Readability Is Freedom:

A Case Against Proprietary Math Empires

A Philosophical Defense of Open-Source Computation

Flyxion

Independent Researcher

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Abstract

In every era, systems of knowledge face the same temptation: the temptation to transform methods into authorities, and authorities into institutions whose legitimacy no longer depends upon understanding. The modern landscape of scientific computing presents a particularly revealing example of this tendency. Proprietary computational systems increasingly mediate access to mathematics, scientific reasoning, optimization, symbolic manipulation, and artificial intelligence. While these systems often provide remarkable practical capabilities, they also create new forms of epistemic dependency, in which the user receives answers while remaining unable to inspect the mechanisms that produced them, and understanding is systematically replaced by trust.

This essay argues that the debate between proprietary and open-source computational systems is not fundamentally a technical dispute. It is a philosophical dispute concerning the nature of knowledge, authority, interpretation, and freedom. Drawing upon the skeptical tradition of Sextus Empiricus, the critique of universal classification developed by Jorge Luis Borges, the constructive mathematical emphasis on witness extraction, and contemporary criticisms of meritocratic ideology, I argue that transparency, readability, auditability, and forkability are not merely engineering preferences. They are epistemic virtues.

The history of intellectual life repeatedly reveals the same structural pattern. Systems that begin as useful tools gradually acquire the status of unquestionable authorities. Taxonomies become realities. Models become ontologies. Credentials become measures of human worth. Computational platforms become gatekeepers of knowledge. At each stage, the underlying mechanisms disappear behind institutional legitimacy, and participation gives way to dependence. Against this tendency stands a different and more enduring tradition: a skeptical tradition that insists upon inspection over deference, mechanisms over declarations, and understanding over authority. Open-source computation represents one contemporary manifestation of this tradition, and its significance lies not merely in reduced cost or increased flexibility, but in its preservation of a fundamental right — the right to examine the processes through which knowledge is produced. Readability is therefore more than a stylistic preference. It is a form of intellectual self-government, and, ultimately, a form of freedom.

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1. Introduction: The Return of the Math Empire

In 1675, Gottfried Wilhelm Leibniz began developing the notation that would eventually become modern calculus. Across the English Channel, Isaac Newton had independently developed a closely related mathematical framework. What followed was not merely a dispute about priority, but a struggle over authority, legitimacy, and ownership. Mathematical discovery, which might have served as a common intellectual inheritance, became entangled in questions of personal prestige and institutional control. The calculus controversy is often remembered as a clash between two extraordinary minds, yet it also reveals a deeper and more persistent tendency in intellectual life: human beings repeatedly transform methods into possessions, discoveries into territories, and knowledge into institutions of authority.

This tendency did not begin with Newton and Leibniz, nor did it end with them. Variations of the same structural pattern can be found throughout the history of science, philosophy, religion, politics, and technology. The history of knowledge is not merely the history of ideas but also the history of who controls access to ideas. Ancient priesthoods claimed privileged access to divine knowledge. Medieval scholastics exercised authority through mastery of specialized texts and languages. Early modern philosophers sought universal systems capable of organizing all knowledge. Twentieth-century bureaucracies constructed credentialing systems that transformed educational achievement into social authority. Contemporary technology companies increasingly mediate access to computation, information, and artificial intelligence through proprietary platforms whose internal operations remain inaccessible to their users. The institutions differ; the pattern remains remarkably similar. A useful tool emerges, the tool becomes important, access to the tool becomes valuable, control over access becomes power, and eventually the institution surrounding the tool acquires a degree of authority independent of the tool's original purpose.

This essay concerns one modern manifestation of this process: the emergence of what may be called *math empires*. A math empire is not defined by mathematics itself, which is among the most successful intellectual achievements in human history, nor is it defined by computational sophistication, since powerful computational systems are often extraordinarily useful. Rather, a math empire emerges whenever access to mathematical reasoning becomes concentrated within institutions whose authority exceeds the transparency of their methods. The defining feature is not complexity but opacity: the user receives conclusions without mechanisms, outputs without explanations, answers without understanding. The problem is not that such systems produce incorrect results, since many proprietary computational systems produce highly accurate results. The problem is that correctness alone cannot serve as the sole foundation of epistemic legitimacy. To understand a result is categorically different from merely receiving it, and this distinction is increasingly important in an era where computation mediates scientific research, economic decision-making, educational assessment, and public policy. As computational systems become more powerful, the temptation grows to treat their outputs as authoritative simply because they are difficult to inspect, and this danger is subtle precisely because it so often disguises itself as efficiency.

The skeptical tradition offers a different perspective. From the writings of Sextus Empiricus onward, skepticism has not primarily been concerned with denying knowledge but rather with maintaining the discipline of inspection. The skeptic does not reject claims because they are false but examines claims because they may be mistaken, and authority alone never settles the matter. This demand for mechanisms over declarations reverberates throughout intellectual history: it appears in the scientific demand for reproducibility, in the constructive mathematical demand for witnesses, in the legal demand for evidence, and in the open-source demand for inspectable code. In every case, the underlying principle is the same — show me not merely the result but the process through which the result was obtained.

The argument developed in this essay is therefore broader than a critique of proprietary software. Proprietary computational systems serve as a particularly visible contemporary example of a much older phenomenon whose structural logic also appears in universal taxonomies that claim to classify reality itself, in theories that mistake models for the world they describe, in meritocratic institutions that mistake successful outcomes for evidence of just selection mechanisms, and in intellectual movements that substitute prestige for explanation. The chapters that follow examine several manifestations of this pattern in sequence, asking throughout what distinguishes understanding from authority, and proposing a simple answer: understanding requires access to mechanisms, while authority requires only acceptance. The distinction between these two conditions may ultimately determine whether future computational systems serve as tools of liberation or instruments of dependence, and for this reason readability is not merely a property of code but a property of institutions, of knowledge, and ultimately of freedom.

2. Sextus Empiricus and the Skeptical Tradition

The modern word *skepticism* often carries unfortunate connotations. To many people, a skeptic is someone who refuses to believe anything, rejects expertise, or delights in contrarianism for its own sake. This understanding bears little resemblance to the philosophical tradition associated with Sextus Empiricus, for whom skepticism was not a doctrine but a method. The skeptic did not begin by asserting that a claim was false, nor by asserting that it was true. Instead, the skeptic investigated competing arguments, examined the grounds on which beliefs were justified, and resisted the temptation to grant certainty where certainty had not been earned. This distinction is crucial: the skeptic is not the enemy of knowledge but the enemy of unwarranted authority.

In the *Outlines of Pyrrhonism*, Sextus repeatedly emphasizes that skepticism emerges not from a desire to deny reality but from a desire to avoid premature conclusions. The skeptic encounters competing explanations, discovers that each possesses strengths and weaknesses, and rather than immediately choosing a side continues examining the matter. The resulting suspension of judgment, or *epoché*, is often misunderstood as a form of paralysis. Human beings must still act, make decisions, conduct experiments, and build institutions. What changes is not action but attitude: the skeptic acts without claiming final certainty, treats conclusions as provisional achievements rather than possessions, and asks not "what must I defend?" but "what have I overlooked?" The difference may appear psychological, but it carries important institutional implications, since entire systems of knowledge can be organized around either attitude. A healthy scientific community is fundamentally skeptical, exposing claims to criticism, replicating experiments, revising models, and permitting no individual to hold permanent authority, while every conclusion remains open to challenge.

Intellectual systems become dogmatic when criticism ceases to function as a mechanism of correction and becomes instead a marker of disloyalty, when questions are treated as threats, when dissent becomes evidence of incompetence, and when the institution gradually protects itself from scrutiny. At this point, authority begins to replace understanding, and the transition is often difficult to detect because it rarely occurs suddenly. Dogmatism seldom announces itself openly. Instead, it accumulates through small substitutions: explanations become slogans, mechanisms become labels, and investigation becomes branding. A philosophical school becomes attached to its founder, a scientific theory becomes associated with a prestigious institution, a computational platform becomes synonymous with expertise, a credential becomes confused with competence. In each case, authority gradually acquires an existence independent of the reasoning that originally justified it.

Sextus provides a useful corrective because he consistently redirects attention away from authority and back toward process. The skeptical question — how was this conclusion obtained? — cuts through many forms of intellectual inflation. Whether the subject is a theory explaining a phenomenon, a researcher making a remarkable claim, or a computational system producing an answer, the appropriate response is not immediately to accept or reject the conclusion but to ask about the mechanism that generated it. Notice that this question does not deny the possibility that the conclusion is correct; it merely refuses to substitute authority for explanation. This distinction becomes especially important in mathematics and computation, where success encourages the temptation to treat outputs as self-justifying. A proof may be valid while its interpretation is mistaken. A model may be useful while its ontology is false. An algorithm may be accurate while its assumptions remain poorly understood. The existence of a result does not eliminate the need for interpretation, and the success of a system does not eliminate the need for scrutiny. Indeed, the more powerful a system becomes, the more important scrutiny becomes.

This skeptical demand reappears in each of the domains examined throughout this essay. When John Wilkins attempts to construct a universal language, the appropriate question concerns the assumptions embedded within his classification system. When meritocratic institutions celebrate their winners, the appropriate question concerns the selection mechanisms that produced them. When proprietary computational platforms claim authority, the appropriate question concerns the opacity of their methods. The specific subject changes; the demand remains constant. The remarkable durability of this demand suggests that skepticism represents not merely one philosophical position among many but a permanent corrective within intellectual life, serving to prevent institutions from becoming empires by insisting that authority remain answerable to understanding. Its central question is not "why should I reject this?" but "how does this work?" and much of the history of knowledge turns upon the difference.

3. The Dream of Perfect Language

Few intellectual ambitions have proven more persistent than the dream of a perfect language. Again and again, philosophers, theologians, mathematicians, and reformers have imagined that human confusion arises not from the complexity of reality itself but from imperfections in the symbols used to describe it, reasoning that if only a better language could be constructed, ambiguity might disappear, disputes might be resolved, and knowledge might become transparent. The attraction of this vision is understandable. Language often appears frustratingly imprecise: the same word can possess multiple meanings, different communities employ incompatible terminologies, and metaphor, irony, context, and history complicate interpretation, so that misunderstandings arise even among people speaking the same language. Faced with these difficulties, the prospect of a universal symbolic system possesses obvious appeal, not merely as a tool for communication but as an instrument capable of revealing the structure of reality itself.

The seventeenth century proved particularly fertile ground for such ambitions. The Scientific Revolution was transforming traditional conceptions of nature, new discoveries created an urgent demand for systems capable of organizing rapidly expanding bodies of information, and advances in mathematics suggested the possibility that symbolic representations might capture deep structural truths about the world. Within this environment, several thinkers pursued projects aimed at creating universal languages, among the most ambitious of which was the project of John Wilkins. In 1668, Wilkins published *An Essay Towards a Real Character and a Philosophical Language*, a work whose title itself reveals the scale of its ambition. He did not merely wish to improve communication but sought a language whose structure would correspond directly to the structure of reality, in which words would not be arbitrary conventions but would encode objective information about the nature of the things they represented. To accomplish this goal, Wilkins first attempted to classify the entirety of human knowledge: reality was divided into major categories, categories into subcategories, subcategories into increasingly specific distinctions, and each position within this hierarchy received a symbolic designation, so that the resulting language functioned as a taxonomic map of existence.

The ambition was extraordinary, and so were the difficulties. The first problem concerned classification itself: which distinctions are fundamental, which are secondary, which categories are natural, and which merely reflect historical habits of thought? Wilkins treated these questions as though they possessed objective answers waiting to be discovered, but reality rarely cooperates. Whether a whale is a fish turned out to depend not on the whale but on the criteria the classifier chose to privilege. Whether political ideologies should be classified by economics, authority structures, historical origins, or cultural values is equally underdetermined. Whether mental disorders should be classified by symptoms, causes, neurological mechanisms, or social effects has no obvious answer that transcends the purposes of the classification. The act of classification is never purely descriptive but always also interpretive, and this realization gradually undermines the dream of a perfectly neutral taxonomy. Every taxonomy contains assumptions, every hierarchy contains judgments, and every map emphasizes some features while ignoring others. The dream of a perfect language depends upon forgetting this fact.

Gottfried Wilhelm Leibniz, working only a few years after Wilkins, pursued a related ambition through his notion of a *characteristica universalis*: a symbolic language capable of expressing all human reasoning with the precision of mathematics, in which disputes might eventually be resolved through calculation rather than argument. The aspiration remains deeply influential. Contemporary efforts in formal logic, computer science, semantic web technologies, ontology engineering, and artificial intelligence all inherit elements of this vision. The dream repeatedly reappears in new forms: a universal ontology, a universal knowledge graph, a universal latent space, a universal symbolic system, a universal representation. Each proposes, implicitly or explicitly, that reality possesses a privileged structure capable of being captured within a sufficiently powerful formalism.

The danger lies not in the failure of such systems, since many achieve remarkable successes, but in what success encourages. A useful representation gradually becomes confused with reality itself, and the map begins to masquerade as the territory. At this point, criticism becomes difficult because questioning the representation appears equivalent to questioning reality. The classification system acquires authority not merely as a tool but as a description of what fundamentally exists, and this is the first step toward what may be called an epistemic empire. The empire emerges whenever a representation acquires sufficient prestige that alternative representations become difficult to imagine: the categories appear natural, the assumptions become invisible, and the framework becomes self-evident. The most effective critiques therefore often arrive not through direct argument but through satire, and no one understood this better than Jorge Luis Borges, who would produce one of the most devastating critiques of universal classification ever written by exposing, through a few absurd categories, the weakness that lies at the heart of every attempt to build a perfect language: the classifier can never entirely disappear from the classification.

4. Borges and the Taxonomy of the Non-Halting Mind

In 1942, Jorge Luis Borges published a short essay titled *The Analytical Language of John Wilkins*. The essay is only a few pages long, yet it contains one of the most profound critiques ever written of classification, representation, and intellectual authority. After discussing Wilkins and other attempts to construct universal languages, Borges introduces a peculiar example: a supposed Chinese encyclopedia entitled *The Celestial Emporium of Benevolent Knowledge*, in which animals are divided into the following categories: (a) belonging to the Emperor; (b) embalmed; (c) tame; (d) sucking pigs; (e) sirens; (f) fabulous; (g) stray dogs; (h) included in the present classification; (i) frenzied; (j) innumerable; (k) drawn with a very fine camel-hair brush; (l) et cetera; (m) having just broken the water pitcher; (n) that from a long way off look like flies.

The effect is immediate. The classification feels absurd: the categories appear arbitrary, incompatible, and irrational, some referring to biological properties, others to mythology, others to artistic representation, still others to temporary events or subjective perception. Yet Borges' point is more subtle than simple ridicule. The humor functions as a diagnostic instrument, exposing assumptions that ordinarily remain hidden. When readers encounter the encyclopedia, they instinctively ask what single principle governs these categories, and the discomfort arises precisely because no such principle appears to exist. Different categories operate according to different criteria, and the taxonomy lacks the coherence that readers have been trained to expect. The deeper implication is unsettling: how much of what we regard as natural classification is merely familiarity, and how much of our taxonomic confidence arises from habit rather than necessity?

The category of those that "from a long way off look like flies" is particularly revealing. It does not classify animals according to any intrinsic property but according to a perceptual circumstance in which distance matters, observer position matters, and visual ambiguity matters. The category depends not merely upon the animal but upon the relationship between observer and observed, and therefore contains information about perception rather than about the animal itself. Similarly, the category of those that "have just broken the water pitcher" makes sense, if it makes sense at all, only as a record of the classifier's current fixation: the event occupies attention, generates frustration, and the mind repeatedly returns to it, so that what appears to be a taxonomy of the world gradually reveals itself as a taxonomy of the classifier's state of mind. What appears to be an objective organization of external reality is a map of preoccupation, a snapshot of cognitive salience.

This insight extends far beyond the immediate targets of Borges' satire, since human beings rarely classify reality in a neutral manner but classify according to interests, incentives, fears, goals, and limitations. What is important becomes visible; what is irrelevant disappears; and the resulting categories often feel objective precisely because their origins have been forgotten. In this sense, every classification system contains a hidden autobiography. The point is not merely psychological but epistemological: a classification system does not simply organize information but determines what kinds of information become visible in the first place. Once categories are established, observations naturally accumulate within them, research programs emerge around them, institutions adopt them, and entire disciplines may become structured around distinctions that initially arose for contingent historical reasons. Economic indicators shape economic policy, diagnostic categories shape medicine, academic disciplines shape research questions, and software architectures shape computational possibilities.

Borges forces readers to confront this instability directly, and in so doing produces a critique whose implications reach far beyond linguistics. Every representation involves selection, every selection involves exclusion, and every exclusion reflects assumptions. The danger emerges when these assumptions become invisible, at which point the classification ceases to appear as a human construction and begins to appear as reality itself. The observer disappears into the system, the categories acquire authority, and the map becomes difficult to distinguish from the territory. This transition marks the beginning of epistemic empire: an empire that does not require coercion but only acceptance, and whose most insidious feature is that it presents itself as self-evident. The skeptic's task is therefore not to abolish classifications, which would be both impossible and counterproductive since human cognition depends upon distinctions, but to preserve awareness that classifications are constructed, that the categories are tools rather than revelations, and that every taxonomy both organizes reality and forecloses upon it.

5. The Selection Fallacy and the Tyranny of Merit

If Borges teaches skepticism toward classifications, Michael Young and Michael Sandel teach skepticism toward selections. The distinction is important, even as the underlying structural logic proves similar. A classification system sorts objects into categories, while a selection system sorts individuals into outcomes. Both involve distinctions, both involve criteria, both generate hierarchies, and both conceal assumptions behind apparently objective procedures. Yet selection possesses an additional feature that complicates analysis: it creates winners, and the existence of winners exerts a powerful psychological force on observers. People naturally gravitate toward visible successes, and the successful entrepreneur, celebrated researcher, prestigious university graduate, and highly compensated executive become evidence that the system functions as intended. The reasoning appears straightforward — the institution selected capable individuals, those individuals succeeded, therefore the institution must be effective — but this conclusion contains a subtle logical error. The existence of winners demonstrates that selection occurred; it does not necessarily demonstrate that the selection process was wise, fair, efficient, or socially beneficial.

This distinction lies at the heart of Michael Young's original critique of meritocracy, which is today remembered almost exclusively as the satirical source of a term that has since been appropriated as unambiguous praise. When Young introduced the word in

The Rise of the Meritocracy in 1958, he intended it as a warning. He imagined a future society organized around increasingly sophisticated mechanisms for identifying talent, intelligence, and achievement, producing a system that would appear fair because positions of influence would no longer be inherited through aristocratic birth but would be earned through demonstrated ability. Young's concern, however, was not that talented individuals would succeed but rather what successful individuals might conclude about themselves. The aristocrat understood, at some level, that privilege had been inherited. The meritocrat could easily, and with far greater ideological force, conclude that privilege had been deserved. The hierarchy would thereby acquire a moral significance unavailable to hereditary aristocracy: the winners would appear not merely fortunate but virtuous, while the excluded would appear not merely unlucky but responsible for their own exclusion. What began as a system for allocating opportunities would gradually become a system for allocating dignity.

Michael Sandel's more recent critique in *The Tyranny of Merit* extends this analysis to show how thoroughly the meritocratic framework has colonized contemporary self-understanding. Sandel's concern is that meritocratic institutions increasingly function not merely as mechanisms of social allocation but as mechanisms of social validation, in which admission becomes recognition, credentials become identity, and selection becomes moral judgment. This aspect of the argument is particularly important because material inequality can, at least in principle, be addressed through redistribution, while the distribution of dignity is far more difficult to correct. A society may profess respect for all forms of labor while simultaneously organizing prestige around a narrow set of credentials and occupations, and the contradiction becomes visible precisely at the moments when people are asked what work they would genuinely be happy for their children to do. The disparity between professed respect and genuine esteem reveals a classification system operating beneath the official discourse of equal dignity, and this hidden taxonomy reflects not objective measures of social value but the accumulated prejudices, path dependencies, and status anxieties of the particular historical moment in which it was constructed.

What the existence of remarkable winners produced by imperfect institutions actually demonstrates is therefore considerably less than it appears to. A lottery produces winners; a casino produces winners; a speculative investment bubble produces winners; even a thoroughly arbitrary or unjust institution will produce individuals who appear remarkably successful relative to those excluded, as long as the institution selects frequently enough from a large enough population of talented people. The mere existence of exceptional outcomes provides surprisingly weak evidence regarding the quality of the selection mechanism, yet observers frequently reverse the direction of inference, reasoning from visible winners to good selection process rather than from selection process to visible winners. This inversion — mistaking the output of a filter for evidence of the filter's wisdom — constitutes what might be called the selection fallacy, and it appears throughout intellectual life wherever institutions defend themselves by pointing toward their most celebrated products. A university points to distinguished alumni; a corporation points to successful executives; an investment fund points to its best trades; a software platform points to the companies built upon it. In each case, the winners become evidence, and the mechanism escapes scrutiny. The skeptic's response is to redirect attention away from outcomes and toward mechanisms, asking not who succeeded but what process selected them, and not whether the outcomes are impressive but what possibilities were excluded in the course of producing them.

6. Maps, Territories, and the Problem of Meaning

One of the most persistent confusions in intellectual life arises from a simple but profound fact: human beings do not interact with reality directly but through representations of reality. Maps, models, theories, equations, diagrams, symbols, classifications, and narratives all serve as intermediaries between observers and the world they seek to understand. Without such representations, systematic reasoning would be impossible, and yet the very success of representations creates a recurring danger in which the representation begins to acquire the authority of the thing represented. Alfred Korzybski famously observed that the map is not the territory, a phrase that has become a cliché precisely because it captures something obvious that intelligent people nonetheless repeatedly forget. A road map is not a road, a globe is not a planet, a balance sheet is not an economy, and an equation is not a physical phenomenon, yet scientific practice, economic policy, and technological development are persistently organized as though these identifications were unproblematic.

The problem rarely begins with representations themselves. Scientific progress depends upon the construction of increasingly useful models, and the difficulty emerges not from model-building as such but from the conflation of usefulness with identity. A model that successfully predicts observations becomes central to scientific practice; researchers begin speaking as though the model itself constitutes reality; and what begins as shorthand eventually becomes ontology. This transition often occurs gradually and almost imperceptibly, so that physicists discuss spacetime as though mathematical descriptions and physical reality were identical, economists discuss markets as though indicators and institutions exhaust the phenomena being measured, and artificial intelligence researchers discuss representations as though representations themselves possessed understanding. The issue is not that such language is always wrong but that linguistic convenience frequently conceals philosophical assumptions, and when a useful model becomes mistaken for a complete description, or a successful representation becomes mistaken for the thing it represents, criticism becomes difficult because questioning the representation appears equivalent to questioning reality.

Every representation highlights certain features while suppressing others, and maps gain usefulness precisely because they omit information. A perfectly detailed map would be unusable. William James observed that the art of being wise consists in knowing what to overlook, and representations embody this principle: they are valuable because they simplify, yet simplification always introduces distortion. The challenge is not to eliminate distortion, which would require eliminating representation entirely, but to remain aware that it exists. This problem becomes especially interesting when discussions turn toward meaning itself, since many contemporary debates in philosophy, cognitive science, artificial intelligence, and information theory revolve around the question of how meaningful structures emerge from formal systems that do not intrinsically possess semantics. A differential equation does not know what it describes, a database does not understand its contents, and a mathematical proof does not interpret itself. Meaning requires some form of correspondence between symbols and what those symbols represent, and this insight serves as a useful corrective to overly reductionist accounts of knowledge that mistake formal manipulation for genuine understanding.

Yet a second danger quickly emerges alongside the first. Having correctly distinguished formal structure from meaning, some theoretical frameworks proceed to treat meaning itself as a primitive rather than as a phenomenon to be explained. The explanation halts, meaning becomes fundamental, interpretation becomes fundamental, and recognition becomes fundamental, while the mystery remains — only its location changes. The situation resembles earlier examples: a classification system becomes reality, a selection process becomes merit, a representation becomes ontology, and now meaning itself becomes an unexplained authority. When a theory proposes a special operation such as "recognition" or "understanding" as the mechanism through which formal processes generate meaningful experience, the skeptic immediately asks what recognition actually is, how it operates, what mechanisms produce it, and what observations would contradict the proposed account. Without answers, such terms function less as explanations than as placeholders, and the history of science provides many examples of exactly this pattern: vital force once appeared to explain life, phlogiston once appeared to explain combustion, and in each case genuine explanation eventually required mechanisms rather than labels. Explanatory frameworks become strongest when they reveal mechanisms rather than merely introducing new primitives, and the commitment to mechanism preserves inquiry in a way that the commitment to unexplained primitives systematically terminates it.

7. Constructive Mathematics and the Demand for Witnesses

The skeptical demand for mechanisms finds one of its most elegant expressions not in philosophy but in mathematics itself. At first glance this may seem surprising. Mathematics is often regarded as the domain of abstraction par excellence, and one might therefore expect it to be especially tolerant of existence claims that provide little concrete information, since its objects need not be physical and its arguments frequently concern idealized entities that exist only within formal systems. Yet one of the most influential traditions within modern mathematical logic moves in precisely the opposite direction, insisting that existence should mean not merely possibility but construction, and that a proof should provide not merely assurance but a witness.

To understand the significance of this claim, it is useful to begin with a distinction between two styles of mathematical reasoning. Classical mathematics often proves that an object exists without explicitly exhibiting it, by demonstrating that assuming the nonexistence of the object leads to contradiction and inferring existence from the impossibility of non-existence. The resulting proof may provide no practical method for finding the object in question, and from the perspective of classical mathematics this is entirely acceptable. Constructive mathematicians adopt a more demanding standard: to claim that an object exists is to claim that one can, at least in principle, construct it. The proof should produce a witness — a concrete example that can be exhibited and examined — and existence that cannot be made visible in this way is treated with appropriate caution. Constructive mathematics emerged most prominently through the work of L. E. J. Brouwer in the early twentieth century, who challenged aspects of classical logic that many mathematicians regarded as self-evident, in particular questioning unrestricted reliance upon the law of excluded middle ($A \vee \neg A$). Classically, every proposition is either true or false. Constructive mathematicians do not necessarily deny this possibility; rather, they deny that such truth may always be asserted without evidence. To claim $A \vee \neg A$ requires more than confidence that one alternative must hold: one should know which alternative holds, and the proof should reveal which one.

This requirement transforms mathematical proof from a static demonstration of truth into an active process of construction. A proof becomes a method, an algorithm, a witness. This perspective reaches a particularly elegant formulation in what is known as the disjunction property: if a constructive system proves $A \vee B$, then one should be able to determine from the proof whether it establishes A or establishes B, not merely certifying that one of the alternatives is correct but identifying which alternative is correct. The philosophical significance is difficult to overstate, since the disjunction property transforms an abstract existence claim into a concrete informational achievement. The demand closely resembles the skeptical questions encountered throughout previous chapters: do not merely tell me that an answer exists; show me which answer. Do not merely tell me that a distinction can be made; show me the distinction. The connection becomes even more striking in the numerical existence property, which holds that a proof of $\exists n\ P(n)$ should allow one to identify a specific witness $P(k)$ for some concrete value k. Again, the proof does not merely certify existence but exhibits existence.

This emphasis upon witness extraction reaches an important milestone in the work of Harvey Friedman, whose early results demonstrated a surprising relationship between the disjunction property and the numerical existence property: for a broad class of constructive systems, a system capable of identifying the correct branch of a disjunction already possesses sufficient constructive strength to extract explicit numerical witnesses from existential claims. The details belong to mathematical logic, but the underlying philosophical lesson is much broader. Different forms of concreteness often arise from the same underlying demand: do not stop at abstract possibility but produce something tangible. This demand reappears throughout intellectual life, whether in the scientist's requirement for reproducible experiments, the engineer's requirement for working prototypes, the programmer's requirement for executable code, or the constructive mathematician's requirement for witnesses. The forms differ, but the underlying attitude remains remarkably similar: in each case, explanation becomes stronger when it produces something concrete, and the demand for witnesses discourages intellectual complacency by exposing hidden assumptions, forcing theories to confront reality, and transforming abstract claims into inspectable objects that can be examined, tested, criticized, and reproduced.

Constructive mathematics therefore offers more than an alternative foundation for logic. It offers a model of intellectual responsibility, and one that illuminates the shortcomings of much contemporary intellectual production. The modern world often rewards grand frameworks, universal theories, comprehensive narratives, and ambitious conceptual architectures, and such frameworks can be valuable, yet they also create opportunities for what might be called explanatory inflation, in which a new term is introduced, a phenomenon receives a label, a conceptual structure emerges, and the audience experiences a sense of understanding without anything concrete having been constructed. The framework may organize thought without generating witnesses; the vocabulary may be elegant without being explanatory; the theory may appear profound while generating nothing that can be independently verified. Constructive mathematics serves as a useful corrective by continually redirecting attention toward what can actually be produced. This is not merely a mathematical virtue but an epistemic one, and its importance becomes particularly clear when applied to modern institutions: a university that claims to identify talent should show the mechanism; a theory that claims to explain meaning should show the witness; a computational platform that claims to democratize knowledge should show the code.

8. Epistemic Warning Signals: How Intellectual Authority Becomes Self-Sealing

The skeptic faces a recurring practical difficulty. Rarely does one possess enough information to determine with certainty whether a theory is correct, whether a founder is trustworthy, whether a research program is productive, or whether an institution genuinely serves its stated purpose. Fortunately, skepticism does not require certainty, and its purpose is not to identify villains, expose frauds, or separate heroes from charlatans with perfect accuracy. The purpose of skepticism is to identify situations that deserve closer inspection. Many intelligent people occasionally exhibit behaviors associated with intellectual overconfidence, many successful institutions develop unhealthy habits, and even productive research programs can drift toward dogmatism. The existence of warning signals does not prove deception but merely raises the burden of scrutiny, and just as physicians recognize symptoms that warrant further examination, skeptics recognize patterns that frequently accompany the transformation of inquiry into authority.

8.1. Vocabulary Inflation

One of the oldest warning signs is the tendency to replace explanation with terminology. When a difficult phenomenon receives a name, the name is repeated frequently, and the audience gradually experiences a sense of understanding, yet little has actually been explained. The process resembles a magician redirecting attention: the mystery remains, and only the vocabulary changes. This phenomenon is surprisingly common across intellectual domains — a psychological process receives a technical label, a social phenomenon acquires a theoretical designation, a computational system introduces a proprietary term — and the label becomes familiar enough that familiarity is mistaken for comprehension. The skeptical response is straightforward: whenever a concept appears important, ask what the term actually explains, what predictions follow from it, what observations would contradict it, and what mechanisms it identifies. A useful term should increase understanding; it should not merely increase terminology.

8.2. The Founder Principle

A second warning sign emerges whenever a body of ideas becomes inseparable from the prestige of its creator. Healthy intellectual traditions survive criticism, survive succession, and survive their founders, while unhealthy traditions often struggle to distinguish between the idea and the individual who introduced it, so that the founder becomes a source of legitimacy, disagreement begins to resemble disloyalty, and criticism becomes personal rather than substantive. The movement revolves increasingly around reputation rather than reasoning. The question is not whether founders deserve recognition, since many founders deserve enormous recognition, but whether the ideas can survive independently of their creators. A theory that depends primarily upon the authority of its founder remains fragile regardless of its sophistication, and the stronger the idea, the less it requires personal protection.

8.3. The Universal Solution Signal

Human beings possess a remarkable appetite for universality, and the possibility that a single framework might explain everything is perpetually seductive. The aspiration itself is understandable: reality appears fragmented and comprehensive explanations promise coherence. The difficulty is that explanatory scope often expands faster than evidential support. A theory developed to explain one domain begins explaining another, then another, and eventually claims authority over nearly every subject. At this point skepticism becomes especially important, since the broader the claimed domain of applicability, the greater the burden of demonstration. A theory that explains everything often explains nothing in sufficient detail, and the most revealing diagnostic question is not where the framework succeeds but where it fails.

8.4. Criticism as Incompetence

Perhaps the most reliable warning sign of all emerges when criticism ceases to function as information. In healthy intellectual environments, criticism serves a productive role: errors are identified, assumptions become visible, weaknesses are exposed, and the theory improves. In unhealthy environments, criticism undergoes a transformation in which instead of informing the theory, it becomes evidence against the critic. Disagreement demonstrates misunderstanding, questions demonstrate ignorance, and objections demonstrate insufficient sophistication, so that every challenge becomes further proof that the theory is correct. At this point the theory acquires the remarkable property that nothing can count against it: the framework has become self-sealing. The skeptic recognizes this development immediately because it undermines one of the central functions of inquiry. A theory that cannot be criticized ceases to be investigated; it becomes protected rather than developed.

8.5. Prestige Substitution

Another warning sign appears whenever prestige begins replacing evidence. The substitution is often subtle: a claim encounters criticism, and instead of addressing the criticism directly, attention shifts toward credentials, awards, institutions, titles, investors, followers, influential supporters, and successful customers. Prestige undoubtedly matters in practical life — expertise deserves attention and experience deserves consideration — but prestige and evidence are not identical. Prestige may justify listening; it does not justify belief, and the distinction is easily forgotten because prestigious individuals are often genuinely knowledgeable. The danger emerges when reputation becomes a substitute for argument rather than a reason to engage seriously with one. The skeptic therefore remains attentive to whether a claim would still be persuasive if no names were attached to it, since the answer often reveals how much of the argument rests upon authority rather than reasoning.

8.6. The Demand for Inspection

Among the most useful habits inherited from both skepticism and constructive mathematics is a simple but powerful demand: whenever possible, ask to see the thing itself. Constructive mathematics expresses this requirement through the notion of a witness, insisting that it is not enough to claim that something exists but that one should, whenever possible, be able to exhibit an example, and not enough to assert that a mechanism works but that one should be able to demonstrate its operation. The witness serves as a bridge between assertion and reality, and without witnesses, claims remain largely rhetorical, while with witnesses they become objects of examination that can be tested, criticized, and reproduced by independent observers.

Closely related to the demand for witnesses is the question of readability. Readability should not be confused with simplicity: some ideas are genuinely difficult, and some phenomena are genuinely complex. The issue is not whether complexity exists but whether complexity remains open to inspection. Can the central claims be explained clearly? Can the methods be examined? Can independent observers reproduce the results? These questions matter because readability functions as a safeguard against the accumulation of unexamined authority. Opaque systems often appear profound precisely because they resist inspection, their complexity discourages criticism, their specialized vocabulary creates dependence, and their conclusions become increasingly difficult to challenge. The resulting authority may be impressive and may even be useful, but usefulness alone does not eliminate the need for transparency. At this point the skeptic returns once again to the demand that has echoed throughout the history of inquiry: not "trust me," not "believe me," not "look at my credentials," but rather "show me — show me the mechanism, show me the witness, show me the process, show me the code." For the moment a claim becomes inaccessible to inspection, authority begins quietly replacing understanding, and it is precisely at that point that skepticism becomes most necessary.

9. The Rise of Computational Sovereignty

For most of human history, the primary institutions of knowledge were libraries, universities, religious organizations, governments, and scientific societies. These institutions determined what information could be preserved, transmitted, and legitimized. The modern world has introduced a new actor into this landscape: the computational platform. Increasingly, access to knowledge is mediated not merely through books, teachers, journals, or public institutions, but through software systems upon which scientific research, economic decisions, engineering, and machine learning all depend. Computation has become infrastructure: like roads, electrical grids, and communication networks, it forms part of the underlying architecture through which modern societies operate. This development is not inherently problematic, and indeed the computational revolution has dramatically expanded human capabilities. The issue is not computational power but the institutional consequences of computational dependence, since as software systems become increasingly central to intellectual life they begin acquiring a form of authority that earlier institutions possessed, and reliance gradually transforms into dependence.

To understand this transition, it is useful to distinguish between two forms of technological power. The first is capability: what a system can do. The second is sovereignty: who controls access to what the system can do. The distinction is crucial, since a powerful computational system available to everyone operates very differently from an equally powerful system controlled by a small number of institutions. The mathematics may be identical; the social consequences are not. Historically, scientific instruments illustrate this distinction clearly: a telescope expands observation, and ownership of telescopes does not necessarily imply control over astronomy, since the instrument extends capability without necessarily centralizing authority. Computational systems behave differently because they are simultaneously instruments and environments. One does not merely use a computational platform but works inside it, and the platform determines available tools, available representations, available abstractions, and increasingly available forms of reasoning. The environment itself shapes thought, and this insight has deep historical roots. Marshall McLuhan famously argued that media influence not merely what people think but how they think, and the same principle applies to computational systems: programming languages influence which solutions appear natural, database architectures influence which relationships become visible, optimization frameworks influence which objectives seem reasonable, and machine learning models influence which distinctions become salient.

When computational platforms achieve sufficient scale, they begin functioning as forms of epistemic infrastructure. Researchers build workflows around them, universities teach them, companies depend upon them, institutions standardize around them, and entire communities become organized around assumptions embedded within the platform's design. The platform acquires sovereignty, and software then does not merely perform computations but governs access to computations. The resulting asymmetries shape intellectual development in ways that are neither accidental nor malicious but structural: a researcher naturally investigates problems that available tools can address, an institution naturally favors methods that existing infrastructure supports, and a discipline naturally evolves around what its computational environment makes visible. These structural effects can become extremely powerful. Citation databases do not merely record scholarship but influence what scholarship becomes visible. Search engines do not merely retrieve information but influence which information becomes discoverable. Recommendation systems do not merely organize content but influence which content receives attention. And mathematical and computational platforms do not merely solve problems but shape the space of problems that users are likely to consider.

Power increasingly operates through mediation, and the most influential institutions are often not those that dictate conclusions directly but those that shape the conditions under which conclusions are reached. A computational platform that mediates access to mathematical reasoning possesses a particularly powerful form of influence, affecting not only what answers are obtained but how questions are formulated. This influence becomes especially significant when platforms are proprietary, since opacity transforms infrastructure into authority: users receive results while remaining unable to inspect the mechanisms that generated them, trust gradually replaces understanding, and dependence gradually replaces participation. The platform becomes indispensable precisely because it has become invisible, its assumptions disappearing into routine practice, its constraints becoming accepted as natural, its abstractions becoming synonymous with reality. At this point, computational sovereignty begins resembling earlier forms of institutional authority: the priesthood mediated access to sacred texts, the bureaucracy mediated access to administrative power, the credentialing institution mediated access to professional status, and the computational platform mediates access to mathematical capability. The mechanisms differ; the structure remains surprisingly familiar.

10. The Proprietary Turn: Mathematics as Managed Infrastructure

The emergence of proprietary mathematical platforms represents one of the most consequential developments in the history of scientific computing. Their success is undeniable: researchers use them to solve differential equations, perform symbolic manipulations, analyze data, simulate physical systems, and construct sophisticated computational workflows; universities teach them; corporations depend upon them; and entire generations of scientists and engineers have built productive careers around them. Any serious discussion must begin by acknowledging this reality. The critique developed in this section is not a critique of capability but of governance, and the distinction matters, since a powerful tool can simultaneously be useful and problematic, a successful institution can simultaneously generate value and create dependencies, and a computational platform can simultaneously expand human capability and centralize authority. The question is not whether these systems work; it is what happens when they work so well that the mechanisms disappear from view.

Historically, scientific computation was fragmented. Researchers wrote custom code, mathematical procedures were often transparent because they had to be implemented directly, and knowledge remained distributed among practitioners. The rise of comprehensive computational environments changed this relationship: instead of building tools, users increasingly adopted platforms; instead of implementing algorithms, users increasingly invoked functions; and instead of understanding mechanisms, users increasingly relied upon abstractions. This transition produced enormous gains in productivity, but productivity came with a cost. Suppose a researcher wishes to solve a system of differential equations. Several decades ago, this might require deriving numerical methods, implementing algorithms, debugging code, and carefully verifying assumptions. Today, a single command may perform the entire operation, and the result appears almost instantly. What disappears from view is the machinery: which numerical methods were used, what assumptions were made, what approximations occurred internally, and under what conditions the algorithm fails. The system has converted understanding into convenience, and convenience is not inherently undesirable — scientific progress depends heavily upon abstraction, and no individual can understand every layer of modern technology — but the difficulty arises when delegation becomes indistinguishable from surrender. At that point, the user ceases to be a participant in the computational process and becomes instead a consumer of computational authority.

This tension becomes especially visible in systems such as Mathematica and the Wolfram Language. Stephen Wolfram's accomplishments are substantial: Mathematica represented a remarkable synthesis of symbolic computation, numerical analysis, visualization, and programming language design, and its influence on computational science is real. The issue lies elsewhere. The Wolfram ecosystem increasingly embodies a particular vision of computational authority in which the user enters a world organized around proprietary abstractions, proprietary implementations, proprietary ontologies, and proprietary infrastructure. The system offers extraordinary capabilities; in return, it requests trust. A user may invoke a sophisticated function and receive a result of extraordinary complexity, and the result may be correct, may even be brilliant, yet the path from input to output often remains inaccessible, and the user encounters what is effectively a computational oracle. This situation introduces a form of asymmetry in which the platform knows more about the computation than the user, and authority accumulates on one side of the relationship. Licensing structures create additional forms of dependence: access becomes conditional, capabilities become permissions, and features become products, so that the computational environment gradually acquires characteristics previously associated with infrastructure monopolies.

This critique is not unique to Wolfram. MATLAB exhibits similar dynamics. For decades MATLAB became deeply embedded within engineering education and industry, accumulating a vast ecosystem of toolboxes, documentation, training materials, and institutional support. Universities taught MATLAB because industry used MATLAB, and industry used MATLAB because universities taught MATLAB. The ecosystem became self-reinforcing, and alternative approaches faced significant barriers regardless of their technical merits. The issue was not capability but concentration: power accumulated because access accumulated, knowledge accumulated because usage accumulated, and authority accumulated because dependence accumulated. Every epistemic empire begins with a useful tool, and the empire emerges when the tool becomes indispensable. The crucial transformation occurs when users cease evaluating the system primarily through understanding and begin evaluating it through outcomes alone — the platform works, therefore the platform must be trusted; the software produces answers, therefore the software must be accepted; the ecosystem generates successful users, therefore the ecosystem must be beneficial. These arguments mirror the selection fallacy discussed previously: visible success becomes evidence for the system itself, and the mechanism disappears behind its outputs. The skeptical question remains unchanged — what mechanism produced these outcomes, and what possibilities were excluded?

11. The Commons Alternative: Open Source as Epistemology

The debate between proprietary and open-source software is often presented as a dispute about economics, with one side emphasizing sustainability, professional support, and centralized development, and the other emphasizing accessibility, transparency, and community participation. These concerns are real, yet they do not fully capture what is at stake. Beneath the economic arguments lies a deeper philosophical difference: open-source software embodies a distinct conception of knowledge and represents not merely an alternative business model but an alternative epistemology. To see this clearly, it is useful to return to the skeptical tradition, which has throughout this essay expressed a common demand: inspect the mechanism, seek access to the process by which conclusions are produced, and resist authority that cannot be examined. Open-source systems institutionalize this impulse. The source code remains visible, the implementation remains inspectable, the methods remain accessible, and the user is not required to accept results solely on the basis of institutional authority but retains the possibility of verification.

This possibility matters even when most users never exercise it. The significance of transparency does not depend upon everyone inspecting every line of code, any more than the significance of an independent judiciary depends upon every citizen auditing every decision. What matters is that decisions remain open to challenge, and that the right to inspection is preserved as a structural feature of the system. In a proprietary environment, trust often functions as a prerequisite: the user must trust the vendor, the researcher must trust the platform, and the institution must trust the implementation. Open-source environments distribute trust differently, allowing it to emerge from inspectability rather than requiring it as a precondition. One trusts not because examination is impossible but because examination remains possible, and authority becomes contingent upon understanding rather than independent of it. This reflects a profound shift in epistemic architecture, in which knowledge becomes participatory and accountability becomes structural rather than ceremonial.

The analogy to science is particularly important. Scientific knowledge advances through criticism, replication, and revision, and a scientific claim acquires legitimacy not because it originates from a prestigious source but because it survives independent scrutiny. Open-source development operates according to remarkably similar principles: code is published, others inspect it, errors are identified, improvements are proposed, and implementations evolve through a process that remains visible to all participants. A system's epistemic health depends less upon the absence of error than upon its capacity for correction, and an institution that occasionally fails but remains open to criticism is often healthier than one that rarely fails but resists scrutiny. The first can improve; the second gradually accumulates hidden fragilities that go undetected precisely because the system discourages the inspection that would reveal them.

The history of Python illustrates this principle with particular clarity. When Guido van Rossum released Python in 1991, he introduced a language shaped by particular aesthetic preferences — readability, simplicity, explicitness, and practicality — which became embedded within the language's culture. Yet something equally important occurred: the language did not remain the personal property of its creator. Over time, governance became increasingly communal, contributors emerged from around the world, and the ecosystem expanded beyond any individual vision. Python remained influenced by its origins while avoiding complete dependence upon them, and this institutional evolution stands in contrast to many founder-centric systems in which the departure of the founder creates a crisis of legitimacy. The Python scientific ecosystem — NumPy, SciPy, Pandas, Matplotlib, SymPy, and their successors — succeeded because it aligned technical architecture with epistemic values, rewarding participation, transparency, inspection, and adaptation in ways that made it unusually compatible with scientific norms. SymPy in particular introduced something distinctive to symbolic computation: the symbolic engine itself remained visible, researchers could inspect implementations, students could examine algorithms, and developers could modify behavior, transforming symbolic computation from a service into a collaborative project and users into participants, participants into contributors, and contributors into stewards.

Readability, understood in this context, distributes power. An unreadable system concentrates authority among specialists, while a readable system broadens participation, lowers barriers to entry, expands the community capable of understanding the system, and transforms expertise from a guarded possession into a transferable resource. Historically, many institutions maintained authority through control of specialized languages — priestly languages, legal languages, bureaucratic languages, technical languages — in which mastery of the language granted access to power and dependence upon intermediaries became structural. Readability weakens this dynamic by reducing the distance between users and mechanisms, enabling individuals to participate in the production of knowledge rather than merely consuming its outputs. This is why readability functions not merely as an engineering principle but as a civic virtue: a readable system allows individuals to participate in a way that an unreadable system forecloses. The significance of this principle becomes increasingly apparent as computation expands into domains previously reserved for human judgment, and open-source traditions provide one possible answer to the question of who can inspect the systems that increasingly influence scientific research, employment decisions, financial markets, and public policy.

12. Readability Is Freedom

The phrase that serves as the title of this essay may initially appear exaggerated, since readability seems like a modest and largely technical concern. Yet many of the most important political questions are ultimately questions about visibility: who may inspect a decision, who may understand a process, who may challenge an authority, and who may participate in the production of knowledge. Readability lies at the center of each of these questions, and for this reason it should not be understood merely as a property of text but as a property of institutions, of systems, and of power. At its deepest level, readability concerns the relationship between those who make decisions and those who must live with the consequences. An unreadable system creates dependence; a readable system creates participation; and this distinction can be observed throughout history in the concentration of authority that follows whenever specialized languages, obscure procedures, and technical complexity create intermediaries whose position depends upon the impossibility of direct understanding.

Legal systems written in inaccessible language concentrate authority among specialists. Administrative systems built around obscure procedures create bureaucratic dependence. Financial systems hidden behind technical complexity shift power toward insiders. Educational systems governed by opaque criteria encourage credentialism rather than understanding. The mechanisms differ but the structure remains remarkably similar: opacity creates intermediaries, intermediaries acquire authority, and authority becomes self-reinforcing. Readability disrupts this process by making mechanisms visible, reducing the distance between action and understanding, and enabling individuals to inspect what previously required trust. This observation helps explain why readability repeatedly emerges as a source of institutional tension, since opaque systems often defend themselves by appealing to complexity — the world is complicated, the problems are difficult, the details require expertise — and while such claims are frequently true, the existence of difficulty does not justify opacity. Difficulty and unreadability are not identical. One may explain a difficult idea clearly, and one may explain a simple idea obscurely. A readable proof does not eliminate mathematical sophistication; it reveals how the conclusion follows. A readable law does not eliminate legal complexity; it reveals how authority operates. A readable algorithm does not eliminate computational depth; it reveals how outputs are produced. The common element is transparency of mechanism, and the goal is not simplification but inspectability.

Throughout this essay, we have repeatedly encountered situations in which mechanisms disappear: taxonomies become realities, selection systems become merit, representations become ontologies, and platforms become authorities. In each case, opacity allows the institution to acquire legitimacy independent of understanding, and readability reverses this process by returning attention to the mechanism. This return is profoundly democratic in a sense that extends beyond formal political participation. Democracy depends upon more than voting; it depends upon the ability of ordinary participants to understand the systems that govern them. Without understanding, participation becomes symbolic: citizens may choose among alternatives while remaining unable to evaluate how decisions are actually made, how algorithms function, or how the criteria that shape their opportunities were determined. A computational ecosystem remains healthy only insofar as users can inspect the mechanisms that produce outputs, and readability therefore functions as a precondition for meaningful participation. One cannot challenge what one cannot inspect, one cannot inspect what one cannot understand, and one cannot understand what remains unreadable.

This relationship becomes increasingly important in an age of algorithmic governance, in which credit decisions, employment screening, educational admissions, recommendation systems, search rankings, scientific workflows, and machine learning models increasingly influence human life while remaining inaccessible to those affected by their decisions. The resulting asymmetry creates a new form of dependency in which individuals receive outcomes without understanding the processes that generated them, and the algorithm becomes an authority, the platform becomes a sovereign, and the user becomes a subject. This transformation often occurs quietly because it presents itself as convenience, and convenience is genuinely seductive. The problem is not convenience itself but what happens when convenience systematically replaces understanding: a society that values convenience above inspectability gradually becomes dependent upon institutions it cannot meaningfully evaluate, and at that point freedom acquires a different and more demanding meaning. Freedom becomes not merely the absence of coercion but access to mechanisms — the ability to inspect, to understand, to modify, and to refuse. This conception of freedom has deep roots in the Enlightenment ideal of public reason, in the scientific requirement for reproducible experiments, in the constructive mathematical demand for witnesses, and in the open-source commitment to inspectable implementations. Each tradition expresses the same intuition: knowledge should not require obedience but should permit participation.

Readability transforms this intuition into institutional form. A readable system allows individuals to understand the forces acting upon them; an unreadable system asks them to submit. The distinction is political, it is philosophical, and in an increasingly computational world it is becoming difficult to separate from freedom itself. A readable institution exposes its procedures, a readable theory exposes its assumptions, and a readable argument exposes its reasoning, so that in each case authority becomes contingent upon understanding rather than independent of it. Readability matters not because readable code is aesthetically pleasing, not because readability improves maintainability, not because readability increases productivity — though all of these things are often true — but because readability preserves intellectual self-government. It preserves the ability to ask questions, the ability to challenge assumptions, and the ability to participate in the production of knowledge. Most importantly, it preserves the ability to demand: show me the classification, show me the witness, show me the selection mechanism, show me the model, show me the code, show me how the conclusion was reached. This simple demand has repeatedly served as one of humanity's most effective defenses against intellectual empire, not because it guarantees correctness, but because it prevents authority from becoming invisible.

13. Artificial Intelligence and the New Empires

The questions explored throughout this essay acquire renewed urgency in the age of artificial intelligence, since the relationship between users and software that characterized most of computing history has been fundamentally transformed. For much of that history, programs performed specific tasks whose capabilities could often be understood in terms of identifiable algorithms, and even when implementations were proprietary the conceptual structure of the system frequently remained visible enough to support meaningful scrutiny. Modern machine learning systems increasingly function not merely as tools but as intermediaries between human beings and knowledge itself, summarizing information, generating explanations, writing code, producing images, recommending decisions, and answering questions in ways that position them as layers through which other tools are accessed rather than as discrete instruments with legible mechanisms. This distinction matters enormously. When a calculator mediates arithmetic, the underlying operation remains relatively transparent. When an intelligent system mediates reasoning, the user receives conclusions without visibility into the processes that generated them, and the system becomes simultaneously instrument and interpreter.

Several structural patterns are already visible. The first concerns scale. Training contemporary foundation models requires enormous computational resources — data centers, specialized hardware, vast datasets, and highly concentrated technical expertise — and these requirements naturally favor large institutions, producing a tendency toward centralization in which a relatively small number of organizations control access to some of the most powerful computational systems ever constructed. This concentration does not arise from malicious intent but from economic and technical realities, yet the consequences remain significant: control over infrastructure becomes control over capability, and control over capability becomes influence over inquiry. The pattern resembles earlier forms of computational sovereignty, with the difference that the magnitude is unprecedented, and the systems in question are being positioned as mediators of inquiry itself rather than merely as tools for particular computational tasks.

The second pattern concerns opacity. Traditional software often allows a user to trace the relationship between input and output, but machine learning systems frequently resist such inspection, and the challenge is no longer simply proprietary secrecy. Even fully open models can exhibit forms of complexity that exceed straightforward human comprehension: a large language model may generate a sophisticated answer through internal operations involving billions of parameters that emerge from distributed statistical structures rather than explicit symbolic procedures, and the path from input to output often remains difficult to reconstruct even for the system's creators. Humanity is constructing systems that are simultaneously powerful, useful, and partially opaque even to those who built them, and this complicates traditional distinctions between transparency and secrecy in ways that demand new frameworks. The demand for readability has not disappeared but has become more important, and the challenge is to develop new forms of readability appropriate to new forms of computation — new interpretability methods, new accountability mechanisms, new ways of distributing the capacity for meaningful inspection to the communities that depend upon these systems.

The third pattern concerns dependence. The rise of application programming interfaces, cloud platforms, and managed services has created powerful incentives toward centralization, transforming the relationship between users and computation from one of ownership to one of access. A locally executed program remains available regardless of institutional decisions; a remotely mediated service remains available only so long as access continues, creating forms of dependency that are not merely technical but political. As managed systems become the default mode of participation, users may lose direct engagement with their own computational infrastructure, the mechanisms recede from view, platforms become indispensable, and users effectively become tenants. The consequences of this arrangement will depend upon whether the technical architectures of artificial intelligence systems become social architectures that concentrate or distribute epistemic authority, and the crucial questions are therefore not merely technical but institutional: who may inspect the system, who may modify it, who may audit it, who may reproduce it, who may challenge it, and who may own it. Open-weight models, open-source tooling, reproducible research, and distributed communities represent one possible trajectory; closed ecosystems, proprietary APIs, and opaque decision-making systems represent another. Whether artificial intelligence becomes an extension of human intellectual freedom or a new form of epistemic infrastructure governed by increasingly centralized authorities will depend on which trajectory is actively chosen and supported.

14. Against Math Empires: A Skeptic's Creed

The argument developed throughout this essay has ranged across an unusual collection of subjects: ancient skepticism, universal languages, taxonomies, meritocracy, constructive mathematics, scientific computing, open-source software, and artificial intelligence. At first glance these topics appear only loosely connected, yet each chapter has examined a different manifestation of the same underlying phenomenon: human beings construct systems, the systems become successful, the success generates authority, and the authority gradually becomes independent of understanding. This process is neither accidental nor rare; it is one of the most persistent tendencies in intellectual history, operating through the same structural logic whether the subject is Wilkins' universal language, a meritocratic university, a proprietary computational platform, or a large language model. A useful classification becomes a description of reality, a successful institution becomes a measure of worth, a powerful model becomes an ontology, and a computational platform becomes an epistemic authority. The transformation is so frequent that it is tempting to regard it as inevitable, but inevitability should not be confused with necessity.

The history of knowledge contains another tradition alongside this accumulation of authority: a quieter tradition that repeatedly interrupts unquestioned authority and refuses to mistake it for understanding. This is the skeptical tradition, and as understood throughout this essay, it is not opposition to knowledge, not cynicism, not relativism, and not the refusal to believe anything. Skepticism is the refusal to stop asking how. How does the classification work? How does the institution select? How does the theory explain? How does the algorithm operate? How does the conclusion arise? The skeptic's question is not "why should I reject this?" but "show me the mechanism," and this demand appears repeatedly in different forms throughout the history of inquiry. Sextus Empiricus asks for reasons rather than declarations. Borges asks us to inspect the assumptions hidden within taxonomies. Constructive mathematics asks for witnesses rather than abstract existence claims. Scientific inquiry asks for reproducibility. Open-source software asks for inspectable implementations. Each expresses the common intellectual instinct: do not confuse authority with understanding.

The importance of this distinction increases as societies become more technologically sophisticated, since complexity naturally encourages delegation and some degree of trust remains unavoidable. No individual can master every domain, and no researcher can inspect every component of every system. The issue is therefore not whether trust should exist but how trust is organized. Healthy institutions make trust revisable, preserving pathways for inspection and accountability; unhealthy institutions gradually make trust compulsory, eliminating the structural conditions under which challenges could be mounted. A math empire can now be defined more precisely: it is not merely a successful computational platform, nor merely a proprietary technology, but any arrangement in which mathematical authority becomes detached from inspectability, in which understanding becomes optional, participation becomes consumption, and mechanisms disappear behind outcomes. The empire does not require coercion; it requires dependence. The user receives answers, the institution retains control of the process, and authority accumulates faster than understanding.

The struggle between openness and opacity therefore transcends software. It concerns the architecture of intellectual life itself: whether knowledge will remain something that individuals can examine, or will increasingly become something delivered by institutions; whether expertise will remain accountable, or whether complexity will gradually shield it from scrutiny; whether computational systems will expand human participation, or will primarily expand human dependence. These questions possess no final answers; every generation confronts them anew in different forms, with different technologies, and under different institutional pressures. The seventeenth century debated universal languages; the nineteenth century debated scientific authority; the twentieth century debated bureaucratic expertise; the twenty-first century debates computational infrastructure and artificial intelligence. The vocabulary changes; the underlying problem remains stable. How should power relate to understanding?

The answer proposed here is neither revolutionary nor novel but simply a reaffirmation of an old principle: knowledge should remain inspectable — not perfectly, not universally, but as a norm, as an aspiration, and as an institutional commitment. Mechanisms should remain visible, claims should remain testable, code should remain auditable, and authority should remain accountable. These commitments do not guarantee truth, do not eliminate error, and do not solve every problem. What they preserve is something more fundamental: the possibility of correction, of criticism, of participation, and of freedom. For freedom is not merely the absence of external constraint but the capacity to understand the systems that shape one's life, and a citizen who cannot inspect institutions, a researcher who cannot inspect methods, and a user who cannot inspect software are all dependent in ways that comfort and efficiency do not dissolve. Readability offers an alternative grounded not in aesthetics or engineering convenience but in intellectual self-government — the preservation of the ability to ask questions, to challenge assumptions, and to participate in the production of knowledge. The first defense against empire, in every era and in every domain, is the simple refusal to accept that the mechanism must remain hidden.

Readability is freedom.

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