomes clear that theoretical gaps exist even in the most sophisticated scientific frameworks. However, these gaps are not merely technological or empirical limitations; rather, they reflect a deeper epistemic constraint on formal systems themselves. Gödel's Incompleteness Theorem provides a fundamental insight into this issue, demonstrating that no axiomatic system can be both complete and self-consistent (Gödel, 1931).

GOP aligns with Gödel's approach by recognizing that axioms must be examined externally—a system cannot fully validate itself from within. This insight suggests that no scientific or mathematical framework can serve as an absolute, self-contained truth, reinforcing the idea that scientific progress is inherently iterative.

Gödel's Incompleteness Theorem, developed in 1931, states that:

1) Any sufficiently expressive formal system (e.g., arithmetic) contains true statements that cannot be proven within the system itself.
2) If a formal system is consistent, it cannot prove its own consistency.

This means that any system capable of representing basic arithmetic is necessarily incomplete—there will always be statements that are true but unprovable within that system. Gödel's proof fundamentally challenged the belief that mathematics could be built upon a fully self-contained set of axioms, as envisioned by David Hilbert and other formalists (Nagel & Newman, 1958).

Evaluating Gödel's Incompleteness Theorem Under the Generality-Observability Principle

Given this, a natural question arises: should Gödel's Incompleteness Theorem itself be subject to the same scrutiny? Gödel's theorem asserts that in any sufficiently expressive formal system, there exist true statements that cannot be proven within the system itself, implying an inherent limit to self-description in mathematical logic (Gödel, 1931). While widely accepted as a fundamental result, its universal applicability remains open to question. If a formal system were discovered that could fully describe itself, then Gödel's theorem would no longer be fully reliable, requiring a reassessment of its epistemic status under GOP.

Gödel's theorem satisfies observability in a mathematical sense. Unlike scientific theories that rely on empirical validation, mathematical theorems are verified through formal proof and logical derivation. Gödel's proof is based on the technique of arithmetization, in which mathematical statements are encoded as numbers, allowing a system to refer to its own properties. By constructing a statement that asserts its own unprovability, Gödel demonstrated that no system encompassing arithmetic can be both complete and consistent. This result has been rigorously examined and reconfirmed through formal logic, making it highly reliable within its domain (Nagel & Newman, 1958). Under the GOP framework, Gödel's theorem is therefore observable within the field of mathematical logic, though it does not have empirical observability in the way physical theories do.

However, generalizability is a more complex issue. Gödel's theorem applies specifically to formal systems that include arithmetic, such as Peano arithmetic and first-order logic. It does not necessarily extend to all possible logical

frameworks, raising the possibility that alternative mathematical structures might escape its constraints. In category theory and type theory, some approaches attempt to reframe formal systems in ways that may avoid Gödelian incompleteness (Ladyman & Presnell, 2022). Additionally, some theorists have proposed that computational or physical systems—particularly those involving quantum mechanics—may not be bound by Gödel's limitations. Quantum computation introduces models of information processing that do not fit within standard formal logic, leading some to speculate whether a self-referential physical system could exist outside Gödelian constraints (Deutsch, 1997). If a system were discovered that could fully prove all its true statements without external reference, Gödel's theorem would no longer be universally generalizable and would shift from being fully reliable to partially reliable under the GOP framework.

Another challenge arises from the self-applicability of Gödel's theorem. If no sufficiently complex formal system can prove all true statements within itself, does Gödel's theorem itself fall under this limitation? The theorem asserts a fundamental restriction on formal systems, yet it is itself derived from within the framework of mathematical logic. This raises a paradoxical issue: can Gödel's theorem fully justify its own conclusions, or does it, too, require an external framework to establish its validity? This is akin to the broader epistemic question of whether a claim about the limits of knowledge can itself be an absolute statement about those limits. If Gödel's theorem is truly universal, then it must apply to itself, which could imply that even it is incomplete in some sense, leaving open the possibility that a deeper meta-theory exists beyond its scope.

Applying GOP to Gödel's theorem highlights the necessity of maintaining epistemic flexibility. While the theorem remains one of the most rigorously proven results in mathematical logic, the GOP framework suggests that its universality should not be assumed without question. Currently, Gödel's theorem is classified as observable within mathematical logic and broadly generalizable (Level 2), failing only in domains that propose alternative logical structures. However, should a system emerge that circumvents its conclusions, its classification would need to be revised.

PART VI— Why This Model Is Unique

Unlike Popper's Falsifiability

One of the key distinctions between the Generality-Observability Principle (GOP) and Karl Popper's falsifiability criterion lies in how each framework evaluates the epistemic reliability of axioms and theories. Popper's falsifiability principle holds that for a theory to be considered scientific, it must be capable of being disproven by empirical evidence (Popper, 1959). If a theory does not permit conditions under which it could be shown false, it is classified as unscientific. While this approach effectively distinguishes science from pseudoscience, it does not account for the varying degrees of reliability among different axioms, including those that are incomplete but still useful.

The GOP framework expands beyond falsifiability by ranking the reliability of axioms, even when they are incomplete or lack direct falsifiability. For example, String Theory exists in an epistemic gray area because it is neither provable nor falsifiable with current technology (Smolin, 2006). Under Popper's model, String

Theory is relegated to the category of non-scientific speculation because it does not make testable predictions. However, under the GOP framework, String Theory is classified as epistemically weak but not necessarily invalid, as it satisfies partial generalizability by unifying aspects of quantum mechanics and general relativity. This distinction allows GOP to provide a more nuanced classification of theoretical frameworks rather than an all-or-nothing approach.

Furthermore, not all valid axioms are falsifiable. Mathematical axioms, such as Euclidean postulates or arithmetic truths, are not subject to empirical falsification, yet they remain foundational to all of science and engineering (Tegmark, 2014). Under Popper's strict falsificationist view, such axioms would not qualify as scientifically valid because they do not make testable predictions that could be proven false. GOP resolves this issue by focusing on reliability rather than falsification, ensuring that axioms can be ranked based on their applicability across systems and their empirical reinforcement.

By moving beyond Popper's binary classification of scientific vs. non-scientific, the GOP framework provides a continuous scale of epistemic reliability. Theories and axioms are not discarded simply because they fail a falsifiability test; instead, they are evaluated based on how well they generalize and whether they can be empirically reinforced over time. This makes GOP a more flexible and inclusive epistemic model, particularly in areas such as theoretical physics and mathematics, where falsifiability alone is insufficient for assessing knowledge claims.

Unlike Pure Rationalism or Coherentism

Another limitation of traditional epistemic frameworks is their reliance on internal coherence as a measure of validity. Pure rationalism and coherentism emphasize the logical consistency of a system as the primary criterion for its epistemic strength (Bonjour, 1985). While coherence is necessary for a system to be meaningful, it is not sufficient to establish reliability. A theory can be internally consistent but still fail to correspond to reality, making it epistemically weak under the GOP framework.

For instance, Freudian psychoanalysis is internally coherent, as its concepts—such as repression and unconscious drives—form a logically connected system (Freud, 1915). However, as previously discussed, it lacks empirical observability and does not generalize well across different cultural and psychological frameworks (Eysenck, 1985). Similarly, in metaphysics, idealism, which argues that reality is fundamentally mental rather than physical, is internally consistent but lacks empirical verification (Berkeley, 1710). These examples illustrate that internal consistency alone does not guarantee epistemic reliability.

The GOP framework addresses this issue by requiring both observability and generalizability. An internally coherent system that fails empirical validation or lacks cross-domain applicability is epistemically weak, even if it appears logically sound. This distinction allows GOP to filter out speculative or unfalsifiable models, preventing internally valid but externally unreliable theories from being classified as epistemically strong. Unlike coherentism, which assesses truth based on how well a belief fits within a broader system of beliefs, GOP requires external validation beyond logical coherence.

A Framework for Scientific & Philosophical Inquiry

The versatility of GOP makes it applicable to both scientific and non-scientific systems, offering a structured way to evaluate knowledge gaps. Unlike many epistemic models that are confined to specific disciplines, GOP can be used to assess mathematical axioms, scientific theories, philosophical claims, and even ideological beliefs. This adaptability makes it a more comprehensive epistemological framework than falsificationism or coherence theories alone.

In scientific inquiry, GOP helps differentiate between theories that are incomplete but useful and those that are fundamentally flawed. This prevents the premature rejection of frameworks like quantum mechanics, which, while incomplete, remain empirically verified and generalizable in most domains. Similarly, it provides a method for assessing emerging theories such as quantum gravity, which lack full empirical validation but may eventually gain reliability as observational methods improve (Penrose, 2004).

Beyond science, GOP can be applied to philosophical and ideological claims by highlighting which axioms fail to meet epistemic standards. Claims that rely purely on internal logic or subjective experience—such as certain metaphysical doctrines or political ideologies—often fail observability or generalizability, making them epistemically weak. By providing a structured way to classify knowledge, GOP allows for a hierarchy of epistemic reliability that helps distinguish between valid, incomplete, and unreliable frameworks. It overcomes the limitations of falsificationism, which dismisses non-falsifiable but useful axioms, and rationalist or coherentist models, which rely too heavily on internal logic without external validation

PART VII– Conclusion

An Existential Necessity

This framework is necessary not only for scientific progress but also for navigating the modern information landscape, where misinformation, ideological bias, and epistemic rigidity threaten the reliability of public discourse. As societies become increasingly reliant on algorithmic decision-making, artificial intelligence, and large-scale data-driven systems, the ability to critically evaluate information is no longer just an academic pursuit—it is an existential necessity (Chomsky, 2021).

As we move toward the development of Artificial General Intelligence (AGI)—machines capable of performing any intellectual task that a human can—the ability to systematically evaluate information becomes even more critical. Unlike narrow AI, which excels in specialized tasks such as image recognition or language processing, AGI will require a robust framework for reasoning, learning, and adapting to new knowledge (Tegmark, 2017). If AGI is to navigate complex human-like decision-making, it will need to distinguish between epistemically strong and weak axioms, avoiding reliance on unverifiable or non-generalizable principles. If such systems are trained on biased or unreliable information, they may reinforce misinformation and ideological distortions rather than pursuing objective reasoning (Bostrom, 2014). A failure to incorporate a structured method—such as the GOP—into AGI models could result in systems that optimize for correlation rather than causation, reinforcing cognitive biases rather than challenging them. Without a way to classify axioms based on their observability and generalizability, AGI could become a highly sophisticated but epistemically fragile system, susceptible to manipulation by bad data, adversarial attacks, or human biases encoded in training sets (Russell, 2019).

The Flaws in a "Theory of Everything" and the Limits of Absolute Knowledge

Beyond artificial intelligence, scientific inquiry itself is constrained by the limitations of knowledge systems, as seen in the search for a Theory of Everything—a single, unified framework that would reconcile quantum mechanics and general relativity (Hossenfelder, 2018). While this pursuit is an essential part of physics, the Gödelian nature of knowledge suggests that no single system can be both complete and self-consistent (Gödel, 1931). A truly fundamental "Theory of Everything" would need to satisfy both generality and observability, meaning it would have to be experimentally validated across all domains and free from self-referential paradoxes. Given the historical trend of scientific revolutions, it is likely that even if such a theory emerges, it will eventually be revised, much like Newtonian mechanics was corrected by relativity, and relativity may one day be corrected by a deeper framework (Penrose, 2004).

A Theory of Everything must also confront the measurement problem in quantum mechanics, the nature of consciousness, and the role of information in physical reality. The GOP framework provides a useful tool for assessing whether such a theory—should it emerge—meets the necessary criteria for epistemic reliability. If it fails observability, it will remain speculative, much like String Theory; if it fails generalizability, it will be an incomplete model rather than a final truth.

The Modern Misinformation Crisis and the Need for Structured Epistemology

In today's digital landscape, misinformation spreads faster and more effectively than truth, particularly on social media platforms designed to optimize engagement over accuracy (Vosoughi, Roy, & Aral, 2018). The rise of deepfake

technology, AI-generated content, and algorithmic echo chambers has made it increasingly difficult to separate valid knowledge claims from epistemically weak statements (Zuboff, 2019). A study by Vosoughi et al. (2018) found that false information spreads six times faster than factual information on Twitter, largely due to its ability to trigger emotional reactions rather than logical scrutiny.

The GOP framework provides a solution to this epistemic crisis by offering a systematic way to assess information, whether it is encountered in a research setting, a political debate, or a social media post. In an era where individuals are exposed to an overwhelming amount of contradictory and often misleading claims, the ability to classify whether a claim is reliable or should be discarded as epistemically weak— based on its observability and generalizability— is crucial.

The Necessity of Evolving Axioms

Scientific knowledge has progressed not because axioms have remained fixed, but because they have evolved in response to new observations and contradictions. The strength of scientific inquiry lies in its willingness to revise its foundational assumptions when new evidence emerges. Newtonian mechanics was considered fundamentally true until Einstein demonstrated its limitations at relativistic speeds (Einstein, 1915). Quantum mechanics is currently accepted as an accurate model at small scales, but it remains incomplete until it can be unified with gravity. Scientific theories are reliable precisely because they update when contradictions arise, whereas axioms that remain static despite contrary evidence—such as outdated medical practices or discredited economic models—lose their epistemic reliability over time (Kuhn, 1962).

A theory, framework, or belief system that does not evolve when faced with new contradictions is epistemically weak by definition. The GOP framework highlights this necessity, providing a structured approach to ensuring that axioms are not arbitrarily accepted but continuously tested, refined, and revised— ensuring that knowledge remains adaptable in an ever-changing world.

Conclusion

The Generality-Observability Principle is not just an academic tool but a practical necessity in an era of exponential information growth, artificial intelligence, and epistemic uncertainty. As societies face challenges such as AGI development, the spread of misinformation, and the limits of scientific knowledge, the ability to systematically assess axioms will determine whether humanity advances toward greater intellectual clarity or falls into deeper epistemic fragmentation.

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