IN-DEPTH ANALYSIS

Requested by the JURI Committee

European Parliament

Artificial Intelligence for Monitoring the Application of EU Law

Policy Department for Justice, Civil Liberties and Institutional Affairs
Directorate-General for Citizens' Rights, Justice and Institutional Affairs
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EN

Artificial Intelligence for Monitoring the Application of EU Law

Abstract

This report, commissioned by the European Parliament's Policy Department for Justice, Civil Liberties and Institutional Affairs at the request of the Committee on Legal Affairs (JURI), examines the use of AI techniques to support monitoring the application of EU Law. First an overview is provided of the state-of-the-art AI solutions used in application of law. Then AI applications in the legislative process are considered, from pre-enactment information analysis, impact forecasting and public engagement, to drafting support and monitoring impacts and compliance. AI in monitoring the implementation of EU law is then analysed, considering both existing applications and prospects for new AI technologies. First the transposition of directives is considered. The application of binding provisions is then addressed, having regard to implementing rules, judicial decisions, administrative action, and social behaviour. Finally potential contributions of AI to a principled approach to EU law is examined, for consistent interpretation and the respect of fundamental rights and principles. Recommendations are finally proposed on using AI to make monitoring more accurate and efficient.

This document was requested by the European Parliament's Committee on Legal Affairs.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ERC	European Research Council
EU	European Union
GDPR	The General Data Protection Regulation
GenAI	Generative Artificial Intelligence
GPT	Generative Pre-trained Transformer
LEOS	Legislation Editing Open Software
LLM	Large Language Model
ML	Machine Learning
NLP	Natural Language Processing
RAG	Retrieval Augmented Generation
SKE	Symbolic Knowledge Extraction
SKI	Symbolic Knowledge Injection
XML	Extendible Markup Language

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EXECUTIVE SUMMARY

Background

The present paper is based on two parallel developments. On the one hand as EU law grows in extent and complexity and governs more aspects of social life, there is an increasing need to effectively monitor its compliant implementation. On the other hand, the accelerated development of novel powerful AI applications opens promising and challenging opportunities to enhance compliance monitoring. Generative AI, thanks to its ability to produce and analyse natural language documents and extract information from them, can provide extensive support.

Aim

The paper has the aim of illustrating existing application and future prospects for using AI to monitor compliance with EU law.

First, it provides an account of the state of the art in legal application:

- Knowledge-based systems have enjoyed significant but limited success (no-game changer).
- Predictive machine learning has enabled computer systems being deployed in a number of new legal tasks.
- Generative machine learning promises to be a game-changer in many domains thanks to LLMs' capacity to generate and analyse natural language.
- Hybrid models combine in various ways the symbolic and machine learning approaches, to achieve controllable and transparent outcomes that better fit legal knowledge and reasoning.

Then the paper examines the use of AI in the legislative process

- In Pre-enactment information analysis, to find and organise relevant information.
- In Pre-enactment Impact forecasting, to anticipate the impacts of a new legislative instrument.
- In Consultation and public participation, to support communication between authorities and stakeholders.
- In Drafting support, to improve clarity and consistency of legislative and regulatory instruments.
- In Post-enactment monitoring, to assess the social impact of adopted laws.

Finally, the paper focuses on the use of AI for monitoring the implementation of EU law, examining both the transposition of directives and the implementation of directly binding law.

Concerning the transposition of directives:

- Some experimental projects have obtained limited and sectorial result.
- However, thanks to recent progress in AI (especially in natural language processing, up to LLMs), new opportunities exist for better monitoring the transposition of EU Directives, speeding up procedures including the management of complaints: Automated translation, Semantic search, Comparison of the directive and all of its national transpositions, Generation of syntheses and documentation (focused summaries and correlation matrices).

Concerning the application of directly binding laws:

- Only some pilot platforms and research projects have addressed limited and sectorial aspects of the application of (a) national rules implementing EU directives as well as (b) directly binding EU provisions (regulations), and corresponding national laws.
- However, recent technological developments open opportunities for AI to provide broader and deeper support with regard to different domains where compliance can be controlled: Further implementing rules, Judicial decisions, Administrative behaviour, Social behaviour. Among the promising AI functionalities, the following can be mentioned:
  - NLP (LLMs) for checking for the existence and adequacy of national regulations and extracting and analysing information pertaining to judicial and administrative decisions, or also commercial practices.
  - Predictive analytics to recognise patterns of non-compliance, so that they can be timely addressed through targeted inquiries.
  - Agent-based modelling for detecting and understanding the impacts of legislative change, distinguishing causality from correlation.
  - Process mining to assess compliance by processing system logs from government databases.
  - Sentiment and social analysis to gauge public perceptions of regulatory instruments.
  - Computer vision technologies to process satellite and other sensors' data.

Policy recommendations:

- EU institutions should test novel AI solutions for monitoring the implementation of EU law. They should engage with novel AI approaches (such as LLMs complemented with RAG), to assess whether they may improve efficiency and accuracy in identifying instances of non-compliance and enable timely responses to complaints and proactive solutions to emerging issues.
- Hybrid solutions, combining the power of LLMs with human generated and understandable knowledge, may provide appropriate solutions in some domains, improving controllability, transparency and integration with existing applications.
- AI-support to monitoring should apply to the transposition of directives, but also to regulations and national implementing acts, judicial decision-making, administrative practice and the behaviour of the final addressees (physical and legal persons).
- AI systems used to monitor EU law should provide explanations that are legally significant, whenever this is relevant and technologically possible. This means they must justify their conclusions by citing specific legal articles and evidence in a way that humans can understand. Equally essential is robust controllability, which can be achieved through hybrid AI architectures and rigorous, domain-specific testing protocols that include adversarial challenges to ensure reliability.
- Monitoring is going to be more effective if AI technologies also support other aspects of the EU regulation process, such as drafting and pre-enactment impact assessment. AI-supported drafting could facilitate the preparation of more concise, and comprehensible texts, better integrated with the *acquis* and with national legislation. This could enable more coherent

Policy recommendations:

interpretations and applications, reduce non-compliance and so facilitate compliance checking. Similarly, AI-supported pre-enactment assessments may enable the proactive identification of formal and substantive issues that may hinder compliance, even from honest and well-disposed addressees.

- AI-supported monitoring requires availability of adequate data. Thus, it is important that strategies for data collection and access are established and defined since the enactment of a new legislative instrument. This includes easy access to textual documents being produced during the implementation process, to structured data from administrative datasets, and even to system logs where needed (to the extent that this is compatible with data protection and other legal requirements).
- Human oversight, assessment and reviews of any automated evaluation should be ensured, given the limitations, potential for error, and the opacity of the technologies most suitable to address crucial aspects of monitoring. Any deployment of AI in monitoring should be compliant with the relevant EU law, such as GDPR and the AI Act.
- Given the importance of AI for effectively monitoring the implementation of legislation, choices concerning its adoption and usage should not be left only to the executive branch, but should be shared with the EU Parliament. An important role in the effective and efficient deployment of AI may be played by a permanent Working Group on Better Law-Making and Artificial Intelligence, to ensure a more active and persistent critical involvement by the Parliament.
- As the deployment of AI in monitoring involves novel technologies and requires an experimental approach, adequate AI skills must be made available within the EU and national institutions, in particular within the EU Parliament.
- Academia can play a pivotal role in the development, assessment and deployment of AI systems for monitoring the implementation of EU law. EU institutions should foster strong collaborations with the research community to promote innovation and ensure that best practices are adopted.

1. OVERVIEW OF THE STATE-OF-THE-ART AI SOLUTIONS USED IN APPLICATION OF LAW BY CITIZENS, MEMBER STATES AND COURTS

KEY FINDINGS

In recent years important developments have taken place in AI & law research and applications.

- Knowledge-based systems have enjoyed significant but limited success (no-game changer). However, research on explicit symbolic representation of legal content has delivered outcomes —such as semantic web standards, smart contracts, and logical models of legal knowledge, reasoning and argumentation— that are relevant to the goal of creating controllable, transparent and auditable systems.
- Predictive machine learning has enabled computer systems being deployed in a number of legal tasks, such as classification and clustering of clauses and documents, analysis of legal documents, prediction of features and outcome of administrative and judicial procedures, the prediction of human compliant or deviant behaviour.
- Generative AI promises to be a game-changer in many domains. In particular, LLMs' capacity to generate and analyse natural language can be usefully deployed in many legal tasks: summarising, analysing and reviewing cases, doctrinal papers, and other documents; answering legal questions; predicting the outcome of future cases; generating contracts, wills, briefs, and other legal texts; interacting conversationally with legal professionals or the general public seeking legal information.
- Hybrid models combine in various ways the symbolic and machine learning approaches, to achieve outcomes that better fit legal knowledge and reasoning and are more controllable and transparent.

In the legal domain various applications of AI exist for legal professions, public administrations and the judiciary. Many more applications, having an impact on core legal activities will be available in the near future, thanks to the deployment of Generative AI.

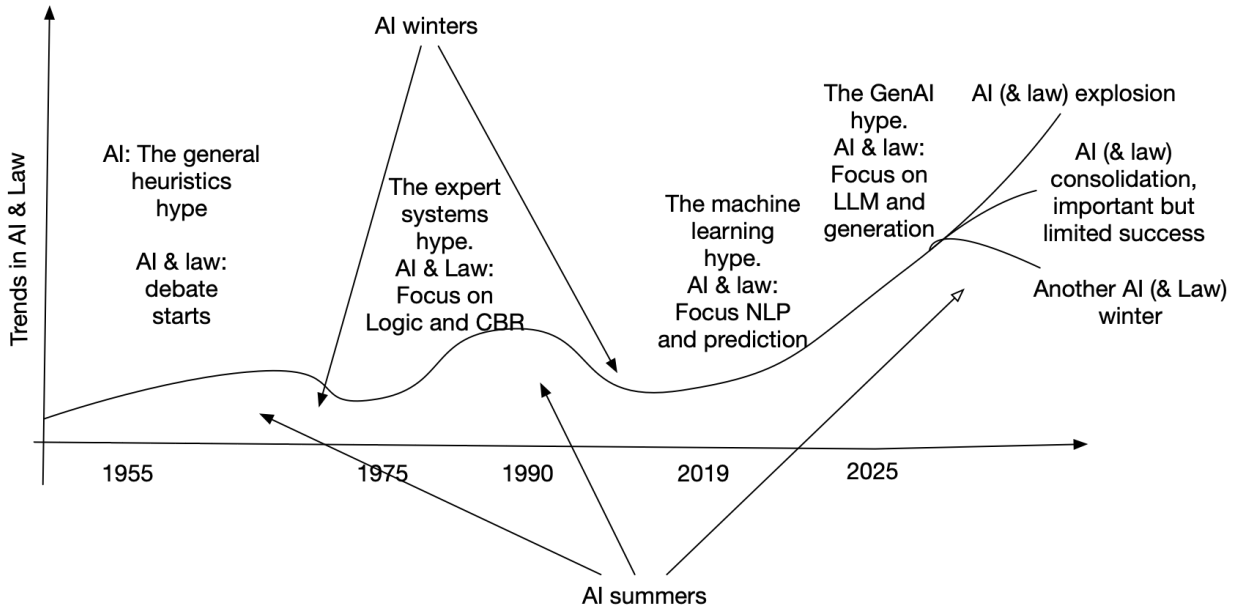
While AI can provide important benefit in the legal domain, its deployment raises serious challenges, which have been originated by machine learning approaches, and have been expanded through generative AI. Such challenges must be addressed to implement the principles of trustworthy AI.

In the following, the trends in the development of Artificial Intelligence applications for the law (AI & Law technologies) will be shortly presented, focusing on the most recent developments. As shown by the picture below, the research and applications in AI & Law have followed the general trends in AI research, going through times of great expectations (the AI summers) in which hype accompanied the emergence of new technologies, and times of relative disillusion (the AI winters), in which the limitations of such technologies were recognised (see Figure 1)[1].

[1] Sartor and Lagioia (2020).

We shall shortly consider the impact of three leading technologies on research in AI and law: (a) knowledge-based systems (also called expert systems); (b) predictive machine learning; and (c) generative machine learning (enabling general purpose AI system).

Figure 1: Hypes and winters of AI



1.1. AI & Law: Knowledge-based systems

Until the end of the past century, the main focus of AI research was on symbolic approach to AI, which led to the development of knowledge-based systems.

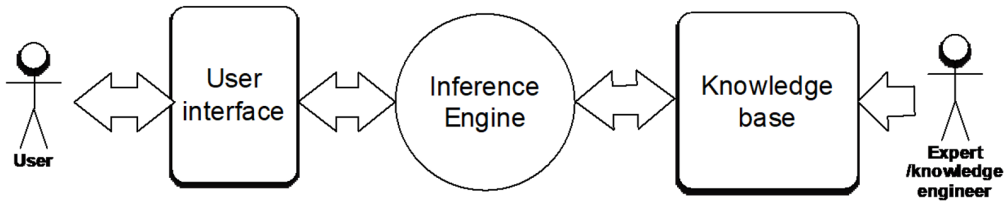
1.1.1. The knowledge-based systems approach

Under this approach, the model (the representation of the relevant information) that the system is going to use in order to perform its task is assumed to be:

- generated by humans,
- consisting of a symbolic structure understandable by humans,
- processed according to inferences meaningful for humans.

The typical structure of a knowledge-based system is shown in Figure 2: there is a human produced knowledge base of rules and concepts, a software for making inference (the inference engine) and an interface toward the users. The user makes requests and provides information through the interface, and the inference engine delivers responses by using the knowledge in the knowledge base and the information provided by the user.

Figure 2: Basic structure of expert systems



1.1.2. Knowledge-based systems in the law

Following this idea, knowledge-based systems have been developed that include vast sets of rules. These systems have been used to address individual cases, e.g., for determining legal entitlements and obligations in fields of taxation and social security. Symbolic representations have also been used in information retrieval, where structured conceptual representations, or ontologies, have improved retrieval by overcoming some of the limitations of searching using textual words or keywords.

Such systems have not been equally successful in other application domains such as the judicial analysis of controversial legal or factual issues, or in administrative tasks requiring the analysis of facts or the exercise of discretion. They have also not been equally successful in the legislative domain, given that the legislative activity does not consist in the application of pre-existing rules, but rather in the creative framing of new rules.

To improve the representation and inference capacities of legal knowledge-based systems, a rich set of approaches has been developed by researchers in AI & law. Some of these approaches have focused on the logical representation of legislative rules and concepts, through logics for deontic notions[2] (to capture permission, obligation, and legal positions), defeasible reasoning[3] (to handle exceptions), conceptual relations[4] (ontologies), agentic aspects[5] (causality and action), mental attitudes[6] (beliefs, desires, intentions), dialectical structures[7] (arguments, counterarguments, justifications). Within case-based reasoning, ways of representing legal cases have been proposed, and ways of relying on such representation to analogise or distinguish precedents.[8]

However, all these attempts have met serious obstacles, namely the so-called *knowledge-representation bottleneck*[9], the fact that explicit legal knowledge is usually available in natural language texts (such as legislation and judicial or administrative precedents) and this knowledge has to be complemented with further tacit information in legal reasoning. Translating natural language texts into formal representations (e.g., logic or programming language) requires selecting what content to capture, within the rich meaning of a natural language texts, and giving this content a single

2 Governatori, Rotolo, and Sartor (2022).

3 Prakken and Sartor (1996).

4 Breuker et al. (2004).

5 Liepina et al. (2023).

6 Lorini et al. (2011).

7 Bench-Capon, Geldard, and Leng (2000)

8 Ascley (2002).

9 Contissa and Sartor (2025).

interpretation, among the possible ones (according to the wording of the text and the interpretive options available in legal reasoning), and formulate it using the limited expressive power of the chosen logical language.

Thus, the original enthusiasm for symbolic representations of the law has left space to a more cautious attitude, inspired by the awareness of the limitations to this approach.

In recent years, however, some interesting developments have taken place, opening new prospects for symbolic legal automation:

- The first development concerns the emergence of *smart contracts*[10]: computer programs that directly implement legally relevant transactions (e.g. sales, loans and rentals) and digital institutions that engage in economic activities, using the crypto payment functionalities available on distributed ledger infrastructures. Once activated, the program can automatically transfer sums, respond to various external triggers and influence the functioning of other computer programs and digital devices (e.g. enable the use of a vehicle or access to a property).
- A second development pertains to the creation of *standards* for modelling legal content, so that multiple projects can use the same or inter-translatable markup-languages and share the use of software programs for representing knowledge and performing inferences[11]. The creation of standards for representing legal knowledge is connected to a broader effort in knowledge representation, namely, pertaining to the development of the so-called *semantic web*, where the textual information available on the web is accompanied by computational representation of the structure and content of documents. In the case of legal documents, we can just mention the Akoma Ntoso[12] standard, for capturing the structure of regulatory documents, and the LegalXML standard for representing legal rules.
- A third development pertains to the creation of logical languages having a form that is similar to natural language, so that they can be understood also by lawyers and other users not having a technical background.[13] The expressions in such languages can be directly processed by an inference engine or be automatically translated into a logic programming language.
- A fourth development pertains to the creation of a computable model of legal argument, where computer systems can construct legal arguments, and determine what legal conclusions are justified, given the interaction of all relevant pro- and con-arguments constructable from a given knowledge base.[14]

In conclusion, while the scope for pure symbolic systems is limited, the modern tools and standards such systems have inspired, such as semantic web standards, smart contracts, and logical models of

[10] Governatori et al. (2018).

[11] For the standard Legal RuleML: https://www.oasis-open.org/committees/tchome.php?wgabbrev=legalruleml .

[12] Palmirani and Vitali (2011).

[13] Among such languages we can mention Attempto Controlled English (http://attempto.ifi.uzh.ch) and Logical English (https://logicalcontracts.com/logical-english/).

[14] See Prakken and Sartor (1996) and Gordon, Prakken, and Walton (2007).

legal knowledge, reasoning and argumentation, are directly relevant to creating transparent, auditable systems for monitoring the application of EU law.

1.2. AI & Law: Machine Learning and Predictive AI

Artificial intelligence has made enormous strides since focusing on applying machine learning[15] to large volumes of data. Data-driven machine learning approaches – where the AI system itself learns from the data how to address its task – have become dominant in recent years.

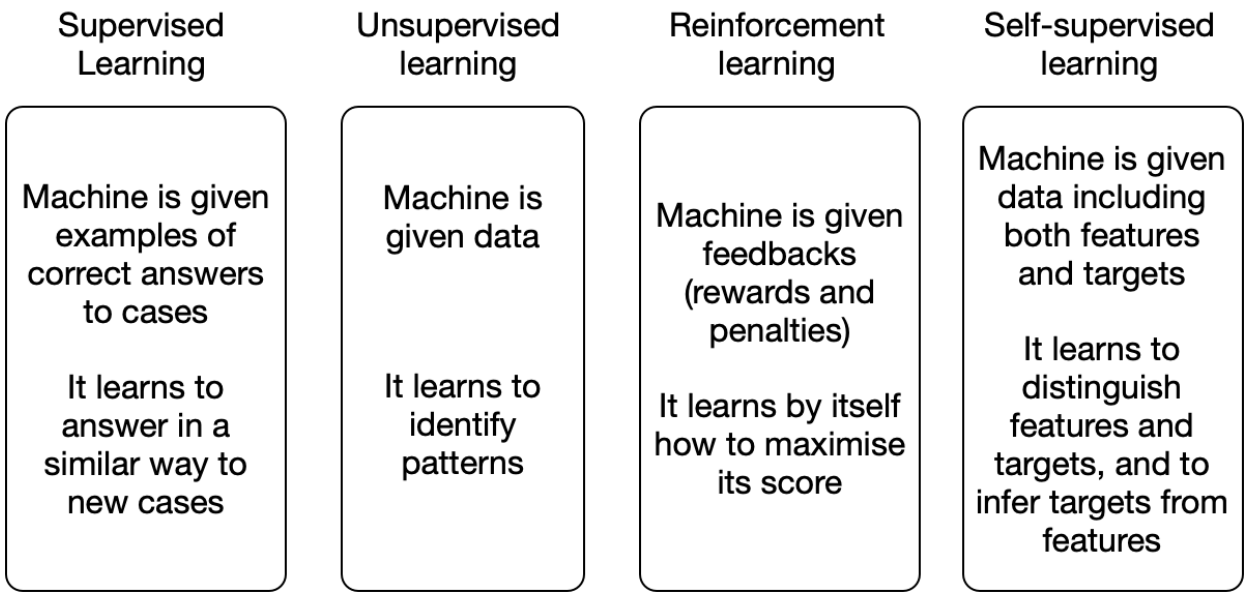
1.2.1. The machine learning approach

In machine learning-based systems, the knowledge relating to the system's domain is no longer provided by humans, but instead such knowledge is "built" into a model that is learned (constructed) by the machine itself, based on the data to which it has access. This approach has led to many successful applications in fields such as information retrieval, translation, marketing, production control and robotics.

The content of the learned models is not anticipated by the creators of a machine-learning system: the creators may only define the general structure of such models, they do not need (and may be able) to understand the details of the machine's internal workings.

There are four main approaches in machine learning: supervised learning, reinforcement learning, unsupervised learning, and self-supervised learning (see Figure 3).

Figure 3: Kinds of learning



A key aspect of machine-learning models pertains to their location in the *transparency-opacity* continuum, i.e., to the extent to which by looking into the model it is possible to understand and explain

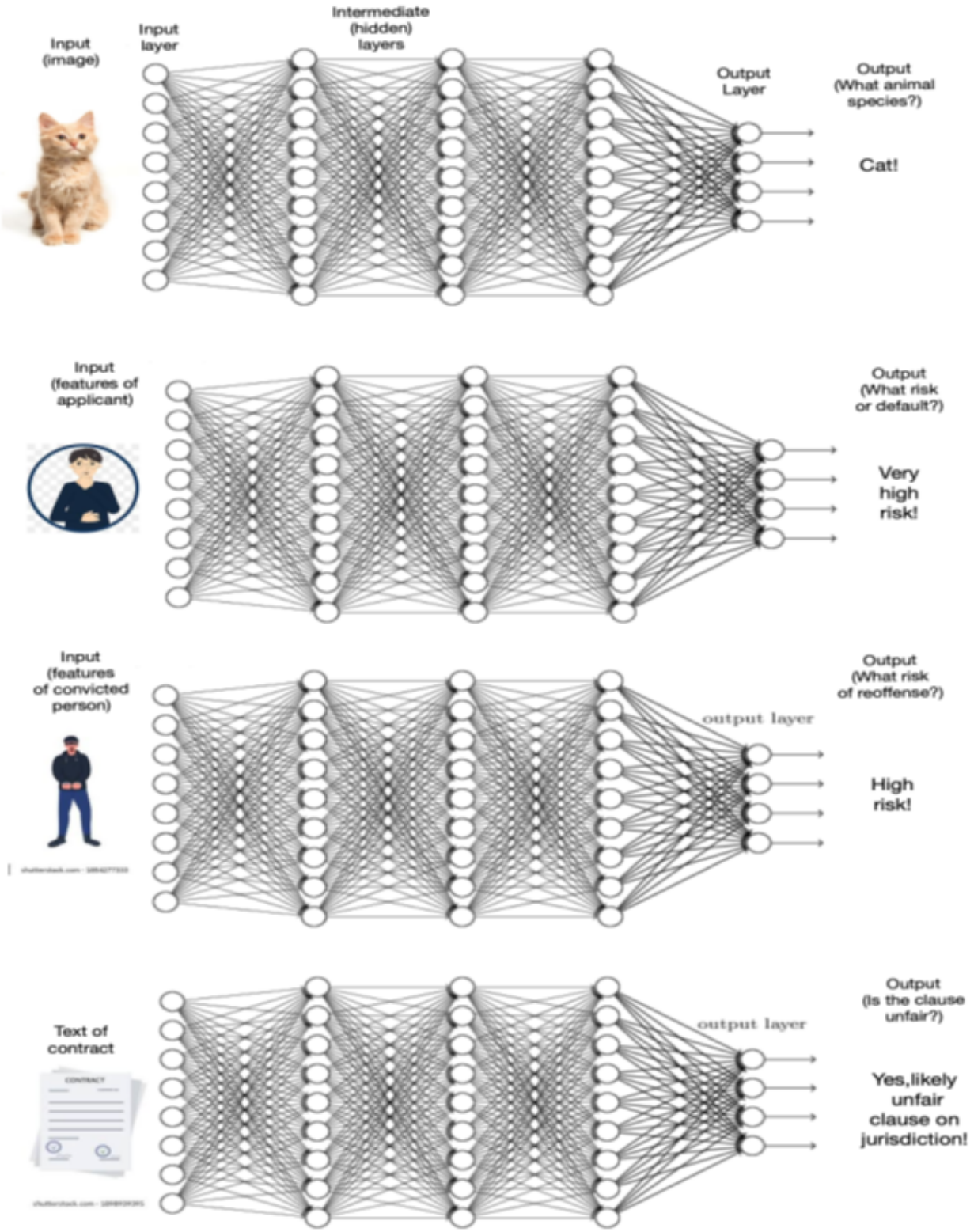
[15] Mitchell (1997).

why the machine delivers certain outputs in response to given inputs. A tension may emerge between performance and opacity, as in some cases opaque systems (e.g., large and deep neural networks) provide better performance than transparent ones (e.g., simple decision trees). The field of Explainable AI (XAI) aims to address this issue by developing methods to make high-performing models more interpretable.[16]

Neural networks are the most important example of an opaque system. They consist of layers of connected artificial neurons (so-called since they are inspired by neurons in biological brains), which respond to incoming inputs by sending computed outcomes over their outgoing connection. Such networks learn by modifying the strength of the connections (parameters) between their neurons. When a network is sufficiently big and complex, the examination of its connections and activation patterns does not provide human understandable reasons why the network has delivered certain outcomes. Figure 4 shows how neural networks can be deployed in different domains.

[16] Ali et al. (2023).

Figure 4: Uses of neural networks



1.2.2. Predictive machine learning in the law

In the legal context, the most popular machine-learning approach has been supervised learning. For instance, this approach has been applied in the Claudette project to build a system that identifies

unlawful or unfair clauses in contracts and privacy policies.[17] In this case, a large number of contracts and privacy policies were examined by competent lawyers, who classified the relevant clauses according to their content and their fairness/unfairness. Being trained on such human-generated classification (Claudette's training set), the system learned to detect unfair clauses in newly submitted documents. Similarly, other projects have relied on supervised learning for classifying the content of different types of legal documents,[18] predicting the outcome of judicial cases[19] or extracting relevant factors out of case-law[20].

Both supervised and unsupervised learning may be used in e-discovery applications to classify documents depending on whether they are relevant to certain litigation claims, or in information retrieval applications to select documents relevant to certain legal issues, or in knowledge extraction, to identify features that are legally relevant.[21]

Machine learning approaches can also be used in the legal context for making factual predictions, such as on recidivism[22] or domestic violence, or to identify locations where criminal activities are likely to take place (so-called predictive policing). They may also be used in the context of administrative or police investigation, e.g., to identify instances of tax or social security fraud. Such applications have attracted a vast debate as on the one hand they may contribute to making law enforcement more effective and accurate, but on the other hand they may give rise to injustice and discrimination (see Section 1.6).

Among further uses of AI technologies the following can also been mentioned:[23]

- Computer vision can analyse satellite imagery, public cameras and real-time visual data to monitor infrastructure, track environmental changes and assess disaster response needs. This is particularly useful in urban planning, environmental monitoring and crisis management.
- Natural Language Processing (NLP) and voice technologies can support text analysis, to provide insights and support evidence-based policymaking, by analysing and summarising large volumes of documents. They can also be used to automate citizen enquiries, help policymakers brainstorm ideas and extract key insights from extensive datasets, and make documents accessible in multiple languages and formats through language translation and summarisation.
- AI-driven forecasts and analytics can support the use of historical data (e.g. census data, economic reports and social media) to identify patterns, forecast trends (in areas such as health, employment and education) and detect recurring patterns, as well as anomalies and violations (e.g. fraud and policy errors).

17 Lippi et al. (2019).

18 https://blog.lawgeex.com/resources/.

19 Aletras et al. (2016).

20 Pereira et al. (2025).

21 For a review, see Ashley (2022).

22 As in the much-debated COMPAS system, used in many jurisdictions in the US.

23 https://www.datatopolicy.org/ai-for-policy.

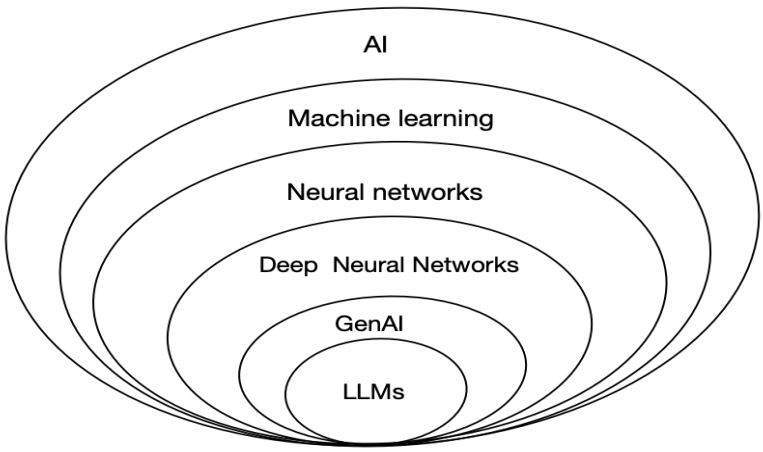
1.3. AI & Law: Large Language Models and Generative AI

The advent of generative AI (GenAI), particularly Large Language Models (LLMs), has recently transformed research at the intersection of AI and law. While this technology was initially met with scepticism, LLMs' growing power and effectiveness have prompted a significant shift in legal research towards this technology.

1.3.1. The GenAi approach: opportunities and challenges

GenAI systems rely on huge and deep (multi-layered) neural networks. Such networks have become the leading technologies in object recognition, achieving human and superhuman capacities, and have then moved into many other domains[24]. The step most relevant to the law has taken place when new approaches, such as transformers architectures[25], have enabled deep neural networks to effectively process language. The combination of such approaches with vast collections of texts and huge computer power has supported the creation of LLMs (large language models), pre-trained deep neural networks that can coherently respond to a variety of textual inputs (prompts)[26]. A new discipline has emerged, *prompt-engineering*, which teaches how to write effective prompts[27], so that a machine can be directed to perform a new task without having been specifically trained for it though a large set of examples (as is the case in the supervised learning approach). Context-engineering, which involves dynamically orchestrating relevant instructions, retrieved data, conversation history and tool outputs to create coherent inputs, further enhances the LLMs' capacity to perform complex real-world tasks[28] Figure 5 positions GenAI within AI technologies.

Figure 5: Technologies for GenAI



As LLMs exhibit the amazing capacity to accomplish a vast and open range of tasks (Figure 6), top scholars, such as linguist Noam Chomsky, philosopher Luciano Floridi, and computer scientists Gary

[24] Bengio, LeCun, and Hinton (2021).

[25] Vaswani et al. (2023).

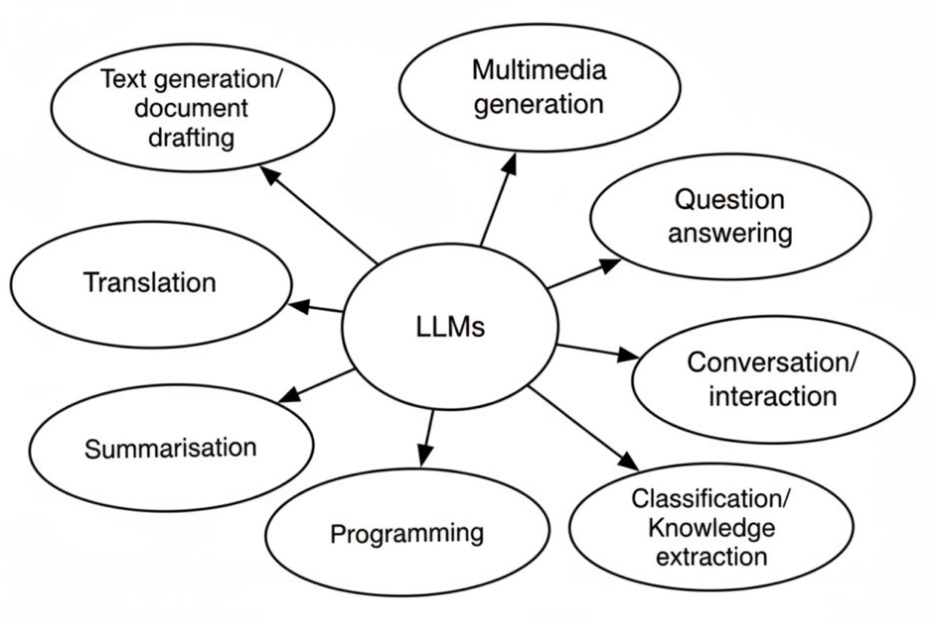
[26] Ouyang et al. (2022).

[27] Berryman and Ziegler (2024).

[28] Osmani (2025).

Marcus, Geoffrey Hinton, Joshua Bengio, and Yan LeCun have expressed opposing views on them: for some LLMs are just "statistical parrots"[29], reproducing with syntactic variation what was in their training set, while for others they have genuine abilities to understand language, form concepts, and engage in theoretical and practical reasoning[30]. Only technological and scientific developments in the coming years will enable us to determine the real nature of LLMs intelligence. For now, we can just be amazed at their impressive performance, while being aware that the truth of their assertion is not guaranteed: they often "hallucinate", or rather "confabulate" (the term preferred by Geoffrey Hinton, among others),[31] i.e., producing coherent stories in the absence of adequate evidence. As leading computer scientist Andrej Karpathy has also said, their intelligence is *jagged*: they usually produce good outcomes but sometimes provide incorrect answers to problems that appear very simple to humans.[32]

Figure 6: Capacities of LLMs



A worldwide race is going on, to develop increasingly large and powerful models, endowed with new functionalities, in which leading ICT companies (such as Open AI, Meta, Anthropic, Microsoft, Google, and Amazon) are making immense investments. As the uptake of LLMs has been most rapid (with ChatGPT now approaching 400 million weekly users[33]), the social and economic impacts of GenAI are already significant, and they are likely to accelerate in coming years, possibly having disruptive implications. LLMs have the potential to boost productivity in business, government, scientific research and education. They can function as *co-pilots*, assisting with creative and routine tasks, or they can be embedded in *agentic AI* systems to complete assignments and interact with users autonomously[34].

[29] Bender et al. (2021).

[30] Bubeck et al. (2023); Ananthaswamy (2024).

[31] Sui et al. (2024).

[32] In a post at his X social media account: https://x.com/karpathy/status/1816531576228053133.

[33] Rooney (2025).

[34] Acharya, Kuppan, and Divya (2025).

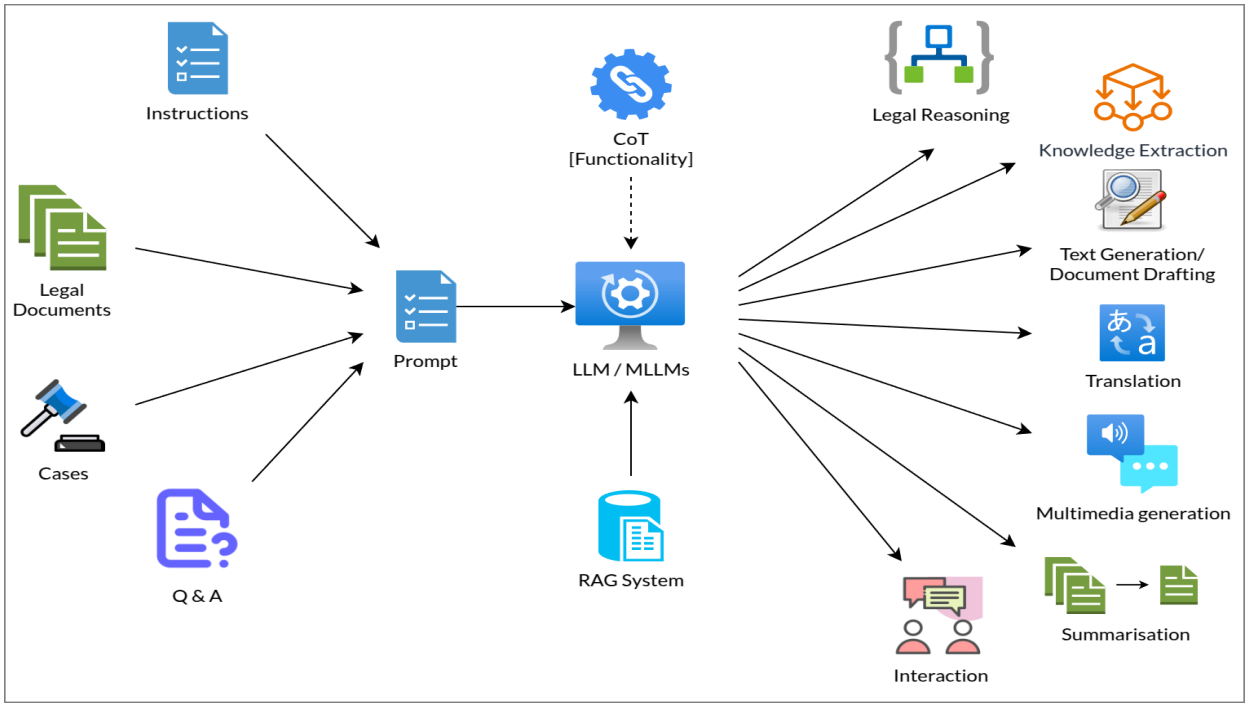
However, these powerful capabilities also present significant challenges, many of which are beginning to emerge (see Section 0).[35]

Ethical, political, and legal aspects of GenAI are at the centre of a vast debate, and leading scientists and politicians have observed that addressing the risks and opportunities of GenAI will decisively contribute to shaping humanity's future.[36] The uncertainties concerning the very development of GenAI and its social impacts should not refrain us from engaging in the informed analysis based on the state-of-the-art, of future scenarios, since the speed of development and the seriousness of impacts require a proactive approach[37]. We must anticipatorily ensure that future developments of advanced AI are aligned with human values.[38]

1.3.2. GenAI in the law

GenAI will have vast and possibly disruptive implications for legal professions and institutions. LLMs' capacity to generate natural language can be usefully deployed in many legal tasks: summarising, analysing and reviewing cases, doctrinal papers and other documents; answering legal questions; predicting the outcome of future cases; generating contracts, wills, briefs, and other legal texts; interacting conversationally with legal professionals or the general public seeking legal information (Figure 7).

Figure 7: LLMs in the law



MLLMs – Multimodal Large Language Models; RAG System – Retrieval Augmented Generation System.

[35] Bengio et al. (2024).

[36] Bengio (2023), Bengio et al. (2024).

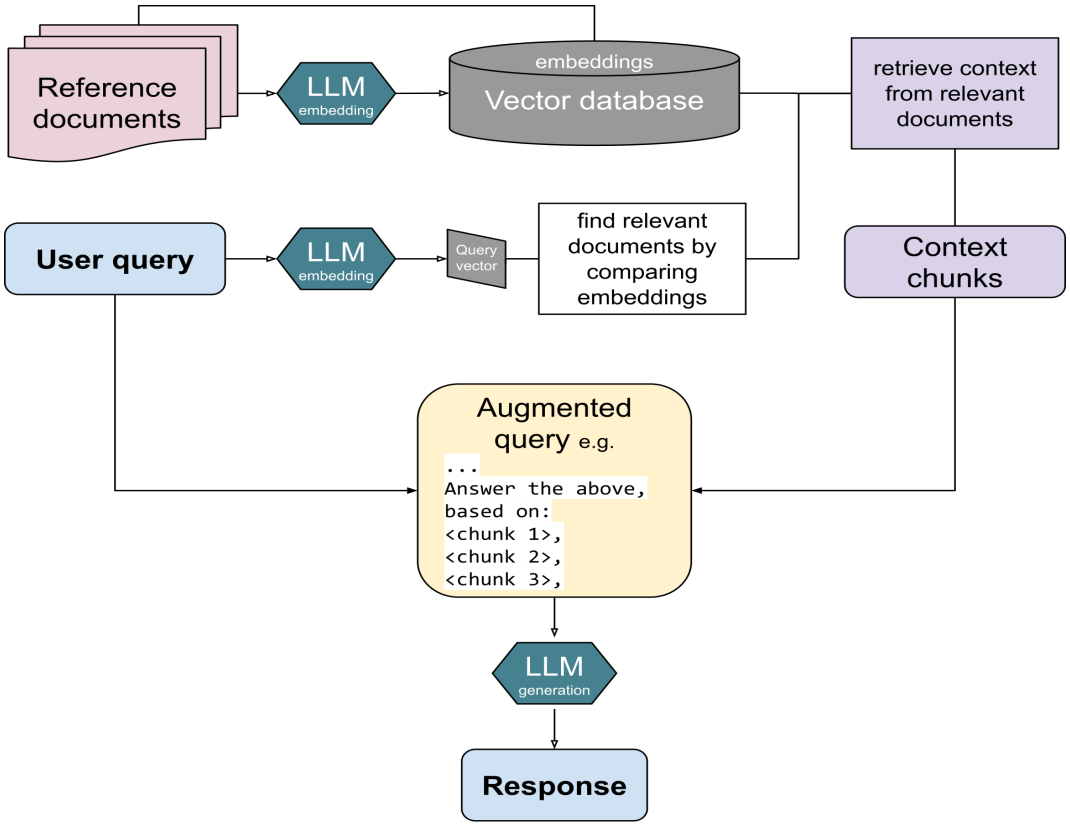
[37] Taeihagh2025.

[38] Russell (2019).

New legally relevant functionalities have recently become available, such as Retrieval Augmented Generation – RAG (Figure 8), which expands users' queries with chunks of information extracted from external sources (e.g., legislation, cases law or legal doctrine retrieved from the Internet or from databases).[39]

In this way LLMs can provide more contextualised and up-to-date responses (also based on data posterior to the training of the LLM).

Figure 8: Retrieval augmented generation – RAG[40]



Other useful techniques include CoT (Chain-of-Thought), which generates linked reasoning steps supporting the presented outcomes[41], ToT (Tree of Thought) where alternative inferences are explored in parallel[42]or CoL (Chain of Logic) where rules are extracted and applied. [43] More recently, *agentic AI* has emerged as a potential improvement. It employs multiple autonomous LLM-based AI agents that can engage in goal-directed activity (e.g., online trading or legal procedures) and collaborate to simulate complex legal processes, such as the deliberations of a judicial bench. This approach moves beyond the outputs of a single model to create dynamic and interactive systems.[44]

[39] Lewis et al. (2020).

[40] From "Retrieval-augmented generation". Wikipedia. Retrieved 4 October 2025.

[41] Wei et al. (2022).

[42] Yao et al. (2023).

[43] Servantez et al. (2024).

[44] Jiang and Yang (2025).

The advent of GenAI has determined an impressive acceleration in AI & Law, as much recent work relies on LLMs (possibly combined with other technologies) to address multiple tasks: summarisation of case law,[45] legal doctrine, and legal news,[46] the extraction of information from cases[47], contracts and privacy policies[48] and indexation through factors[49], the generation of briefs[50], the prediction of the outcome of cases[51], etc. Other works have focused on evaluating the results obtained by LLM[52].

1.4. AI & Law: Hybrid systems

As machine learning has become the dominant approach to AI and LLMs are playing a leading role in legal applications, many researchers have argued that machine learning should be integrated with the explicit modelling of legal knowledge and reasoning, possibly according to XML-based standards, logic or other formalisms.[53]

1.4.1. The hybrid approach

The hybrid AI research has led into different directions: *Symbolic Knowledge Injection* (SKI), *Symbolic Knowledge Extraction* (SKE). SKI (also known as *informed machine learning*) uses symbolic knowledge to guide a model throughout its training process. For instance, it can mould the model's architecture to mirror established legal rules, incorporate logic-based constraints into the learning algorithm's loss function.[54] Conversely, SKE addresses the opacity of complex models by translating their learned behaviour into human-readable symbolic rules.[55] This makes their reasoning transparent and verifiable for legal experts. The success of both integrations depends on rigorously evaluating the quality and significance of the symbolic knowledge, which is usually determined by balancing predictive performance (fidelity), human readability, and completeness.

Other forms of integration of symbolic AI and machine learning are possible, where part of the processing is done by using machine learning approaches, and part using symbolic models. For instance, structured information can be extracted by natural language cases using machine learning models, and then this information can be processed through rule-based reasoning or argumentation.[56]

[45] Pisano et al. (2024); Deroy, Ghosh, and Ghosh (2024); Santosh, Aly, and Grabmair (2024), Dal Pont et al (2023).

[46] Benedetto et al. (2025).

[47] Chaitra et al. (2024).

[48] Palka et al. (2025); Rodriguez et al. (2024).

[49] Ashley (2022).

[50] Choi et al. (2023).

[51] Shui et al. (2023).

[52] Fei et al. (2024).

[53] Rodriguez-Doncel et al. (2020), Ashley (2022).

[54] Rueden et al. (2021).

[55] Garcez, Broda, and Gabbay (2001).

[56] Bex (2025).

1.4.2. Hybrid models and LLMs in the law

In the legal domain, the hybrid integration between LLMs and logical modelling can take different directions:

- LLMs can exploit the information specified in machine readable formalisations, for improving retrieval, generation (e.g., of overviews or summaries) and query-answering[57].
- LLMs can extract information from legal texts (e.g., keywords, classifications of provisions and entities within them), that can be added as machine readable annotation to such texts (enhancing their usage according to standards, e.g., Graphie from the UK[58]).
- LLMs can extract content from the legal texts (both legislation and case law) and give it the form that enables its use for case-based reasoning or logical inference (e.g. factor extraction for legal judgements)[59].

With specific regard to legislative documents, it has been claimed that legal application based on ML should profit from the precise symbolic specification of certain very important features of legal texts:

- The structure of legislative and other documents (i.e., for legislative documents division in titles, sections, articles, paragraphs, etc.), specified according to machine readable standards, allows for the automated identification of thematic units.
- Legal citations complement sentences in legal documents with various kinds of linked content (e.g., definitions, derogations, modifications, integration of prescriptiveness, penalties, conditions).
- Temporal parameters (dates of enactment, modification, etc.) are important to understand the dynamic of legislation and case law, and should be taken into account, e.g., to determine the comparative significance of incompatible documents (as posterior laws usually prevail over anterior ones).
- Logic and semantic-web annotations can specify the role of different sentences in a text (e.g., as stating definitions, obligations, permission, sanctions, etc.), and their logical connections.
- Common interchange LegalXML standards (such as Akoma Ntoso) can support the creation of a common annotated digital corpus for robust AI applications.[60]

1.5. AI in the legal domain

In this chapter we shall provide some data on the use of AI in the public administration and on the judiciary, based on recent review works.

[57] Pipitone and Alami (2024).

[58] Tzanis et al. (2023).

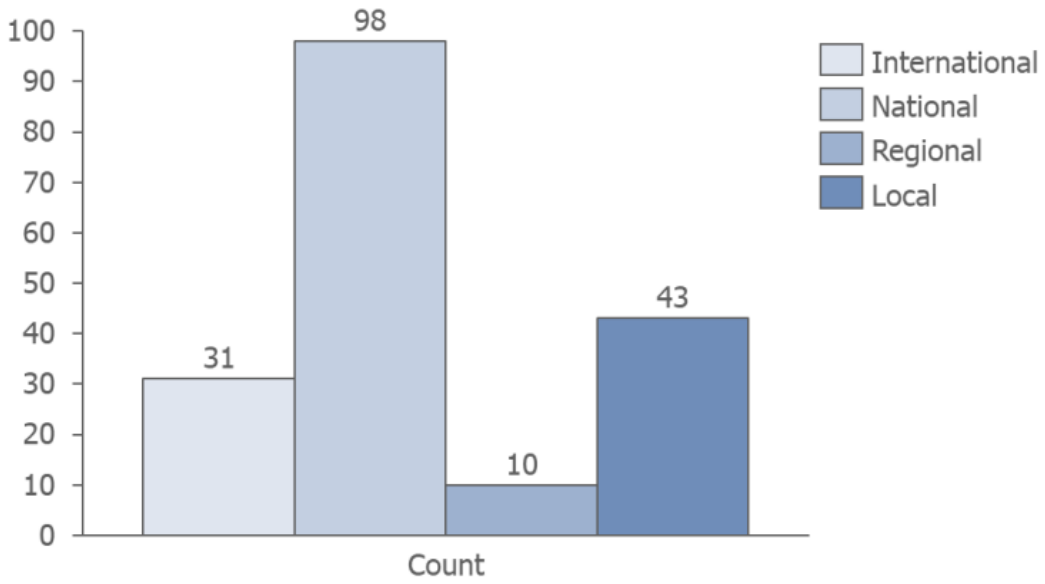
[59] Pereira et al. (2025).

[60] Palmirani et al. (2024).

1.5.1. AI applications in public administration

A 2024 Study on *AI applications in public administration*[61], based on data collected up to 2021, identified 182 projects dealing with AI in the public sector in Europe. These projects were divided according to their administrative level (see Figure 9).

Figure 9: Administrative levels of AI projects



The study identified several main policy areas in which AI is being deployed, based on such applications:

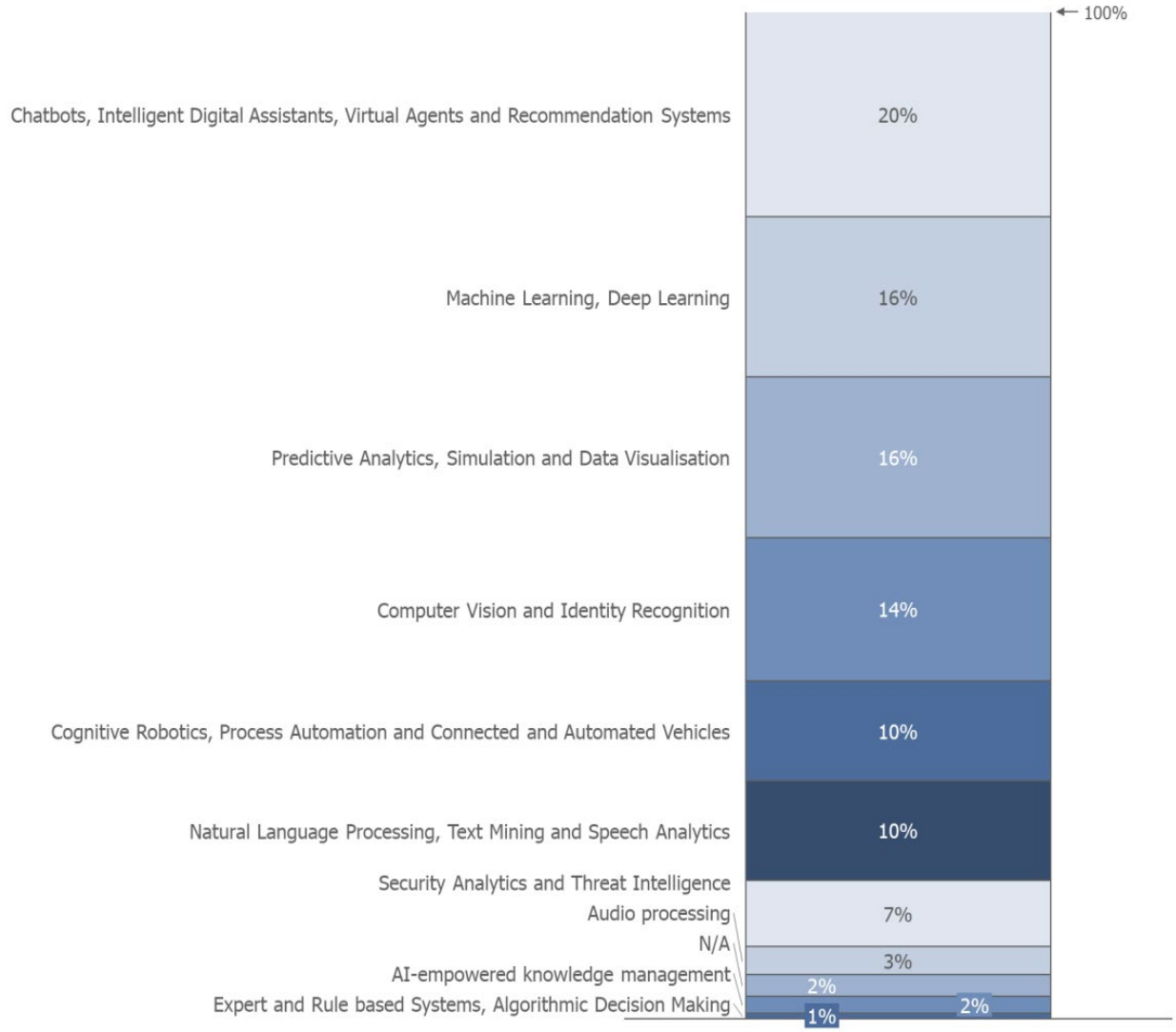
- General public services (combined public administration and public services), including technologies that contribute to the provision of digital services to citizens, such as chatbots, intelligent digital assistants and virtual agents;
- Economic affairs (transportation), including projects that use predictive analytics to help improve traffic flow;
- Public order and safety (police services) include AI technologies such as computer vision and security analytics for law enforcement, e.g. detecting traffic violations or identifying fraud;
- Health (medical equipment), including the technologies needed for health purposes, as well as predictive analytics for diagnostics.

Finally, concerning the technologies being used for such applications, a classification was proposed in Figure 10.[62]

[61] European Commission (2024).

[62] According to the analysis proposed in Misuraca and van Noordt (2020).

Figure 10: AI projects: typologies



With regard to the US, here are various examples of current AI applications in public administration. For instance, the Bureau of Labor Statistics (BLS) uses an AI system to categorise reports of workplace injuries submitted by over 200,000 businesses, [63] and the Food and Drug Administration uses AI to track and report on microbial sources in real time during foodborne outbreaks.[64]

1.5.2. AI applications in the judiciary

The use of AI is also increasing within the EU's judicial systems, though before the advent of LLMs, its impact on the core judicial functions was very limited. According to the "2025 EU Justice Score board"[65], AI may assist judges and legal professionals by helping them to focus on substantive work, for example by assisting with tasks such as document filing, managing repetitive duties and researching legislation and case law. Some courts and prosecution services in the Member States are utilising AI

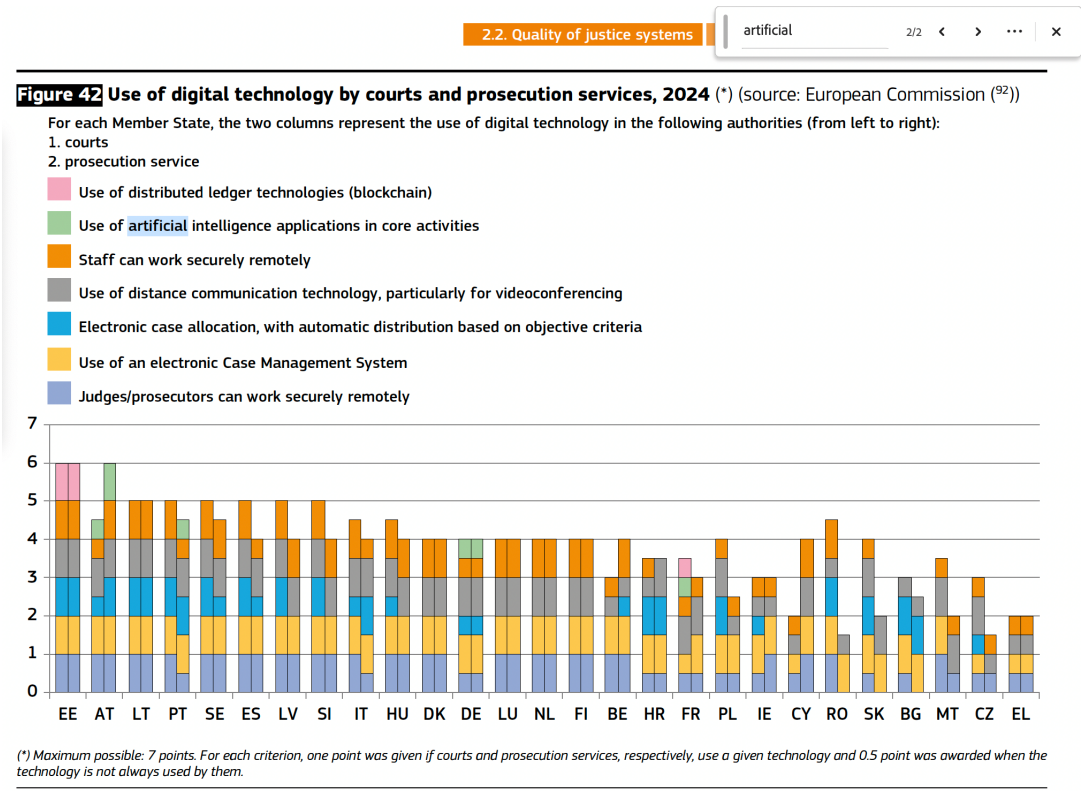
[63] Measure (2020).

[64] Nathan (2025).

[65] European Commission (2025).

applications in their activities, albeit to varying degrees. However, according to the Score Board, very few applications of AI address core judicial activities (see Figure 11).

Figure 11: AI in the judiciary[66]

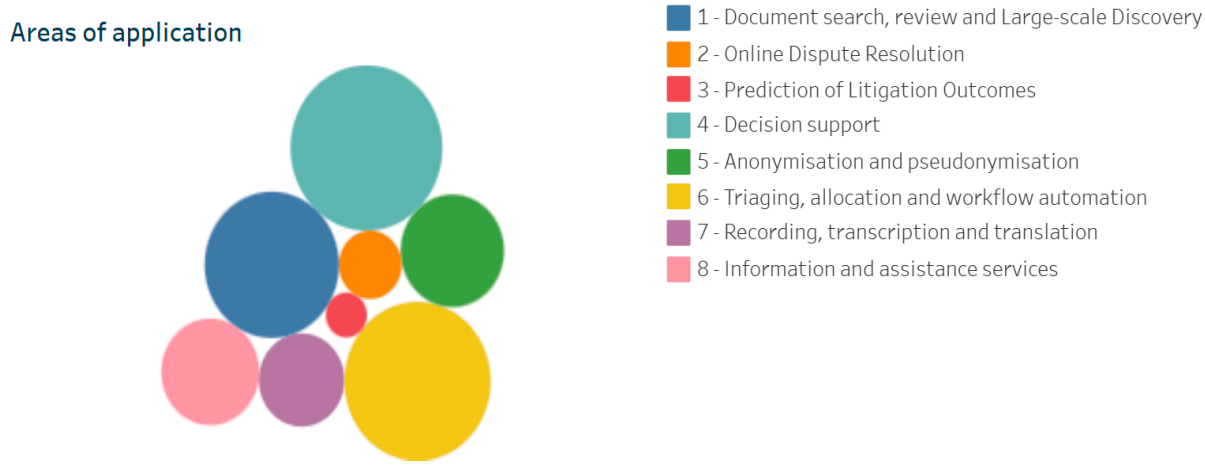


An in-depth analysis of the AI in the judiciary has also been developed by the Council of Europe, where the European Commission for the efficiency of justice (CEPEJ) is maintaining a database collecting information about AI applications in the judiciary, on the basis of which reports are delivered.[67] The 2025 report already includes some developements linked to the use of LLMs, which we will discuss in the next section. According to the report, 125 AI tools are used or developed for the justice sector, for the areas of applications described in Figure 12.

66 From European Commission (2025).

67 CEPEJ (2025).

Figure 12: AI in justice[68]



1.5.3. The prospects of GenAI

Any account of the use of AI in the legal profession, in public administration and in the judiciary, even delivered just a few months ago is likely to underestimate the dimension of such a use, since LLMs are bringing rapid and widespread developments.

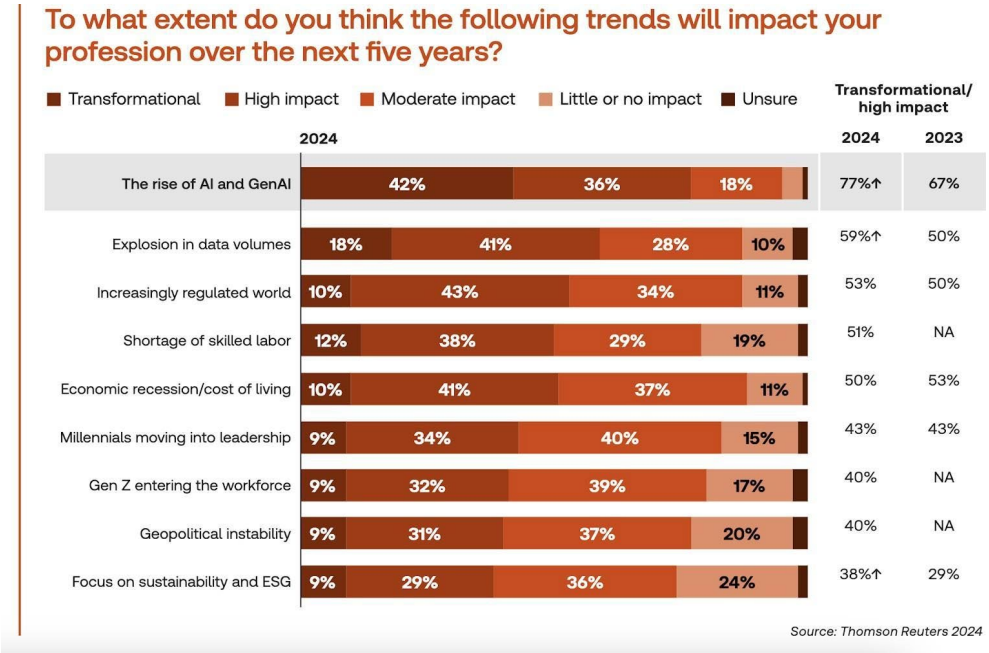
The uptake of GenAI in the legal profession, in public administration and in the judiciary has been pervasive[69]. Many lawyers, public offices and judges are directly querying LLMs for legal information and are learning to create prompts directing LLMs to perform legal tasks (legal prompt-engineering). Many have purchased individual LLMs accounts or are using LLMs through third-party applications, some of which are offered by leading legal information providers[70]. Some use products built upon LLMs, but many more rely on LLMs available to the general public, to which they submit legally relevant tasks. According to US lawyers, the uptake of GenAI is the trend having the largest impact on the future of legal professions (Figure 13).

[68] From CEPEJ (2025).

[69] Siino et al. (2025).

[70] Greenstein (2025).

Figure 13: GenAI's impact on the legal profession



As LLMs have been adopted by legal practice, their application in public domains has also been rapid and indeed accelerated. In a recent review,[71] the following application domains are listed:

- Legislation and policy making, including document classification[72], policy analysis and legislative drafting, policy simulation,[73] support to political participation.
- Political communication and engagement with public opinion, including analysis and classification of policy-relevant texts[74], the support to public deliberation,[75] producing and countering deception[76] search and possible echo-chamber effects.[77]
- Political Analysis and Decision-Making, including simulations of electoral behaviour[78] and the creation of artificial focus groups[79] and political Sample simulations.[80]
- Diplomacy and National Security, including military planning, simulations of conflicts and diplomatic interactions.
- Economic and social models including social simulation[81], economic and epidemic modelling[82].

71 Aoki (2024).
72 Gunes and Florczak (2025).
73 Zeng et al. (2025).
74 Heseltine and Clemm von Hohenberg (2024).
75 Kuo et al. (2025).
76 Park et al. (2024).
77 Sharma, Liao, and Xiao (2024).
78 Yu et al. (2024).
79 Ashkinaze et al. (2025).
80 Qi, Lyu, and Luo (2025).
81 Guo et al. (2024).
82 Filippas, Horton, and Manning (2024).

In the EU, public administration staff and citizens in Member States already have access to GenAI services for handling simple yet laborious tasks. Available through the "AI-Based Multilingual Services" platform[83], these tools offer functions such as summarisation, anonymisation, translation, writing, and speech-to-text. At the European Commission, there are also AI tools available, such as the GPT@EC[84], launched as a pilot in October 2024. GPT@EC is a secure, general-purpose corporate generative AI tool for European Commission staff. Developed by DG DIGIT, it serves as a safe alternative to third-party AI tools for tasks like drafting texts, summarising documents, and writing. Its security architecture is a core feature, ensuring that internal Commission information is processed without being shared with external parties.

Significant challenges remain. Firstly, although it is certain that the European institutions use multiple AI tools internally, there is a lack of public transparency regarding the full scope of this usage. Secondly, greater integration and synchronisation of AI development and deployment across these institutions would foster a more unified and consistent approach.

1.6. Challenges of AI in the legal domain

In this section, we shall briefly refer to some challenges that arise from the use of AI in the legal domain. A vast amount of work exists addressing such issues, also in connection with the interpretation and application of the AI Act.[85] We will only refer to some specific issues.

1.6.1. Challenge of knowledge-based systems

Symbolic AI systems (knowledge-based systems) have not originated serious legal or social issues. It has sometimes been argued that the automated application of formally specified rules might lead to a mechanical application of the law, restricting the discretion of officers and their ability to take human and social issues into account. However, the application of such systems has being limited to administrative domains already characterised by a standardised and often automated application of legal rules. In such contexts, knowledge-based systems may enable a more transparent and controllable application of the law in comparison to the opacity of computer systems built by using different programming methods.[86] As long as the original legal sources are written in natural language, it is always possible to contest the interpretations that have been modelled into the rules of the system.

A challenge however may arise in the context of the so-called *code-as-law* movement, namely to the idea that official legal sources should have the form of a computable specification, being written using some logical formalism or programming language. Producing laws that are originally computer-implementable, it is argued, would contribute to legal certainty and equality in front of the law, while increasing efficiency in the implementation of the law. The prospect of code-as-law has been to some

[83] See https://language-tools.ec.europa.eu/

[84] Directorate-General for Digital Services (2024).

[85] See De Filippi and Wright (2018) Barraclough, Fraser and Barnes (2021); and Novelli et al. (2024).

[86] See Schartum (2020).

extent adopted by some projects.[87] However, contrary to the idea of expressing the law in computable languages, it has been argued that the law should continue to have humans as its primary addressees, and that using natural language (with its richness of content, and relative indeterminacy) is needed to ensure flexibility in the application of the law, its adequation to the relevant human interests and its alignment with fundamental rights and values.[88]

We submit that the latter vision is preferable, since the law should be centred on citizens and provide them with guidance they can understand, apply to their cases, and critically assess. Thus, legal texts should continue to be expressed in natural languages, those languages that in principle all citizens can understand. This does not exclude that laws can be operationalised into computable representations whenever this may serve the purpose of the implementation of the law. Both human understanding of EU laws and the possibility of automatically processing can profit from an improvement in legislative drafting: a clear and structured way of expressing laws in natural language can facilitate both human understanding and translation into computable formalisms.[89]

1.6.2. Challenges of machine learning

While symbolic AI has not raised significant novel issues in the automation of legal and administrative practice, such issues have emerged in connection with the use of machine learning based approaches. In fact, machine learning techniques have enabled to expand automated decision-making much beyond the application (of large sets) of clear and precise rules, into domains characterised by uncertainty and discretion: the prediction of health issues and the suggestion of therapies, the identification of social issues (e.g., domestic violence), the prediction of criminal activities and the suggestion of police intervention (predictive policing), the prediction of recidivism, the detection of probable instances of money laundering, tax evasion or fraud to social benefit, the identification of environmental issues, the appointment of workers and the enrolment of students and the evaluation of their performance, the prediction of judicial and administrative decisions, etc.[90]

A huge literature exists on issues that have emerged in such contexts[91], like the following:

- Systems trained on biased and prejudiced data (e.g., human decisions on lending or appointments) may reproduce such biases and prejudices, replicating them to a larger scale;
- Systems trained on unbalanced datasets (e.g., including a much smaller proportion of individuals of a certain gender or a race), may provide less accurate determinations concerning members of underrepresented groups;

[87] Various recent projects are inspired by the code-as-law idea, such as Lynx (https://lynx-project.eu/), OpenFisca (https://openfisca.org/en/) and others.

[88] The ERC-Advanced project CompuLaw has addressed issues and advantages of different computational representation of the law (https://site.unibo.it/compulaw/en/project). This is also a focus of ERC-Advanced project HyperModeLex project (https://site.unibo.it/hypermodelex/en). For criticisms of code-as-law, see also Kaeseberg (2019).

[89] See Reichman and Sartor (2022).

[90] For a general account of automated decision making, see Barocas, Hardt, and Narayanan (2023).

[91] See among many others, Kleinberg et al. (2017), Wang et al. (2024).

- Individuals which are predicted to incur in unfavourable events or conditions may be subject to additional harshness because of such predictions (e.g., in health insurance, or in admission to schools);
- Systems which are focused on certain favourable or unfavourable features (e.g., attendance of top/bottom educational institutions) that mostly apply to certain groups (e.g., rich/poor students), may provide unfairly unfavourable outcomes for those that do not possess the favourable features, or possess the unfavourable ones;
- Excessive trust in automation may lead to the acritical endorsement of the outcomes of automated processes, to the point that a merely statistical probability (e.g., on the existence of a fraud) may substitute the careful assessment of individual cases.

Here we cannot consider such issues in detail. It may suffice to highlight a paradigmatic case where excessive reliance on a flawed predictive system resulted in serious social problems and triggered a political crisis. This was the child-care benefits scandal (*toeslagenaffaire*) in the Netherlands.[92] The Dutch tax authorities relied on a predictive system — based on a vast set of data including employment, personal debt, benefit, education and housing records— to identify likely instances of child-benefit fraud. The system's predictions led to immediate action against suspected fraudsters without adequate scrutiny by competent officers: the individuals classified as high-risk were asked to pay large sums (including severe sanctions, beside the restitution of the received benefits) within a short timeframe or face legal action. As a consequence, many innocent families —often with lower incomes or belonging to ethnic minorities— were pushed into hardship and poverty. This resulted in some suicides and in children being put in foster care. On January 15th 2021, the Dutch cabinet led by Prime Minister Mark Rutte resigned in response to the highly critical report from a Parliamentary Investigation Committee. The Committee concluded that the Dutch government had violated the foundational principles of the rule of law through the way suspected fraudsters with childcare allowances had been treated, especially because of the following: (1) the harshness of the sanctions, even in cases of small administrative errors; (2) the attitude of mistrust, evidenced by the assumption that 80% of the recipients were fraudsters, and the assumption of guilt and intent in every case, which blocked the opportunity for a lenient payment arrangement.

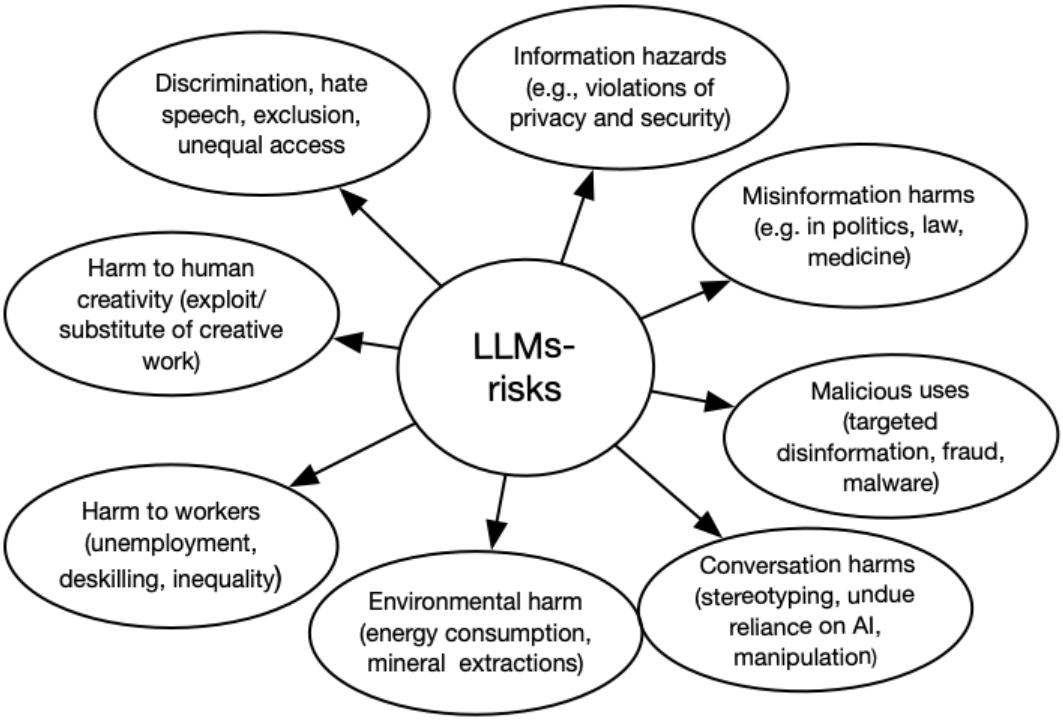
1.6.3. Challenges of GenAI

The deployment of LLMs, by expanding the capacity for AI applications and the scope for their use increases some of the challenges mentioned in the previous section, and adds new critical aspects.[93] As they are pre-trained on any kind of human-produced text (and media, in multimodal system) LLMs may deliver knowledge, beauty and more generally useful and lawful outputs, but also falsity, prejudice and hatred, and more general unlawful or anyway damaging content. Further risk pertains to their possible negative impacts on human labour and creativity and on their malicious or excessive deployment (see Figure 14).

[92] Fenger and Simonse (2024).

[93] Bengio et al. (2024).

Figure 14: Risks of LLMs



When using LLMs in legal context, we should be aware of their current limitations: they have no sense of truth and no access to the physical and social world and no sense of the law's connection to social and human realities; their ability to engage in reasoning and argumentation is limited and brittle; they occasionally provide false or unverified information (so-called hallucinations).[94] It is true that LLMs capacities are increasing, but so do the risks of their inappropriate deployment: legal decision-makers may adopt suggestions based on false facts or fallacious reasoning; they may fail to consider the legal, moral, and societal significance of the issues to be addressed and the legal principles at stake; they may end up endorsing unfair outcomes resulting from biased data. Excessive reliance on LLM may deskill legal professionals, should they passively endorse the machine's outputs rather than submitting them to rigorous factual, legal, and logical checks.[95] It may induce lawyers to passively endorse the machine's proposals, rather than taking a critical and creative attitude. Reliance by the public on erroneous or inadequate legal advice provided by LLMs may lead individuals to mistaken choices, possibly with serious adverse implications.

Mitigating these risks requires more than just technological safeguards and progress in explainable AI.[96] The legal community must take a proactive approach to ensure that, as these powerful tools are integrated into legal practice, the necessary awareness, critical engagement and rigorous human oversight are in place. Only in this way we can adequately implement, in the LLM domain, the principles of trustworthy AI: human agency and oversight; technical robustness and safety; privacy and data

94 Dahl et al. (2024).

95 Kosmyna et al. (2025).

96 Dong et al. (2024), Zheng et al 2025; Zheng, Rana, and Stolcke (2025).

governance; transparency; diversity, non-discrimination and fairness; societal and environmental well-being and accountability.[97]

[97] AI Act, Recital 27, which refers to the 2019 Ethics guidelines for trustworthy AI developed by the independent AI HLEG appointed by the Commission.

2. ANALYSIS OF POTENTIAL CONTRIBUTIONS OF AI TO THE LEGISLATIVE PROCESS

KEY FINDINGS

AI can be used in different ways in the legislative process

- In Pre-enactment information analysis, to find and organise relevant information: retrieval of relevant documents, classification of information, comparison of information sources, information extraction, logical modelling, summarisation and translation;
- In Pre-enactment Impact forecasting, to anticipate the impacts of new legislative instruments: data integration and enrichment, assessment of legal impact on normative systems, predictive modelling of social impacts, agent-based modelling, scenario analysis;
- In Consultation and public participation, to support communication between authorities and stakeholders: public feedback analysis, interaction support, communication generation;
- In Drafting support, to improve clarity and consistency of legislative and regulatory instruments: searching and classifying similar provisions, text generation, consistency checking, clarity and readability enhancement, analysis of the legislative process, knowledge extraction, logical modelling, recasting, codifying and simplifying legislation;
- In Post-enactment monitoring, to assess the social impact of adopted laws: data collection and analysis, analysis of regulatory implementation and of judicial and administrative application, anomaly detection, social impacts evaluation, sentiment and feedback monitoring.

The use of (generative) AI in the legislative process raises specific challenges. They may: deliver unexpected mistakes, undermine independent and critical thinking, generate accountability gaps, engender security risks and opportunities for undue influence and manipulation, facilitate homogenisation and bias.

To address such challenges interinstitutional coordination is needed as well as contribution by external expertise, based on collaboration with the research and academia.

In this section, we shall consider the prospects of the use of AI in the legislative process. Given the huge recent developments resulting from generative AI, our analysis will mostly gesture to future opportunities, rather than pointing to existing solutions.

The potential areas of intervention for AI in the legislative process cover different aspects of it, where AI can operate as a companion to competent humans, who must always maintain full control and awareness:

1. Pre-enactment information analysis;
2. Pre-enactment impact forecasting;
3. Consultation and public participation;
4. Drafting support;

5. Post-enactment monitoring.

In the following section we shall briefly consider the first four domains, and then expand our analysis of the 5th one, which is the specific target of our inquiry.

2.1. Pre-enactment information analysis

Pre-enactment information analysis pertains to the retrieval and organisation of the information that is relevant to the production of new legislative documents. We can distinguish different activities in which drafters and decision-makers can profit from AI support.

- *Retrieval of relevant documents*. AI can complement, through semantic search, the capabilities offered by traditional text retrieval. This can be obtained relying on similarities between automatically generated numerical representations (so-called embeddings) of queries and documents.[98]
- *Classification of information.* AI systems can sort legal and other documents by type (e.g., statute, regulation, court ruling, journal articles) or by topic. For instance, provisions in a legislative document can be classified according to subject matter or normative qualification (obligation, permissions, sanctions, etc.).
- *Comparison of information sources*. AI can support comparison between different legal instruments, eliciting commonalities and differences. For instance, legal instruments that address the same issues in different EU jurisdictions may be compared when designing new EU laws, to understand the different contexts in which the new norms will operate.
- *Information extraction.* Recent developments in natural language processing (particularly in the context of LLMs) have enabled AI to be used for information extraction. Named Entity Recognition (NER) concerns identifying and tagging elements such as dates, authorities, references to other laws, jurisdictions, case numbers, legal parties, etc. Particularly important is the ability to recognise references and generate networks of them. Moreover, concepts and their relations can also be automatically extracted from documents. This may be useful for better understanding the role that each provision plays within the legal system.[99]
- *Logical modelling*. An extension of the information extraction functionality consists in using AI to support the creation of knowledge maps and even computer processable rules (usually with human supervision and revisions). In this way the division between human-understandable automatically processable knowledge bases and machine learning can to some extent be overcome, and the realisation of systems for the automated implementation of the law can be facilitated.[100]

[98] Katz et al. (2023), Quevedo et al. (2024).

[99] Dozier et al. (2010), Leitner, Rehm, and Moreno-Schneider (2019).

[100] Dal Pont et al. (2025).

- *Summarisation and translation textual sources.* LLMs have enabled huge improvements in the processing of natural language texts, and they can be used to summarise and translate legal sources and other documents to be used in legislative processes.[101]

2.2. Pre-enactment impact forecasting

Pre-enactment impact forecasting is concerned with anticipating the impacts that the new legislative instruments are likely to have on the legal system and consequently on social (economic, environmental, administrative, etc.) dynamics. Such forecasts usually rely on expert assessments, stakeholder consultations, and econometric models. AI can significantly augment this process by enabling more *data-driven, scenario-based, and real-time* evaluations.

Among the uses of AI in pre-enactment forecasting the following can be mentioned:

- *Data integration and enrichment* – AI systems can aggregate data from multiple sources—including historical government records, sensor data, open data portals, and proprietary datasets—to create a comprehensive evidence base for forecasting.[102]
- *Assessment of legal impacts on normative systems*. AI can be used to detect what impacts new norms can have on normative systems, at the EU and at national level, by conflicting with existing norms, abrogating, derogating or complementing them, or extending or limiting the scope of their application.
- *Predictive modelling of social impacts.* Machine learning models can complement the use of statistical methods to estimate likely changes based on proposed policy parameters (e.g. on GDP, unemployment rates, crime incidence, or emissions levels).[103]
- *Agent-based modelling* – An agent-based approach enables simulations of how individuals, firms, and institutions might adapt their behaviour to new legal rules.[104] Thanks to LLMs, new opportunities have emerged for agent-based simulations, the so-called agentic AI, where planning agents rely on LLMs for obtaining information and constructing plans.
- *Scenario analysis* – AI can run multiple "what-if" scenarios by varying input parameters such as tax rates, regulatory thresholds, or subsidy levels, producing comparative forecasts of different policy designs[105]. This enables legislators to choose between alternatives based on projected impacts according to the metrics adopted, from cost-benefit ratios to UN development goals, equity effects, administrative and compliance feasibility.

[101] Fidelangeli et al. (2025).

[102] Ghosh et al. (2022).

[103] Varian (2014).

[104] Helbing (2015).

[105] Stern (2022).

2.3. Consultation and public participation

AI tools could be used to support communication between legislative authorities and relevant stakeholders:

- *Public feedback analysis* – Natural language processing can summarise and categorise thousands of citizen comments on proposed laws, enhancing the ability to make use of citizens' consultations. Besides extracting the content, by relying on sentiment analysis, public attitudes toward specific provisions could also be detected.
- *Interaction support* – Chatbots could be used to provide targeted information to all relevant stakeholders, including the general public, on legislative initiatives and related issues.
- *Communications generation* - AI could support the creation of documents suited for communication to the public, providing syntheses at the needed length and level of technicality.

By expanding the interactions between citizens and legislators, AI could contribute to creating involvement and awareness.[106] For example, the Citizens' Engagement Platform[107], which is a forum for citizens to participate in policymaking, could be enhanced by using GenAI to provide additional analytical functions: identifying main discussion topics, mapping trends across responses, highlighting emerging concerns, etc.

2.4. Drafting support

Whatever support AI may provide for drafting, it must be integrated with the existing drafting software, such as tools to control that: legal documents are appropriately structured, references are exactly expressed, amendments are correctly managed, consolidation is automated, linguistic variants are kept aligned, appropriate patterns are identified, digital dictionaries are made available, provisions are linked to concepts from dictionaries and ontologies, etc.[108]

In the new technological context characterised by GenAI, a set of novel and deeper ways through which AI can support legislative drafting have become available. LLMs may contribute to improve the quality of drafting, by facilitating the production of legislative documents whose structure and language enhance accessibility by all addressees of such documents (common citizens, officers, and specialists).[109] We may wonder whether a new drafting style may emerge, where human drafters interact their AI companions, asking the latter to control, revise and expand human-drafted textual fragments, and to produce new relevant textual fragments to be humanly controlled, revised and integrated. Such an interaction may resemble the interaction now becoming pervasive both in

[106] For more information on citizen involvement in the implementation of EU law, see Drake and Bosangit (2025).

[107] See https://citizens.ec.europa.eu/index_en.

[108] Palmirani et al. (2024).

[109] See Xantaki (2025).

computer programming and creative writing, where the final output results from human-machine collaboration.[110]

Among the tasks that AI can play to support drafting, the following can be mentioned:

- *Searching for and comparing with similar provisions* – NLP systems, and in particular LLM can collect and classify relevant provisions from prior legislation, from the same or for other legal systems, or also from doctrinal contributions. This may facilitate alignment with best practices across jurisdictions. The retrieval of all legislative or other definitions for a certain term, however formulated, may support the drafting of new definitions. This is particularly important to align EU and national legal terminology. Moreover, automatic comparison can elicit commonalities and differences, so that a formulation may be chosen with awareness of its position relative to other possibilities.
- *Text Generation* – Large language models can produce draft statutory provisions based on policy instructions, templates, or legislative style guides. These systems can adapt tone, complexity, and structure to match the jurisdiction's legislative drafting conventions. The generation of such proposals can be obtained in response to prompts by drafters or be automatically suggested to improve the clauses being written by the drafters.
- *Consistency Checking* – AI can automatically compare new provisions with existing statutes to detect contradictions, duplications, or terminology inconsistencies, internal to the text being written. Such cross-referencing helps to reduce the likelihood of enacting conflicting or incoherent laws.
- *Clarity and Readability Enhancement* – AI can assess the readability of draft legislation, by suggesting revisions while maintaining legal precision. Machine learning models can simplify the syntax of overly complex clauses while preserving their meaning. An interesting opportunity may also pertain to having AI to revise redundant or anyway lengthy legislative provisions, providing shorter more principled formulations, to be possibly complemented with standards or other sub-legislative sources.
- *Analysis of the legislative process* – AI can examine the documentation produced during the legislative process including revisions and stakeholder inputs, changes and committee reports or debates, produce summaries and elicit rationales. This may be useful to enable drafters to exactly capture legislative intents.
- *Knowledge extraction and analysis of documents being produced* – AI can support drafters in identifying key aspects of the documents, i.e., in identifying the obligations it establishes, the sanctions it introduces, etc. The generation of compliance checklists for regulated entities may also be useful during the legislative process. It may help verify whether the obligations being imposed on addressees are all relevant, sustainable and justified by the goals being pursued (taking also into account possible negative side effects).

[110] Santos et al. (2025).

- *Logical modelling* – AI could help to develop logical models of the content of new legislative documents. This may involve constructing knowledge graphs connecting the concepts, as well as logical rules modelling provisions. This may help to control the consistency of legislative texts and elicit syntactical ambiguities and may facilitate the development of knowledge-based systems.
- *Recasting, codifying and simplifying* – AI could help simplifying the stock of EU law and reducing administrative costs, pursuing the goals of the Regulatory Fitness and Performance (REFIT) Programme and the 'one in one out' strategy.[111] Various functionalities just mentioned could be deployed to this purpose, from retrieval of all relevant provisions to the identification of conflicts and redundancy, the reformulation and clarification of complex provisions, the extraction of conceptual structure and logical models.

2.5. Monitoring impacts and compliance

Effective monitoring requires the availability of data on the implementation of the legislation being considered. The deployment of AI assumes indeed that data are available, which requires that appropriate socio-technical procedures are established for data collection and conservation.[112] However, AI itself can contribute to data collection by extracting data from textual and other (e.g., visual or audio) sources. To make data-collection cost effective and sustainable, it is necessary to design data collection and creation policies under which data are automatically produced as a side effect of administrative processes, resulting from the actions by governments and citizens. Such measures should be planned as from the enactment of legislation.[113] There is indeed a strong connection between the pre-enactment impacts assessment and post enactment monitoring, since the monitoring includes the post-enactment assessment meant to verify to what extent the expected outcomes have been achieved.

Private companies have excelled at collecting data in providing services and using this data to train AI systems. The same should apply to both the EU and Member States. In this connection, data protection and ethical issues pertaining to data collection should be considered from the very start, so that the data processing respects data subjects' rights and meets their factual and normative expectations. Risk reduction measures should be adopted, in accordance with the principles of data protection by design and by default (with a particular emphasis on the anonymisation or pseudonymisation of data).

Among the uses of AI in post-enactment assessment and monitoring, the following may be considered:

- *Data collection and analysis* – AI systems can analyse regulatory documents, case law, administrative decisions, regulatory filings, company reports, public datasets, citizens' complaints. Data automatically collected though sensors (e.g., environmental data), Internet of Things (IoT) or satellite observation can also support the analysis of the impacts of legislation

[111] See https://commission.europa.eu/law/law-making-process/evaluating-and-improving-existing-laws/refit-making-eu-law-simpler-more-efficient-and-future-proofen.

[112] Sartor (2022).

[113] Sartor (2022).

and specifically instances of non-compliance (e.g., illegal deforestation or mining, destruction of protected natural habitats). Data may be clustered in different ways and relevant information can be extracted from them.

- *Analysis of regulatory implementation* – AI can be applied to regulatory instruments to assess the extent to which, and the ways in which, they implement higher level instruments (such as EU directives and regulation, with regard to national legal systems). This presupposes the retrieval of the relevant regulations and entails the use of NLP methods to assess whether the requirements set in higher-level instruments are duly interpreted and implemented. The analysis of legal literature may also be relevant to detect issues and possible solutions.
- *Analysis of judicial application* – AI can be used to determine in what cases a legislative instrument is applied (or its application is omitted) by the judiciary according to what interpretations. Its contribution would consist in using NLP technologies (in combination with ontology and other semantic-web technologies) to extract the relevant information from legal cases and aggregating it.
- *Analysis of administrative application* – AI can be used to determine the extent to which administrative authorities tasked with the application of regulatory instruments have adopted corresponding determination in individual cases.
- *Anomaly detection* – AI-powered anomaly detection systems flag unusual patterns that may indicate violations. For instance, transitions can be analysed for detection of potential violation of anti-money laundering law or instances of tax evasion. Graph-based and deep learning approaches further enhance detection accuracy and adaptability.[114]
- *Social impacts evaluation* – AI can be used to assess the extent to which the key performance indicators aligned with a law are being met. The first key aspect to be analysed is the extent to which EU law is effective, by determining as desired the behaviour of the social actors. Moreover, the social evaluation would include an analysis of the extent to which the intended purposes of the EU legislation were achieved and the associated side effect. This requires having access to the relevant datasets and extracting from them aggregate evaluations of the achievement of the legislation's purposes (e.g., increasing occupation in certain domains, supporting certain economic activities, improving impacts on the environment).
- *Sentiment & feedback monitoring* – Natural Language Processing enables analysis of citizen complaints, news media, and social media to assess public reactions and unintended consequences of legislation.

2.6. Challenges of AI in the legislative process

The use of AI within the legislative process does not raise some of the issues we mentioned in Section 1.6, since the legislative process deals with the production of general norms, rather than of individual decisions. However, the deployment of AI in legislation raises some challenges that need to be tackled

[114] Motie and Raahemi (2024).

to ensure that AI contributes not only to the efficiency of the legislative process but also to the epistemic and democratic quality of legislation. Such risks are increased by the deployment of LLMs, which vastly enhances the prospects for the use of AI, but also augments certain risks:

- *Unexpected mistakes* – AI systems, and particularly LLMs, exhibit a brittle or jagged behaviour: they deliver amazing performance but also incur in unexpected mistakes (see in Section 0,). They have no sense of truth, and so often hallucinate or confabulate: they ``invent'' false or anyway uncontrolled information which is somehow coherent with the data to which they have had access during training or consultation. Unless their outputs are subject to critical human controls, their deployment in the legislative process may lead to serious mistakes, which may affect legislative debates and even the content of legislative provisions.
- *Undermining independent and critical thinking* – Excessive reliance on AI tools, may undermine the process of independent and critical thinking in MPs and their collaborators. If we constantly offload our mental effort to the AI, not only we may fail to apply our mental abilities where needed, but we risk losing the skill to deploy such abilities effectively. This cognitive atrophy is of particular concern for the legislative process, which requires a deep and nuanced interpretation of complex texts, the understanding of social realities and attitudes, the capacity to link normative solutions to policy goals and communal values. This risk is increased by GenAI, which synthesises, organises and expands the available information, without the users having to critically examine the original sources. Even worse, if LLMs learn to adapt to the users' political and social preference, their deployment might lead to the formation and diffusions of biased and polarised opinions, to the detriment of reasonable political compromise.
- *Accountability gaps* – Excessive reliance on AI may create an accountability gap, to the extent that AI systems would substantially write legal documents -- including legislative texts and amendments -- with minimal human intervention and without an accurate and knowledgeable control. It is true that formally the responsibility would remain with the Members of Parliament and their human collaborators, but in fact drafting and the underlying technical and political choices would be delegated, at least partially, to the machine. This would entail transferring a sovereign function to the private technology companies that develop these systems, challenging the principle that legislators are elected to exercise their own judgement and represent their constituents' values.[115]
- *Security risks* – Dependence on external AI providers, most of which are based outside the EU, may raise significant technical and security risks. This is because information could be shared with foreign entities or used to train future models without adequate oversight. The choice between on-premises installations versus cloud-based services also introduces distinct security trade-offs that require careful consideration. AI systems are also vulnerable to manipulation through adversarial attacks or prompt injections.

[115] Fitsilis et al. (2024).

- *Undue influence and manipulation* – The fact that leading AI systems are delivered by a small number of large companies (mostly located in the US and in China) increases the risks of undue influence and manipulation by such powerful actors.
- *Homogenisation and bias* – Finally, the widespread adoption of generative tools could lead to an excessive degree of homogenisation and bias. As lawmakers increasingly rely on the same few GenAI tools, their legislative outputs may become statistically homogeneous, reflecting the models' biases and linguistic patterns. This could result in a body of law that is less innovative and rife with bias. Research[116] has already shown that texts produced using LLMs and search engines tend to cluster together, with little overlap with the more diverse outcomes of human thought alone.

In conclusion, while AI may contribute to improve multiple dimensions of the legislative process, its deployment raises specific challenges. Addressing these challenges requires robust standards, quality benchmarks and frameworks for continuous ethical oversight to be established, the education of Members of Parliament and staff. Since few regulators possess the necessary expertise and resources to address these challenges independently, there is a compelling case for interinstitutional collaboration in developing standards, procedures and tools that contribute to the beneficial deployment of AI, while safeguarding the integrity of democratic systems.[117] The EU Parliament, in this context, may play a leading role, providing a model for national legislatures and other regulators. Contributions by external experts — in particular but not only, from academic backgrounds— would also be needed to ensure the technical, legal and ethical quality of the adopted solutions, and an appropriate framework for such contributions should be implemented.[118]

[116] Kosmyna et al. (2025).

[117] Fitsilis et al. (2024).

[118] Maciejewski (2018).

3. AI AND MONITORING EU LAW

KEY FINDINGS

ICT support is today a necessary condition for efficient monitoring compliance with EU Law. AI can contribute to different aspects of an ICT-based monitoring system, including the collection of data, their categorisation, their validation, their analysis and presentation in different forms.

Compliance monitoring has traditionally focused on the transposition of EU directives. AI technologies could contribute to ensuring that directives are correctly and timely implemented:

- Some pilot platforms and research projects have addressed the implementation of EU directives through national legislation, with limited and sectorial results.
- Thanks to recent progress in AI (especially in natural language processing, up to LLMs), new opportunities exist for better monitoring transposition, speeding up procedures. Among such technologies are the following: automated translation, semantic search, comparison between the directive and all of its national transpositions, generation of syntheses and documentation.
- AI could provide substantial help in improving the management of complaints, e.g., grouping similar complaints, organising them according to topics, providing structured information, implementing prioritisation criteria, drafting answers for the simplest cases to be submitted to human review.

Some pilot platforms and research projects have addressed limited and sectorial aspects of application of national rules implementing EU directives as well as the application of directly binding EU provisions (regulations), and corresponding national laws. However, recent technological developments open opportunities for AI to provide broader and deeper support with regard to different dimensions where compliance can be controlled further: regulations, judicial decisions, administrative behaviour, social behaviour.

Among the promising AI functionalities, the following can be mentioned:

- NLP (LLMs), to check for the existence and adequacy of national regulations and extracting and analysing information pertaining to judicial and administrative decisions, or also commercial practices;
- Predictive analytics, to recognise patterns of non-compliance, so that they can be timely addressed through targeted inquiries;
- Agent-based modelling, to detect and understand the impacts of legislative change, distinguishing causality from correlation;
- Process mining, to assess compliance by processing system logs from government databases;
- Sentiment and social analysis, to gauge public perceptions of regulatory instruments;
- Computer vision technologies, to process satellite and other sensors' data.

Besides support to monitoring the application of particular rules, AI could also support the respect of the principles of EU law. It could contribute to:

- the uniform interpretation of EU law, by detecting and comparing interpretations of given EU related provisions, and informing EU officers, courts and administrators on the extent to which a certain interpretation departs from other interpretations, under what aspects.
- the identification and assessment of violations of fundamental rights and principles and the preparation of reports and further initiatives, e.g., through NLP based search and information extraction tools and sentiment and social analyses.
- early warning on cases in which the principles of EU law are not respected;
- increased citizens' awareness of and involvement in legislative issues, thus promoting political participation and democratic dialogue.

In this section, we shall first introduce some basic notions relevant to monitoring the implementation of EU law. Then we shall focus on the use of ICTs to this effect.

3.1. Legal instruments

In considering the possible uses of AI, we need to take into account the key distinction between the two main kinds of instruments for EU legislation: directives and regulations.

A directive is "binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods" (Art. 288 TFEU). Thus, compliance with directives is a two-step process. The first step is *transposition*: each Member State should transfer the content of the directive into its legal system, by enacting national laws that fully implement the requirements of the directive. Second, the Member States' judicial and administrative authorities must apply consistently the enacted national laws, so that the goals of the directive are fully achieved. Both steps (transposition and application) need to be monitored, to track compliance.

A regulation has "general application" and "is binding in its entirety and is directly applicable in all Member States". Thus, compliance with a regulation requires that national authorities actively and correctly apply the regulation's provisions, to fully achieve the goals of the regulation.

In recent European legislation, regulations are playing an increasingly significant role, both quantitatively and qualitatively (they play a dominant role, for instance, in the digital domain).[119] Thus, the traditional focus on the transposition of directives by national legislatures (as the key aspect of compliance) needs to be complemented by increasing attention to the application of law by judges and public administration, and on the behaviour of the addressees of legislation.

A further aspect to be considered, which goes beyond single directives or regulations, pertains to the principle of *consistent interpretation*, according to which national legislation has to be interpreted in

[119] See Xantaki (2025).

ways that are consistent with EU law. We need to consider whether AI can provide some help in this regard.

Finally, we shall shortly consider whether AI may contribute also to detect instances in which the non-compliance does not (only) concern the failure to implement specific provisions of EU law, but rather it pertains to the failure to respect the fundamental rights and principles of EU law.

Before moving into an analysis of monitoring compliance, it is important to stress the need to adopt a holistic perspective, since the effectiveness of compliance monitoring is also affected by other aspects of the legislative process. First of all, we may consider the complexity and unclarity of EU law, which includes an ever-growing number of texts, whose length is also expanding, and whose terminology is disconnected from the national legal systems. Improving the legislative quality of such texts and reducing their verbosity could contribute to facilitating compliance and thus also to monitoring compliance.[120] It has also been argued that the monitoring of compliance could profit by greater involvement of citizens, which could be facilitated by granting them clear procedural and substantive rights and facilitating their participation in the enforcement process through incentives and administrative and technological affordances. We agree with these observations (see Section 2.4 for some considerations on the use of AI in drafting and in interactions with stakeholders). However, they are beyond the scope of the present report, where we will focus on the deployment of AI in the context given by existing regulatory frameworks and practices.

3.1.1. The concept of monitoring

For the concept of monitoring, we may refer to the Better Regulation Toolbox 2023, which addresses monitoring under tool #43[121]. Monitoring is there characterised as follows:

> Monitoring is a continuous and organised process of systematic data collection (or access) throughout the life cycle of an initiative to oversee its progress. Monitoring is necessary to generate information that feeds into future evaluation and impact assessments and to provide a solid evidence base for policymaking. Monitoring generally involves tracking progress with respect to previously identified targets or objectives.

In the same document, somehow inconsistently, monitoring a (legislative) initiative is characterised both as "an integral part" of the evaluation of the initiative, and a complement to the evaluation (so that monitoring is both a part of the evaluation, and is outside of it, being complementary to it). To stress the distinction between monitoring and evaluation, is it claimed that

> The evaluation entails a more encompassing and in-depth retrospective assessment of whether the initiative actually achieved its objectives and how. Evaluation also assesses whether the objectives have been met efficiently (i.e. at least cost), as well as the reasons for its success or

[120] See Xantaki (2025).

[121] European Commission https://commission.europa.eu/law/law-making-process/better-regulation/better-regulation-guidelines-and-toolboxen

otherwise. Evaluation also captures the causality between the effects and the evaluated initiative, which is not the case for monitoring.

Possibly we could settle the relation between monitoring and evaluation, by saying that monitoring is not limited to collecting data (e.g., administrative decisions) but also includes analysing and aggregating such data (e.g., quantify whether and how a certain provision was applied in such decisions), to obtain an assessment of the extent to which certain indicators were satisfied. Thus, monitoring may be viewed as an important phase or aspect of the evaluation (broadly understood), which precedes and complements further analyses and reflections.[122] With regard to the object of monitoring, we only focus on compliance, namely on the extent to which the behaviour of the actors concerned — legislators, judges, administrative authorities, and private actors— respects EU law. Thus, we do not consider the possible use of AI for monitoring the extent to which compliance with the EU law delivers further expected socio-economic results (e.g., level of economic activity, pollution levels, consumption, innovation, etc.).

3.1.2. The monitoring process

Monitoring compliance provides the critical input for processes aimed at remedying failures to implement EU law, and, if needed, to sanction violations. A formal procedure for enforcing Member State's obligations is established by Art. 258 and 260 TFEU. The main steps are the following. First, the Commission delivers a reasoned opinion to the allegedly infringing State, who may submit its observations; following the State's non-compliance with the opinion, the Commission may bring the matter to the Court of Justice, who may order the infringing State to take the measures needed to achieve compliance. Finally, if these measures have not been adopted, the Commission may again deliver a reasoned opinion to the State, who may submit its observations; following the State's non-compliance with this opinion, the Commission may ask the Court of Justice to sanction the State.

Alternative or complementary processes are also available such as the EU Pilot mechanism and high-level bilateral meeting between the Commission and the Member States. The smart enforcement approach adopted by the Commission focuses on prevention and on gradual-informal pressures aimed at achieving compliance. A central aspect of it consists in setting up a dialogue with the concerned Member State, in order to find consensual solutions: for such a dialogue to be productive, exchanges of information and evidence-based analyses are needed, so that appropriate measures can be agreed upon.[123] The Commission has also committed to capacity building in Member States, by working in partnership with national authorities through various sectorial networks, by ensuring that independent authorities or inspectorates required by EU legislation are adequately empowered and equipped, and by supporting judicial reforms and training.

Every year the Commission publishes a report on 'Monitoring the application of European Union Law', on which the Parliament adopts an opinion. Critiques by the Parliament consistently address issues

[122] This is just a terminological arrangement. It might also be possible to reserve the term "evaluation" for these further analyses.

[123] See Ballesteros (2015).

such as the lack of transparency on the enforcement activities by the Commission, the need to improve and merge digital resources and to speed-up the processing, in particular when processing complaints and petitions.[124]

The European Court of Auditors (ECA), in her recent report,[125] has concluded that while the Commission has improved its management to detect and correct infringements of EU law, it still takes too long to close infringement cases and that in some cases the threat of sanctions does not lead to compliance. It also observed that the current model is reactive, primarily triggered by complaints or missed deadlines. Moreover, these initial triggers, particularly public complaints, are processed with relevant delays, so that early warnings of systemic non-compliance are often missed.

Error! Reference source not found.[126] summarises the key performance indicators from the ECA's 2024 report, starkly illustrating the gap between the Commission's targets and its actual performance.

Table 1: The EU Enforcement Deficit in Numbers

Metric	Benchmark/Target	2023 Performance/Finding
Infringement Cases (Failure to Notify) Resolution	1 Year	72% of cases exceeded the target in 2023.
EU Pilot Dialogue Resolution	N/A (Informal)	28.4 months average handling time in 2023.
Public Complaint Handling	1 Year	38% of cases exceeded the target (2012-2023).
Persistent Non-Compliance	N/A	Documented cases of non-compliance despite years of penalties.

To address this situation, the Court of Auditors recommends that case handling should be analysed to identify and address bottlenecks. The management of complaints, petitions and EU Pilot dialogue should be sped up, and appropriate information on their processing (including prioritisation criteria) should be provided to the relevant stakeholder, to increase transparency.

[124] For a critical discuss of the Commission's report, see McGuire and Schulte-Noelke (2025).

[125] From the European Court of Auditors. https://www.eca.europa.eu/en/publications?ref=SR-2024-28

[126] Ibid.

3.2. ICTs for monitoring the implementation of the EU law

ICTs support is today a necessary condition for efficient monitoring. The Better Regulation Toolbox, at tool #43 affirms indeed that a monitoring system could benefit from IT support, which could contribute to the following:

- cataloguing data collection requirements (frequency of data provision, actors, etc.);
- collecting or harvesting data;
- data storing;
- data quality assurance, including (automatic) validation;
- data processing and analysis;
- database interoperability;
- data visualising, sharing and disseminating results;
- data access and discovery (for example by making available metadata or referencing collected data on data.europa.eu).

AI has become a crucial element of this digital infrastructure. It can contribute to different aspects of the functioning of a monitoring system, including the collection of data, their categorisation, their validations, their analysis and presentation in different forms.

In the following, we shall focus on the use of AI for monitoring compliance with EU law, developing the general consideration we presented in Section 3.2. As noted above, the whole AI and law domain is going through a rapid evolution because of the breakthroughs provided by LLMs and other novel AI technologies. Therefore, while mentioning some existing applications (which only provide limited solutions), we will focus on novel opportunities, to be pursued in the near future.

3.3. AI and the Transposition of Directives

As noted above, compliance monitoring has traditionally focused on the transposition of EU directives. Here the core challenge is to evaluate *semantic and legal equivalence*, between the obligations stated in the directives and national legal system, i.e., to verify to what extent a national legal system includes all legal arrangements needed for the full implementation of the directive's obligations.

This is a domain where there is a vivid contrast between what is available today and what may be delivered in the close future. The AI tools proposed by AI & law research to assess transpositions only offer a limited support in specific domains of the law and are still to be tested in real-life contexts. However, we think that the recent advances in natural language processing, including the recent development through LLMs, offer great opportunities. Thus, while mentioning currently available systems, we shall focus on open potentialities.

3.3.1. Existing AI Tools

Some pilot platforms and research projects have addressed the implementation of EU directives through national legislation.

In particular within the FACILEX project an experimental pipeline has been developed to quantify the extent to which an EU Member State has transposed EU directives into its legislation.[127] The process starts with a pre-processing phase, during which European and national legislative segments are subjected to cleaning and normalisation to ensure consistent text formatting. This step is followed by the generation of semantic graphs and word embeddings (e.g. based on the LEGAL-BERT approach)[128]. Finally, a harmonisation metric is computed between the European legislative segments and their corresponding national transpositions, quantifying the alignment level within the dataset.

The idea of automatically checking transposition is also indicated as one of the goals of the **Augmented LEOS**[129] (Legislation Editing Open Software) initiative, which aims to create a drafting ecosystem including AI-powered *smart functionalities*. LEOS is an open-source web-based tool supported by the European Commission. It builds upon standards like the Akoma Ntoso[130] for capturing the structure of regulatory documents and relies on ontologies and other semantic web technologies for retrieval and drafting support. LEOS also aims to make use of NLP technologies, in particular for detecting obligations, rights, permissions, and penalties in legal texts. Currently, as far as we know, these detection functionalities have been implemented only to a limited extent. Beyond this, there is the project to augment LEOS with a broader set of NLP-based smart functionalities, including automatic classification of provisions, terminology and consistency checks, entity recognition and linking to authoritative sources, cross-referencing and citation verification, as well as summarisation and comparative text analysis for transposition support.[131]

The *"Ask the Archives"*[132] chatbot is a publicly accessible GenAI service, meant to enable European Union staff and citizens to search the European Parliament's historical archives (1952–1994) using natural language queries. The chatbot uses a RAG architecture and the Amazon Bedrock service to access an index of over 100,000 archival documents, generating answers with the Claude model from Anthropic. This application demonstrates how AI technologies can help in extracting information from large data sets. By applying such technologies to national legal databases, administrative data, and further data sources, information relevant to the implementation of EU law could be similarly extracted.

THEMIS (the Tool for Harmonised European Monitoring and Information System)[133], is a communication and workflow platform, meant to manage the process of implementation and monitoring of EU-Law end-to-end. It will provide for the following services to support the exchange of information between Member States and the Commission during the phase of implementation of European legislation and in case of infringement proceedings:

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127 Audrito et al. (2024).

128 Chalkidis et al. (2020).

129 LEOS - Open-Source software for editing legislation. LEOS - Open-Source software for editing legislation | Interoperable Europe Portal.

130 Vitali and Palmirani (2019).

131 Overview of smart functionalities in drafting legislation in LEOS. https://interoperable-europe.ec.europa.eu/sites/default/files/document/2024-06/Augmented%20LEOS%20with%20smart%20functionalities%20final%20report.pdf.

132 See https://archidash.europarl.europa.eu/ep-archives-anonymous-dashboard.

133 See https://interoperable-europe.ec.europa.eu/interoperable-europe/themis.

- notification of national measures of execution for the transposition of directives;
- correspondence between the Commission and the Member States before launching an infringement procedure (EU Pilot);
- communication of replies and requests for prolongation of the deadlines to infringement decisions.

THEMIS relies on structured data, notifications and predefined workflows to manage the transposition of EU directives. Integrating AI through NLP for the automated comparison of EU and national legislation, machine learning to predict infringement risks and semantic search to enable more efficient legal research would greatly enhance the platform's capabilities. AI-driven functionalities such as structured summaries, obligation tracking, and consistency checks would transform THEMIS from an administrative tool into a proactive system that supports compliance. This would enable the faster and more accurate application of EU law, thereby improving harmonisation across Member States.

GPT@JRC is a project developed at the Joint Research Center under the Commission ICT Governance Framework. It provides a secure platform for staff to access and experiment with Large Language Models (LLMs), in order to study the risks and opportunities of using Generative AI, identify key policy support use cases and build user-driven guidance, cooperate with AI practitioners (through API provision) on scientific research on/with AI, contribute to the Artificial Intelligence in the European Commission (AI@EC) network and engage with similar initiatives at corporate level.

3.3.2. Future Prospects

Given the recent progress in AI (especially in natural language processing, up to LLMs), new opportunities exist for better monitoring the transposition of EU Directive, such as the following:

- Automated translation may facilitate comparing transpositions in different Member States.
- Semantic search may facilitate retrieving national provisions linked to the implementation of the directive.
- Comparison of the directive and all its national transpositions can facilitate the identification of good and bad examples, suggest possible solutions and identify misalignments.
- The generation of focused summaries of the relevant legal texts can facilitate the work of human analysts.
- Correlation matrices can be produced, conceptual alignment and gaps can be detected, and transposition coverage can be visualised.

Better performance can often be obtained by combining a general LLM model with legal information that is suitable for this task, for instance by relying on Research Augmented Generation (RAG), as noted in Section 1.3. Experiments are needed to verify to what extent LLMs, supplemented with specific legal information, can be guided by appropriate extensive prompts into delivering the useful outputs, and how this can be improved by providing them with examples and other texts.

We are aware that the use of LLMs raises certain serious issues: LLMs are opaque, and subject to hallucination and unexpected mistakes. Moreover, most leading models are provided by a few US and Chinese companies. To address such worries, LLMs should be used with care: available techniques should be used to obtain explanations, possibly by the LLM itself (see above Section 1.3 on step-by-step reasoning and other prompting methods), and in any case outcomes should subject to accurate controls by expert lawyers and administrators. The possibility should be also be investigated to complement LLMs with semantic-web technologies, whenever appropriate machine-readable information (expressed according to standards) is available or where human tagging is meaningful and sustainable (See Table 2).

Table 2: Summary of AI Contribution to Monitoring Transposition

Task / Problem	**AI Method / Technique**	**Potential Applications**	**Key Challenges**	**References**
Semantic Similarity & Custom Metrics	Transformer-based (e.g., BERT, LLMs) and Statistical Similarity Metrics.	Compare directive and national implementation measure provisions, measure textual similarity to create correlation matrices, identify conceptual gaps, and visualising transposition coverage.	Distinguishing legal meanings from simple lexical similarity, opacity and hallucinations	Audrito et al (2024);
Knowledge Representation, Semantic web technologies	Legal Ontologies and Knowledge Graphs, Augmented LEOS Ecosystem (Akoma Ntoso, LegalRuleML + NLP tools	Map legal concepts, create structured, machine-readable representations of legal acts automate checking logical consistency.	High upfront cost and the expertise to build and maintain texts augmented with machine-readable information and ontologies	Palmirani et al (2024) LEOS - Open-Source software

3.4. AI for Monitoring the Application of Directly Binding Provisions

In this section, we shall consider the monitoring activity aimed to assess the extent to which EU relevant binding legal rules are correctly applied and respected. This applies to a diverse set of EU-related provisions:

- National rules implementing EU directives;
- Binding EU provisions (regulations), and further national laws dealing with their application.

It has been observed that the sheer quantity of EU related provisions to be applied and enforced at a national level makes it challenging not only to apply and enforce such provisions, but also to monitor the ways in which this happens. Various national authorities are tasked with the implementation of EU-related provisions, according to different norms, and these authorities may have different legal competences and levels of capacities and resources. In the resulting enforcement jungle,[134] the practical effectiveness of the law can vary considerably. This context suggests using AI tools to obtain more scalable, evidence-based pictures of the real-world impact of EU law.

Monitoring the national applications involves addressing the following layers:

- implementing rules,
- judicial decisions,
- administrative procedures,
- social behaviour by final addressees, both physical and legal persons.

Layers from the second to the fourth bullet point address the norm-governed behaviour of social actors. Thus, such layers may rely on approaches based on computational social science.[135]

3.4.1. Implementing rules

The first layer pertains to the enactment of further rules implementing higher level norms, by providing substantive or procedural specifications. Such rules may be established by competent national authorities, or by private standardisation bodies, possibly with inputs and controls by public bodies. We shall not specifically consider here the use of AI technologies to monitor the existence of implementing rules, or assess their adequacy, since we have already addressed these aspects in Section 3.3 (with regard to checking the implementation of directives).

3.4.2. Judicial decisions

The monitoring of judicial decision making (layer 2) presupposes having access to judicial decisions in all Member States, to identify decisions dealing with EU-related provisions, detect trends, assess coherence and incoherence. Advances in natural language processing could greatly facilitate information sharing and institutional dialogue across different legal systems and national languages, thus contributing to identification and resolution of relevant issues.

[134] Demkova and De Gregorio (2025).

[135] El-Sayed (2024).

3.4.3. Administrative action

We could not find operational applications aimed at monitoring the implementation of EU law through national administrations, though several methodologies are suggested.[136]

First of all, NLP could be applied to analyse large sets of administrative decisions detecting trends, commonalities and differences. The AI technologies suitable for this task are similar to those applicable to the analysis of the case law.

Another proposed methodology is *predictive analytics*, as applied to "predictive (non) compliance". In certain regulatory domains, such as finance and tax, AI models have learnt from historical data to identify probable non-compliance or predict potential future breaches. After being trained on historical and real-time data, these systems can recognise patterns indicating a heightened risk of future non-compliance.

Similarly, ML technologies can be applied on inspection and fining records to predict under-enforcement of EU-related norms.[137] If data shows, for example, that environmental targets are regularly missed, predictive analytics could identify risk factors pointing to specific industries, geographic or social aspects. This would allow enforcement resources to be targeted more effectively. Although predictive analytics is mostly used in financial contexts (such as for detecting tax fraud), this risk-based approach is applicable more broadly.

Agent-based modelling can be used to simulate the actions and interactions of autonomous agents and observe the emerging systemic patterns.[138] This approach may enable detecting and understanding the effect of legislative changes or of changes in legislative practice. In particular agent-based modelling can enable distinguishing causality from mere correlations, as it is possible to intervene in the simulation by making changes in the input parameters to see the resulting outcomes. In the context of policy evaluation, for example, agent-based modelling can simulate the potential impact of new legislative norms or new administrative or judicial practices. For example, it was used to evaluate interventions for countering radicalisation. [139]

Two other methodologies proposed in the literature are process mining and sentiment analysis. *Process mining* involves analysing event logs from government databases, such as permit applications or decision logs, to verify compliance with mandated procedures and detect operational bottlenecks. This technique has been suggested for use in compliance verification pathways in public procurement law, for example.[140]

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[136] For example, Cejas et al. (2023) proposes using NLP to check compliance with GDPR frameworks. Meanwhile, Savelka et al. (2021) demonstrate the transferability of multilingual legal NLP models across jurisdictions for cross-border applicability.

[137] Jain et al. (2024).

[138] Weisburd et al. (2024).

[139] In EU-funded Horizon 2020 project PROTON: https://www.transcrime.it/en/stories/proton-project/

[140] Audrito et al (2024).

3.4.4. Social behaviour

AI-powered *sentiment and social analysis* can process unstructured text from news articles and social media. While not a direct measure of legal compliance, this functionality gauges public perception of a law's impact and can act as a valuable *early warning system* by highlighting implementation issues before they emerge through formal channels.

Finally, if data on regulated activities by physical and legal persons are available, it is possible to measure the extent to which crucial provisions are complied with. This is facilitated where the outcomes of regulated behaviour are available online, so that compliance with binding legislative standards (provisions on unfair contractual terms and information to be provided to data subjected) can be automatically checked. Monitoring compliance can also be viewed as a side-effect, or an additional functionality of systems developed for different purposes.

Moving from the digital domain into the physical domain, we may consider the deployment of computer vision technology to analyse satellite imagery or public camera data to monitor infrastructure or track environmental changes, aiding in the enforcement of environmental regulations. Inquiries meant to identify and categorise instances of non-compliance can profit from predictive analytics, to analyse historical and real-time data to identify patterns that indicate a heightened risk of future non-compliance, such as in detecting tax fraud.[141]

3.4.5. Some existing tools

The possibility of using AI for monitoring the application of AI law, according to some of the approaches just described, can be confirmed by some tools already existing or being currently developed:

- Some AI systems are used for assessing compliance with EU regulations like the Anti-Money Laundering Directives (AMLD), performing real-time transaction monitoring and automated reporting.
- Some AI systems exploit data available online to monitor compliance with EU legislation, such as GDPR
- The Copernicus programme uses AI to analyse satellite and sensor data for enforcing environmental rules.
- Various AI tools exist to analyse platform-provided data to assess risk and mitigation measures, e.g., with regard to disinformation.

Table 3 lists the main methods that can be used for monitoring compliance, specifying corresponding requirements and potentials.

[141] See Wendehorst and Duller (2021).

Table 3: Summary of AI methods for monitoring compliance

AI Methodology	Data Requirements	Potential for Monitoring
Machine Learning on Judicial/Administrative Data	Large databases of national court cases or administrative records	Assessing consistency of interpretation; identifying patterns in judicial/administrative behaviour.
Agent-Based Modelling (ABM)	Socio-economic statistics; demographic data for model validation	Evaluating *ex-post* effectiveness, examining ex-ante possible changes
Sentiment Analysis / Social Media Monitoring	Publicly available data from news media, social media platforms, and online forums	Gauging public and stakeholder perception, providing an early warning system
Process Mining	Government event logs from digitised administrative processes (Review 2).	Checking if mandated procedures are followed; detecting bottlenecks and inefficiencies.
Predictive Analytics / Risk Scoring	Violation statistics; historical enforcement data, **transaction monitoring** (e.g., predictive policing, money laundering, market abuses, tax frauds))	Predicting regulatory breaches to allocate resources; optimising inspections
Computer Vision / Remote Sensing	Geographic data, Satellite collection	Assessing implementation of Agricultural Policy, and environmental laws
Analysis of online data and platforms	Access to data available online, and collected by platforms	Assessing implementation of digital regulations

3.4.6. Claudette for compliance

As an example of using AI for checking compliance, we can mention the Claudette software.[142] As noted above, Claudette was originally developed with the goal of supporting individual consumers and data subjects in assessing the legality and fairness of contracts and privacy policies. However, the same software has also been used to assess compliance with EU law provisions on unfair contractual clauses and on information duties toward data subjects. For this purpose, Claudette has been run over a sufficiently large datasets or terms of services and privacy policies, to identify and classify instances of non-compliance. By collecting and organising the data provided by Claudette, an assessment could be made of the extent of compliance with the relevant provisions, in different business domains.

3.5. AI for a Principled Approach to EU Law

In this section, we shall succinctly consider the prospect of using AI to support a principled approach to the application of EU law, i.e., relatively to consistency in interpretation and respect of fundamental rights and principles.

3.5.1. AI for Consistent Interpretation

That EU law should be consistently interpreted across the EU Member States is a key goal whose achievement of which is entrusted to the EU Court of Justice (at the highest level), but also to the cooperative dialogue between EU institutions and Courts and administrative authorities of all Member States. Given this institutional background, and the limitation currently faced by the best-performing LLMs, AI could not substitute the role of humans as interpreters and assessors, but it could provide useful assistance. The AI contribution could consist first of all in identifying the different interpretations that are currently given to certain provisions of EU law in judicial and administrative practice, in eliciting commonalities and differences, and in ranking the interpretations according to their fit with EU law (in particular the case law of the Court of Justice).

There is, to the best of our knowledge, no tool already available which can achieve this goal, i.e., analyse thousands of national court rulings to determine to what extent and in what cases judicial interpretation is converging or rather diverging across Member States.[143] However, the recent development in automated translation and in natural language processing (in particular though LLMs) provides an unprecedented opportunity for technological support. An LLM find-tuned on the relevant EU legislation, or maybe just supported by an expanded RAG and having access to all national and EU legislation and case law could indeed engage in detecting and comparing all interpretations of given EU related provisions. This could provide useful information to all actors tasked with the application of EU law, who will have to decide, according to their institutional role, and the importance they assign to the value of consistency (in comparison to the substantive values to which a divergent interpretation may contribute), how to interpret the provisions at stake.

[142] Lippi et al. (2019).

[143] Ferrod et al. (2023).

3.5.2. AI for the Respect of EU Fundamental Rights and Principles

Compliance with the EU law goes beyond compliance with specific rules in EU legal instruments, it also includes respecting the fundamental rights and principles of the EU legal system. Determining the extent to which a national legal system respects such rights and principles is not an assessment to be delegated to any AI technologies. This assessment requires indeed understanding the human and social meaning of such rights and principles, the role they play in individual and communal life, and the extent to which they may be affected by different public measures and private activities.

However, we submit that AI could contribute to this goal by supporting the identification and assessment of violations of fundamental rights and principles and providing useful materials for the preparation of reports (such as the Commission Report on the Rule of law and corresponding country chapters).[144] NLP based search and information extraction tools (including LLMs guided by appropriate prompts and supported by RAG) could support the extraction, analysis, organisation and synthesis of the relevant information to be found in administrative documents, journals, and any kind of online documents and database. Sentiment and social analysis could also be used to detect public perceptions of the extent to which EU legal principles are respected or rather disregarded and violated.

AI could also contribute to the detection of instances in which EU legal principles are at risk. Consider, for instance, the use of spyware to unduly interfere with the activities of political opponents, journalists and commons citizens, as in the infamous Pegasus case[145]. The early identification of such problematic cases, by the analysis and organisation of all available information in public sources, may enable EU institutions and the relevant stakeholders to take timely actions.

The effective use of AI tools by citizens and NGOs could also more generally contribute to increasing their awareness of and involvement in legislative issues, thus promoting political participation and democratic dialogue. By providing citizens with targeted information on their rights, their infringements and possible legal and other responses, and supporting them in taking appropriate actions, AI could contribute to the effective implementation of EU law.[146]

144 https://commission.europa.eu/publications/2025-rule-law-report-communication-and-country-chaptersen.

145 Sartor (2022b), Mildebrath (2024).

146 See Drake and Bosangit (2025).

4. RECOMMENDATIONS AND CONCLUSION

As noted above, this report addresses a shifting landscape characterised by the tension between the paucity of AI applications for monitoring EU law (and more generally, the implementation of legislation) and the apparently great opportunities provided by recent breakthroughs (in particular through LLMs).

In this context only tentative proposals can be formulated based on an experimental attitude:

- EU institutions should test novel AI solutions for monitoring the implementation of EU law. They should engage with novel AI approaches (such as LLMs complemented with RAG), to assess whether they may improve efficiency and accuracy in identifying instances of non-compliance and enable timely responses to complaints and proactive solutions to emerging issues.
- Hybrid solutions, combining the power of LLMs with human generated and understandable knowledge, may provide appropriate solutions in some domains, improving controllability, transparency and integration with existing applications.
- AI-support to monitoring should apply to the transposition of directives, but also to regulations and national implementing acts, judicial decision-making, administrative practice and the behaviour of the final addressees (physical and legal persons).
- AI systems used to monitor EU law should provide explanations that are legally significant, whenever this is relevant and technologically possible. This means they must justify their conclusions by citing specific legal articles and evidence in a way that humans can understand. Equally essential is robust controllability, which can be achieved through hybrid AI architectures and rigorous, domain-specific testing protocols that include adversarial challenges to ensure reliability.
- Monitoring is going to be more effective if AI technologies also support other aspects of the EU regulation process, such as drafting and pre-enactment impact assessment. AI-supported drafting could facilitate the preparation of more concise, and comprehensible, texts, better integrated with the acquis and with national legislation. This could enable more coherent interpretations and applications, reduce non-compliance and so facilitate compliance checking. Similarly, AI-supported pre-enactment assessments may enable the proactive identification of formal and substantive issues that may hinder compliance, even from honest and well-disposed addressees.
- AI-supported monitoring requires availability of adequate data. Thus, it is important that strategies for data collection and access are established and defined since the enactment of a new legislative instrument. This includes easy access to textual documents being produced during the implementation process, to structured data from administrative datasets, and even to system logs where needed (to the extent that this is compatible with data protection and other legal requirements).
- Human oversight, assessment and reviews of any automated evaluation should be ensured, given the limitations, potential for error, and the opacity of the technologies most suitable to

address crucial aspects of monitoring. Any deployment of AI in monitoring should be compliant with the relevant EU law, such as GDPR and the AI Act.

- Given the importance of AI for effectively monitoring the implementation of legislation, choices concerning its adoption and usage should not be left only to the executive branch, but should be shared with the EU Parliament. An important role in the effective and efficient deployment of AI may be played by a permanent Working Group on Better Law-Making and Artificial Intelligence, to ensure a more active and persistent critical involvement by the Parliament.
- As the deployment of AI in monitoring involves novel technologies and requires an experimental approach, adequate AI skills must be made available within the EU and national institutions, in particular within the EU Parliament.
- Academia can play a pivotal role in the development, assessment and deployment of AI systems for monitoring the implementation of EU law. EU institutions should foster strong collaborations with the research community to promote innovation and ensure that best practices are adopted.

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This report, commissioned by the European Parliament's Policy Department for Justice, Civil Liberties and Institutional Affairs at the request of the JURI Committee, examines the use of AI techniques to support monitoring the application of EU Law. First an overview is provided of the state-of-the-art AI solutions used in application of law. Then AI applications in the legislative process are considered, from pre-enactment information analysis, impact forecasting and public engagement, to drafting support and monitoring impacts and compliance. AI in monitoring the implementation of EU law is then analysed, considering both existing application and prospects for new AI technologies. First the transposition of directives is considered. The application of binding provisions is then addressed, having regard to implementing rules, judicial decisions, administrative action, and social behaviour. Finally potential contributions of AI to a principled approach to EU law is examined, for consistent interpretation and the respect of fundamental rights and principles. Recommendations are finally proposed on using AI to make monitoring more accurate and efficient.

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