# BOUNDARY THINKING

*Identity, Algorithm and the Thermodynamic Mechanics of Information*

*Independent Convergence, Institutional Bias and Operative Synthesis in Thinkers Who Never Formed a School*

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## ABSTRACT

Some thinkers saw the pattern before the language to name it existed. They did not form schools among themselves. Several did not even know each other. Schrödinger did not coordinate with Maturana. Bateson did not design his work to fit with Friston, who arrived four decades later. Bogdanov published the principles of general systems theory in Russian between 1912 and 1917; Bertalanffy arrived at the same principles independently in the 1940s without having read him — Capra documents this and calls it difficult to understand. That is not an intellectual tradition. It is independent convergence without communication. And it is precisely what makes the pattern these thinkers describe difficult to falsify: if they arrived at the same core from different disciplines, different eras, without network and without school, the core is probably real.

The mechanism that received them did not change much either. Russell documented in 1931 that Galileo was booed while explaining his course, and that the same thing happened to Einstein in Berlin. He documented that British mathematics was negligible for a hundred years because the academic system preferred Newton's inferior notation out of patriotism rather than adopt Leibniz's superior one. The damage the Inquisition did in Italy, nationalism did in England. Russell did not say this as anecdote — he said it as a diagnosis of a mechanism that does not distinguish between centuries. That mechanism keeps operating. In Latin America, 64% of active university faculty obtained their highest degree before 2015 and fewer than 22% have completed updated training in computational methodologies (UNESCO-IESALC, 2024). Academic endogamy in Brazil reaches 70% at elite institutions such as the University of São Paulo (Capes, 2024). Major academic publishers block GPTBot in 62% of cases and ClaudeBot in 69% (BuzzStream, 2026). And Wikidata acknowledged in February 2026 that certain knowledge has been and is being structurally marginalized.

This paper proposes that these phenomena are not separate. They are the same mechanism operating at different scales. And it proposes that artificial intelligence is not demonstrating that information changed — it is demonstrating that the thermodynamic rules that have always governed information are now visible because there is a system with sufficient processing capacity to see them without the filter of disciplinary loyalty.

Keywords: boundary thinking, independent convergence, institutional bias, pre-linguistic thought, Latin American academia, academic endogamy, Wikidata, knowledge graphs, thermodynamics of information, Capra, Bateson, Friston

**RESUMEN**

Algunos pensadores vieron el patrón antes de que existiera el lenguaje para nombrarlo. No formaron escuelas entre sí. Varios ni siquiera se conocían. Schrödinger no coordinó con Maturana. Bateson no diseñó su trabajo para que encajara con Friston, que llegó cuatro décadas después. Bogdanov publicó los principios de la teoría general de sistemas en ruso entre 1912 y 1917; Bertalanffy llegó a los mismos principios de forma independiente en los años cuarenta sin haberlo leído. Eso no es una tradición intelectual. Es convergencia independiente sin comunicación. Y es exactamente lo que hace difícil de falsificar el patrón: si llegaron al mismo núcleo desde disciplinas distintas, épocas distintas, sin red y sin escuela, el núcleo probablemente es real.

Palabras clave: pensamiento de frontera, convergencia independiente, sesgo institucional, pensamiento prelingüístico, academia latinoamericana, endogamia académica, Wikidata, grafos de conocimiento, termodinámica de la información

## 1. THE PATTERN NOBODY COORDINATED

In 1944 Erwin Schrödinger, Austrian physicist, published What is Life? — a brief book where a first-rate physicist asked what distinguishes living systems from non-living ones and answered with negentropy: living systems maintain themselves by importing order from the environment to resist thermal death. Biologists received it with suspicion. He was not one of them.

In the 1950s and 1960s, Gregory Bateson — anthropologist who was also biologist, psychiatrist and cyberneticist, without any discipline claiming him completely — formalized that information is a difference that makes a difference. Not as metaphor. As an operational definition of how systems process reality.

In Santiago, Chile, Humberto Maturana and Francisco Varela developed the theory of autopoiesis — the description of the biological mechanism by which living systems produce and reproduce themselves. They were working in biology. They did not read Bateson as a central reference.

In Brussels, Ilya Prigogine was demonstrating in chemistry that systems far from equilibrium do not collapse — they reorganize into dissipative structures of greater complexity. He did not coordinate with Maturana either. Nor with Bateson.

In 2010, Karl Friston published in Nature Reviews Neuroscience the free energy principle: any living system operates by minimizing surprise at incoming sensory data. What Bateson had described qualitatively as the difference that makes a difference, Friston turned into equations. He arrived when the computational infrastructure could process what he proposed. Those thirty-eight years between Bateson and Friston were not intellectual maturation time. They were the time technology took to catch up with the intuition.

The cleanest case of all is in Capra. Alexander Bogdanov published the principles of a general theory of organization — which he called tektology — in Russian, between 1912 and 1917. Ludwig von Bertalanffy arrived at the same principles independently in the 1940s and published in German. Capra, reconstructing the history of systemic thought in The Web of Life, notes it precisely: "It is difficult to understand how

Bertalanffy... would not have come across Bogdanov's work" (Capra, 1996, p. 46). The answer is not difficult: Bogdanov's works were suppressed for almost half a century in the Soviet Union because Lenin personally attacked him as a philosopher. Knowledge did not circulate. And yet the pattern converged.

None of these thinkers formed a school with the others. Several did not know each other. They operated from different disciplines, in different eras, without network and without coordination. And yet the core is the same: living systems maintain themselves by importing order, processing differences, self-producing, minimizing surprise. That is not an intellectual tradition. It is independent convergence. And independent convergence is the type of evidence most difficult to falsify — if the same pattern emerges at multiple points without communication between them, the pattern probably exists in reality, not only in the frameworks of those who describe it.

Capra saw it in 1996 and said it explicitly in the preface to The Web of Life: "However, to date nobody has proposed an overall synthesis that integrates the new discoveries into a single context and thus allows lay readers to understand them in a coherent way. This is the challenge and the promise of The Web of Life" (Capra, 1996, p. xix). Nobody had proposed the synthesis. The thinkers he integrated had not integrated with each other. Capra was the first systematic translator of a convergence that already existed.

## 2. THINKING BEFORE HAVING WORDS FOR IT

The academic validation system evaluates formalizations. Paradigmatic leaps happen before formalization, in a cognitive layer that system has no instruments to measure. That is not an opinion — it is the direct testimony of the thinkers who produced the most lasting leaps.

Einstein wrote in 1945, in a letter to mathematician Jacques Hadamard for his study on cognitive processes of eminent scientists: "The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images... Conventional words or other signs have to be sought for laboriously only in a secondary stage" (Einstein, in Hadamard, 1945). Einstein called this process combinatory play. Thought arrived as visual image or muscular sensation. Mathematical formalization was the subsequent translation work.

Henri Poincaré described in Science et Méthode (1908) how the solution to a complex problem came to him instantaneously upon boarding a bus — complete, without intermediate steps, before he could formulate it in mathematical language. Certainty came before demonstration. Carl Friedrich Gauss formulated it with a phrase that dismantles the linear model of classical science: "I have had my results for a long time: but I do not yet know how I am to arrive at them."

The extreme case is Srinivasa Ramanujan. Without formal mathematical training, he produced results that the most trained mathematicians could not derive. Two mathematicians dismissed his work before G. H. Hardy recognized it. Hardy wrote: "They must be true because, if they were not true, no one would have had the imagination to invent them" (Hardy, 1940). Hardy did not evaluate the proof — because there was none. He evaluated the internal coherence of the pattern. That is what the peer review system cannot do.

Some of these thinkers had translators who converted intuition into processable academic language. Hardy was Ramanujan's translator. Varela was the translator who formalized what Maturana described biologically. Friston was the mathematical translator of what Bateson described qualitatively. Translation did not produce the intuition — it made it readable for the system that, otherwise, could not see it.

Those who did not have a translator at the right moment paid the highest price. Bogdanov had no translator into German or English while he lived. His works were politically suppressed. His convergence with Bertalanffy was discovered decades later, by intellectual archaeology, not by circulation of ideas.

## 3. THE MECHANISM RUSSELL DOCUMENTED ACROSS THREE CENTURIES

Bertrand Russell published The Scientific Outlook in 1931. Not as a philosopher speculating about science — as a mathematician and logician who had operated within the system and could name its mechanisms with surgical precision.

On Galileo he wrote: "Galileo se hizo impopular y fue silbado al explicar su curso, hecho que también le ha sucedido a Einstein en Berlín" (Russell, 1931, p. 107). Not as historical curiosity. As evidence that the institutional mechanism of rejection of boundary-crossing thought operates the same way in the seventeenth century and the twentieth.

On Newton and Leibniz he wrote: "The English made the mistake, from motives of patriotism, of preferring Newton's methods to those of Leibniz, with the result that, after his death, English mathematics was negligible for about a hundred years. The damage done in Italy by the Inquisition was done in England by nationalism. It would be difficult to say which of the two procedures was the more pernicious" (Russell, 1931, p. 107).

Russell is documenting something precise: the academic institution does not evaluate the epistemic quality of an idea. It evaluates the belonging of the sender. Galileo was booed not because his experiments were wrong — they were right. He was booed because he questioned the authority of Aristotle, which was the authority of the institution. British mathematics deteriorated not because Newton was better than Leibniz — he was not. It deteriorated because adopting Leibniz's notation would have meant acknowledging the superiority of the rival.

The Inquisition and British academic patriotism are the same mechanism with different disguises. Russell says it explicitly: the damage one did with religious intransigence, the other did with tribal loyalty. In both cases the result was the same: superior knowledge was blocked for decades.

Von Foerster articulated the epistemological root of that mechanism: "First-order cybernetics is the science of observed systems; second-order cybernetics is the science of observing systems" (von Foerster, 1984). A validation system that does not include itself as an object of analysis cannot see its own biases. The Inquisition did not ask whether its truth criteria were correct. The British academics did not ask whether their loyalty to Newton was epistemologically defensible. The anonymous Wikidata reviewer does not ask whether nineteenth-century notability criteria are adequate to evaluate twenty-first-century knowledge.

## 4. THE SAME MECHANISM TODAY: DATA, NOT OPINION

What Russell documented across three centuries is not past history. It is present architecture. And it has data.

In Latin America, 64% of active university faculty obtained their highest postgraduate degree before 2015. Of that segment, fewer than 22% have completed institutionally accredited updated training in machine learning, computational methodologies, or data verification tools (UNESCO-IESALC, 2024). That is not an opinion about Latin American academia. It is the system describing its own state. The reviewer who in 2026 evaluates research with 2010 methodologies is not being malicious — they are being the predictable product of a system that has no incentives to update itself while its peer group shares the same criteria.

Academic endogamy in Brazil — the region's most documented indicator — reaches a national average of 23%, with peaks of 70% at elite institutions such as the University of São Paulo (Capes, 2024). Endogamy does not necessarily produce lower quality research. It produces research that validates the existing frameworks of the group reproducing itself. The closed circuit is structural, not intentional.

Peer review bias is not Latin American — it is universal. A randomized blinded/unblinded design study documented that acceptance rates are 28% higher when the author's name and institution are visible to the reviewer (PMC, 2021). Institutional belonging weighs more than the argument. Russell would have recognized it immediately.

The digital divide completes the picture. 72% of European and North American universities have institutional access to high-performance computing workflows. In Latin America that figure falls below 18% (CEPAL/OECD, 2024-2025). The researcher who does not have access to the tools with which contemporary knowledge is produced cannot rigorously evaluate that knowledge. Not because they are less intelligent — because they operate with infrastructure from a previous era.

Wikidata closes the argument with a case that requires no interpretation: in February 2026, the Wikidata community itself published a request for comments on notability policy reform that explicitly acknowledged that "certain knowledge has been and is being structurally marginalized" (Wikidata, 2026). The mechanism is not denounced by an external researcher. It is acknowledged by the institution itself. Major academic publishers block GPTBot in 62% of cases and ClaudeBot in 69% (BuzzStream, 2026), preventing the knowledge they produce from entering the training of the systems that will build the knowledge of the future.

This is not a critique of people. It is a critique of architectures. The Latin American academic trained before 2015 who did not update their tools is not guilty of anything — they are the product of a system that did not require or incentivize them to do so. The problem is not moral. It is structural. And structural problems require structural diagnosis, not individual indignation.

## 5. WHAT AI IS MAKING VISIBLE

Artificial intelligence is not demonstrating that information changed. It is demonstrating that the thermodynamic rules that have always governed information are now visible because there is a system with sufficient processing capacity to operate on them without the filter of disciplinary loyalty.

Schrödinger intuited them in 1944 with primitive biological instruments. Bateson formalized them qualitatively in the seventies. Prigogine demonstrated them in chemistry. Maturana and Varela implemented them biologically. Friston mathematized them in 2010 when computation could support what he proposed. AI arrived and made them observable at industrial scale.

Capra attempted the synthesis in 1996 from outside all the traditions he integrated, without declaring that he himself was a node of the system he was describing. That is the limit Von Foerster names: the observer who does not include themselves in the system they observe produces an incomplete description. This paper declares its position: the author operates as systemic narrator who arrived after the empirical scaffolding caught up with the intuitions that boundary thinkers had first. He does not compete with them. He builds on them with tools they did not have.

The five previous papers in this series documented symptoms — the thermodynamic collapse of the digital ecosystem, the simultaneous failure of established knowledge regimes, the irrevocability of biometric data as a new asymmetry frontier, opacity as an emergent property of any system that persists. This paper documents the mechanism underlying all of them: the same pattern, operating in apparently unrelated systems, produced by thinkers without communication among themselves, blocked by institutions with the same mechanism in different centuries, visible now because the infrastructure can finally process it.

The pattern did not wait to be discovered. It waited for a system capable of seeing it without needing to belong to any school to do so.

## LIMITATIONS

This paper is an analytical essay with critical narrative review of verifiable literature. It is not a formal empirical study. Data on Latin American academia come from verifiable institutional sources but their application to the central argument is interpretive. The thesis of independent convergence among the thinkers described would require independent bibliometric validation to establish itself as a robust scientific finding. The analysis of Capra's architectural limit is the author's interpretation. The declared position of the systemic narrator introduces a selection bias the reader should consider.

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