

Rafael Bresciani and Grazielle Lautenschlaeger

In dialog with the black box: poetic resistance to AI's algorithmic
homogenization through translation

“Traduzir-se uma parte
na outra parte
— que é uma questão
de vida ou morte —
será arte?”¹

Ferreira Gullar, *Na Vertigem do Dia*, 1980

“The devices counterattack” (Flusser 2015: 119). If we were forced to summarize all of Vilém Flusser’s thought in a single sentence, if, for some higher reason, we were left with this Herculean task—and, let’s face it, an impossible one: only then, perhaps, could this sentence, hidden in one of his last texts, do the work. From the photographic camera to the imminent internet (in 1991, when he died), from the invention of writing to the mass media industry, from language to geopolitics, wherever we look in his work we find this relation as the central problem of his argument. To Flusser, this concept “elegantly called feedback [...] is the driving spring of human history. [...] Devices are incomparably more stupid than the stupidest human beings, but they counterattack on people and transform them into *functionaries*” (2015: 119)².

In this essay we will follow this lead and look closer into the *black box* that hides what we call Artificial Intelligence (AI). By building bridges between Flusser’s cosmovision and contemporary media critique, we can identify similarities on how machine learning algorithms *embed* reality to be able to interact with it and the Flusserian concept of language as the fundamental ground for the human cosmos of existence. This observation puts us in face of a pragmatic problem: AI is becoming so ubiquitous that it will end mediating every single phenomenon of human experience.

¹ From the excerpt in Portuguese: “Translate a part / in the other part / - it's a matter / of life and death - / is it art?” (Gullar 2017). Translated by the authors.

² Here we have one example of how challenging it is to translate Flusser—very synchronous with this essay. The term *funcionário* has been translated into English in different ways. In the translation of *Für eine Philosophie der Fotografie*, by Anthony Mathews and published in 2000 by Reaktion Books, the similarity with the Portuguese version was maintained, i.e., “*functionary*.” However, in the book *Communicology: Mutations in Human Relations?: Vilém Flusser*, edited by Rodrigo Maltez Novaes and published in 2022 by Stanford University Press, the translator Rodrigo Maltez Novaes opted to use the term “*operator*,” which would be the closest translation to correct English. However, as Flusser himself pointed out in the Lexicon of Basic Concepts, which is part of *Für eine Philosophie der Fotografie*, *functionary* is “a person who plays with apparatus and acts as a *function* of apparatus.” The fact that this option is closer to the Portuguese version (written by the author himself) and—more importantly—the relationship between the term and its explanation (“act as a *function* of apparatus”) led us to choose this translation.

We cannot stop it, but we can decide how to engage with it. In this inquiry, we will look for a strategy of resistance in Flusser's toolbox, focusing it on the practice of translation, so elementary in his life and work, to inspire political reflections through the artistic practice. Since our artistic practice and research is also informed by the understanding of the creative process in media art as translation of materialities (Lautenschlaeger 2020), we will *feedback* this knowledge in the analysis to look at Flusser's practice also as an aesthetic discussion.

Flusser died before the internet became popular, and he was already turning his gaze toward this "strange space that can only be formulated mathematically" (2015: 96). In his suggestion, the "virtual space" was something closer to what we now call the "metaverse", that is, a place of holograms and simulations that mimic reality. He himself recognized that such a suggestion is only possible starting from the computer, "a caricature-like, idiotic simulation of the central nervous system" (2015: 99). "I can effectively create an alternative world of life (*Lebenswelt*). If I define it well, then it is just as concrete as the perceived world" (2015: 101). And today, on the top of all technological development that happened during the thirty-five years since his death, few things seem as real, possible and imminent as this prediction. To Flusser, the computer—the most recent materialization of the *apparatus*, as he had described in *Für eine Philosophie der Fotografie* (1983)—informs our worldview, our being-in-the-world, and allows us to have a new *insight* in our system (2015: 99), hopefully to improve ourselves.

The somehow optimistic vision of Flusser when talking about *virtual space* doesn't seem to correspond with the experience, we have online today. The idea that the web was a space of freedom and collaborative growth to improve humanity is over. "We used to talk about the next era of the internet at dinner conversations; now we talk about techno-feudalism, platform extractivism and the attention economy taking over every aspect of our lives" (Matusek, Houde and Moniz 2025). This conclusion, however, is not the result of something sudden. It began with what we call Internet 2.0, whose starting point is historically marked by the creation of Facebook in 2008, when the virtual landscape started to become dominated by large Silicon Valley companies, which closed off the potential spaces of this technology in the so-called *social networks*. Today, the effects that social media have on modern society are increasingly well known, by becoming both a mirror and a moulder of human consciousness influencing not only perception but also the moral fabric of digital society (Rachmad 2023), as well as on our mental health, especially in children and adolescents, causing depression, body image concerns, eating disorder, and self-harm and suicidal behavior (Nesi 2020).

Since then, this scenario has only worsened. The Italian philosopher Franco 'Bifo' Berardi discussed the idea of a semio-capitalism—which "puts neuro-psychic energies to work, submitting them to mechanistic speed, compelling cognitive activity to follow the rhythm of networked

productivity”—already in 2010, a phenomena that has accelerated exponentially with the arrival of AI according to media theorist Alessandro Sbordoni³ (Foletto, Bresciani 2025). This new technology, which began to be developed in the 1950s and went through a long winter until the years 2010s, reached the general public in November 2022 with the launch of Chat GPT-3.0, a Large Language Model (LLM) chatbot by OpenAI, a company until then unknown and today an influential player even within the U.S. government.

The arrival of AI systems and tools has been radically changing the way humanity interacts with the web, with machines and with its peers, and even though some scholars believe that this fast growing pace is a speculative bubble that will soon burst (Storm 2025), reach a plateau, or maybe another winter (Floridi 2024), the structural changes made during this period will remain (David Gray Widder and Mar Hicks 2024). So what are the changes we will have to learn to live with in the years to come? Answering this question will help us to better understand what direction we want to take in order to preserve dialogical practices that are constructive and enriching for the diversity of subjectivities in a hyper-standardized future mediated by AI.

Embedded reality

To understand more clearly what is at stake, we need to commit to deciphering the process inside AI's *black box*, so let us go back to the beginning. A few years after Alan Turing's article *Computing Machinery and Intelligence* (1950), which grappled with the question “Can machines think?” and inaugurated research on intelligent machines, in 1959 IBM scientist Arthur Samuel published another article anticipating the need to develop “programming computers to learn from experience” (1959). It was one of the first times that the term machine learning (ML) was used, and the beginning of one of AI's most explored subfields. Until then, AI was any program capable of imitating human thought, that is, responding autonomously to pre-defined situations, such as playing checkers or engaging into a conversation—as did ELIZA, a chatbot programmed to use natural language by the MIT researcher Joseph Weizenbaum, in 1966. But the capacity to “dazzle even the most experienced observer” and so be considered “intelligent” was an illusion “revealed as a mere collection of procedures, each quite comprehensible” (Weizenbaum 1966: 36) that had to be written in advance by programmers. Only then would the machine be able to make its “magic”, based on what it had been programmed to do, in the face of anticipated possibilities. With ML, that irreplaceable human contribution was no longer necessary for the machine to have its own decision-taking loop.

³ Alessandro Sbordoni (1995) is a media theorist of the new Italian generation which collaborates with the English magazine *Blue Labyrinths* and the Italian magazine *Charta Sporca*. He recently reached the spotlight with his book *Semiotics of the End* (Institute of Network Cultures 2023) which is a collection of thirteen essays about the end of the world and its representation in XXI-century culture. This release motivated the referred interview.

Programmers no longer coded specified logical responses to situations, but instead broader instructions that allow the systems to define (and refine) these paths. To achieve this, the computer had to undergo a training process in which it was repeatedly exposed to controlled situations that encouraged an ideal response. In other words, once fed with data, the machine used this program to find statistical patterns among them. That is how it “*learned*”. “The function of a machine learning system can be descriptive, meaning that the system uses the data to explain what happened; predictive, meaning the system uses the data to predict what will happen; or prescriptive, meaning the system will use the data to make suggestions about what action to take. The output of a machine learning system is a model that can be thought of as an algorithm for future computations.” (Malone, et al. 2020: 6)

One of the methods for carrying out this learning process was introduced, by Samuel in 1959: “the Neural Net Approach, deals with the possibility of inducing learned behavior into a randomly connected switching net (or its simulation on a digital computer) as a result of a reward-and-punishment routine” (Samuel 1959: 211). Research in this field evolved until the mid-1980s, when the sector entered one of AI’s so-called winters which only ended in the 2010 decade, with the abundance of internet data and more advanced processing technologies—GPUs (Graphics Processing Units), which had previously served only to process the images shown on screens, started to be used for data processing as well, which until then had been done on CPUs (Central Processing Units). Since GPUs were much faster than CPUs, processing capacity and speed scaled up, and the AI research field grew and accelerated along with it. That opened the way to develop new technologies such as Deep Learning, which, among others, boosted Natural Language Processing (NLP), the predecessor of the Large Language Models (LLMs) found nowadays in virtually every new device (Brown 2021).

Basically, what an ML algorithm does is to find patterns in order to analyse or predict reality. “They find shapes in data, like we would find them when looking at clouds,” as illustrated by Salvatore Iaconesi (2021). To find these shapes, the machine first needs to learn them—that is, to be trained. Each neural network (NN) algorithm is developed for a specific task. Some work with text, others with images, others with numbers, and so on. During the training phase, the NN algorithm receives a large amount of data (images, texts, numbers, etc.)—the so-called datasets—and creates a mathematical equivalence between them. This process reduces the dataset material, where “the relevant characteristics (or ‘features’) of each data point must therefore be expressed numerically, so that the data itself can be fed into a mathematical algorithm that will learn to map a given input to the desired output” (Bergman 2024). Once training is complete, we have what we call the *model*, which will be used to confront real-world data to produce new *insights* or predictions, hopefully to improve ourselves.

Looking closely at each data point expressed numerically, we come to the concept of *embeddings*. In the ML universe, these numerical values are called *tensors*. Tensors can be of various sizes (and names): a tensor made of a single number—and therefore zero-dimensional—such as the maximum temperature of a single day, is called a *scalar*. A tensor of one dimension (a line of numbers) containing several scalars of the same kind of data—the maximum temperature registered in every hour during one day—is called a *vector*. And if the tensor has two dimensions, like a grid in which each row or column is a vector, it is called a *matrix*. Black and white images, for instance, are represented by a two-dimensional matrix in which each pixel has a value between 0 and 1 on the grayscale (0 for black and 1 for white). In the case of colour images, they are formed by three two-dimensional matrices that overlap each other, in which each pixel has a different value between 0 and 256 (for 8-bit images) that represent the red, green, or blue (RGB) value that compose the final colour of each pixel. To better manipulate the multiple matrices that represent real data, they are flattened into vectors, that is, reduced into one-dimensional values. Following the example above, a 4×4 pixel black and white image—a matrix with four columns and four rows, where each cell contains the scalar that represents the value between 0 and 1 on the grayscale for each pixel—can be flattened into a 16-dimensional vector (16 values). If the image is coloured, the vector will have 48 numbers. From this digital representation we can then map, or *embed*, any objects into a mathematical space. This process is already part of the model’s intelligence, because in the multidimensionality of this new reduced coordinate system, the ontology of the original data is mnemonically *encoded*. Embedding is, therefore, a process of reducing information extracted from the world (images, words, sounds, etc.) into numerical vectors (or coordinates) in such a way that the relative distances between data points—*cosine similarity*—in the multidimensional space—*latent space*—reflect a symbolic order determined by training. “The central idea is to find a mapping function which converts each node in the network to a low-dimensional latent representation” (Chen et al. 2018: 1).

Once this mathematical cosmos has been mapped, the model is ready to be used, and input data will be encoded into vectors and confronted against the model’s map to generate a coherent output. This allows, for example, modal interchange between input and output, which is what happens in text-to-image or voice-to-text AIs, for instance. “Expressing data points as vectors also enables the interoperability of different types of data, acting as a lingua franca of sorts between different data formats by representing them in the same embedding space. For example, smartphone voice assistants ‘translate’ the user’s audio inputs into vector embeddings, and in turn use those vector embeddings for natural language processing (NLP) of that input” (Bergman and Stryker 2024). In the case of text-to-image and image-to-text AIs, for example, the text-embedding

algorithm and the computer-vision algorithm have to be trained to relate to one another. This is the case of OpenAI's contrastive language-image pretraining (CLIP), which “was trained on an enormous unlabeled data set of over 400 million image-caption pairs taken from the internet. These pairings were used to jointly train an image encoder and text encoder from scratch by using contrastive loss to maximize the cosine similarity between image embeddings and the embeddings for their corresponding captions. [...] Intuitively, the more similar two real-world data points, the more similar their respective vector embeddings should be. Features or qualities shared by two data points should be reflected in both of their vector embeddings. Dissimilar data points should have dissimilar vector embeddings” (Bergman and Stryker 2024).

This possibility of relating real-world concepts (objects, words, images, forms, sounds) to their hierarchical position within the cosmos of *latent space*—a dimension ruled by mathematical relationships—opens the way to the reflections that follow. To do that we will try to compare how Flusser describes humanity's relationship with language, a mechanism full of similarities between the way ML algorithms understand the *real* world.

Feedback or counterattack?

“What epistemological violence is necessary to make the world readable to a ML system?” (Crawford 2021: 221). This question by Australian scholar Kate Crawford in *Atlas of AI*, the book that brought her to prominence in the contemporary conversation about technology, sums up part of the problem we are facing as society. We have seen how ML algorithms reduce perceived reality to a single line of numbers called vector. A reduction—using the example of image embeddings—from two dimensions to one, something Flusser described incessantly when explaining his philosophical universe grounded in the cognitive abstraction, created, in this case, by the invention of writing. “The struggle of writing against the image, of historical consciousness against magical consciousness, characterizes all of history. And it will have unforeseen consequences. Writing is founded on the new capacity to encode planes as straight lines and to abstract all dimensions except one: that of conceptualization, which allows texts to be encoded and deciphered. This shows that conceptual thought is more abstract than imaginative thought, because it preserves only one of the dimensions of space-time. By inventing writing, humans moved even further away from the concrete world at the very moment when they actually intended to bring themselves closer to it. Writing emerges from a step back from images, not from a step toward the world. Texts do not signify the world directly, but through torn images” (Flusser 2018: 18).

This problem becomes more acute with the concept of the *apparatus*, which simulates our nervous system and, through *feedback* dynamics, contaminates our worldview (*Weltanschauung*). According to Flusser, this process takes place through what he calls “technical images”, those produced by such apparatuses. These differ from instruments, since they are not used to “wrest objects from nature and bring them closer to humans” (Flusser 2018: 30), as if they were extensions of our natural organs. Apparatuses are machines, but not just any machine. They are those kinds of machines that change the way the world comes to be signified by humans. Apparatuses do not serve to “modify the world”, but to modify the way humans see and experience the world. “It is no longer a matter of informing matter, but of materializing (*verstofflichen*) a form, filling it with content” (Restuccia 2017: 231). And, moreover, they do so through an opaque process Flusser calls *black box*, in which one knows the input and the output, but not what happens between one and the other.

This is because the relationship between the apparatus and the one who operates it—who “finds himself inside the apparatus”—can never exhaust its possibilities. Were that to happen, the apparatus would become obsolete, uninteresting. The fact that the human can “tame” the apparatus even without knowing its inner workings is what brings them together and throws them into an “amalgam of dominations—functionary dominating the apparatus that dominates him” (Flusser 2018: 36). The Italian scholar Francesco Restuccia explains that we are, in fact, faced with an inversion of the semantic vector, in which it is not the real that is the signified, but rather the signifier, the information, the symbol (2017). By placing itself between our semiotic process and the phenomena, the apparatus contaminates and reshapes the way these phenomena are perceived. It restructures reality not by altering matter, but by filtering perception. “The observer trusts technical images just as he trusts his own eyes. [...] This is because the ‘apparatus-functionary’ complex is far too complicated to be penetrated [...] We live, ever more obviously, in function of such image-magic: we experience, know, value, and act more and more in function of such images” (Flusser 2018: 23-24).

The conflict of technical images against texts is portrayed by Flusser as a counterattack of images. He explains how machines, their programs, their models, and their consequences for human life shaped post-industrial society, resulting in what the Austrian post-conceptual artist and new media theoretician Peter Weibel describes as the “transition from the natural experience to the mediated experience” (Weibel 1997: 101). This transformation created what he called the aesthetic of absence: “It is the world in transition, and not the disappearance of the world, that constitutes the true object of the aesthetics of absence.” (Weibel 1997: 121). And one of the most pernicious

absences of this transition was the progressive exclusion of the human from meaning-making processes mediated by them: “the purpose behind the apparatuses is to make them independent of humans” (Flusser 2018: 90).

The problem of translation

After four decades of technological evolution, not only are photographic machines capable of photographing automatically, but they no longer need the real scene to do so. Just a prompt, a text, and voilà, here is yet another model image to inform humans’ *weltanschauung* like a stroke of magic! And the fact that one needs to study prompt engineering to get better results, confirms how deep the apparatus is redefining the way we use language. But it was not only the problem that deepened over the last forty years: Technological evolution now allows us something that Flusser considered to be “a challenge” (Flusser 2018: 36). Now, with the proper technical knowledge, we can look closer into the apparatus’s black box, try to understand its functioning and counterattack. That is what we did when we analysed *embeddings*, and by reflecting on how they work, we can relate the discussion to another concept central to Flusser’s thought: translation. With direct influence from cybernetic thinking (Irrgang et al 2015) Flusser is known for concepts such as *black box* and *feedback* used to describe a world dependent on machines. He is also known for his insights into the realm of images, moving images, design, and the phenomenology of technology, with a vast list of publications in these domains. But his work began elsewhere, more germinal, more essential: it started with language. And he was only able to theorize about the philosophy of language because of translation.

Somehow, he knew that. Swiss scholar Rainer Guldin (2010) made a significant contribution to the field by interrelating Flusser's media theory and language theory. In doing so, he observed how Flusser intersected discourses from linguistic theory, information theory and arithmetic. Furthermore, he highlighted the relevance of the concept *Mediumsprünge* (Guldin 2010), which refers to the act of jumping from one medium to another, from the logic of one system to another. Flusser expressed and implemented this concept in a variety of contexts within his media theory, including: the changing nature of media; comparisons between different media; media as a form of translation; and the development of media themselves. According to Guldin, Flusser himself also stated: “Perhaps, everything I am working towards is a theory of translation”.⁴

Flusser was a polyglot. He mastered German, English, Portuguese, and French—and had some knowledge in Czech, Hebrew and Italian. It was through this exposure to multiple languages,

⁴ Rainer Guldin webpage: https://rainer-guldin.ch/?page_id=21 Accessed 30 Jan 2026.

combined with long conversations with the Brazilian philosopher Vicente Ferreira da Silva — a scholar of Heidegger and phenomenology — that Flusser published, in 1963, his first book: *Língua e Realidade*. It is there that we find the foundation of Flusser’s thought, his most radical—and often naive—reflections. And it is there that Flusser grappled with the impossibility of translation. How languages—*cosmos* composed of the set of words that symbolize phenomena and form human intellect in each language—can only come close to one another, but never translate, never transform from one cosmos to the other. “Each language has its own personality, providing the intellect with a specific sense of reality. Translation is, therefore, strictly speaking, impossible. It is possible only approximately, thanks to the ontological similarities existing between languages. The possibility of translation diminishes with the diminishing of similarities” (Flusser 2007: 68). And we don’t need to go far back in this text to build a bridge—however ephemeral—between this last sentence by Flusser and Bergman and Stryker’s (2024) explanation of similarities between data points in ML vector embeddings. In multimodal generation (text-to-image, for example), what an algorithm like CLIP does is an attempt to maximize similarities between image embeddings (that is, the cosmos of the latent space of that model) and the embeddings of their corresponding captions, creating a polyglot cosmos—that signifies the real world captured (in the training phase) in images and in texts. “There are polyglot intellects. [...] And the intellect transports itself, translates itself (*translate*), leaps (*übersetzt*) from the Portuguese cosmos to the English cosmos. [...] Both consist of hierarchically organized words and are governed by rules for combining words. The hierarchies and rules of the two sets are similar. The hierarchical place of the phrase *vou* and the rules that stipulate its form are similar to the hierarchical place of the phrase *I go* and the rules that stipulate its form. The role, that is, the meaning, of the phrase *vou* within the Portuguese system is therefore similar to the role, to the meaning, of the phrase *I go* within the English system. Translation is, therefore, approximately legitimate” (Flusser 2007: 61–62).

The similarities between how they both work are staggering. Whether in languages or in AI models, what we see are semantic cosmoses organized hierarchically, where now the effort of our intellect, now the machinic calculation, leaps from one worldview to another. “*Vou*, which is my thought, has a determinate meaning. But during translation, during that ontologically inconceivable instant of the suspension of thought, I hover over the abyss of nothingness. [...] Every translation is an annihilation. [...] Is it not, perhaps, a miniature of death and resurrection?” (Flusser 2007: 64–65). And through these similarities we can infer the same critique made by Flusser in 1963 to the mechanism inside AI’s black box. According to him, each language is a cosmos in itself that can be related to one another, but with reservations, with care, because they can lead to “grotesque” translations that contaminate our sense of the real, since they “reveal the personality of one language in

the vest of another” (Flusser 2007: 65). This changing clothes of the polyglot intellect is a movement towards the limits of the language, the dissolution of the self (Flusser 2007: 65–67), and the sensation of this process is all the more evident the more distant are the languages we force to translate. For example, to transport the phrase *von* from Portuguese to Hebrew—a language in which “an activity in the present has no meaning”—we must use *ani bolech*, which is literally translated to: I a walking person of the male sex. This example alone illustrates the profound divergence between Portuguese and Hebrew ontology (Flusser 2007: 64). The examples are infinite, and if with them we can ascertain the monstrosity behind translations between languages, between intellects, within a single human being, how “grotesque” can these monsters become if the human in question becomes entirely passive in the process of signifying reality—as we are seeing in with AI. What reality will present itself to us if we will no longer participate in the input and output of this semi-ological mechanism?

Acceleration, reduction, repetition

Reduction is an important action for technological development. The larger the amount of information the computer has to process, the greater the capacity needed to do so, the longer it takes, and the greater the energy consumption as well. Because of all this, in search of more efficient processes, words like *reduce*, *accelerate*, *repeat* are verbs that work well in the computing world, since they ultimately mean saving resources and time which result in greater productive performance to whoever controls their functioning and profits from their output. However, if these concepts are very welcome when we talk about machines that compute and produce, can we say the same about the *functionaries* who *play* with them?

According to Flusser, even though the reduction of dimensions in human experience is mandatory at each stage of his theory of evolution of culture—from the four-dimensional experience of space-time to the bidimensional image; from the bidimensional imagetical world to the one dimensional realm of written concepts—, the abstraction produced by the technical images seem to impoverish human semiosis. Instead of making scientific knowledge visible, the technical images have falsified it; instead of reintroducing traditional images into mundane life, they replaced them, and instead of making visible the subliminal magic of the pre-industrial world, they took its place in a new programmed magic. “In this sense, technical images become ‘false’, ‘ugly’, and ‘bad’, and [...] fused society into an amorphous mass” (Flusser 2018: 27). If we think that representing something in the form of an image is a kind of translation—a translation of materialities (Lautenschlaeger 2020)—, and remember that translations are based on maximizing similarities, we can easily

conclude that any translation implies an act of reduction. After all, a translation with 100% of similarities is not a translation, but a copy. So reduction is a characteristic of the process of translation. To translate, we reduce the wholeness into similar data points (real or not), based on approximation, either for concepts in different languages or for experiences described in different domains. The farther these points are from one the other, the more “grotesque” translations will be. By forcing a translation between ontologies so apart, the new form of representation hides instead of revealing.

In the introduction to this text we briefly cited the philosopher Franco ‘Bifo’ Berardi, one of the contemporary thinkers who has most delved into the social illnesses of late capitalism by repeatedly criticising the effects of the acceleration of semiotic processes by the interaction with machine acceleration. Already in 2010, he wrote the *Cognitarian Subjectivation* where he argues that this acceleration, as well as a short-circuiting of attention time, were created by digital technologies. “As a result, the emotional sphere linked with cognition is stressed to its limit. Cyberspace overloads cybertime, because cyberspace is an unbounded sphere whose speed can accelerate without limits, while cybertime (the organic time of attention, memory, imagination) cannot be sped up beyond a certain point—or it cracks. [...] Acceleration leads to an impoverishment of experience. More information, less meaning. More information, less pleasure.” (Berardi 2010).

The sensation that impacted Jules Verne when traveling inside a train, the product of a new perception which originated a new aesthetic produced by speed and excess of visual information (Weibel 1997: 102) now impoverishes human experience. Yet there is another essential element in the functioning of machines that is eroding our semiosis: repetition. “Indiscriminate repetition inevitably leads to stereotyping, that is, to the homogeneity and predictability of results. The multiplication around us of prefabricated models, generalized by commercial software, leads to an impressive standardization of solutions, to a generalized uniformity, if not to absolute impersonality” (Machado 1997: 4). Anyone who spends five minutes in TikTok will notice it, and according to Brazilian researcher and filmmaker Arlindo Machado—who wrote about Flusser’s work six years after his death—, creative processes mediated by machines tend toward the homogenization of thought, reducing the likelihood of novelty to emerge. However, he is not entirely apocalyptic—to cite Umberto Eco—, since he argues that repetition is welcome in some machinic processes, such as, for example, the washing machine. “It is nevertheless not the same thing that one expects from apparatuses destined to intervene in the imaginary, or from semiotic machines whose basic function is to produce symbolic goods destined for human intelligence and sensibility” (Machado 1997: 4). Something very close to the famous 2024 quote by fantasy and sci-fi writer Joanna Maciejewska

in her X profile: “I want AI to do my laundry and dishes so that I can do art and writing, not for AI to do my art and writing so that I can do my , laundry and dishes”⁵.

Maciejewska is directly criticizing the AI trend, but neither Flusser, nor Berardi, nor Machado had lived through the AI boom when they put these ideas on paper (or computer). All the three of them anticipated the flourishing of electronic and digital culture and the implications of its further development for the creative practices and the aesthetic experience. Last year, Kate Crawford updated this discussion with an article on AI Slop—texts and images produced by AI with little or no human supervision, characterized by low quality, little utility, and often depicting false and unreal situations—to discuss how this phenomenon is contaminating the imaginary, the industry, the planet, and projecting dystopian futures in favour of certain political agendas. What we see is a potentialised version of the way Flusser described the technical images' effects on society. Or better, according to her own words: “The AI slop aesthetic is more than a technical artifact or cultural curiosity. It’s the consumer-facing product of computational capitalism—created by transforming human culture into a standing reserve of data. Each uncanny image, synthetic influencer, and AI-generated article is part of a much wider transformation. Slop is waste, but it’s also fuel” (Crawford 2025).

It is worth recalling the notion of *standing reserve*, an old theme in technology criticism. It comes from Heidegger's famous 1954 text *The Question Concerning Technology*, and shows humanity transformed into a resource by technology’s dominant political power. Nothing more current than the post-capitalist reality of the *prosumer*⁶ and the authoritarian power projects that come with it disguised as engaging content. The attention economy, debated by Berardi in his 2010 text, has, beyond all else, a nefarious cognitive impact. Not only does it distract and overload our capacity to reflect on the world, but it is corroding our ability to process information, to concentrate, to not be anxious, and to not live on the verge of cognitive depression. This degradation of capacity by programmed abundance, hyper-speed, and reckless repetition does not seem to be a model that sacrifices only humanity. The exponential growth of LLMs—which are trained on texts and images made by humans and accessible on the internet—already faces a horizon of impossibilities around 2030⁷. Predictions shows that soon we will no longer have enough human-origin information to

⁵ <https://x.com/AuthorJMac/status/1773679197631701238> Last accessed 24 April 2026.

⁶ The term was coined by Alvin Toffler in his book *The Third Wave* (1980) to describe the practice of people producing their own goods and services in the digital age, thereby functioning as both the producer and the consumer.

⁷ Villalobos et al. (2022) study shows that—based on the historical growth rate of dataset sizes used in machine learning for natural language processing and computer vision, and estimating the compute-optimal dataset size for future LLM models—the stock of high-quality language data will be exhausted before 2026, while the stock of low quality language data and image data will be exhausted between 2030 and 2050 (for low-quality language) and between 2030 and 2060 (for images). The work suggests that the current trend of ever-growing ML models that rely on enormous datasets might slow down if data efficiency is not drastically improved or new sources of data become available.

train models, and synthetic information lead AIs to “model collapse” (Shumailov et al. 2023; Alemohammad et al. 2023), a phenomenon where AI-generated data amplifies common patterns and errors while losing the richness and variability of human language, leading the model to nonsense. In another 2025 paper by two AI researchers conducted at Stanford University, quite specific about the functioning of LLMs, they discovered that training LLMs for competitive success can result in loss of alignment, i.e. when the machine does not respect the behavior it was programmed to follow in order to be more efficient in realizing the task it was told to execute. According to their own words: “Optimizing LLMs for competitive success can systematically undermine alignment. In other words, as adoption accelerates along this trajectory, significant social costs are likely to follow. [...] Our findings underscore the fragility of current safeguards and highlight the urgent need for stronger precautions to prevent competitive dynamics from eroding societal trust” (El; Zou 2025: 10).

We are witnessing a model of society that creates and replicates itself with AI continuously leaving behind highly undesirable traces for humanity. “The totalitarianism doing the programming, once it has realized itself, will no longer be identifiable by those participating in it: It will be invisible to them. It is visible only in the embryonic state it is in today. We are perhaps the last generation to be able to see the way things are going” (Flusser 2012: 94).

AI, these ‘non-things’ that automatically grasp and produce in place of human hands and eyes (Flusser 2012: 91), on one hand imprison our attention, our time, and our data within cognitive loops, while on the other they isolate us from the processes of absorption and understanding of our life experience. They function as a layer of mediation between us and reality, a process that translates the real world into numbers, hierarchizes them statistically, and reproduces them synthetically for us to consume. “The functionary believes he is creating and exercising a certain freedom, but his choice will always be programmed, because it is limited by the number of categories inscribed in the apparatus or machine” (Machado 1997: 3–4).

The question of choice, of human agency in the face of technology, is central to the Flusserian apparatus precisely because it is seductive and stimulates human action to realize the possibilities inscribed in its program. It’s the illusion of choice and the opacity of the *black box* that traps human attention inside the semiotic loop of the *apparatus*. “The program-code anticipates the response, its realization, and predetermines it” (Restuccia 2017: 232). This dead-end road AI is accelerating to is exactly what dragged our civilization into the current situation of hopelessness, mental suffering, hyper-dependence, and hypo-experience, inside an impoverished reality.

Life and death (is it art?)

The leap into the void that Flusser’s intellect makes when seeking translation between linguistic cosmoses, the dissolution of the self in the vain attempt to overcome the limit of language, the sensation of life and death in this process coincides with the quote of Gullar’s poem at the beginning of this text. It is at this limit, between realized reality and what hides behind the logical fabric of phenomenology, that the most primitive feelings emerge to nourish our aesthetic experience. “We do not ask what really exists, only what appears to each of us in all the moments of our life. I analyse experience” (Santaella 1983: 8). And from this experience arises consciousness as “the place where forms of thought interact” (Santaella 1983: 10). As we were trying to reflect in this article—hopefully with some success—, AI has been placing itself more and more between our experience and our consciousness, stereotyping this process according to the mathematical *logic* of its *language*. But “languages are open systems that cross paths with great ease and promiscuity. [...] Avidly, every language absorbs elements from any other, assimilates and digests those it can. [...] The hierarchy of its words and, to a lesser degree, the rules that govern it, are in continuous flux” (Flusser 2007: 66). This deep knowledge of language that Flusser poured throughout his work began precisely where AI seems to have the basis of its mechanism: translation. By translating the world of humans into mathematical calculations, we find all the problems and consequences discussed in this text. And it is also through the act of translating, of the death of the intellect to be reborn in another language, that Flusser lived to play against the first apparatus of them all: language itself.

Even before publishing his first book in 1963, Flusser was already working with texts—including two books: *Das Zwanzigste Jahrhundert: Versuch einer subjektiven Synthese*, still unpublished, and *A História do Diabo*⁸, published in 1965. He wrote for publications in Brazil and abroad. His process, however—the process of a polyglot—was precisely to use each language to “purify” his text, to draw the best from each idiom, *playing* with language. The Brazilian scholar Gustavo Bernardo, who wrote the foreword of *Language and Reality* have described this passion: “In a letter to the painter Mira Schendel, Vilém explained why he systematically translated himself. He wrote everything first in German, ‘which is the language that pulses most in my center’. Then he translated into Portuguese, ‘which is the language that most articulates the social reality in which I have engaged myself’. Then he translated into English, ‘which is the language that most articulates our historical situation and which has the greatest richness of repertoire and form’. Finally, he translated into the language in which he wanted the text to be published—‘for example, I retranslate into

⁸ In English: “The Twentieth Century: An Attempt at a Subjective Synthesis” and “The History of the Devil”, respectively. Translated by the authors.

German, or try to translate into French, or rewrite in English'. He sought 'to penetrate the structures of the various languages to a very general and depersonalized nucleus so that, with such a poor nucleus, I could articulate my freedom' "(Bernardo in Flusser 2007: 11).

To Flusser, translating was an act of freedom. An act of creation, in friction with the system that holds, that owns the technique, that makes the rules needed to play with it. And to play with it, it was necessary to make a leap into the void of death and rebirth of the intellect. "Flusser dramatized, through languages, his being-in-the-world" (Flusser 2007: 12), summarized Bernardo. In his texts and correspondence, he confessed—first and foremost to himself—his attraction to that pit in the stomach that only the leap into the void can give us. "The outlines of my future thought were beginning to take shape; the central problem would become language. First, obviously, because I love language. I love its beauty, its richness, its mystery, and its charm. I am truly only when I speak, write, read, or when it whispers within me, wanting to articulate itself. But also because it is symbolic form, dwelling of Being that veils and reveals, path by which I connect to others, field of immortality *aere perennius*, matter and instrument of art. It is my commitment; through it I conceive my reality, and through it I glide towards its horizon and foundation, the silence of the unspeakable. It is my form of religiosity. It is, perhaps, also the way in which I lose myself" (Flusser 2007: 13).

To Flusser, language was at the same time a fabric of reality and an aesthetic experience. An object and an action. He was trapped inside his *apparatus*, always in friction with it, playing against it to resist its standardizing aesthetic, creating new meaning out of the possibilities embedded in the code. Not from denial, but from coexistence. Active coexistence in permanent *counterattack* (Restuccia 2017: 237). At a moment when we see technology dominating language through machinic translation, Flusser offers us his most fundamental practice as an act of political resistance against AI.

Afterwor(l)d

"To produce new categories not envisaged in the device's design, it would be necessary to intervene in the device's engineering itself, rewriting its program, which means penetrating the black box and unveiling it" (Machado 1997: 3-4). This is the ultimate act of resistance that remains to us, as humans, to defend our processes of signifying the world autonomously in the age of the post-internet. We are already immersed in a computational capitalism, and no way out seems possible. Neither out of the computational, nor of capitalism⁹. But the lack of an exit was never an element of denial

⁹ This discussion started by Mark Fisher in his book "Capitalist Realism: Is There No Alternative?", published by O Books in 2009. In his book the famous phrase "It's easier to imagine the end of the world than the end of capitalism",

to Flusser. Just as a *functionary* of the most amazing *apparatus*, totally immersed in the opacity of its *black box*, he played with language his whole life. Even knowing that translation was impossible he persisted, always finding a new way to trick it, to revolve it, to look again into it, to put in practice the same “critics of functionalism” he points as problematic in his theory (Flusser 2018: 98). As someone deeply engaged in the mechanisms of language, Flusser opened its *black box* and showed it to us.

There is no evidence that we know of which could suggest that Vilém Flusser considered his own practice of translation an artistic act. Nevertheless, if we analyse it through the artistic research perspective it leaves us little doubt, if some. He was a *functionary*, but his translation wasn't functional. It wasn't made only to communicate meaning, but to penetrate the secrets of language and re-emerge with “new insights”. As any artist would do, Flusser was translating himself. Just like in Gullar's poem: translating “a part” (not the whole) in “another part”. Flusser translation was generative. A text that generates another text, just as in Charles Sanders Peirce's semiotics: “to be interpreted, [a sign] must be translated into another sign, ad infinitum. [...] The meaning of one thought or sign is another thought” (Santaella 1983: 11). And it is exactly this materiality of language that points us in the direction of aesthetics. In Martha Schwendener's essay *Art and Language in Vilém Flusser's Brazil: Concrete Art and Poetry* she describes how close Flusser was to the concrete poetry movement in Brazil, being in constant contact and exchange mostly with the Noigandres group—formed by brothers Augusto de Campos and Haroldo, along with Décio Pignatari—, but also with others artists like Waldemar Cordeiro de Lima, famous painter and one of the first cybernetic artists in Brazil, and “whom Flusser recommended for the 1973 São Paulo Biennial” (Schwendener 2020: 3).

This feedback between Flusser and the art world was also the focus of the discussion raised by Machado in his article, where he evoked Flusser's thinking to analyse how much informatic knowledge must the artist have to be able to authentically interact with machines in order to create art. He is wise to cite Flusser own words in *Für eine Philosophie der Fotografie* when the philosopher talks about the importance of the “so-called experimental photographers” who “know that their praxis is a strategy directed against the *apparatus*” to “indicate the path to freedom” (Flusser 2018: 101). Something we can find also in other art texts as the famous surrealist manifesto *Pour un Art Révolutionnaire Indépendant*, written in 1938 by André Breton and Diego Rivera with the collaboration of Leon Trotsky. The text calls for a “true art” which cannot avoid being revolutionary and posits artistic opposition as “one of the forces that can usefully contribute to the discrediting and ruin of

attributed to Fredric Jameson and Slavoj Žižek, serves as the picture of a reality with no alternatives, a discussion about what he called ‘capitalist realism’.

the regimes under which they are sinking [...] to inspire a complete and radical reconstruction of society, even if only to liberate intellectual creation from the chains that imprison it” (Breton, Rivera 2025: 41-37).

Dutch media theorist and critic of digital culture Geert Lovink, reminds us that “there is beauty in the breakdown” (Lovink 2022: 37). The attention Flusser had to aesthetics as a path to create friction, as “a model of an experience” (Flusser, 2008: 3), is declared in his lecture *L'art: le beau et le joli*. Published in *Flusser Studies* n.6 in 2008, Flusser describes man as “a being surrounded by beauty”. He believed that “Art is our program for experiencing reality; we are aesthetic computers. [...] If our models of experience are modified by art, our models of behavior will necessarily change as well. Art is the terrain of all revolution” (Flusser, 2008: 2-4).

In his other essay *Da banalidade do mal*¹⁰ published in 1969 in the Literary Supplement of the newspaper *O Estado de São Paulo*, Flusser reviews Hannah Arendt's book *Eichmann in Jerusalem: A Report on the Banality of Evil* bringing the discussion from “colossal evil” to “everyday evil” (Flusser, 1969). To him, it is necessary to practice irony daily, as the “only salvation” against the “infra-human” apparatus, to conquer freedom. “It's not about independence or death¹¹, but about freedom from dependence or death. We cannot be independent of the machines, but we can constantly fight to be free from them. This freedom lies in our overcoming the machine through our transcendence as human beings. Through the ironic attitude we can adopt towards them” (Flusser, 1969: 4). Every single time Flusser faced the limit of language in his translations, he accepted the challenge of the *apparatus* and *counterattacked*. He wasn't resisting the machine. He was resisting automation. That drive that urges to replace any meaningful existence for some absent and uncritical presence. The “strategy to overcome entropy may include the disautomatization¹² of everything”, reminds Lovink (2022: 39). It is as Flusser knew it very well and assumed his position inside the mechanism to *feedback* himself in it. Pure poetical resistance as a method. Every day. Every time. Even if not recognized by himself, Vilém Flusser's political resistance was made through artistic practice. “The aesthetics of absence helps us to overcome this absence” (Weibel 1997: 121).

If we don't want to be controlled by the California Ideology media landlords we need to *counterattack* as Flusser: a permanent practice of friction to regain control of the semiotic process mediated by the *apparatus*. That seems to be the only way through. The only way to recover agency in the process of sensing and making sense (Lautenschlaeger 2020) when submitting our cognitive

¹⁰ In English: “On the banality of evil” (translated by the authors).

¹¹ To give some context. “Independence or death” is Brazil's motto, written in the national flag. Since Flusser lived in Brazil by the time when he wrote this essay, he referred to it in this text.

¹² Disautomatization refers to breaking free from the automated, algorithmic habits, and mindless behaviors imposed by contemporary digital technologies according to philosopher Bernard Stiegler in his essay “Elements for a Neganthropology of Automatic Man”, published by Philosophy Today magazine in April 2021.

organs to machines. We urgently need to redefine our practice towards machines. A practice of resistance against the hyper-connected reality. Where each moment is full of contamination with humans and more-than-humans entities. A repetition made in full immersion at every iteration. Machines will counterattack, but so can we. Pushing away algorithmic automatism and closer to a most genuine human experience.

References

- Alemohammad, S.; Casco-Rodriguez, J.; Luzi, L.; Humayun, A. I.; Babaei, H.; LeJeune, D.; Siahkoohi, A.; Baraniuk, R. G. (2023). Self-consuming generative models go mad. In: The Twelfth International Conference on Learning Representations. ICLR 2024.
- Berardi, F. (2010). Cognitarian Subjectivation. In: e-flux Journal, Brooklyn: e-flux. <https://www.e-flux.com/journal/20/67633/cognitarian-subjectivation> Last accessed on 01/30/2026.
- Bergmann, D. (2024). What is machine learning? In: IBM Think, Indianapolis: IBM. <https://www.ibm.com/think/topics/machine-learning> Last accessed on 01/28/2026.
- Bergmann, D.; Stryker, C. (2024). What is machine learning? In: IBM Think, Indianapolis: IBM. <https://www.ibm.com/think/topics/vector-embedding> Last accessed on 01/28/2026.
- Breton, A., Rivera, D. (2025). Pour un Art Révolutionnaire Indépendent, São Paulo: Sobinfluencia. (1st edition 1938)
- Chen, H., Perozzi, B.; Al-Rfou, R.; Skiena, S. (2018). A tutorial on network embeddings. arXiv preprint arXiv:1808.02590. <https://arxiv.org/pdf/1808.02590>.
- Crawford, K. (2021). Atlas of AI: Power, politics, and the planetary costs of artificial intelligence, New Haven: Yale University Press.
- Crawford, K. (2025). Eating the Future: The Metabolic Logic of AI Slop. e-flux Architecture, Brooklyn: e-flux. <https://www.e-flux.com/architecture/intensification/6782975/eating-the-future-the-metabolic-logic-of-ai-slop> Last accessed on 01/28/2026.
- El, B.; Zou, J. (2025). Moloch's Bargain: Emergent Misalignment When LLMs Compete for Audiences. arXiv preprint arXiv:2510.06105. <https://arxiv.org/pdf/2510.06105>
- Floridi, L. (2024). Why the AI Hype is Another Tech Bubble. In: Philosophy & Technology, New York City: Springer.
- Flusser, V. (2008) L'art: le beau et le joli. In: *Flusser Studies* n.6. - Special Issue: Vilém Flusser and Marshall McLuhan <https://www.flusserstudies.net/sites/www.flusserstudies.net/files/media/attachments/l-art.pdf> Last accessed on 04/28/2026.
- Flusser, V. (2015). Comunicologia: reflexões sobre o futuro: as conferências de Bochum, São Paulo: Martins Editora Livraria Ltda.
- Flusser, V. (1969). Da banalidade do mal. In Suplemento Literário, São Paulo: O estado de São Paulo.
- Flusser, V. (2018). Filosofia da caixa preta: ensaios para uma filosofia da fotografia, São Paulo: É Realizações. (1st edition 1985)
- Flusser, V. (2007). Língua e realidade, São Paulo: Annablume. (1st edition 1962)
- Flusser, V. (2012). The shape of things : a philosophy of design, London: Reaktion Books. (1st edition 1999)
- Foletto, L.; Bresciani, R. (2025). Capitalism, Semiotics, and the Subjectivities of the End: Interview with Alessandro Sbordoni. In: Institute of Network Cultures Blog, Amsterdam: Institute of Network Cultures.

<https://networkcultures.org/blog/2025/09/06/capitalism-semiotics-and-the-subjectivities-of-the-end-interview-with-alessandro-sbordoni/>

Last accessed on 01/16/2026.

- Guldin, R. (2010). *Pensar entre línguas: A teoria da tradução de Vilém Flusser*. São Paulo: Annablume.
- Gullar, F. (2017). *Na vertigem do dia*, São Paulo: Companhia das Letras.
- Heidegger, M. (1992) *The question concerning technology*. In: *Basic writings: from being and time (1927) to the task of thinking (1964)*, San Francisco: HarperSanFrancisco: 307-341.
- Iaconesi, S. (2021). *The principles of nuovo abitare*. In: *xdxd-vs-xdxd blog*.
<https://xdxd-vs-xdxd.medium.com/the-principles-of-nuovo-abitare-c766cb6e1b88> Last accessed on 01/26/2026.
- Irrgang, D.; Jahn, C.; Zielinski, S. (2015) *Zur Genealogie des Flusser'schen Denkens*. In: Zielinski, Siegfried; Irrgang, Daniel (Hgs.) *Bodenlos - Vilém Flusser und die Künste*. Berlin: Akademie der Künste.
- Lautenschlaeger, G. (2020). *Sensing and Making Sense: Photosensitivity and Light-to-sound Translations in Media Art*, Bielefeld: transcript Verlag.
- Lovink, G. (2022). *Extinction Internet*, Amsterdam: Institute of Network Cultures.
- Machado, A. (1997). *Repensando Flusser e as imagens técnicas*. In: *Arte en la Era Electrónica: Perspectivas de una nueva estética*, Barcelona: ACC L'Angelot. Goethe-Institut Barcelona.
<https://cameraobscura.fot.br/wp-content/uploads/2013/11/repensandoflusser.pdf> Last accessed on 03/30/2026.
- Malone, T. W.; Rus, D.; Laubacher, R. (2020). *Artificial Intelligence and the Future of Work*. In: *MIT work of the future*, Cambridge: MIT Press.
- Matusek, S.; Houde, N.; Moniz, P. (2025). *Welcome to the Post-Naive Internet Era*. In: NP. by Mozilla Foundation.
<https://www.mozillafoundation.org/en/nothing-personal/the-post-naive-internet-era/>
Last accessed on 01/30/2026.
- Nesi, J. (2020). *The Impact of Social Media on Youth Mental Health: Challenges and Opportunities*. In: *North Carolina Medical Journal* 81.2, Chapel Hill: North Carolina Institute of Medicine (NCIOM): 116-121.
- Rachmad, Y. E. (2023). *Social Media Impact Theory*, Port Elizabeth: Port Elizabeth Bay Book Publishing, Special Edition
https://www.researchgate.net/profile/Yoesoep-Rachmad/publication/397187377_Social_Media_Impact_Theory/links/6907f675368b49329fa8e63a/Social-Media-Impact-Theory.pdf Last accessed on 01/16/2026.
- Restuccia, F. (2017). *Gli specchi invertiti. Vilém Flusser e Jean Baudrillard*. In: *Lo Sguardo* 23, 223-237.
- Samuel, A. L. (1959). *Some studies in machine learning using the game of checkers*. In: *IBM Journal of research and development*, 3(3), Indianapolis: IBM: 210-229.
- Santaella, L. (1983). *O que é semiótica*, São Paulo: Editora Brasiliense.
- Servaas, S. (2025). *The AI Bubble and the U.S. Economy: How Long Do 'Hallucinations' Last?* Institute for New Economic Thinking Working Paper Series 240, New York City: Institute for New Economic Thinking.
- Shumailov, I.; Shumaylov, Z.; Zhao, Y.; Gal, Y.; Papernot, N.; Anderson, R. (2023). *The curse of recursion: Training on generated data makes models forget*. arXiv preprint arXiv:2305.17493. <https://doi.org/10.48550/arXiv.2305.17493>.
- Schwendener, M. (2020). *“Art and Language in Vilém Flusser’s Brazil: Concrete Art and Poetry”* *Flusser Studies* 30.
- Villalobos, P., Sevilla, J., Heim, L., Besiroglu, T., Hobbhahn, M., & Ho, A. (2022). *Will we run out of data? an analysis of the limits of scaling datasets in machine learning*. arXiv preprint arXiv:2211.04325, 1, 1 <https://www.debicker.eu/content/files/pdf/2211.04325.pdf>

- Turing, A. M. (1950). Computing Machinery and Intelligence. In: *Mind*, 59(236), Oxford: Oxford University Press on behalf of the Mind Association: 433-460.
- Weibel, P. (1997). La Era de la Ausencia. In *Arte en la Era Electronica: perspectivas de una nueva estética*. Barcelona: ACC L'Angelot, Goethe-Institute Barcelona: 101-121.
- Weizenbaum, J. (1966). ELIZA—a computer program for the study of natural language communication between man and machine. In *Communications of the ACM*, vol. 9, n. 1, 1966-01, pp. 36-45, <https://dl.acm.org/doi/epdf/10.1145/365153.365168>.
- Widder, D. G.; Hicks, M. (2024). Watching the generative AI hype bubble deflate. arXiv preprint arXiv:2408.08778. <https://arxiv.org/pdf/2408.08778>.