

# Addressing the challenges of harmonizing law and artificial intelligence technology in modern society

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## Article Info

### Article history:

Received Sep 1, 2024

Revised Mar 6, 2025

Accepted Mar 15, 2025

### Keywords:

Artificial intelligence

Category theory

Ethics

Law

Technology

## ABSTRACT

The invasion of artificial intelligence (AI) in all forms of human activity causes the sudden change of social cohesion into a new hybrid reality, where the static rule of law maybe is overthrown by the instant violations of fundamental human rights, including the general rights of personhood, in its image, honor, and privacy, as well as, of general principles of law, including the principle of the “abuse of rights”, the principle of contractual autonomy, principles of tort liability, and general principles of intellectual property law. In that sense, AI disrupts the *acquis* due to the poor regulatory quality indicators covering unforeseen occurrences. We call this instantiation AI legal “*coup d’état*”. This paper constitutes a philosophical thesis statement which is in accordance with the global efforts to legally embed AI into societal systems. As part of an ongoing research on AI and law synergy, this paper focuses on proposing a theoretical framework utilizing category theory to align AI functionalities with traditional legal principles.

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## 1. INTRODUCTION

Artificial intelligence (AI) has become one of the main driving forces of modern industrial development as well as of the digital economy and now has a profound influence on the formation of social evolution, human communication, economic transactions, personal development and, thus, on most dimensions of human life [1]–[4]. The increasingly pervasive and substantial interaction between the internet of things, big data, AI, real economy and social relationships, creates new demands and challenges for the existing legal systems [5]. More precisely, AI has a catalytic effect on the production processes of goods, the coexistence of workers and machines, the way decision making process are made equally the formation of new regulatory requirements in the field of human will, human behavior and the concepts of “responsibility” and “accountability” as consequences of specific actions [6].

Within the context of AI-enriched anthropocentric environments, critical questions arise regarding the adequacy of current legal systems. Is there a need for an innovative lattice of laws that includes new legal fictions [7], or can existing legal thought be adapted to address the complexities introduced by AI [8]? Furthermore, to what extent can human behavior alone suffice in this evolving landscape [9]? Historical perspectives suggest that, despite technological revolutions, traditional legal principles have endured [10]. As articulated by American Judge Curtis Karnow, it is not technology that alters the law; rather, it is the law that evolves in response to new economic realities introduced by technology [11]. Yet, as the economy

expands, we must consider how fundamentally the tenets of law must shift. Questions also arise regarding the relationship between AI entities and natural persons under civil law. Can an AI system be legally analogous to traditional tools like telephones or typewriters? Is it feasible to hold AI entities accountable as one would for a defective product within the supply chain? These inquiries underscore ethical dilemmas associated with AI's pervasive presence in everyday life and the fragility of societal structures in response to such rapid change [12]. Regardless of how these questions are addressed, law will play a crucial role in shaping coexistence with these "intelligent," "reasonable," and "autonomous" entities—whether they manifest as robots, machines, or software. Many existing legal systems, including national, supranational, and international frameworks, have already initiated processes of re-regulation, co-regulation, and de-regulation to adapt to the demands of a new digital landscape [13].

This study approaches AI's legal disruption as a "quasi-coup" that challenges established legal structures, analogous to historic societal shifts, where sudden changes required legal frameworks to undergo swift and fundamental adaptations. However, unlike traditional upheavals marked by force, AI's integration is a subtler force, permeating various sectors such as healthcare, finance, transportation, and even the legal field itself. This unprecedented evolution necessitates a proactive legal shift to ensure that the values embedded in traditional law, including privacy, fairness, and human accountability, are preserved in the face of AI's transformative impact.

This paper aims to illuminate AI's transformative potential within law-centric environments, serving as a starting point for rethinking regulatory frameworks that respond to AI applications significantly influencing the foundations of legal science. It posits a philosophical thesis in alignment with global efforts to integrate AI legally into societal structures. The methodology employed is bibliographic research, for otherwise it cannot be based on empirical data, but on critical analysis and clarification of specific terms that constitute the basic conceptual tools of the study. As part of the ongoing research into the synergy between AI and law, this paper explores how AI disrupts traditional legal systems, leading to what we describe as "*legal coup d'état*" to emphasize the urgent need for regulatory reform in future hybrid societies. Indeed, AI challenges the core principles of law by operating autonomously, often beyond human control or predictability, thus complicating liability, accountability, and the protection of fundamental human rights. Despite the extensive research on the social and ethical implications of integrating AI into society, much of the existing literature tends to approach these issues from a narrow perspective. Most studies focus either on technical features or on general guidelines, often neglecting to propose comprehensive solutions that effectively bridge the gap between the rapid advancements in AI technology and the stability of legal systems. To address this pressing challenge, the paper proposes the application of category theory (CT) as a foundational framework for rethinking the relationship between AI and legal systems.

## 2. METHOD

This study employs a multi-step methodology designed to analyze the legal challenges posed by AI, conceptualize the urgent need for a legal shift, and propose a framework for managing this shift through CT. The method is divided into three primary stages: i) a broad scoped literature review in order to identify challenging issues of AI integration into society; ii) a comparative analysis on how legislation has handled sudden legal shifts in the past; and iii) a theoretical model development using CT. This approach provides both a broad understanding of AI's legal impact and a novel framework for integrating AI within existing legal systems.

### 2.1. Broad scoped literature review

The first step of the methodology involved conducting a comprehensive literature review across disciplines, with a focus on both technical and legal scholarship. This review aimed to identify current academic, legal, and ethical discussions around AI, particularly concerning violations of fundamental human rights and of general principles of law. Academic databases, including IEEE Xplore, JSTOR, and LexisNexis, were used to gather relevant literature on AI, law, and ethics. Keywords included "AI legal challenges," "AI legal gaps," "AI legal principles," "AI integration into society," and "AI in justice." Sources were selected based on relevance, and their focus on AI's legal implications. Both formal sciences (e.g., engineering and computer science literature) and social sciences (e.g., law and ethics) were reviewed to ensure a multidisciplinary understanding of AI's impact. This diverse body of literature provided foundational insights into the primary challenges of AI integration, which are summarized in the results and discussion section under specific legal challenge areas.

### 2.2. Comparative analysis of past legal shifts

To assess how traditional legal systems handle disruptive technologies and novel societal shifts, the study undertook a comparative analysis of relevant legal precedents and regulatory frameworks. This stage focused on identifying gaps between current laws and the unique characteristics of AI, which traditional laws

were not designed to address. Recognizing AI as a transformative force, the study investigated historical events (e.g., political and economic shifts) that required significant legal adaptation. This analysis informed the conceptualization of AI as a “quasi-coup” in legal terms.

### 2.3. Theoretical model development by using category theory

Building on the identified legal gaps and historical analogies, the study proposed CT to create a structured framework for integrating AI into legal systems. The feature of CT to bridge diverse structures provided a foundation for harmonizing AI’s adaptive functions with the static principles of traditional law. CT was used to construct a theoretical model that maps AI functionalities onto legal principles, using mathematical concepts like categories and functors to formalize relationships. This approach allowed the study to create a flexible yet structured framework capable of accommodating AI’s evolving capabilities within legal boundaries.

The methodology culminated in a synthesis of insights from all three stages, which collectively inform the results and discussion section. By combining multidisciplinary literature review findings on challenges of AI integration into society, comparison of handling precedent legal shifts, and category-theoretic modeling, the study offers a comprehensive framework for addressing AI’s challenges. This structured approach not only highlights the existing gaps in AI regulation but also suggests concrete adjustments to ensure that AI’s integration respects fundamental legal principles and societal values.

## 3. RESULTS AND DISCUSSION

This section presents the findings on critical thinking and their implications for the AI and law synergy. The results are organized into subsections that explore specific aspects, followed by an in-depth analysis situating these findings within the broader context of legal theory and the integration of AI into society.

### 3.1. Navigating the challenges of aligning AI with law: catalysts for a legal shift

The rapid advancement of AI has introduced a series of complex challenges for legal systems worldwide, pushing traditional legal frameworks toward a potential paradigm shift. As AI’s influence expands into diverse areas of daily life and professional practice, it reveals significant legal ambiguities and gaps, especially regarding privacy, accountability, intellectual property, and liability [14]–[19]. In response to the numerous challenges posed by AI integration into society, this study focuses on specific violations of fundamental human rights and core legal principles that are driving a shift in legal frameworks. Although the literature extensively documents AI’s rapid influence and the limitations of current laws, there are still open issues and unresolved gaps, particularly around AI’s autonomous actions and their implications for established legal value-principles (i.e. principles that are evoked by and allude to values) as shown in Table 1.

Table 1. Catalysts for the legal shift

| Challenge area               | Value-principle  | Description  | Key issues   | Legal shift   |
|------------------------------|--|--|--|---|
| Privacy and data protection  | The general rights of personhood, in its image, honor, and privacy | AI’s reliance on extensive personal data raises significant privacy concerns and may undermine individual data sovereignty.                                      | Existing data protection laws (e.g., GDPR) lack specificity for AI, creating legal ambiguities [20], [21]. | Calls for AI-specific data privacy regulations to address unique AI data processing methods [22], [23]. |
| Smart contracts              | The principle of contractual autonomy                              | Self-executing AI-powered contracts automate transaction enforcement [24], presenting challenges in enforceability and adherence to traditional legal standards. | Questions arise over intent, fairness, and adaptability within traditional contract law.                   | Necessitates new standards for validating and enforcing AI-powered legal contracts [25].                |
| Intellectual property        | General principles of intellectual property (IP) law               | Autonomous AI creation challenges traditional IP frameworks by blurring lines of authorship, originality, and ownership rights [26].                             | IP laws attribute rights to natural persons, creating ownership issues for AI-generated outputs.           | Drives redefinition of IP laws to address AI’s role in creation and authorship [27].                    |
| Liability and accountability | Principles of tort liability                                       | Autonomous decisions by AI, particularly in fields like autonomous vehicles, complicate the allocation of responsibility for harm [28], [29].                    | Traditional tort laws inadequately address accountability in cases of AI-caused harm.                      | Pushes for AI-specific liability frameworks to clarify accountability [30].                             |
| AI in legal practice         | The principle of the “abuse of rights”                             | AI’s role in legal analysis and potentially judicial decision-making raises concerns about impartiality, transparency, and procedural fairness [31].             | Algorithmic opacity and data bias may compromise core legal rights, such as a fair trial.                  | Advocates for regulatory oversight on AI use in judicial and legal processes to preserve fairness [32]. |

These challenges illustrate how AI's integration disrupts established legal norms and frameworks. They push legal systems toward a foundational shift necessitated by AI's autonomous and transformative impact. This legal shift highlights the urgent need for a regulatory evolution that can accommodate the unique, evolving nature of AI while safeguarding fundamental rights and societal values.

### 3.2. AI's legal disruption: the quasi-coup

This research first examines whether the legal challenges posed by AI can be approached similarly to historical "coups" or other significant societal shifts that have necessitated profound legal adjustments. In this context, AI is conceptualized as enacting a "*legal coup d'état*," symbolizing a disruptive force that parallels past events, which have triggered foundational changes in social and legal orders. The application of this analogy to AI emphasizes the urgency of establishing a responsive and adaptive legal framework, as the rapid and often unpredictable growth of AI strains fundamental legal principles, including accountability, human rights, and privacy. Viewing AI's integration as a form of quasi-coup underscores the pressing need for proactive legal reform to prevent social and legal systems from being destabilized by AI's pervasive impact.

Historically, the scientific community often references transformative past events to study how societies have adjusted to major changes in social, political, and economic structures. Such events—coups, revolutions, and other radical shifts—are not only sociological phenomena but also carry significant legal implications [33], [34]. Coups, whether military or political, signal abrupt transitions in governance and societal norms, often leading to substantial re-evaluations of law [35]–[37]. The concept of a "coup" therefore offers a useful framework for understanding AI's legal disruption. Unlike military coups, which are characterized by the overt use of force, AI's impact on legal systems represents a subtler but equally profound shift. Its rapid infiltration into various sectors challenges traditional legal boundaries, pushing society toward an implicit legal evolution or quasi-coup. The distinction between this quasi-coup and traditional coups lies in three factors: the intention behind the change, the mechanism of the transition, and the ultimate impact on society.

From a legal perspective, coups can sometimes be viewed as mechanisms for legal evolution, introducing necessary reforms or modifications to accommodate new realities [38], [39]. In this quasi-coup framework, AI-induced changes are akin to an internal reformation rather than a complete overthrow of legal principles. AI's development and deployment have created significant challenges, particularly as AI entities increasingly perform tasks that traditionally fell under human jurisdiction. This shift raises questions about accountability, privacy, and liability, where existing legal frameworks do not fully cover the autonomy and capabilities of AI.

Legal theorists argue that when societal conditions shift dramatically, legal systems must evolve to maintain relevance and effectiveness [40]–[42]. The quasi-coup action introduced by AI represents just such a shift, whereby laws must reform to accommodate AI's unique attributes. For instance, the principles of continuity and unity of the state may remain intact, but specific aspects of the legal framework, especially concerning AI's interactions with humans and data, require significant revision to ensure coherence and applicability. This concept is aligned with the principle of effectiveness in international law, which holds that legal systems adapt when faced with new facts, even if such adaptations involve redefining legality in unconventional ways [43], [44]. For example, in response to the increasing deployment of autonomous vehicles, legal systems face new layers of complexity, particularly concerning liability in the case of accidents. When harm results from an AI-driven decision, questions arise as to whether liability rests with the manufacturer, programmer, or user—a challenge compounded by the multiplicity of factors (e.g., algorithms, data inputs, and operational models) influencing AI behavior.

This quasi-coup perspective on AI thus emphasizes the need for well-designed regulatory frameworks that can balance AI's technological advancements with the preservation of legal and ethical standards. In the case of autonomous vehicles or other high-stakes AI applications, the difficulty lies in crafting regulations that not only address liability but also maintain public trust and accountability. The complex interplay of socio-legal factors in AI integration calls for a dynamic, resilient legal framework that can adapt to the realities of AI's quasi-coup action, maintaining social cohesion and public confidence in the rule of law.

### 3.3. Categorical insights: controlling the ai legal coup d'état

In response to the need for a structured yet flexible framework, the second part of this research introduces CT as a theoretical approach for integrating AI within legal systems. CT [45], [46], with its structure-preserving mappings and capacity to bridge relational domains, is proposed as a means of harmonizing AI's adaptive capabilities with the static nature of traditional legal systems. Through the concept of functors, this mathematical framework enables the mapping of AI functionalities onto core legal principles, thereby providing a structured, adaptable approach to AI regulation. This model is intended to support the evolution of legal frameworks to accommodate AI, ensuring that core principles like privacy and accountability remain intact, even as AI's role in society expands.

To enable a smooth and lawful integration of AI into society, categorical thinking, the disciplined application of CT, is essential. For categorization to be beneficial and align with societal values, two primary conditions must be met: validity and utility. Validity ensures that a category is logically sound and legally acceptable, while utility ensures that it serves a practical, beneficial purpose across different contexts. CT provides a robust framework to assess and manage these requirements, as it offers tools to evaluate the qualitative similarities between separate categories and interpret one category's structure in the context of another [47], [48]. This flexibility makes CT especially relevant for integrating AI into a legal framework that is resistant to rapid shifts.

In categorical terms, a “category” represents a collection of elements with shared properties, while a “functor”, a structure-preserving map, relates two categories by maintaining their internal relationships. Applying this to AI and law synergy, we can conceive of two distinct categories: one for law (denoted as C), consisting of rules (objects) and their relationships (arrows), and one for AI (denoted as D), consisting of AI processes (objects) and the connections between them (arrows). The functor F then acts as a bridge between these two categories, preserving the structure of the legal principles in category C and mapping it into the AI category D. This structure-preserving function allows legal principles to guide and frame AI's operations within legally defined boundaries, supporting a cohesive and lawful AI integration.

From this perspective, CT provides a framework to safeguard fundamental human rights and ensure legal continuity amidst AI's transformative impact on society. The functor serves as a tool that embeds essential legal principles within AI systems, allowing the law to “interpret” [49] AI's behaviors in alignment with established societal norms and ethical expectations. For example, the right functor in this case could represent core legal principles such as accountability and privacy, ensuring that these values are upheld in every application of AI. In this way, CT not only fills potential legal gaps but also acts as an integrative tool that ensures AI development supports societal goals rather than undermining them.

Ultimately, this category-theoretic framework offers a scalable, adaptable model for integrating AI into the legal domain, equipping legal systems to maintain coherence in the face of AI's rapid evolution. It allows for legal principles to be continuously mapped onto new AI functionalities, ensuring that the rule of law remains a guiding force as AI becomes increasingly embedded in the social scenery. Through this approach, society can control the effects of the AI “*legal coup d'état*,” fostering ethical integration of AI into human-centered systems. Our future work will be based on functorial semantics, inspired by Lawvere [50], to interpret the outcomes of the AI evolution into the well-grounded anthropocentric legal system.

#### 4. CONCLUSION

This study is semantically aligned with the ongoing research on sustainable coevolution of law and technology. The importance of the research is mainly documented in articles of the European Parliament (Special Committee on Artificial Intelligence in the Digital Age–AIDA), in which, the necessity of finding a legal framework for AI systems is identified. Despite the measurable progress in the field of AI ethics, there is no consensus on a global trustworthy AI regulation. We conjecture that significant improvement can be obtained only by matching technological singularity to a robust legal system. In this perspective, the convergence of the two distinct structures, namely AI and law, is investigated. It is evident that changes in the AI structure, due to the rapid technology advances, triggers unforeseen consequences to the law structure, as law is a firm human-centered system. Following the AI systems evolution new rules of law have to be created in the law structure. This unstoppable process may cause moral conflict and ambiguity. Consequently, there is a need for a legal interpretation framework able to smoothly embed the AI structure into the law one. That is, it must, on the one hand, allow the development of AI for social, economic or individual benefit, and on the other to anticipate and manage with a ‘sense of justice’, the dangers that threaten fundamental rights and democracy. This study contributes a theoretical model that supports ongoing adaptation, enabling legal systems to harness AI's potential while safeguarding fundamental human rights and societal values. The concept of a quasi-coup reinforces the importance of proactive reform, urging policymakers and legal theorists to recognize and address AI's transformative influence before existing legal structures become obsolete. Future research should explore the practical application of this category-theoretic framework to specific AI-driven scenarios, further refining the model and ensuring a balanced integration of AI within human-centered legal systems.

#### FUNDING INFORMATION

Authors state no funding involved.

# AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

| Name of Author           | C | M | So | Va | Fo | I | R | D | O | E | Vi | Su | P | Fu |
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| Lamprini Seremeti        | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ | ✓ | ✓ | ✓ | ✓ |    |    |   |    |
| Sofia Anastasiadou       | ✓ | ✓ |    | ✓  | ✓  |   | ✓ |   |   | ✓ |    | ✓  |   |    |
| Andreas Masouras         |   |   | ✓  | ✓  |    | ✓ | ✓ |   |   | ✓ | ✓  |    |   |    |
| Stylianios Papalexandris | ✓ |   |    | ✓  | ✓  | ✓ | ✓ |   |   | ✓ | ✓  |    |   |    |

C : **C**onceptualization  
M : **M**ethodology  
So : **S**oftware  
Va : **V**alidation  
Fo : **F**ormal analysis  
I : **I**nvestigation  
R : **R**esources  
D : **D**ata Curation  
O : Writing - **O**riginal Draft  
E : Writing - Review & **E**diting  
Vi : **V**isualization  
Su : **S**upervision  
P : **P**roject administration  
Fu : **F**unding acquisition

# CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

# DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.




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