Legal Drafting in the Era of Artificial Intelligence and Digitisation

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SUMMARY

EXECUTIVE SUMMARY

The study explored and demonstrated the potential of the use of innovative/advanced IT (including AI) to substantially improve the core business of the Commission, i.e., drafting legislation and developing policy. It identifies a concrete roadmap for harnessing digital change in the drafting of legislation.

The vision that emerges centres around a paradigm shift enabled by the combination of advances in IT (Artificial Intelligence, Machine Learning, Natural Language Processing, etc.), the use of standards, and progress made in understanding the theory and practice of law making. A well-integrated IT ecosystem with an 'Augmented LEOS' at its core has the potential to digitally transform legislative processes and facilitate a structural change with a significant positive impact on quality, efficiency, and transparency.

The study's findings provide a solid basis for kick-starting follow-up initiatives.

Key takeaways

A well-integrated IT ecosystem with an 'Augmented LEOS' at its core has the potential to digitally transform legislative processes with a significant impact on quality, efficiency, and transparency.

The study confirms this potential and provides a solid basis on which to further explore the domain and to consider more pilots at a larger scale.

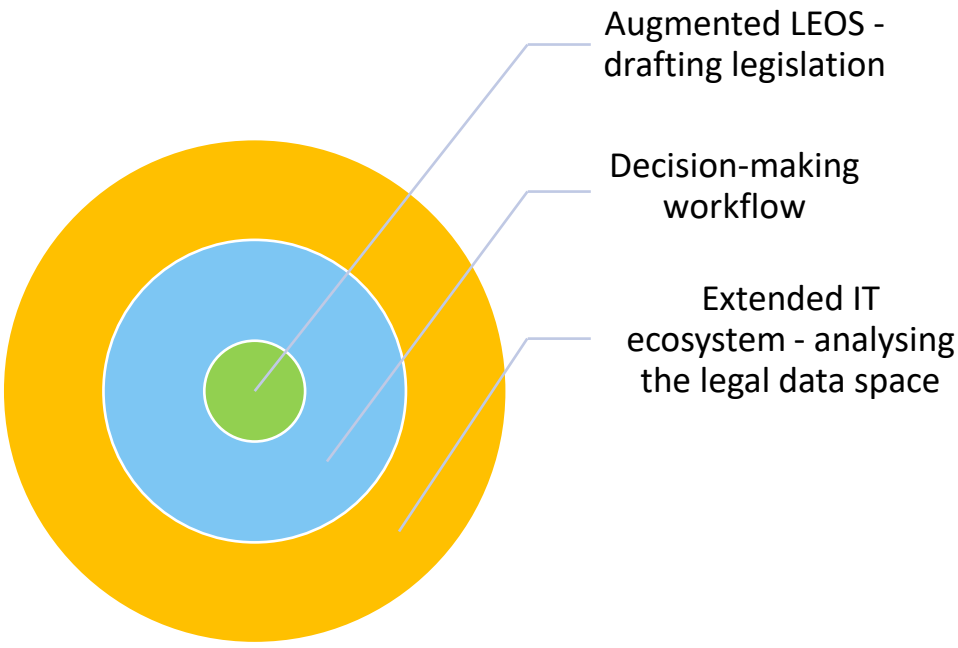

Figure 1 - Goals of the report.

An inquiry into drafting legislation in the era of Artificial Intelligence covers a vast domain. This study, in particular, includes an in-depth survey of the literature in the emerging field of '**LegalTech'**; it illustrates the potential of 'LegalTech' by piloting four concrete use cases; it identifies 'smart' functionalities that could facilitate and improve the work of legal drafters and policymakers; it presents a brief discussion of potential roadblocks, along with ways to overcome these; and it gives an initial indication of how to proceed in case a decision is taken to proceed with full-scale implementation.

The understanding this study offers relates, among other things, to the use of standards such as AKN4EU[1], the value that innovative IT can bring, the richness of knowledge that can be extracted from the legal data stored in, e.g., EUR-LEX[1], and the transformative power brought about by the concept of machine-processable law.

What follows is a high-level schematic summary of the scope of the study and the topics covered.

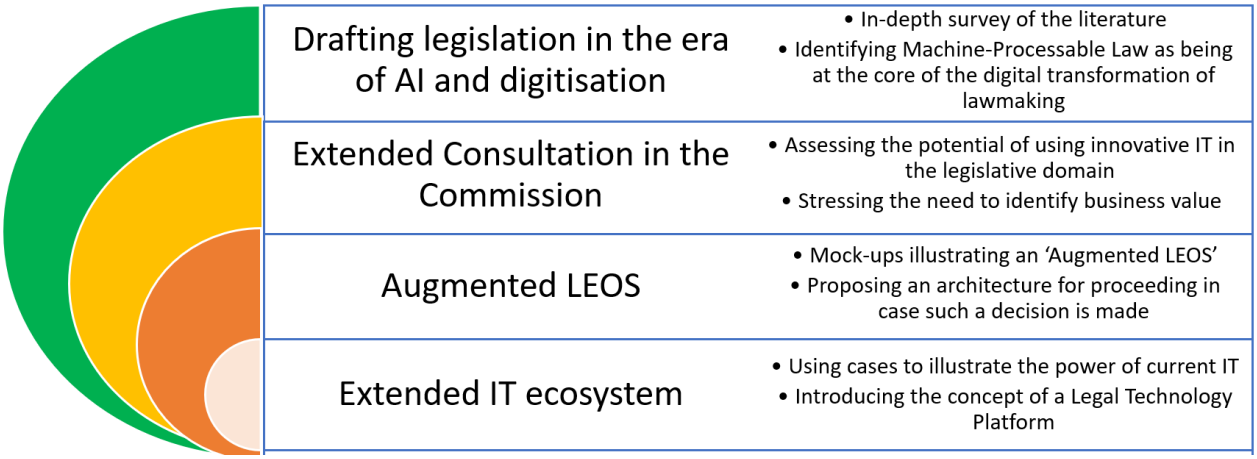

Figure 2 - Steps.

The 'LegalTech' landscape that emerges draws on (i) advances in IT, (ii) progress in the study of the theory of law, (iii) the use of standards, (iv) understanding the business of law-making, and (v) the recognition of the need to consider the broader ethical and legal implications early on. At the centre is a hybrid AI approach for human oversight.

The study advocates creating a solid theoretical framework of models for the concept of 'Law *as* Code' (rather than 'Law *is* Code') or, better yet, 'Law as Platform'. The framework needs to be compatible with constitutional law (flexibility, legitimacy, enforceability), the theory of law (hermeneutics), and democratic systems (separation of powers) and be based on different disciplines, including philosophy of law, legal informatics, and computational linguistics, thus fostering a plurality of perspectives for modelling a new vision.

Outlined below are the technology landscape and the components that constitute the building blocks of this 'LegalTech' landscape.

The study provides a comprehensive overview of the commercial availability of these technology components, while looking at what is available at open-source technology.

The study examined in detail the application of AI in drafting legislation. Some 30 concrete smart functionalities were identified. These are grouped into three broad categories: (i) legal drafting support, (17 smart functionalities), (ii) AI for legal consistency and better regulation (6 smart functionalities), and (iii) legal systems analytics (10 smart functionalities). The study illustrates the feasibility of implementing these functionalities: it does so by providing several mocks-up and suggesting an architecture for an 'Augmented LEOS'. However, before we can consider how to implement these functionalities, we need a detailed assessment of 'value for money'. Although the limited time and resources available did not allow us to go to the depth needed to work through all the implications of these investments decisions, the study does lay out the groundwork, offering a solid basis on which to make these kinds of assessments.

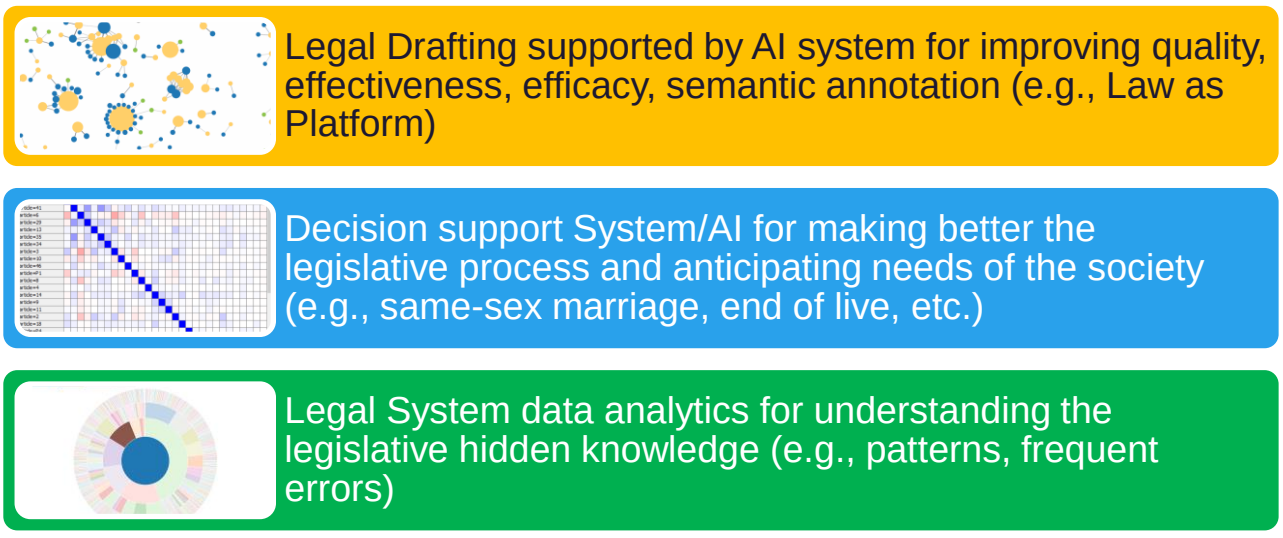

Figure 3 – Different applications of AI in Legislative domain.

The study piloted four use cases on (i) learning from corrigenda, (ii) verifying the transposition of EU law by a Member State at the click of a mouse, (iii) which derogations and transitory provisions apply in this case, and (iv) assessing digital readiness. The research on the pilots is concerned with defining a methodology, preparing a dataset (extensive use is made of EUR-LEX), selecting and applying available IT tools (with a specific emphasis on visualisation), and preliminarily analysing results. The results clearly

demonstrate the power of the application of hybrid AI, the need for human oversight, and, e.g., the use of visualisation tools. Furthermore, the study identifies the insights learned from these pilots to improve the drafting of legislation.

The study identifies several important roadblocks, while also proposing mitigating actions. The roadblocks are not necessarily specific, though it looks at (i) the application domain of law-making and (ii) the use of novel IT, including AI calls for a greater alertness to ethics, and (iii) it draws attention to the need for consultation and communication all through the process.

Figure 4 - Interdisciplinary grounds.

To proceed 'at scale' in the various directions explored in the study, a number of essential preconditions will need to be fulfilled. These preconditions include (i) ensuring management engagement on the direction of travel, (ii) obtaining buy-in from all, including a willingness to change, and (iii) strengthening partnerships in and beyond the Commission. For more details see below.

Figure 5 - Strategy dimensions.

Achieving these preconditions will make it necessary to elaborate and implement a comprehensive action plan. Such an action plan should at least include (i) laying out a detailed communication plan, (ii) defining further work on additional pilots close to the business, and (iii) setting up a team to move the agenda forward. For more details see below.

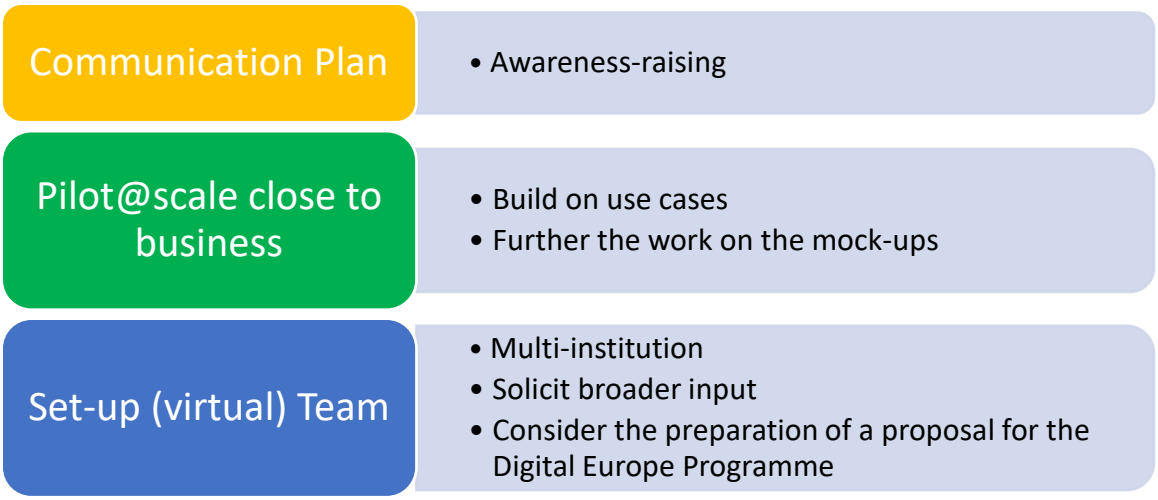

Figure 6 - Dissemination goals.

One of the main tasks of the team would be to draw up detailed roadmaps as set out in the study report.

PART I: SCOPE OF THE STUDY AND EXECUTION

1. Introduction

The study got underway at the start of 2021. The contract was awarded to the University of Bologna because of its unique knowledge in the domain of IT and law-making, among other reasons. The study supports the European Commission digital transformation agenda and comes at a time when efforts to implement 'better regulation' are picking up steam. In particular, the study contributes to gaining new insights into the potential advances that IT offers to improve the quality and efficiency of law-making in the Commission, and it extensively discusses how to realise this potential.

In the execution of the study emphasis was placed on concrete results that inspire and provide a glimpse of how smart IT can better assist law-making. Early in the study it was decided to focus on the legal drafting process in the Commission, though the study ultimately ended up covering much more ground, for it essentially envisions 'a holistic IT eco-system for law-making'. A lot of attention was given to consultation within the Commission. This included setting up a reflection group consisting of the main Commission actors involved in law-making. Also, preliminary study orientations were discussed in two focus groups. Close cooperation between the contractor and the Commission was ensured throughout the study, among other reasons to keep the study in sync with developments in the Commission and to allow the early dissemination of results to a wider audience including to the European Parliament, the Council, the Office of Publications, and the extended LEOS community. Initially the study was to last nine months. However, the duration was extended to eleven months, to have more time for an in-depth survey of the literature and a fuller elaboration of the concrete use cases and to set out recommendations and finalise this report.

The report consists of three parts. Part I sets the scene of the study. This part summarises the objectives, gives a detailed description of the state of the art, and presents in greater detail the methodology adopted in the execution of the study. The case is conceived for responsible, hybrid AI with human oversight. The focus in Part II is on the use cases to demonstrate the potential of AI and on mock-ups to illustrate how the actual implementation of smart functionalities in LEOS may look like. Part II also includes a brief overview of roadblocks, a possible architecture, and possible ways to proceed in implementing an 'Augmented LEOS'. Part III finally presents the main recommendations along with a roadmap.

2. Scope

The scope of the study is twofold: (i) to explore the opportunities offered by hybrid AI to enhance legal drafting and improve the quality, efficiency, and transparency of law-making; and (ii) to discuss actions to harness digital change in the drafting of legislation by using AI in a fair, accountable, ethical, and 'explainable' way. The study thus supports the formulation of an ambitious digital transformation agenda.

The aim is to improve the **quality** of legal content and of the law-making process by investigating several features, among which the following:

- textual clarity supporting legal drafters and end-user presentation, including accessibility and visualisation (legal design);
- linguistic variants and temporal version management of each type of legislative document;
- law-making and policymaking through all the steps in the Commission's decision-making supporting, e.g., amendments and the consolidation of amendments;
- metadata consistency (ELI, ECLI, AKN, CDM, etc.) through all the different steps of law-making to guarantee legal validity over time and for long-term preservation;
- logic reasoning using legal norms expressed in the legislative document; and
- facilitating Member States in the implementation of law by making it possible to track the transposition of law and supporting its adoption.

The aim is also to improve the **efficiency** by investigating the following features:

- reducing manual/error-prone work by using patterns (e.g., corrigenda) and best-practice templates in the process of legal drafting to automate as much as possible consolidation and semantic annotation, using legal ontologies and thesauri (e.g., EuroVoc);
- maximising reuse of similar legal concepts detected using machine learning and legal data analytics applied to the whole legal system (e.g., definition, derogation, exception analysis);
- assisting the implementation of policy priorities in legislation (e.g., digital readiness, gender neutrality); and
- enhancing transparency and searchability up to publication.

Finally, the study proposes novel scenarios and a **comprehensive vision** to make, in the next five years, significant progress towards a fully digital/paperless decision-making process by embracing innovative technologies whilst preserving legal rigour.

3. Study methodology

The study started with an in-depth desk research. Attention was given to extensive consultation in the Commission. In particular a reflection group was set up early on in the project. To facilitate a meaningful discussion in the 'reflection group', a questionnaire was drawn up setting out the scope of the study in concrete terms. This questionnaire was also examined in two focus-group meetings.

Further efforts to make the work concrete concentrated on the definition and very detailed elaboration of four telling use cases and on the provision of mock-ups to demonstrate how new functionalities could be integrated into LEOS. The use cases and the mock-ups were chosen to demonstrate the potential of modern technology. The limited time and resources of the study did not make it possible to conduct a full consultation process to set priorities in use cases/desirable functionalities, nor did it make possible an in-depth assessment of the benefits/value or feasibility in terms of the resourcing needed for implementation. Nevertheless, the results obtained are very valuable and set a clear 'direction of travel'. The work already resulted in a publication in JURIX 2021 and in a forthcoming publication in AICOL2022.

In addition, the study included an initial exploration of a possible IT architecture for an extended smart IT ecosystem with an 'Augmented LEOS' at its core. This is complemented by a brief, very preliminary study on possible ways to proceed with the actual implementation of this envisaged IT ecosystem, along with the identification of roadblocks and ways to overcome them. The latter is based on the expertise, knowledge, and experience gained and makes good use of existing literature, in particular at the OECD.

Finally, throughout the study concrete actions and recommendations were identified.

4. State of the art

LegalXML representation as basis for robust AI

Over the last twenty years we have witnessed an evolution in the digitisation of legal sources, and in particular legislative ones. The process has gone through several phases:

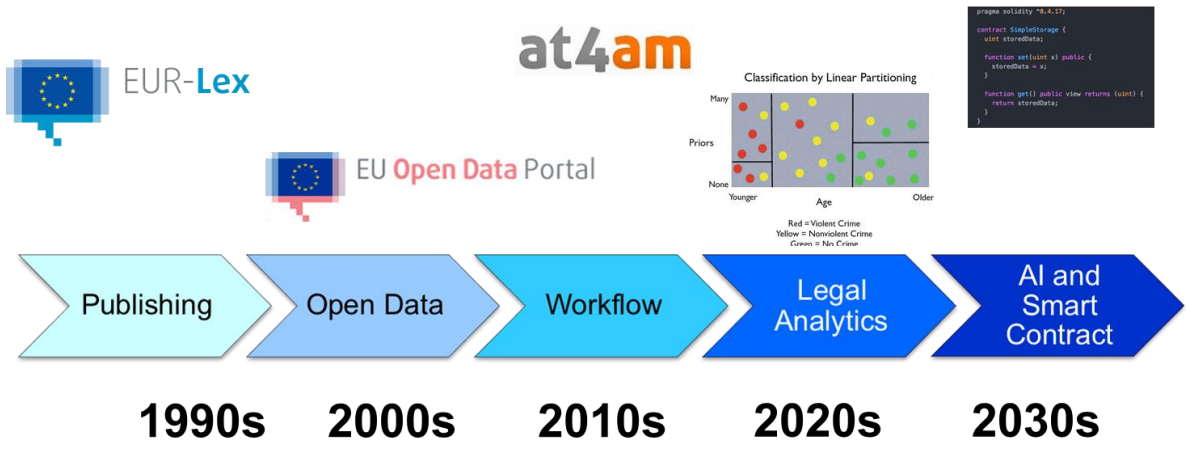

Figure 7 - Evolution in the digitisation of legal sources.

At first, we started to digitise the Official Journal to provide open access to law online using the Web. Second, we focused on the 'Web of Data', transforming the information included in the law into open data using open standards (Filtz 2020). Third, we applied the same standard for a deep digital transformation of the law-making process, while enhancing workflows between institutions. The fourth step is to use all the open data and the legal

document structure represented in open standards to enable legal data analytics, so as to create new AI applications by using these legal big data and also to transform portions of procedural rules into smart contracts that are immediately executable and enforceable.

Several official journals, national archives, and parliaments have sought to manage legal sources within legal corpora with the use of technologies like databases, XML, RDF-metadata, and logic formulas. Subsequently, they also set out to provide updated versions of the law at any moment in time (the so-called point-in-time mechanism). In 1995, EnAct (Arnold-Moore 1995), by the Government of Tasmania, was the first system to produce such a point-in-time legislative database in SGML. In 1992, the LII (Legal Information Institute) of Cornell Law School, launched by Peter Martin and Tom Bruce (Bruce 1994), provided the web (HTML) with the consolidated United States Code. AustLII, the Australasian Legal Information Institute, cofunded by Graham Greenleaf in 1995, to this makes AI instruments like DataLex available. These instruments are based on rule-based legal inferencing software that is capable of dialoguing with the end-user (Greenleaf 2020). Using Formex, an SGML data standard now translated into XML (Formex v4), Eur-Lex began to consolidate the database of European Legislation in 1999. On 1 January 2001, Norway activated a web service by Lovdata and began to provide consolidated legislation. In 2002, France transformed the commercial service Jurifrance into a public web portal called Legifrance. This includes consolidated texts in mixed format (HTML, XML, PDF). Today, it also supports the Akoma Ntoso format. Austria launched the eLaw project (2004) and transformed its previous RIS database (1983) into a web collection of authentic documents, thus completely dematerializing the publication of its official journal. The Emilia-Romagna Region (Italy) started to consolidate regulations back in 2003 using the NormeInRete XML schema. The Italian High Court of Cassation started the same mark-up in 2005 and is now approaching the consolidation of the entire body of documents. The Senate of Italy adopted the Akoma Ntoso standard for bills, transcripts, and other kinds of documents also provided in Open Government Data. On 30 June 2009, the Senate of Brazil launched the parliamentary consolidated database (LexMLBrazil)[1] with a point-in-time function based on a customisation of the XML Akoma Ntoso schema. The Library of Congress of Chile also provides up-to-date legislation using Akoma Ntoso. The National Archives of the UK have progressively been transforming all UK legislation into XML, RDF, and Akoma Ntoso since 2012. The Kenya Law Report is now converting their database of laws into XML documents marked-up in the Akoma Ntoso standard. In 2017, the United Nations approved Akoma Ntoso as the official standard for their documentation (AKN4UN),[2] and the EU institutions

[1] https://normas.leg.br/ https://www.lexml.gov.br/
[2] https://unsceb-hlcm.github.io/

launched a similar project in 2018 with the AKN4EU initiative. Interoperability between institutions and the simplification of the law-making process between different bodies is facilitated by the use of XML legal standards. Moreover, LegalXML modelling provides a robust and solid digital serialization of legal documents by applying principles of legal theory to annotate legal knowledge (e.g., temporal parameters, semantic web annotation, document structure, normative citations).

AI and Law: From the Web of Data to Machine-Consumable Law

AI and Law communities over the last thirty years have developed widely shared theories and models that can manage norms, values, principles, beliefs, interpretation, and argumentation (Sartor, Prakken, Rotolo, Boella, van der Torre). Other scholars use ML/NLP/AI non-symbolic techniques for extracting, classifying, and analysing legal knowledge and legal norms starting from the text (Ashely 2017). Many members of the AI&Law community have developed logic theories and methods for modelling norms in legal formula and have also developed tools for managing the legal reasoning interaction with legal experts (Governatori, Palmirani, Boella).

Some research projects started important investigations in the direction of “Law as Data” to extract data from legal texts and to improve information retrieval based on semantic and legal ontologies (Palmirani 2018, 2019, 2020). The Lynx project (https://lynx-project.eu/) aims to translate a legal system into a knowledge graph; ManyLaws (https://www.manylaws.eu/) mixes different legal metadata to improve searchability. What is new in these research endeavours is the aim to codify normative thought directly using programming languages without passing through any legal language. OpenFisca (https://openfisca.org/en/) undertakes to codify significant fragment of legal system with programming; and Marcell, for example, uses AI to improve multilingualism in legal documents (https://marcell-project.eu/). These projects are currently isolated and not well integrated in a unique research vision, and especially they do not fully include the philosophy of law, legal theory analysis, or constitutional law, and do not create a robust legal framework for digital a legal system that is dynamic and diachronic in multilingual perspectives with multiple interpretations and meanings. The ERC project CompuLaw (https://site.unibo.it/compulaw/en/project) is one of the more advanced projects that takes an interdisciplinary approach including legal-techno-social aspects. However, it is more focused on logic-symbolic and nonsymbolic modelling of norms integrated with AI techniques like predictive law and eJustice. Legal Design (Hagan 2020) applications, based on graphic arts and human computer interaction pillars, are oriented toward simplifying communication in legal documents using visualization and dynamic interfaces. This new visual approach demonstrates that is possible to produce normative content with nonlinguistic instruments like infographics, comix, and icons (Moroni 2016, 2020; Haapio

2018; Rossi 2021) and to be very effective, explicable, and transparent, overcoming the complexity of legalese.

We need to go beyond the state of the art and take the challenge of 'coding of the law'[3] by building a solid IT-based legal framework supported by the philosophy of law, informatics (AI), and computational linguistics (NLP) that makes legal authentic and authoritative the machine-computable law produced directly by institutions like the linguistic version. In the future, a chatbot could support a human in writing law like in journalism or education (self-generation essay with GPT-3) (Fitsilis 2021) or in LegalTech practices (e.g., contract, applications). Several law schools are introducing 'coding for lawyers' courses. We aim to anticipate the risks of these new trends, to capture the opportunities, and to propose new e-legal system models that are based on solid theoretical scientific methodologies. Otherwise, this 'coding of law' could turn into a black box whose results cannot be explained to a genuine end-user (Pasquale 2015, Sovrano 2021). For this reason, we promote a 'law as code' model which uses AI techniques to make the law machine-consumable, and which at the same time reflects the theory of law and the long-term preservation of legal validity even for generations to come.

A hybrid AI technological framework

Non-symbolic AI (Machine Learning / Deep Learning) is rapidly evolving, and it is becoming evident that a hybrid technical framework combining machine learning and deep learning based on stochastic technologies, with semantic knowledge modelling, legal reasoning, and a symbolic rule-based approach (Palmirani 2020, Ashley 2020, Verhij https://hybridintelligence.ewi.tudelft.nl/) could produce better results in the legal domain. The main problem with current applications of non-symbolic AI (ML/DL) in the legal domain is the lack of contextual information. This affects the ability to create useful relationships between different annotations, classifications, clustering, correlations, and regressions.

In more detail, the main problems in the current state of the art in ML/DL applications for legal documents include the following:

- ML/DL works without logic or semantics, and much contextual information included in the legal document is neglected, with an evident lower capacity of interpretation.
- Legal citations are a consolidated best practice in legal disciplines, which entrust some important meta-role to external textual resources (e.g., definitions, derogations, modifications, integration of prescriptiveness, penalties, conditions). This means that ML/DL should also consider cited text, especially considering that some algorithms (e.g., similitude, grouping) can find similarities in texts (e.g., "art. 3" and "art. 13") when the content is completely different. For this reason, the network of norms through citations should be included in the baseline of the experiments.

[3] See Savelka, et al. 2021 for a comprehensive discussion.

- Temporal parameters are fundamental to creating a robust ML/DL dataset. Case-law based on repealed legislation should have lower relevance in the dataset feeding the AI treatment of case-law based on new legislation, even if these datasets are less frequent. So, frequency, probabilistic calculus, and temporal series should be mitigated with criteria of relevance and legal validity. And
- Logic and semantic web annotation should also be integrated with ML/DL in order to understand the type and meaning of relationships that connect different sentences in the text (e.g., obligation and penalty, obligation and derogation).

For these reasons, a hybrid architecture, one that includes symbolic and non-symbolic AI, is strongly advocated in integrating ML/DL legal knowledge with Semantic Web annotation and legal deontic logic modelling (Deakin 2020). Akoma Ntoso as a common interchange LegalXML standard could be a good bridge for creating a common annotated digital corpus for robust AI applications (Sovrano 2020).

A hybrid AI for human oversight

The hybrid approach is functional also with regard to the explicability principle contained in the Artificial Intelligence Act (AIA)[4] (see Arts. 13 and 14 – Human oversight). The hybrid approach, based on the New Legislative Framework (NLF),[5] is also instrumental for implementing Recital (61)[6] AIA (Ebers 2021), i.e., co-regulation through standardization bodies. Furthermore, it is essential in supporting interoperability within the large landscape of Artificial Intelligence, to minimize fragmentation, overcome technical and organizational barriers, and set different benchmarking criteria and legacy systems (Veale 2021). Interconnecting all the extracted legal knowledge, using, for instance, the Akoma Ntoso LegalXML common standard, permits better interpretation by human beings (Hildebrandt 2020) and the implementation of the human-in-the loop, human-on-the-loop, and human-in-command principles (Monarch 2021, Verhij 2021, Atkinson 2020). Akoma Ntoso implements the principle of 'self-containment', meaning that all the metadata and fragmented knowledge are represented in the same XML logic structure and, if need be, in physical files. This permits AI tools to keep in one place all the knowledge that is necessary for deducing new information or for explaining why, what, how the AI-process is conducted. Robust human oversight of AI in the legal domain is necessary to prevent bias, apply interpretation, and integrate machine-readable modelling together with human expert reasoning.

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[4] European Commission, Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts (COM(2021) 206 final) (hereafter AIA).
[5] https://ec.europa.eu/growth/single-market/goods/new-legislative-framework_en
[6] "[s]tandardization should play a key role to provide technical solutions to providers to ensure compliance with this Regulation".

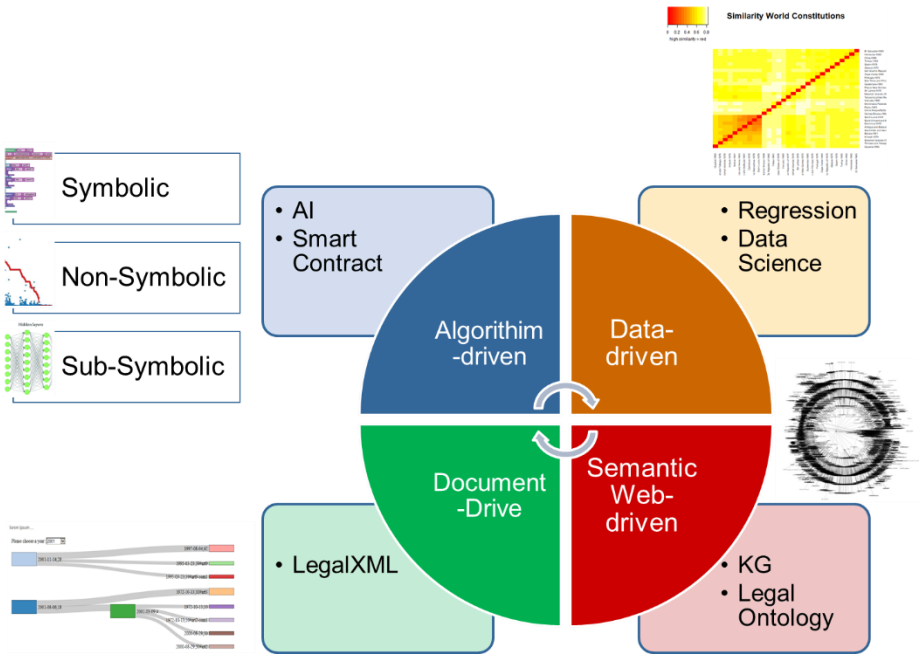

Figure 8 – AI and the legal domain.

5. Legal and ethical implications

Applying AI in the legal drafting domain has different implications. From a constitutional point of view it raises the question of the delicate relation between the democratic separation of powers; from a legal theory point of view, it raises the problem of interpretation that is hidden in the computational code, such that open-text principles are not adhered to; from an ethics perspective, issues arise when the machine would indicate regulation that would lead to possible discrimination or would limit autonomy in political decision-making.

At least the following risks need to be managed:

- Law is not just made up of rules but also includes elements that can hardly be reflected in static formulas (e.g., principles and values).
- Fixing norms in a monolithic code is a form of translation of the legislative text that does not allow norms to adapt to the evolution of the society.
- To use 'artificial languages' is to use a subset of natural language (Chomsky 2006), which comes with limitations.
- Norms could be intentionally kept vague, e.g., in order to implement a balancing between different institutions.
- Any prediction based only on the past is inherently limited. And
- Predictions influence decision-makers and future human behaviour (Hildebrandt 2021).

Some scholars (Hildebrandt 2020, Oster 2021, Barraclough 2021) argue that it is impossible to reduce the law to computable code or data, and they remark that risks related to a new computational legalism (Diver 2020) could reduce law to a crystallisation of norms into unmodifiable coding, with severe prejudice to some important '[c]onstitutional principles, such as legality, accountability, transparency and other expressions of the checks and balances of the rule of law that are core to constitutional democracies'. The hybrid AI

approach explained above charts a new direction in AI research where the *human-in-the-loop*, *human-on-the-loop*, and *human-in-command* principles[7] are combined with various complementary disciplines (law, philosophy, ethics) and the use of symbolic and sub-symbolic AI techniques integrated with Semantic Web findings. The latter adds context and meanings to a pure data-driven or code-driven methodology. Hybrid AI is a very promising approach especially in the legal domain, where context, values, and concepts are fundamental to a correct application of AI (AICOL 2021, Fratrič 2021). Additionally, the European Commission is developing a roadmap for digital-ready legislation[8] on an interdisciplinary approach and is taking on the challenge of 'drafting legislation in the era of artificial intelligence and digitisation'.[9]

In the current study we thus propose a third way (referred to as Hybrid AI for Law or Law as Platform) based on a legal and technical model for developing computable informatics legal systems (compliant by-design, or legal protection by-design, as Hildebrandt has defined it) in combination with the theory of law (understood in an autopoietic role, in which it creates a completely new framework). Legal formalism and logical positivism (reductionism and textualism), used for decades, are not sufficient for achieving coding of law that adapts to evolution. It is necessary to maintain flexibility to be pertinent in diverse jurisdictions, varying contexts, different historical periods, and changing societies. Neither radical legal hermeneutics nor subjectivism, used in the legal area, are good approaches for the Web of Data (Filtz 2021). For these reasons, the finding of this study is ground-breaking in suggesting a new innovative structure that reconciles legal theory and the philosophy of law with emerging technologies that are profoundly modifying current society and crossing silos. Additionally, we need to consider the Goodhart and Campbell laws and the Hildebrandt consideration that any excessive use of predictive AI automatically produces modifications in people's behaviour as a result of these predictions (Hennessy 2021, Chalkidis 2019). Because this topic is vital, we must counter a nonsceptical and simplistic technocratic approach that may generate significant risks for our democratic legal system. Oster (2020) stresses the point: 'That leaves one question open: how does the digitalization of law—the

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[7] High-Level Expert Group on AI presented Ethics Guidelines for Trustworthy Artificial Intelligence, 2019. 'Human oversight. Human oversight helps ensuring that an AI system does not undermine human autonomy or causes other adverse effects. Oversight may be achieved through governance mechanisms such as a human-in-the-loop (HITL), human-on-the-loop (HOTL), or human-in-command (HIC) approach. HITL refers to the capability for human intervention in every decision cycle of the system, which in many cases is neither possible nor desirable. HOTL refers to the capability for human intervention during the design cycle of the system and monitoring the system's operation. HIC refers to the capability to oversee the overall activity of the AI system (including its broader economic, societal, legal and ethical impact) and the ability to decide when and how to use the system in any particular situation.'

[8] https://joinup.ec.europa.eu/collection/better-legislation-smoother-implementation/digital-ready-policymaking

[9] https://ial-online.org/seminar-drafting-legislation-in-the-era-of-artificial-intelligence-and-digitisation-brussels-november-2019

drafting, interpretation and/or enforcement of the law by digital agents—affect the epistemology of law, that is, the theory of knowledge of the law?'. We advocate creating a theoretical solid framework of models for the concept of Law *as* Code (not Law *is* Code) or, better yet, Law as Platform. The framework needs to be compatible with constitutional law (flexibility, legitimacy, enforceability), the theory of law (hermeneutics), and democratic systems (separation of powers) and be based on different disciplines, including the philosophy of law, legal informatics, and computational linguistics, thus fostering a plurality of perspectives on which to model a new vision.

We are convinced that it is possible to develop, under certain conditions (to be defined), a robust theoretical and empirical legal-techno-linguistic framework that facilitates the task of defining legal norms in an official and an authoritative manner in a machine-consumable format (e.g., XML, logic formula) that has the same legal value as the natural language text that for centuries has been the medium of choice for legal systems (Raz, Alchourrón).

It is evident that making legal and ethical norms machine-*consumable*, and not simply machine-readable, is a pressing need, making it possible to save time, promptly react to change, correctly allow the application of regulations, allow machine-to-machine dialogue with digital artefacts (e.g., implement policies), analyse impact, and make prompt decisions for the economy and society. If a sound Law as Code framework is defined and adopted by parliaments, deliberative bodies, government institutions, and public administrative entities we can save significant amounts of time in the implementation of norms in practice, avoid errors, easily monitor the effects of legal norms, correct ineffective prescriptions, and develop an integrated ecosystem with the digital infosphere entities preparing future interaction with robots, multi-agents, AI, blockchain, and smart contracts.[10] Additionally, AI systems can support the legislative law-making process in the drafting stage to produce better regulation that avoids mistakes and inconsistencies. This approach saves money for businesses, lowers the number of lawsuits, and reduces litigation costs, while making compliance with the rules and respect for the rule of law more effective.

Most legal systems are affected by some fragmentation of legal sources (e.g., international, European, national, regional), with issues related to overproduction (e.g., secondary/subsidiary law), the evolution of sovereignty (e.g., Brexit), and, at the same time, pressing demands from liquid democracy (Blum 2016) and a hyperconnected society (Floridi 2014). On the one hand there is the risk that other more agile forms of legal sources could arise (e.g., BitTech Law), and on the other hand different formats of regulation of society may be adopted in practice (e.g., distributed rules, smart contracts) with detrimental

[10] See Flood 2017, Barraclough 2021, Won Lo 2021, Greenleaf 2020, Cummins 2020, Huggins 2021, Branting 2021.

effects on the role of institutions. What is needed, then, is a complex and groundbreaking project requiring a long-term commitment to developing a new legal theory for the e-legal system and then a proper technical framework. This is the urgent mission in the current digital and knowledge society. Otherwise, simplistic solutions arise, often solely driven by commercial interests that may erode democratic systems, core rule-of-law concepts, and the authority of institutions.

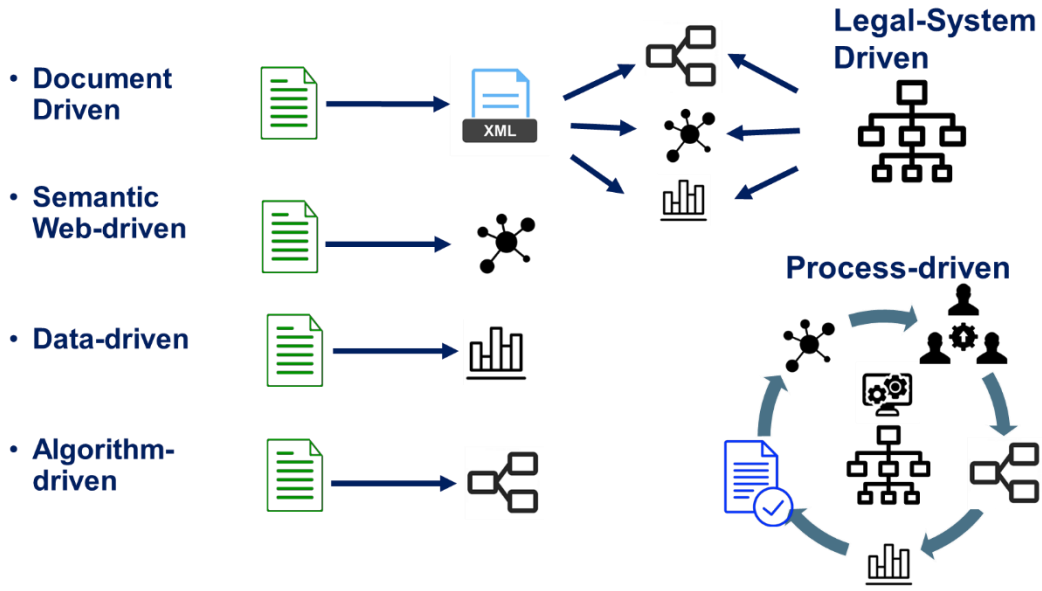


Figure 9 – Law as Ecosystem geared toward documents, processes, and the legal system.

6. AI for legislative drafting

On the basis of the state of the art presented above, and considering the specific legal domain of legislative drafting, we can classify possible scenarios in which to apply AI techniques, in the hybrid meaning, in three main macro-domains.

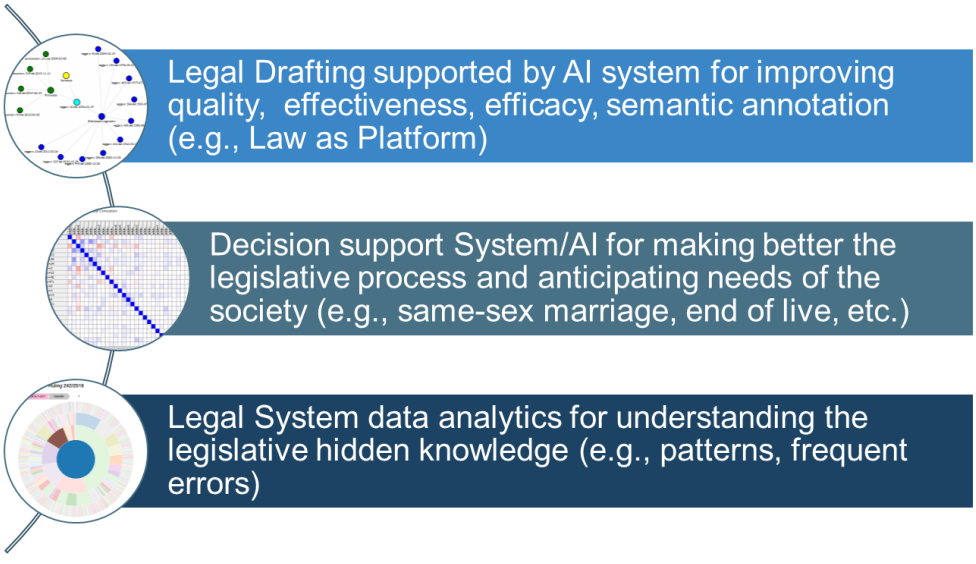


Figure 10 – Three main domains where AI is helpful in legislative drafting.

1. AI to support the drafting of legislative documents and the related workflow processes. These scenarios include features to propose better wording of legal texts (e.g., linguistic analysis, harmonization of legal definitions) and to support the translation process. The workflow

process includes *ex-ante* and *ex-post* regulatory impact assessments. AI applications may support these two steps

Example of drafting rules:

'Do not use *shall* in non-enacting terms such as recitals or annexes or in subordinate clauses in enacting terms.'

'To give permission to do something, EU legislation uses *may*.'

'To impose a prohibition, EU legislation uses *shall not* or *must not*.'

'Do not use *may not* for a prohibition in non-enacting terms, as it could be taken to mean a negative possibility. Use an alternative such as *must not* instead.'

Example of provisions where these rules are not followed. In these cases a smart editor could support the correct application of the deontic verbs *shall*, *may*, and *must not*:

'The principal amount of the instruments may not be reduced or repaid, except in either of the following cases:'[11]

'Refusal to redeem the instruments, or the limitation of the redemption of the instruments where applicable, may not constitute an event of default of the institution.'

'4. Associated deferred tax liabilities of the institution used for the purposes of paragraph 3 may not include deferred tax liabilities that reduce the amount of intangible assets or defined benefit pension fund assets required to be deducted.'

2. AI techniques for supporting decision-making, including at the policy level, and for checking consistency with the existing body of norms. *Consistency* does not mean avoiding *conflicting rules*, which are sometimes necessary for flexibility, allow different interpretations, and ensure applicability to numerous odd cases. *Consistency* means detecting legislation that is not in line with the principles defined at the policy level, e.g., gender issues, digital readiness, simplification, better regulation, or evidence-based legislation.

Example: we want to detect the parts of legislation that do not support the digital transformation:

> '5. The group of organisers shall be responsible for the collection of the statements of support from signatories in paper form.'[12]

3. AI techniques for analysing the legal system and assessing the effect of a legislative action. Data analytics algorithm could be very useful for this purpose. AI can detect existing hidden knowledge and provide an explanation for some phenomena embedded in the legal system. In this way it is possible to avoid errors based on past experience, support good practices, and steer the law-making process closer to the needs of stakeholders.

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0575&qid=1622036526324
[12] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0788&qid=1629610504081

Example: we want to detect the parts of legislation that state derogations depending on temporal conditions:

> 'By way of derogation from the date of application referred to in the second paragraph of Article 61, Article 46 shall apply from 17 June 2018 insofar as necessary in order to allow a timely recognition of control authorities and control bodies.'[13]
>
> In particular we need to extract 17 June 2018 and to connect this temporal information to the derogation destination (second paragraph of Article 61 and Article 46).

7. Benefits of applying AI in the legal domain

AI applications have been shown to yield important benefits in the following domains.

1. Information retrieval: legal metadata and knowledge provide legal operators, companies, and citizens with a more effective means to search relevant and pertinent legal sources using Web portals and Semantic Web tools.

Example: we want to retrieve all the derogation applied to a given Member State like Cyprus:

> '5. The provisions relating to railways, and in particular any requirement to connect airports and ports to railways, shall not apply to Cyprus and Malta for as long as no railway system is established within their territory.'[14]

2. Legal reasoning: symbolic AI combined with non-symbolic findings to assist compliance checking, reasoned argumentation, detection of errors in the technical norms, etc.

Example: Art. 5 is related to Art. 19. This makes it possible to retrieve all the penalties connected with a given obligation and, e.g., to check whether, for each obligation, a penalty is set forth.

Article 5

Obligation of traceability

Traders shall, throughout the supply chain, be able to identify: …

Article 19

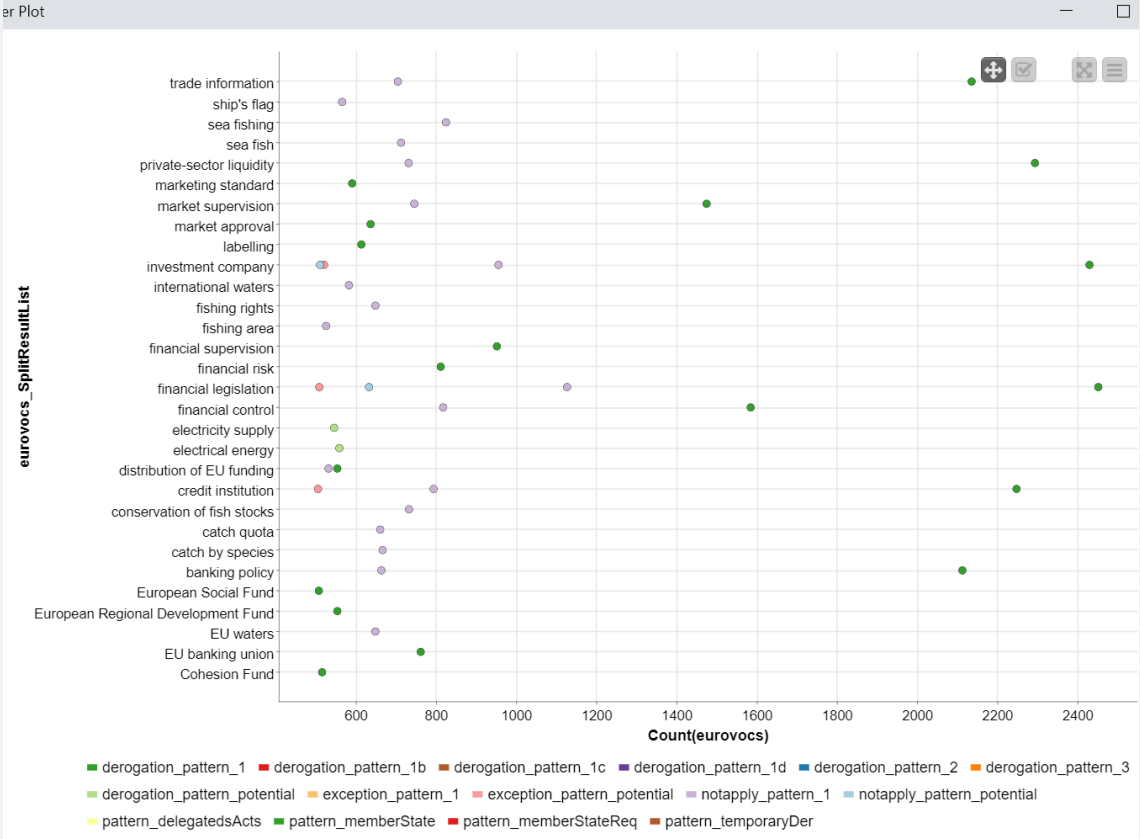
Penalties

1. The Member States shall lay down the rules on penalties applicable to infringements of the provisions of this Regulation and shall take all measures necessary to ensure that they are implemented.

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018R0848&from=EN
[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0788&qid=1629610504081

3. Visualisation: information can be presented in a visually appealing manner to attract the interest of, e.g., citizens, stakeholders, the press, and businesses. IT enables smart visualization of legislative content and can be used to summarise in simple plain language complex legal texts for better communication, e.g., with citizens.

Example: we want to visualize in which Eurovoc topics there are the greatest concentrations of derogations. In the x axes we have the number of derogations; the colour of the dots indicates the different types of derogations; the Y axes show the Eurovoc label that is assigned to the document where we have found the derogations. The result below shows that the most relevant concentration of derogations is in the financial area: documents classified by the Publication Office with the labels of Eurovoc trade information, private-sector liquid, investment company, financial risk, and banking policy record more than 2,000 derogations. A similar thing is happening in the fish and energy sectors. This is very reasonable for the fish and the energy sectors because these are areas where Member States have legal competence and jurisdictions. However, in the Digital Single Market era we are expecting fewer derogations in financial instruments and in banking policy relative to the current situation. This graph could help the decision-maker and the legal drafter to monitor the derogations and to decide if they are really necessary under the European general policy.



4. Interoperability: the information available in LegalXML format (Akoma Ntoso or LegalRuleML) could be reused by Member State specially to manage domestic laws with EU legislation.

Example: we could use the Akoma Ntoso XML format to compare a directive and the corresponding implementation and detect similar portions of text. The following

example compares article 11, on discrimination in Directive 2019/1024,[15] and the German implementation in article 5(2).[16] We can notice that in the original directive the word 'document' (*Dokumente*) is used and in the implementation the national legislator decided to harmonize the norm with domestic legislation and to use the word 'data' (*Daten*). Using Akoma Ntoso we can compare the structure of two heterogenous documents and thus compare portions of the paragraph. We also connect the differences with the legal definitions annotated in the special metadata of the Akoma Ntoso markup. We can discover that in the national transposition the legal concept 'document' is changed with the concept 'data'. Detecting these divergencies makes it possible to better apply some cross-border services using the correct legal definition beyond linguistic differences and national implementation.

Artikel 11	§ 5
Nichtdiskriminierung (2) Werden Dokumente von öffentlichen Stellen als Ausgangsmaterial für eigene Geschäftstätigkeiten weiterverwendet, die nicht unter ihren öffentlichen Auftrag fallen, so gelten für die Bereitstellung der Dokumente für diese Tätigkeiten dieselben Gebühren und Entgelte und sonstigen Bedingungen wie für andere Nutzer.	Nichtdiskriminierung (2) Werden Daten von einer öffentlichen Stelle als Ausgangsmaterial für die eigene Geschäftstätigkeit genutzt, die nicht unter den öffentlichen Auftrag der öffentlichen Stelle fällt, so gelten für die Bereitstellung der Daten für die Geschäftstätigkeit dieselben Entgelte und sonstigen Bedingungen wie für andere Nutzer

8. Reflection group, questionnaire, and focus groups

As indicated above, one of the main deliverables consisted in drawing up a questionnaire. The purpose of the questionnaire was to illustrate concepts, ideas, and suggestions for what modern IT technology can offer to assist legal drafting (and to assess the impact of legislation and, e.g., research the EU legal corpus) by concrete examples and illustrations. Modern IT technology refers, among other things, to AI, machine learning, natural language processing, and big data.

The questionnaire is divided into three parts:

Part A – Legal Drafting Support. The 17 concepts, ideas, and suggestions can be grouped as follows:

- Context-aware verification of the correct use of, e.g., citations, references, or the legal lexicon, while also detecting similar regulations.
- Granular tracking of changes or modifications.

[15] https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:32019L1024
[16] http://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&jumpTo=bgbl121s2941.pdf

- Legal assistance in drafting an act, e.g., in detecting and avoiding structures that could create issues in legal interpretation or in spotting incompatibilities in temporal parameters or identifying explicit or implied obligations.
- Discovery of practices, e.g., by classifying corrigenda.

Example. In Regulation EU 2018/1725, Recital 48, we have the following: 'Such processing includes "profiling" that consists of any form of automated processing of personal data evaluating the personal aspects relating to a natural person, in particular to analyse or predict aspects concerning the data subject's performance at work, economic situation, health, personal preferences or interests, reliability or behaviour, location or movements, where it produces legal effects concerning him or her or similarly significantly affects him or her.'

The GDPR Regulation 2016/679 defines 'profiling' as follows:

'profiling' means any form of automated processing of personal data consisting of the use of personal data to evaluate certain personal aspects relating to a natural person, in particular to analyse or predict aspects concerning that natural person's performance at work, economic situation, health, personal preferences, interests, reliability, behaviour, location or movements.

Example: the following definition is mutable according to context.[17] The legal drafter could be supported by smart functionality in detecting all the different variations of the same definition and retrieving the connected legal sources.

(9) 'beneficiary' means:

(a) a public or private body, an entity with or without legal personality, or a natural person, responsible for initiating or both initiating and implementing operations;

(b) in the context of public-private partnerships ('PPPs'), the public body initiating a PPP operation or the private partner selected for its implementation;

(c) in the context of State aid schemes, the undertaking which receives the aid;

Another similar example[18] that also involves acronyms. In this case a specialized editor can provide the correct definition and acronym in the correct context:

(17) 'competent authority of the MMF' means:
(a) for UCITS, the competent authority of the UCITS home Member State designated in accordance with Article 97 of Directive 2009/65/EC;
(b) for EU AIFs, the competent authority of the home Member State of the AIF as defined in Article 4(1)(p) of Directive 2011/61/EU;

Part B – AI for Legal Consistency and Better Regulation. The 6 concepts, ideas, and suggestions can be grouped as follows:

- Linguistic support in correctly formulating legal language in accordance with the English Style Guide or in detecting divergences between different linguistic translations.
- Legal assistance within the act by detecting implicit or incomplete modifications or identifying obligations, rights, permissions, and penalties.

[17] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1060&qid=1638118281792
[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R1131&qid=1638118561731

- Supporting semantic annotation in legal drafting in an easy way using user-friendly HCI interfaces. This helps legal drafters better retrieve the information necessary to their work and look for hidden relationships between connected regulations.
- Supporting gender-neutral language, digital-ready wording, and nondiscriminatory linguistic formulations.

Examples. In the following examples we can see the use of non-neutral language in the word 'chairman', which should be replaced with 'chairperson'.

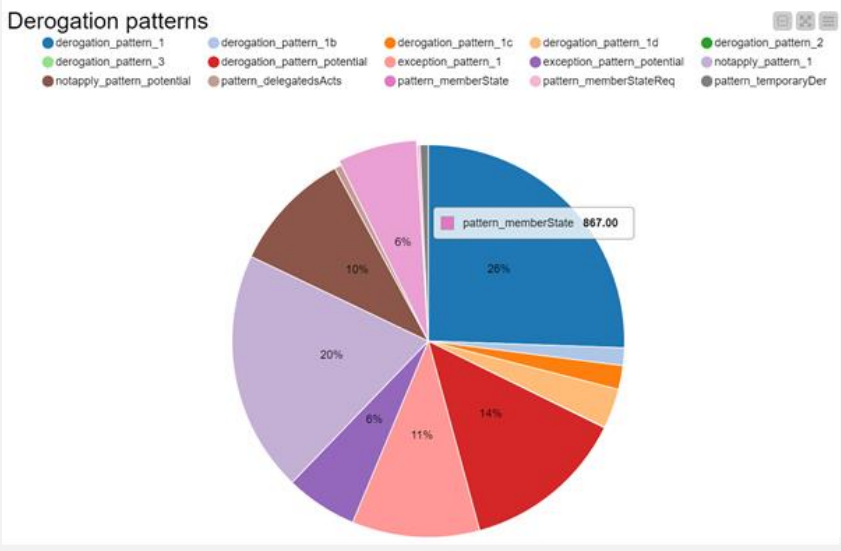
> Article 26
>
> The Chairman may invite individuals or representatives of bodies with wide experience in the field of employment or movement of workers to take part in meetings as observers or as experts. The Chairman may be assisted by expert advisers.

Part C - Legal Systems Analytics. The 10 concepts, ideas, and suggestions can be grouped as follows:

- Analysing the entire legal system to improve a single act by detecting and avoiding errors and discovering and facilitating the application of best practices.
- Modelling relevant parts of legislation, identifying templates (e.g., patterns), and/or facilitating their application.
- Harmonising linguistic aspects.
- Improving the analysis of the entire legal system in order to extract legal knowledge useful to decision-makers, but also to legal drafters.
- Analysing the entire legal system and deducing patterns that are useful to legal drafters in implementing new features in informatic systems.

Examples

In the following example we can analyse the pattern of derogations and discover that 6% of derogations between 2010 and 2020 are delegated to the Member States.



9. Maturity of the market

The AI market offers several important tools; however, the legal domain requires a specific customisation, and a new market referred to as LegalTech[19] is emerging. Many AI applications target case-law analysis (e.g., Lex Machina[20] and Ravellaw[21]) or support the drafting of legal contracts (e.g., Donna,[22] Lawgeex,[23] Ontra[24]).

The use of AI in the current LegalTech market can be divided into four different avenues:

i) ML for analysing large numbers of documents to improve information retrieval, classify them, and predict trends;

ii) network diagrams for discovering new inferences and connections;

iii) legal question-answering systems (e.g., Lexis Answers); and

iv) summarising and creating new text (e.g., GTP-3).

Many of these customisations reuse or refine existing software modules provided by several main players like Microsoft Azure, Google AI, IBM Watson, and Amazon.

Here we briefly present the state of the art in the market formed by these three players, summarising the offer of cloud-based AI services with a focus on Natural Language Processing. At the end of each section, we point to techniques that support Explainable AI (XAI). This overview is complemented by a section on comparable technologies available in the open-source domain.

Microsoft Azure

Microsoft Azure[25] is a collection of various cloud computing services, including remotely hosted and managed versions of proprietary Microsoft technologies and open technologies, such as various Linux distributions deployable inside a virtual machine. Azure makes it possible to create ML pipelines similar to KNIME. One of the major benefits of using Azure may be its (almost automatic) interoperability with other Microsoft services (e.g., Teams). Furthermore, it may speed up deployment especially where no team of professional software engineers and developers is available to accomplish the task.

Azure offers a suite of services as follows:

- Azure Digital Twins
- Azure Machine Learning and Azure Databricks
- Azure Cognitive Search
- Azure Bot Service
- Azure Form Recogniser

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[19] https://techindex.law.stanford.edu/
[20] https://lexmachina.com/
[21] https://www.ravellaw.com/
[22] https://www.donna.legal/
[23] https://www.lawgeex.com/
[24] https://www.ontra.ai/
[25] https://www.techrepublic.com/article/microsoft-azure-the-smart-persons-guide/

- Machine Translation
- Speech Transcription.

Azure Digital Twins is a service, currently in preview, that provides the tools necessary to model the relationships between people, places, and devices using virtual representation of a physical environment known as the spatial intelligence graph.

Azure Machine Learning and Azure Databricks provide an easy-to-use drag-and-drop interface to interact with tools for the following:

- **Feature Engineering.** Dropping high-cardinality or no-variance features (i.e., with PCA), imputing missing values (for numeric features, imputing with the average of values in the column), generating more features (i.e., extracting the frequency of terms), transforming and encoding (transforming numeric features that have few unique values into categorical features), word embedding (converts vectors of text tokens into sentence vectors by using a pretrained model), and cluster distance (trains a k-means clustering model on all numeric columns; produces k new features, one new numeric feature per cluster, that contain the distance of each sample to the centroid of each cluster).
- **Algorithm Selection.** Decision trees, linear regressions, decision forests, logistic regressions, neural networks, support vector machines, k-means clustering.
- **Hyper-Parameter Tuning.** Tuning hyperparameters with the HyperDrive package by exploring the range of values defined for each hyperparameter. Specifying the primary metric you want hyperparameter tuning to optimize. Each training run is evaluated for the primary metric. The early-termination policy uses the primary metric to identify low-performance runs.

Some libraries supported by Azure Machine Learning and Azure Databricks are ONNX, PyTorch, scikit-learn, and TensorFlow. The supported languages are Python and R. Azure Machine Learning and Azure Databricks are also compatible with Power BI, Excel, and SQL Server.

Azure Cognitive Search is a service designed to do Knowledge Mining, so as to uncover latent insights from content–documents, images, and media. It can help you discover patterns and relationships in your content, understand sentiment, extract key phrases, and more. Azure Cognitive Search comes with a few tools for Question Answering, supporting TF-IDF with Lucene. Azure Cognitive Search can perform **Natural Language Processing**, and its skills include entity recognition, language detection, key-phrase extraction, text manipulation, sentiment detection (including opinion mining), and PII detection. With these skills, unstructured text is mapped as searchable and filterable fields in an index. For example, **PII Detection** skill extracts personal information from an input text and gives you the option of masking it. Azure Cognitive Search can also perform **image processing**, and its skills include Optical Character Recognition (OCR) and identification of visual features, such as facial detection, image interpretation, image recognition (famous people and landmarks), or attributes like image orientation. These skills create text representations of

image content, making it searchable using the query capabilities of Azure Cognitive Search. Furthermore, Azure Cognitive Search has also skills that include auto-complete, geospatial search, filtering and faceting capabilities for a rich user experience, key phrase extraction, and named entity recognition to unlock insights. Built-in skills in Azure Cognitive Search are based on pretrained machine learning models in Cognitive Service APIs: Computer Vision and Text Analytics. You can attach a Cognitive Services resource if you want to leverage these resources in content processing.

Azure Bot Service can be used to develop enterprise-grade conversational AI experiences and build multilingual and multimodal bots for nearly any scenario, from sales to customer support to employee productivity.

Azure Form Recogniser can be used for Document Process Automation to turn documents into usable data by automating information extraction. Azure Form Recogniser can extract text, key-value pairs, tables, structures, and other actionable information from documents.

The XAI supported by Azure are the following:

- SHAP (tree, kernel, linear, etc..), a post-hoc explainability model-agnostic tool that can estimate the role of given features in the decisions of AI.
- Mimic Explainer (Global Surrogate), symbolic AI (fully explainable) trained to mimic the behaviour of black-box (unexplainable) AI.
- Permutation Feature Importance Explainer (PFI), another technique whose objective is similar to that of SHAP.
- Among other things, Azure sells already available AI solutions for the following:
- **Combating financial crime.** Preventing fraud with machine-learning models that detect anomalies, enhance knowledge graphs to find relationships between disparate entities, and identify suspicious behaviour within financial systems.
- **Improving customer experiences.** Understanding customers and improving their experiences with intelligent contact centres, personalised portfolio management, and proactive offers powered by AI.

Google AI

Through many satellite companies, Google is currently a leading company in AI, developing cutting-edge technology. Google is an AI-centred company that holds a strong position of leadership in the global market.

Following are some of the most famous Google products that can be used to deploy an AI-based application.

- **Tensorflow** is a free and open-source software library for machine learning and artificial intelligence. It can be used for a range of tasks but has a particular focus on training and inference of deep neural networks. TensorFlow was developed by the Google Brain team for internal Google use in research and production (https://en.wikipedia.org/wiki/TensorFlow). Tensorflow's original programming paradigm was that of a lazy code execution (a.k.a. static computation graph), making it extremely

efficient on several kinds of hardware, because of automated code optimisations, but very hard to debug and use in practice. In other terms, the first version of Tensorflow was powerful but difficult to use. Recently, and after the release of PyTorch (its main competitor), Tensorflow decided to add support for both lazy and eager (a.k.a. dynamic computation graph) code execution, thus improving the readability and debugging of its code with little sacrifice to efficiency. Furthermore, Tensorflow has recently reached an agreement with Keras (a mainstream easy-to-use library for programming neural networks with ease) to embed Keras abstractions in Tensorflow, further improving the library's readability and complexity. Tensorflow can work with CPUs, GPUs, and TPUs (proprietary Google hardware).

- **Angular.js** (commonly referred to as 'Angular 2+' or 'Angular CLI')[4][5] is a TypeScript-based free and open-source web application framework led by the Angular Team at Google and by a community of individuals and corporations. Angular is a complete rewrite from the same team that built AngularJS. Angular is used as the front end of the MEAN stack, consisting of the MongoDB database, the Express.js web application server framework, Angular itself (or AngularJS), and the Node.js server runtime environment (https://en.wikipedia.org/wiki/Angular_(web_framework)), although the MEAN stack can run also with libraries other than Angular, like React or Vue.js. One of the major drawbacks of Angular (and also Angular.js) is that it is very hard to integrate with external libraries (i.e., all those written in Javascript: D3.js, plotly, etc.) unless specific Angular extensions are released or built. Interestingly, web apps written with Angular can be converted into apps for iOS or Android by using NativeScript.
- **CoLaboratory**, or 'Colab' for short, allows you to write and execute Python in your browser (in the form of Jupyter notebooks), with little configuration required. Google Colab is all about running code in Jupyter notebooks. You literally upload data (from Google Drive or directly in Colab), run code cells, and then eventually share your notebook with others (or just download it). (https://mtszkw.medium.com/google-colab-vs-paperspace-gradient-47aa65ebab89). Colab also gives free access to Google's GPUs, and this probably one of the main reasons why Colab is frequently used, making it possible to use expensive hardware for free. Google Colab is totally free. You don't have to pay to run experiments on their GPU and your code can run for at most twelve hours, after which the session will be terminated, unless you decide to use Colab Pro for a fee. Colab gives you their GPU resources for free, you can use it for twelve hours, but:
  - there is no way to choose which GPU you will connect to;
  - you will be disconnected after idle time (90 minutes, but this may vary);
  - in the middle of session, you may be told that GPU is unavailable;
  - Colab supports collaborative developing.
- Like Colab, **Paperspace Gradient** is an end-to-end machine learning platform where individuals and teams can build, train, and deploy Machine Learning models of any size and complexity. Paperspace Gradient comes with three pricing plans (plus one for Enterprise), one of which is free. In the Free plan you are allowed to
  - store up to 5GB in dedicated persistent storage;
  - use free-tier CPU/GPU, i.e., C3 CPU, NVIDIA M4000 and P5000 GPUs;

- run your code for at most six hours when using free CPU/GPU instances;
- use only public notebooks (which cannot be set to private in the free tier).

In Paperspace there are plenty of CPU and GPU instances to choose from, and you can literally choose (unlike in Colab, where you never know what type of GPU you will get). But there is one important thing. Although more instances are available in higher-subscription plans, it does not mean they are free. There are only three instances that you can use at no cost (C3, M4000, P5000). In the table above, ticks under pricing plans mean that these GPUs are available to you, but you still need to pay to use them (usually a few cents per hour). (https://mtszkw.medium.com/google-colab-vs-paperspace-gradient-47aa65ebab89).

Specialised Hardware for Deep Learning

- **GPU.** The de-facto specialised hardware for deep learning is GPU hardware.The graphics processing unit, or GPU, has become one of the most important types of computing technology, both for personal and business computing. Designed for parallel processing, the GPU is used in a wide range of applications, including graphics and video rendering. Although they are best known for their capabilities in gaming, GPUs are becoming more popular for use in creative production and artificial intelligence (AI). (https://www.intel.com/content/www/us/en/products/docs/processors/what-is-a-gpu.html) One of the major issues with GPUs is that they normally consume a lot of energy (watts). In other terms, training deep-learning models may have a significant ecological impact.
- **TPU**[26] is an AI accelerator application-specific integrated circuit (ASIC) developed by Google specifically for neural network-machine learning, particularly using Google's own TensorFlow software.[1] Google began using TPUs internally in 2015, and in 2018 made them available for third-party use, both as part of its cloud infrastructure and by offering a smaller version of the chip for sale. The first main difference is that the TPU (Tensor Processing Unit) is an ASIC (application-specific integrated circuit), while GPU is a general-purpose processor. What this all means in simple terms for us users is that there are no GPUs implemented with tensor cores, and we can only work on GPUs which do not have tensor processing units. The second main difference is that CPUs/GPUs are widely available, while TPUs can only be found inside Google's data center. To summarize, there are a number of differences between a TPU and a GPU, and these make the TPU better suited than regular CPUs to deep-learning tasks. This, however, does not mean that GPUs cannot be used for these tasks. Both devices can achieve high accuracy and good throughput with low power consumption. The second difference between TPUs and GPUs is their programming language. As mentioned before, the TPU can only run machine-learning tasks, so it is programmed in C++ to execute commands on thousands of cores at once. GPUs are programmed in either CUDA or OpenCL, depending on the manufacturer, but they are designed to use general-purpose programming languages, so there is a speed disadvantage when running machine-learning tasks. The third main difference between TPUs and GPUs lies in their source of power. The Tesla P40 from NVIDIA draws around 250 watts, while the TPU v2 draws

[26] https://cloud.google.com/tpu/

around 15 watts. This means that the NVIDIA Tesla P40 uses 25 times more power than the TPU v2 to run a machine-learning task. (https://mygraphicscard.com/tpu-vs-gpu/)

- **Cloud AI**[27]

Unlike Azure, Google offers more than cloud-related services, and it seems to be following a different marketing strategy. While Azure seems to be designed to attract companies, offering them cloud services, Google appears to be more focused in being at the state of the art, publishing (sometimes) open-source solutions (i.e., Tensorflow). The most similar service to Azure that is provided by Google is certainly Cloud AI. In fact, with Cloud AI you buy access to Google Cloud and to specialised tools to efficiently perform AI tasks on the cloud.

Google Cloud's products for AI are the following:

- **Vertex AI.** Building, deploying, and scaling ML models faster, with pretrained and custom tooling within a unified AI platform.
- **AutoML.** Training high-quality custom machine-learning models with minimal effort and machine-learning expertise. Create your own custom machine-learning models with an easy-to-use graphical interface. You just provide data examples (i.e., a set of labelled images) of what you want to do, and AutoML infers the best model available to solve the task defined by the data examples (if there are enough).
- **Conversational AI.** Speech-to-text, text-to-speech (convert text into natural-sounding speech), and Virtual Agents (conversational self-service, with seamless handoffs to human agents for more complex issues).
- AI for documents.
- AI for industries.

- **AI for documents** includes tools for the following:
  - **Translation** from one language to another.
  - **Vision OCR.** Automatic recognition of hand-written characters.
  - **Invoice parser.** Based on OCR, it scans an invoice and inserts it into a database.
  - **Form parser.** Same of invoice parser but for forms.
  - **Sentiment Analysis.** Classifies snippets of text according to the sentiment they might convey to the reader (i.e., positive, negative, neutral).
  - **Syntax analysis.** Dependency, parse label, part of speech, lemma.
  - **Sentence classification.** Natural Language API reveals the structure and meaning of text with thousands of pretrained classifications. AutoML classifies content in custom categories for your specific needs.

[27] https://cloud.google.com/products/ai

- **Entity recognition.** Recognizes organisation, person, location, consumer good, event, address, number, and price.

- **AI for industries** includes tools for the following:
  - **Media Translation.** Translates real-time streaming or prerecorded audio into text in another language.
  - **Healthcare Natural Language.** Assists healthcare professionals in finding, assessing, and linking medical knowledge in text data.
  - **Recommendations AI.** Delivers highly personalized product recommendations at scale.
  - **Lending DocAI.** Transforms the home-loan experience for borrowers and lenders by automating mortgage-document processing.
  - **Procurement DocAI.** Automates procurement data capture at scale by turning unstructured documents like invoices and receipts into structured data.
- Furthermore, Google Cloud offers **smart analytics solutions**[28] for the following:
  - **Retail.** Analytics and collaboration tools for the retail value chain.
  - **Consumer Packaged Goods.** Solutions for CPG digital transformation and brand growth.
  - **Financial Services.** Computing, data management, and analytics tools for financial services.
  - **Healthcare and Life Sciences.** Health-specific solutions to enhance the patient experience.
  - **Media and Entertainment.** Solutions for content-production and distribution operations.
  - **Telecommunications.** Hybrid and multi-cloud services to deploy and monetize 5G.
  - **Gaming.** AI-driven solutions to build and scale games faster.
  - **Manufacturing.** Migration and AI tools to optimize the manufacturing value chain.
  - **Supply Chain and Logistics.** Digital supply-chain solutions built in the cloud.
  - **Government.** Data storage, AI, and analytics solutions for government agencies.
  - **Education.** Teaching tools to provide more engaging learning experiences.

- Two XAIs are supported by Google Cloud:
  - **What-If Tool.** A counterfactual explainer that tries to answer questions like ‘What if I change this part of the input: would the output be the same?’

[28] https://cloud.google.com/solutions/smart-analytics/

- **Feature Attribution.** Tools for understanding what is the importance of features in producing the decisions suggested by AI, i.e., XRAI (eXplanation with Ranked Area Integrals), Integrated gradients, and Sampled Shapley.

There is a library that was experimented with good results in the legal domain. It is called BART (Bidirectional Encoder Representations from Transformers) and is especially useful for extracting knowledge from the text, e.g., case-law (see Zheng, et al. 2021, Savelka, 2020; Savelka, et al. 2019) or some specific part of legislation (e.g., events). Law-BART[29] and Legal-BART[30] are good examples of customization of this module in the legal domain.

IBM Watson

IBM seems to put more emphasis on XAI than Google Cloud and Microsoft Azure. Like Azure and Google, IBM also sells cloud-related services for AI.

IBM's featured cloud AI solutions are as follows:

- **AI for customer service**. This service is compatible with external Customer Relationship Management (CRM) systems like Salesforce, Cisco, and Avaya.
- **AI for business automation.** Ad hoc solutions tailored to specific businesses.
- **Natural Language Processing.** A set of tool for processing natural language and extracting value from text.
- **Explainable AI.** A set of tools for making AI pipelines explainable and for explaining AI.

The solutions for **Natural Language Processing** are the following:

- Automated Question Answering.
- **Predefined Categories (text classification).** Returns a hierarchical taxonomy of the content. The top three categories are returned by default.
- **Custom Text Classifications.** Classifies input using a custom multilabel text classifier.
- **Concepts.** Returns high-level concepts in the content. For example, a research paper on deep learning might return the concept 'Artificial Intelligence' even if the term is not mentioned.
- **Emotion (sentiment analysis).** Detects anger, disgust, fear, joy, or sadness conveyed in the content or by the context around target phrases specified in the targets parameter.
- **Entities.** Identifies people, cities, organizations, and other entities in the content. See 'entity type systems'.
- **Keywords.** Returns important keywords in the content.

[29] https://towardsdatascience.com/lawbert-towards-a-legal-domain-specific-bert-716886522b49
[30] https://aclanthology.org/2020.findings-emnlp.261.pdf

- **Metadata.** Returns information from the document, including author name, title, RSS/ATOM feeds, prominent page image, and publication date. Supports URL and HTML input types only.
- **Relations (knowledge graph extraction).** Recognizes when two entities are related and identifies the type of relation. For example, an awardedTo relation might connect the entities 'Nobel Prize' and 'Albert Einstein'.
- **Semantic Roles (labelling).** Parses sentences into subject, action, and object forms.
- **Sentiment Analysis.** Analyses the general sentiment of content or sentiment toward specific target phrases.
- **Syntax.** Returns information about the tokens and sentences in the input text.
- **Summarization.** Returns a summary of the source content.

IBM also sell already available AI solutions for the following:

- **IT operations.** These reduce monitoring time and resolve problems quickly, so your IT team can focus on what really matters.
- **Advertising.** Understanding your customers better and reaching them with the right messaging at the right time.
- **Healthcare.** Simplifying operations and improving patient-care experiences with a data-driven approach.
- **Financial Operations.** Using modern planning, budgeting, and forecasting tools to drive more-informed decision-making.
- **Risk and Compliance.** Improving governance, reporting, compliance, and risk management, while also reducing costs.
- **Video.** Boosting the overall reach and engagement of your livestreamed and on-demand video content.
- **Security.** Detecting, investigating, and responding to the most critical cybersecurity threats facing your organization.
- **Supply Chain.** Gaining end-to-end insights and visibility into your supply chain, thereby helping to reduce disruption and better meet demand.
- **Return to Work.** Ensure the health, safety, and productivity of your employees and environment in a changing workplace.

The XAIs supported by IBM comprises two open-source libraries providing plenty of tools:

- AI Explainability 360[31] and
- AI Fairness 360.[32]

[31] https://aix360.mybluemix.net
[32] https://www.ibm.com/blogs/research/2018/09/ai-fairness-360/

The AI Explainability 360 Python package includes algorithms that span the different dimensions of ways of explaining along with proxy explainability metrics. The AI Explainability 360 interactive demo provides a gentle introduction to the concepts and capabilities by walking you through an example use case from the perspective of different consumer personas. The tutorials and other notebooks offer a deeper, data-scientist-oriented introduction. The complete API is also available. AI Explainability 360 (AIX360) includes many different algorithms capturing many ways of explaining [1], which may result in a daunting problem of selecting the right one for a given application. Therefore, AIX360 provides some guidance to help you through a visually appealing decision tree.[33]

The AI Fairness 360 Python package includes a comprehensive set of metrics for datasets and models to test for biases, explanations for these metrics, and algorithms for mitigating bias in datasets and models. The AI Fairness 360 interactive demo provides a gentle introduction to the concepts and capabilities. The tutorials and other notebooks offer a deeper, data-scientist-oriented introduction. The complete API is also available. The metrics and algorithms in AIF360 may be viewed through the lens of distributive justice, and clearly do not capture the full scope of fairness in all situations. The toolkit should only be used in a very limited setting: allocation or risk-assessment problems with well-defined protected attributes in which one would like to have some sort of statistical or mathematical notion of sameness. Even then, the code and collateral contained in AIF360 is only a starting point to a broader discussion among multiple stakeholders on overall decision-making workflows.

10. Open-source frameworks and libraries for AI

We should start by noting that Artificial Intelligence (AI) is an umbrella term that covers a wide range of disciplines. With this report we are going to focus on AI methods that could be of major interest for legal-informatics practitioners:

- Natural Language Processing/Understanding (NLP/NLU). Used for processing legal documents, etc.
- Formal Reasoning. Used for reasoning with laws, representing knowledge in an unambiguous format, etc.
- Computer Vision. Used for processing photos and images (i.e., with a legal meaning), handwritten text recognition, optical character recognition, face recognition, etc.
- Reinforcement Learning (RL). Used for recommender systems (marketing, advertising), robotics (autonomous driving), trading and finance, and simulations, but also NLP (text summarisation, question answering, machine translation, sentiment analysis), etc.

[33] https://aix360.mybluemix.net/resources#guidance

NLP & NLU

Natural language processing is probably the most common task in AI&Law. Being able to automatically process natural language implies the ability to cope with incredible amounts of (legal) documents in minutes or even seconds. Everyone knows that both reading and writing (technical, legal) documents may be challenging, especially for those who are not familiar with the specific terminology and vocabulary.

Reading a ten-page paper may sometimes take hours or even more, so what if a software can speed up this process, allowing us to extract or generate the information we need in the blink of an eye?

For this reason and many more, the whole AI&Law community has studied for years how to exploit NLP and NLU techniques to solve real problems in the legal domain. These include (https://github.com/Liquid-Legal-Institute/Legal-Text-Analytics/blob/main/use-cases-details.md#optical-character-recognition) the following:

- Optical Character Recognition. Comprehensive digitalization of physical documents (from paper to PDF and then into a machine-encoded text) which were created before the era of digitalization (historic documents), and so were produced physically (originals with handwritten signature, notarial deeds, passports, etc.). Given that legal practice heavily relies on written information, this is relevant for virtually all practice areas (litigation, contract, investigation, etc.).
- Legal Document Preprocessing. Legal documents are drafted in a way (i.e., natural language) that humans, particularly legally trained users, can understand and peruse them, usually utilizing digital means as support. Perusal of documents occurs in the context of the drafting of the relevant documents as well as in connection with work on other matters (e.g., in the context of litigation that relates to documents and investigations). To such end the content of documents must be converted into a form that allows the relevant software to 'understand' them.
- Clause Segmentation and Sentence Boundary Detection
- Information Extraction. As a step to machine-based perusal of documents, this is essential for basically all fields of legal practice, given that basis for legal work essentially consists of written information not often structured.
- Named Entity Recognition. Essentially this may be viewed as a subcategory of 'Information Extraction'. Main fields of application include the redaction of legal documents to prepare (i) precedent documents for use as form documents or (ii) documents in investigations (as when having to comply with data privacy rules), though in this case more information will often have to be eliminated (see also 'Anonymization').
- Legal Norm Classification. The categorization of norms forms a basis for the legal analysis of cases. This analysis principally follows certain patterns. These are mainly based on the systematic order/function and the interaction of norms, concepts, theories, etc. (that is, on systematic positioning and rational order), which can be reflected by their categorization.

- Machine Translation. Due to globalization of business, legal advice is sought by clients from multiple jurisdictions. Even though advice is frequently given in English, in the international context there still is frequently need for translation. This may be due to regulatory and statutory reasons (e.g., many public bodies like registries require that filings be made in the language of the respective jurisdiction), the involvement of individuals who request documents in their native language in addition to the documents' original language (convenience translations), the inclusion of legal concepts that are best referred to in the original language, etc.

- Document Comparison. The comparison of documents is a use case that has been common to the legal market for years, and in certain respects for decades. It is essential for many tasks which legal practice is faced with. Reliability of the result of the comparison is of the essence. Current software compares the language word-by-word so that satisfactory results are attained only when the comparison is run for different versions of the same document.

- Semantic Matching. Document comparison is essentially designed to identify discrepancies between documents that have the same 'origin', as when looking at different versions of the same document. A future step may encompass the ability to compare different documents that relate to the same content, i.e., software that makes it possible to compare content. This may be achieved through semantic matching. This would be helpful, for instance, in comparing (i) plaintiff and defendant briefs in litigation cases or (ii) agreements and clauses relating to different projects.

- Text Summarization. In legal practice, summarization will particularly become of importance when it comes to provide information such as that contained in legal analysis, rulings, contracts, briefs, data rooms, and the like to stakeholders who need not know every detail, typically either nonlawyers or nonspecialist lawyers. To that end abstraction-based and aided summarization would be appropriate instruments.

- Argument Mining. Legal practice relies on the exchange of arguments in various fields, namely, on the analysis of cases, litigation, and negotiation. Whereas the latter mostly will turn out to be an oral exercise, in litigation as well as in legal analysis relevant content will be derived from data sources stored as hard or soft copy (court rulings, legal literature, court filings). Such content forms the basis for the development of arguments utilized in the relevant context.

- Question Answering. Question Answering does not appear to be the appropriate tool for responding to more complex legal questions such as whether a (more complex) claim exists, which steps need to be taken to allege a claim, to defend against a contended claim, etc. Yet it may be an instrument for answering more 'straightforward' questions that only need to retrieve very specific information from a confined set of documents, even only a single document (which would be a very restricted corpus, even if this is not untypical of daily needs in legal practice), or a wider defined scope of sources of information. In the context of purchase agreements, this may include the period of a statute of limitations, the maximal amount of liability, or the term for alleging a claim. Of course, a set of comparatively 'straightforward' questions may then be aggregated to provide answers of a more complex nature.

Predicting the outcome of legal cases

- Reference and Coreference Extraction. Legal texts frequently contain references. Such references may be explicit or implicit. An explicit reference could be that a

certain clause makes explicit reference to another one within the same document or to a different document. For example, a clause in a contract may make reference to a different clause in the same contract or to another agreement or statute. Instead of citing another clause, the reference may also exist by virtue of using a definition found in a different clause. An implicit reference can be viewed where clauses by their mere meaning require the existence of a different clause without containing an express reference.

- Document Assembling and Generation. Today, many legal documents, particularly agreements, are drafted on the basis of standard forms or precedents. While about a decade ago the manual adjustment of those forms/precedents already constituted a considerable step towards increased efficiency, document automation may be considered the next in this respect. The goal would be that the user provides the relevant, case-specific input and the software will add this at the appropriate space in the respective document. The less the effort that needs to be expended in preparing forms by tagging relevant fields to allow for automated adjustment, the easier the task of preparing documents for automation.

- Voice Transcription. Since its development, voice transcription has facilitated legal practice when thinking of the past customary practice of dictating a lot of work (letters, agreements, briefs, memoranda) which were then typed by secretaries. As a result of computers making their way into the office, on virtually every desk, the relevance of voice transcription may have decreased; however, other fields of practical use may develop such as oral contract drafting in negotiations. By the same token, other practical applications have developed or may do so in the future. For instance, voice transcription has gained importance in the context of investigations where interview minutes can instantly be recorded as machine-readable soft copy, and telephone conversations can far more easily be made part of the corpus of data that is explored; this may also become more relevant in the context of public proceedings.

- Anomaly Detection. Anomaly detection may support legal practice in any effort to increase the accuracy of documents. Yet one would expect that anomaly detection as such is embedded into a commonly used software, possibly as a function that can be activated in a wider context and under a different ‘label’. Also, anomaly detection may be useful in areas like investigations where certain conduct detected as noncompliant can be expected to be ‘not normal’ and thus be found only in rare or unusual circumstances. In this context practitioners are faced more directly with this form of data analysis (i.e., not as a function of another software).

- Data Anonymization. As regards application in the ‘legal’ sphere, data anonymization has a material overlap with the use case ‘named entity recognition’. It is broader in scope, as it would generally encompass the elimination of content that could allow de-anonymization, i.e., not only names. This is of particular importance in light of the requirements of the European GDPR. Any private data that is disclosed to a third party must be anonymized absent the concerned person’s consent. In addition, for reasons other than statutory requirements (e.g., business or tactical reasons) one may decide that information is principally disclosed except for sensitive data.

Contract consistency checking

To solve these tasks and many more, there are a lot of open-source solutions that can be adapted to one’s needs. Among them we should mention the following libraries/frameworks:

- NLTK (Natural Language Toolkit). This tool provides easy-to-use interfaces to over 50 corpora and lexical resources such as WordNet, along with a suite of text-processing libraries for classification, tokenization, stemming, tagging, parsing, semantic reasoning, wrappers for industrial-strength NLP libraries, and an active discussion forum. It is not normally used for tasks requiring deep learning.

- spaCy (https://en.wikipedia.org/wiki/SpaCy) is a software library for advanced natural language processing, written in the programming languages Python and Cython. The library is published under the MIT license. Unlike NLTK, which is widely used for teaching and research, spaCy focuses on providing software for production usage; spaCy also supports deep learning workflows that make it possible to connect statistical models trained by popular machine-learning libraries like TensorFlow, PyTorch, or MXNet through its own machine-learning library Thinc. Using Thinc as its backend, spaCy features convolutional neural network models for part-of-speech tagging, dependency parsing, text categorization and named entity recognition (NER). Prebuilt statistical neural network models for performing these task are available for 17 languages, including English, Portuguese, Spanish, Russian, and Chinese, and there is also a multi-language NER model. Additional support for tokenization for more than 65 languages allows users to train custom models on their own datasets as well.

- Scikit-Learn. A free software machine-learning library for the Python programming language supporting a wide variety of (shallow) machine-learning techniques (it is not normally used for deep learning). It features various classification, regression, and clustering algorithms, including support vector machines, random forests, gradient boosting, k-means, and DBSCAN, and is designed to interoperate with the Python numerical and scientific libraries NumPy and SciPy.

- Transformers and re-rained embedding models (including LegalBERT). State-of-the-art Natural Language Processing for PyTorch and TensorFlow 2.0. Transformers provide thousands of pretrained deep-learning models (e.g., BERT, distilledBERT, GPT-2, etc.) to perform tasks on texts such as classification, information extraction, question answering, summarization, translation, and text generation in over 100 languages. Its aim is to make cutting-edge NLP easier to use for everyone.

- Flair. Flair builds directly on PyTorch, making it easy to train your own models and experiment with new approaches using Flair embeddings and classes. Flair allows you to apply state-of-the-art natural language processing (NLP) models to your text, such as named entity recognition (NER), part-of-speech tagging (PoS), special support for biomedical data, and sense disambiguation and classification, with official support for English, German, Dutch, and Spanish.

- Blackstone (Legal Named Entity Recognition and Text Categorizer). Blackstone is a spaCy model and library for processing long-form, unstructured legal text. Blackstone is designed to perform Named Entity Recognition and Text Categorisation. Blackstone is an experimental research project from the Incorporated Council of Law Reporting for England and Wales research lab ICLR&D. Blackstone is specifically trained for use on long-form texts containing common law entities and concepts. Blackstone has been trained on data spanning a considerable temporal period (as early as texts drafted in the 1860s). This is useful because an interesting quirk of the common law is that older writings (particularly judgments) go on to remain relevant for many, many years. Blackstone's language models have been trained on English case law, and the library has been built with the peculiarities of the legal system of

England and Wales in mind. That said, the model has generalised well and should do a reasonably good job on Australasian, Canadian, and American content, too. The data used to train Blackstone's models was derived from the Incorporated Council of Law Reporting for England and Wales's archive of case reports and unreported judgments. That archive is proprietary, and this prevents us from releasing any of the data used to train Blackstone. Blackstone is not a judge or litigation-analytics tool.

- Legal Reference Detection II. This is a toolkit for extracting references from (English) legal documents. References to law sections and case files are supported.
- Haystack. This is an end-to-end framework for Question Answering or semantic document search, not specialised for the legal domain. It uses Huggingface's Transformers, Elasticsearch, or Milvus. In some cases, it may support Continuous Learning.
- LUIMA SBD. An open-source Python software published on GitHub, for Sentence Boundary Detection in US Caselaws.
- KNIME. A free and open-source data analytics, reporting, and integration platform. KNIME integrates various components for machine learning and data mining through its modular data pipelining concept. A graphical user interface and use of JDBC allows assembly of nodes blending different data sources, including preprocessing, for modeling, data analysis, and visualization without, or with only minimal, programming. It is not normally used for tasks requiring deep learning.
- CiteURL. This is an extensible tool that parses legal citations and makes links to websites where you can read the cited language for free. It can be used to quickly look up a reference or to insert a hyperlink for every long- or short-form citation in a longer text. By default, CiteURL supports Bluebook-style citations to over 130 sources of US law, including most state and federal court cases, the US Code and Code of Federal Regulations, the US Constitution and all state constitutions, and the codified laws for every state and territory except Arkansas, Georgia, Guam, and Puerto Rico. You can also add more sources of law by writing your own citation templates in the YAML format.
- Marian. This is an efficient, free neural machine translation framework written in pure C++ with minimal dependencies. It is mainly being developed by the Microsoft Translator team.
- LexNLP. LexNLP is a Python library for working with real, unstructured legal text, including contracts, plans, policies, procedures, and other material. LexNLP provides functionality such as segmentation and tokenization, pretrained word embedding and topic models, pretrained classifiers for document type and clause type, named entity recognition (i.e., monetary amounts, dates, courts, regulations, and citations), and clustering and classification methods. LexNLP is available under a dual-licensing model. By default, this library can be used under AGPLv3 terms as detailed in the repository LICENSE file; however, organizations can request a release from the AGPL terms or a non-GPL evaluation license.
- Sonnet. Sonnet has been designed and built by researchers at DeepMind. It can be used to construct neural networks for many different purposes (e.g., unsupervised or supervised learning, reinforcement learning).

Formal reasoning

Formal legal reasoning is a discipline of AI&Law that studies how to represent legal knowledge and how to perform logical reasoning over it in an automated way. To this end, many different logical systems have been studied and proposed by the scientific community, each with its own peculiarities. Legal reasoning usually differs from traditional monotonic reasoning in the way it handles uncertainty. In fact, while in monotonic logics (i.e., First-Order Logic) true facts are always true, in nonmonotonic logic some facts may be true for a time and then no longer true (i.e., after a new law has been enacted or a different interpretation has been given to it). Defeasible (Deontic/Temporal) Logic and Argumentation Theory are probably the most common paradigms in literature on legal reasoning.

Open-source tools for such reasoning are as follows:

- SPINdle. This software, written in Java, implements a reasoner to compute the consequence of theories in defeasible logic. The implementation covers both basic defeasible logic and modal defeasible logic.
- openlcbr, an algorithm called IBP that combines case-based and model-based reasoning for an interpretive CBR application, predicting the outcome of legal cases. IBP uses a weak model of the domain to identify the issues raised in a case and to combine the analyses of these issues; it reasons with cases to resolve conflicting evidence related to each issue. IBP reasons symbolically about the relevance of cases and uses evidential inferences.
- DiArg, an Argumentation-Based Dialogue Reasoner. DiArg is a Java library for argumentation-based dialogue reasoning (introduced in this paper). The focus of DiArg is to manage argumentation framework sequences. During a dialogue, arguments and attacks are iteratively added to an argumentation framework and the framework is resolved after each iteration (i.e., after a set of arguments and attack relations have been added).

Computer vision

Computer vision may be needed in several tasks within the scope of legal informatics, i.e. whenever there is a need to automatically process and analyse handwritten documents, images, semiotics, videos, etc.

Open-source tools for computer vision are as follows:

- OpenCV. OpenCV is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage and then Itseez. The library is cross-platform and free for use under the open-source Apache 2 license.
- DeepFace. This is a lightweight framework for Python that does face recognition and analyses facial attributes (age, gender, emotion, and race). It is a hybrid face-recognition framework wrapping state-of-the-art models: VGG-Face, Google FaceNet, OpenFace, Facebook DeepFace, DeepID, ArcFace, and Dlib. These models have already reached and even surpassed humans in the level of accuracy.
- YOLO is a state-of-the-art, real-time object-detection system. On a Pascal Titan X it processes images at 30 FPS and has an mAP of 57.9% on COCO test-dev. YOLO is

an object detection algorithm or model launched in May 2016. YOLO stands for 'You Only Look Once'. This algorithm looks at the entire image in one go and detects objects.

- Tesseract. Tesseract is the most acclaimed open-source OCR engine of all and was initially developed by Hewlett-Packard. It is a free software under Apache license that has been sponsored by Google since 2006. The Tesseract OCR engine is considered one of the most accurate, freely available open-source systems available. With its LSTM-based latest stable 4.1.1 version, Tesseract now covers up to 116 languages. Executed from CIL (command-line interface), Tesseract needs a separate GUI (graphical user interface), as it is not equipped with one of its own. It has a sophisticated image preprocessing pipeline and can learn new information through its neural networks.
- SimpleHTR. This is a Handwritten Text Recognition (HTR) system implemented with TensorFlow (TF) and trained on the IAM offline HTR dataset. The model takes images of single words or lines of text (multiple words) as input and then outputs the recognized text. Three-quarters of the words from the validation set are correctly recognized, and the character error rate is around 10%.

Reinforcement learning

Reinforcement Learning (RL) is an area of machine learning concerned with how intelligent agents ought to take actions in an environment in order to maximize the notion of cumulative reward. Reinforcement learning is one of three basic machine-learning paradigms, alongside supervised learning and unsupervised learning.

In legal informatics, RL can be used for recommender systems and simulations, but also for NLP (text summarisation, question answering, machine translation, sentiment analysis), among other uses.

Two open-source libraries for RL are the following:

- RLlib. RLLib is a lightweight C++ template library that implements incremental, standard, and gradient temporal-difference learning algorithms in Reinforcement Learning. It is an optimized library for robotic applications that operates under fast duty cycles (e.g., ≤ 30 ms). RLLib has been tested and evaluated on Robocup 3D Soccer Simulation agents and physical NAO V4 humanoid robots to learn behaviours and to represent learnable knowledge.
- TRFL. TRFL (pronounced 'truffle') is a library built by DeepMind, on top of TensorFlow, that exposes several useful building blocks for implementing Reinforcement Learning agents.

11. Conclusions of the explorative research and consultation in the Commission

Below is a summary of the conclusions that can be drawn based on the explorative research, the many discussions held (including bilateral meetings), a quick assessment of internal

Commission documents, and the monitoring of recent developments in the domain of legislative drafting.

The vision that emerges centres around a paradigm shift to be triggered by machine computable law. This paradigm shift is enabled by the combination of advances in IT (Artificial Intelligence, Machine Learning, Natural Language Processing, among other technologies), the use of standards, and the progress made in understanding of the theory and practice of law-making. A well-integrated IT ecosystem with an 'Augmented LEOS' at its core has the potential to digitally transform the legislative process and facilitate a structural change in a cooperative culture with a significant positive impact on quality, efficiency, and transparency.

In greater detail, the following very preliminary general conclusions can be drawn:

- The collaborative legal drafting environment EdiT/LEOS as currently developed provides a solid basis on which to build an integrated IT ecosystem and develop an 'Augmented LEOS'.
- The potential offered by machine-consumable legislation provides an additional reason to roll out EdiT/LEOS.
- The explorative work done, along with the meetings held, brings together a full business understanding, in-depth knowledge of modern IT, and unique expertise in the emerging field of legal technology/computational law. This is very valuable.
- There continues to be much interest in the service this study can provide, with a sense that we shouldn't miss the opportunities that current modern IT has to offer.
- The high potential in terms of improving quality and increasing efficiency as set out in the tender specification is confirmed.[34]
- The study points to and highlights other dimensions in which modern IT can have a significant impact, such as serving as a tool in explaining or teaching the drafting of legislation.
- Several related initiatives, relevant activities, and important documents in the Commission (and beyond) have been identified. These include EDDA, the Common Drafting Rules, Translation Methodology and Guidelines using AI and NLP,[35] SeTa/TIM standards,[36] and ManyLaws,[37] the ISA Digital-Ready initiative,[38] and AI

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[34] In the Terms of Reference quality relates to '(i) improving content including consistency/version control/integrity and preservation, (ii) the law-making/policy process throughout all steps in decision making in the Commission, (iii) clarity including accessibility and (iv) facilitation of the implementation up to adoption of law by the Member States' and efficiency relates to '(i) reducing manual/error prone work, (ii) maximizing reuse data throughout the decision-making process including translation and (iii) increasing transparency up to publication.

[35] Brussels/Luxembourg, 26.11.2015, DGT.IS/IP/DH/GH/th-(2015)5977178, DGT Translation Quality Guidelines, https://ec.europa.eu/translation/maltese/guidelines/documents/dgt_translation_quality_guidelines_en.pdf Translation Memory Techniques, https://ec.europa.eu/jrc/en/language-technologies/dgt-translation-memory

[36] Akoma Ntoso, LegalRuleML

[37] ManyLaws: https://www.manylaws.eu/

[38] https://joinup.ec.europa.eu/collection/better-legislation-smoother-implementation/news/june-virtual-breakfast-key-takeaways-0

and Law literature.[39] It is essential to address their fit and integration in the envisaged legal drafting IT landscape.

- The study is pertinent to the recent Commission Communication 'Better regulation: Joining forces to make better laws'. It is in line with the Inter-Institutional Agreement between the European Parliament, the Council, and the Commission on better law-making and provides solid ground on which to implement recent advances as set out by OECD Observatory of Public Sector Information by effectively 'exploring how to embrace more open, digital and innovative practices'.
- The role of LegalXML[40] standards combined with AI techniques is fundamental in providing the necessary context and semantic to the outcomes offered by AI. In particular, it is fundamental in mitigating AI probabilistic methodologies including parameters capable of assigning different weights to obsolete legislation, repealed citations, abrogated regulations, a variety of jurisdictions, and derogation depending on the Member States (e.g., Denmark or now Brexit). The information about the document's lifecycle is very relevant in obtaining a correct interpretation of AI findings and in properly applying the hermeneutic legal methodology used by legal experts.
- Semantic annotation using legal and linguistics ontologies (and metadata) are another fundamental part of the work, especially when it comes to explicating the process performed by AI and the meaning of the output offered by these techniques.

39 ICAIL2021. Proceedings of the Eighteenth International Conference on Artificial Intelligence and Law. Association for Computing Machinery, New York, NY, USA.

40 Akoma Ntoso, LegalRuleML, ELI, ECLI.

PART II: ILLUSTRATING THE POTENTIAL OF AI AND IMPLEMENTATION

This part details the work done to illustrate the potential of innovative IT and discusses how to implement the vision arrived at in Part I. To illustrate the potential, a number of use cases have been identified and developed. In addition, a number of mock-ups to demonstrate how some of novel functionalities identified in the study could be integrated in LEOS are provided. The sections on implementation identify roadblocks, discuss a possible architecture, and consider adopting an open-source approach.

12. Identification of use cases: An overview

The following use cases have been selected based on the discussions in the Focus Group meetings and by considering the availability of the data sets necessary to implement the use cases.[41] These use cases provide a reasonable and hopefully convincing illustration of the business value that can be obtained, and the potential that advanced IT has on offer.

The use cases currently under consideration are four, as follows:

1. Exploring what understanding can be gained by examining a large dataset of corrigenda of regulations. This use case can detect patterns that could be avoided in legal drafting. This will result in benefits in terms of better regulation in general and clarity of legislation. Moreover, it will reduce costs, as republications are avoided and save time/effort.
2. Exploring how IT can be used to document the transposition and consolidation of EU law in Member States. This will bring benefits to both EU Institutions and Member States, and in principle it will make possible a more objective comparison of the state of play. The challenges of this use case are manifold and include the handling of all official languages.
3. Exploring how AI classification can detect derogations and transitory provisions and relating these to the initial obligations. This will improve the searchability of the legal corpus and offer support to legal drafters.
4. Exploring how to support the assessment of an act's digital readiness. Policies (and legislative acts) are digital-ready if they enable smooth and digital-by-default policy implementation through the best use of digital technologies and data.

13. Use cases: Details

Case Study 1: Learning from examining corrigenda[42]

Exploring what understanding can be gained by examining a large dataset of corrigenda of regulations. This use case can detect patterns that could be avoided in legal drafting, with

41 Special thanks to the OP to assist the contractor

42 For more details see the paper Palmirani et.al. 2021, JURIX2021.

benefits that include better regulation, clear legislation, bringing down the costs associated with republication, and saving time in making updated legislation available.

Corrigenda in EU Legislation and a preliminary taxonomy

Corrigenda are a special modification necessary due to an error in the official publication process. Since under the theory of law corrigenda are a material but not substantial error, it has immediate efficacy from the beginning of the legislative act. The modifications introduced by way of corrigenda are thus inserted in the first publication of the text, as if it had never been published differently. Corrigenda involve Directives, Regulations, and Decisions. For this reason, corrigenda need to be immediately published in the EU's Official Journal, and they are immediately implemented in the original text. If we query CELLAR,[43] we get about 24,000 triples that connect each corrigendum to a corrected document, involving all the 24 official languages of the EU institutions, but only about 8,500 of them are connected to the English language variant. The corrigendum actions can be numerous and scattered across different points of their target documents (destination), and they are not just textual but can also play different semantic roles. The aim of this case study is to better isolate the portion of the text involved (greater granularity), to understand the legal role of modifications (e.g., temporal modification) and to understand why they are so frequent. We have prepared a light taxonomy of corrigenda (modificatory instructions), with 25 classes grouped into five macro-areas:

i) ***Structural modifications*** (e.g., provisions, annexes, footnotes, recitals, and preambles)

On page 1, footnote 1: for: '(1) OJ L 145, 13.6.1977, p. 1. Directive as last amended by Directive 2006/98/EC (OJ L 221, 12.8.2006, p. 9).', read: '(1) OJ L 145, 13.6.1977, p. 1. Directive as last amended by Directive 2006/98/EC (OJ L 363, 20.12.2006, p. 129).

ii) ***Temporal legal information*** (e.g., date of efficacy, date of adoption)

On the cover page, on page 11 and page 12, adoption date: for: '15 March 2021', read: '15 February 2021'.

iii) ***Qualified portion of text*** (e.g., definitions, references, modifications of modifications)

On page 257, point (b) of the first paragraph of Article 112: for: '(b) Article 10 and points (a) and (b) of Article 12(1) of Directive 98/79/EC, and …', read: '(b) Article 10, points (a) and (b) of Article 12(1) and Article 15(5) of Directive 98/79/EC, and …'.
On page 98, Article 2(1)(18): for: '(18) "competent authority" means a competent authority as defined in Article 2(1)(26) of Directive 2014/65/EU;', read: '(18)"competent authority" means a competent authority as defined in Article 4(1)(26) of Directive 2014/65/EU;'

iv) ***Entities*** (e.g., role, places, number, organization, etc.)

[43] http://publications.europa.eu/webapi/rdf/sparql

On page 10, in the column 'COUNTRY OF ISSUE':
for:'CZECH REPUBLIC',
read: 'CZECHOSLOVAKIA'.

v) ***Presentational information*** (e.g., images, punctuation, publishing information)

On page 89, in the Annex, on the 12th line 'Austria', in the second column:
for: '343 405 392',
read: '343 473 407'.

Dataset of corrigenda

The first step of the experiment was to select a dataset: this consists of all the corrigenda files in Formex 4.0, in English, with the corresponding original file. The total number of corrigenda files is 2,513, with 3,478 pairs of modifying and modified text. The words in the old text are 87,906 and the words in the new text are 100,416. The average of the modifications for each correcting document is 1.81 modifications, but even corrigenda with up to 77 modification instructions can be found.

The second step was to convert these files into Akoma Ntoso, including the CELLAR RDF information in a unique XML file that, despite not being perfectly marked up, is valid against the AKN-XSD schema or perfectly matches the AKN4EU specifications. This second step makes it possible to have context, normative references, temporal parameters, metadata (e.g., ELI), modifications, and annotation qualifications in a unique consistent XML format. The Publication Office supported the team of the University of Bologna with extraction operations.

Methodology

The methodology used in this work combines unsupervised clustering K-means enriched with Akoma Ntoso annotation and light-taxonomy information. In the end it is a mix of annotated text and unsupervised classification. Unlike much other research in the same field, we want to use the legal document's structural information (e.g., articles) and the light taxonomy extracted using classic NLP techniques. Machine Learning (ML) approaches can classify a part of the legal text as 'definition' or 'modification' and can detect the 'date' included in the sentence, but connecting all this information in a meaningful way can be quite challenging. Additionally, the same corrigendum could be classified in different ways: a corrigendum can be a temporal modification, a table modification, or a definition modification.

We want to go beyond a pure classification methodology and group into clusters the corrigenda modifications using the destination type (table, annex, normative provision, footnote, etc.), the type of modification (substitution, insertion, repeal), the text modified in relation to the old text (when it is present), the role of the text being modified (e.g., definition), and the temporal parameters (e.g., date of application). For this reason, the methodology is called hybrid, and it mixes annotated validated information with unsupervised AI techniques.

The mix of the two could make it possible to obtain a more semantic clustering that can be closer to the legal needs of the domain. The clustering may help the end-user with tools by which to avoid the mistakes that gave rise to the corrigenda. We used KNIME as a Data Analytics tool to compare the clustering with some parameters: similarity distance, typology, granularity of the destination (target) text involved in the modification, and the type of document.

Hybrid pipeline

The pipeline uses a hybrid approach and involves the following steps:

a) ***Preliminary light taxonomy of the corrigenda***. Legal experts have analysed a random sample of corrigenda with a good balance between years, and then they created an agnostic taxonomy of the main modificatory events that is used by the technical team as the light taxonomy needed for the classification. Legal experts have also identified good signals in the text for classifying the corrigenda using regular expressions. We have identified 25 classes.

b) ***Conversion in Akoma Ntoso***. We have converted corrigenda documents from Formex 4.0 in Akoma Ntoso using Python and RegEx.

c) ***Classification of the Corrigenda***. Using simple NLP signatures we have classified the corrigenda using a light taxonomy and the Akoma Ntoso metadata. In this way we have assigned the qualification of each modification (e.g., substitution, insertion, repeal).

d) ***Clustering of the Corrigenda***. We have created clusters of the corrigenda using K-Means algorithm techniques.

e) ***Distance of the text calculation***. We have calculated the distance between the old text and the new text using the Levenshtein distance.

f) ***Data Analytics***. This step combines the results of the previous ones with AKN information, relying on user interfaces to explain some interpretations, statistics, and analyses using KNIME.

g) ***Evaluation***. We set up a legal expert team composed by three members: two members check the work, and the third supervises them and resolves conflicting interpretations. The goal of this step is to evaluate the results of the clustering and of the data analytics work.

h) ***Legal interpretation***. The legal experts use the diff-text and the graphs of the user interface to provide a legal interpretation. In this step we also refine the light taxonomy by adding legal meaning. The same error could also have different meanings and semantics depending on the topic, so the legal interpretation is a fundamental part of the research.

Akoma Ntoso conversion of the corrigenda

We have converted Formex 4.0 into Akoma Ntoso in order to achieve the following goals:

a) **To detect the destination's granular citations.** This information is not present in Formex 4.0, and we have parsed the normative citations to represent the correct destination (e.g.,

article 23, paragraph 3, point a). This is relevant in order to provide the context of the corrigendum's semantic action.

```
<CORRECTION>
  <DESCRIPTION>
    <NP>
<NO.P>8.</NO.P>
<TXT>Page 69, Article 23(3)(a) and (b)</TXT>
    </NP>
  </DESCRIPTION>
  <OLD.CORR FOR.READ="YES">
    <P>for:</P>
     <QUOT.S LEVEL="1">
      <P>
       <QUOT.START CODE="2018" ID="QS0015"
REF.END="QE0015" />environmental limits
       <QUOT.END CODE="2019" ID="QE0015"
REF.START="QS0015" />
        </P>
      </QUOT.S>
  </OLD.CORR>
  <NEW.CORR FOR.READ="YES">
        <P>read:</P>
        <QUOT.S LEVEL="1">
          <P>
            <QUOT.START CODE="2018"
ID="QS0016" REF.END="QE0016" />environmental
performance test limits
            <QUOT.END CODE="2019"
ID="QE0016" REF.START="QS0016" />.</P>
        </QUOT.S>
      </NEW.CORR>
    </CORRECTION>
```

```
<paragraph eId="para_8">
    <num>8.</num>
     <content>
       <p>Page 69, <ref
href="/akn/eu/act/regulation/2016-03-23/2016-
168/!main#article_23__para_3__point_a"
eId="ref_9">Article 23(3)(a)</ref> and (b)
for:
<mod eId="para_8__mod_1">
 <quotedStructure eId="para_8__mod_1__qtr_1">
<p> environmental limits</p>
 </quotedStructure>
read:
 <quotedStructure eId="para_8__mod_1__qtr_2">
<p> environmental performance test limits</p>
 </quotedStructure>.
  </mod>
  </p>
 </content>
</paragraph>
```

b) **To convert the modifications** into metadata that are not represented in Formex 4.0. These are the @period attributes, which qualify the span of time across which the modification is valid; @old and @new, which are also present in Formex 4.0; and @destination with a precise specification.

```
<textualMod type="substitution" period="#eventRef_8">
      <source href="#para_8__mod_1"/>
      <destination href="/akn/eu/act/regulation/2016-03-23/2016-
168/!main#art_23__para_3__point_a" fmx:modLevel="1"/>
      <old href="#para_8__mod_1__qtr_1"/>
      <new href="#para_8__mod_1__qtr_2"/>
</textualMod>
```

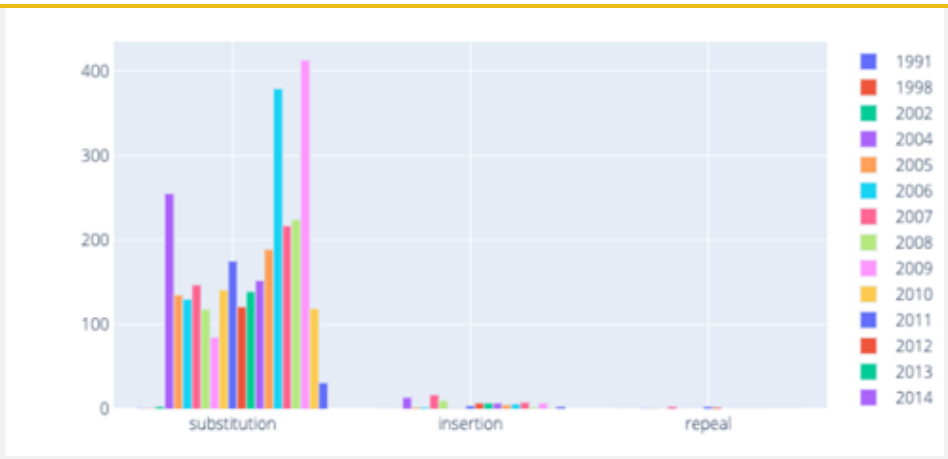

Figure 11 - Qualification of the types of modifications in the corrigenda.

Conclusions: case study 1

Our conclusions[44] can be summarised as follows:

- 1) Too much text is involved in the corrigenda, which could themselves introduce new errors, and it is then very difficult for the end user to detect the new part of the text affected by the corrigendum. Also, the consolidated text offered by the EUR-LEX service is not granularly annotated, and the legal expert needs to read the two texts comparatively next to each other.

2) The clustering operates on the basis of the type of provision involved in the modification and the type of modification (e.g., C4 is mostly modifications at article level, and with modification of the meaning).

3) The statistics detected an intense period of modifications between 2004 and 2009, and that is also to be expected considering the relative figures of the total number of legal documents issued during this period. We need to work on these findings to transform the outputs into a policy to be provided to legal drafters, decision-makers, and the technical team so as to improve the quality of legislation.

4) This work also underscores the difficulty in providing an interpretation and sound evidence of the meaning of the results coming from unsupervised ML and confirmed the hypothesis that a supervised hybrid architecture could also help in the task of explaining AI for better transparency.

[44] See the dataset, the software, the output in https://gitlab.com/CIRSFID/AI4LegalDrafting

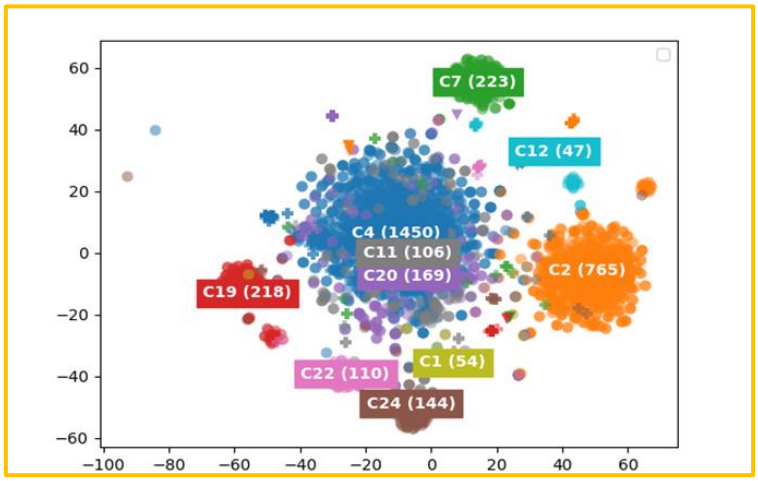

Figure 12 – Classification with K-Means.

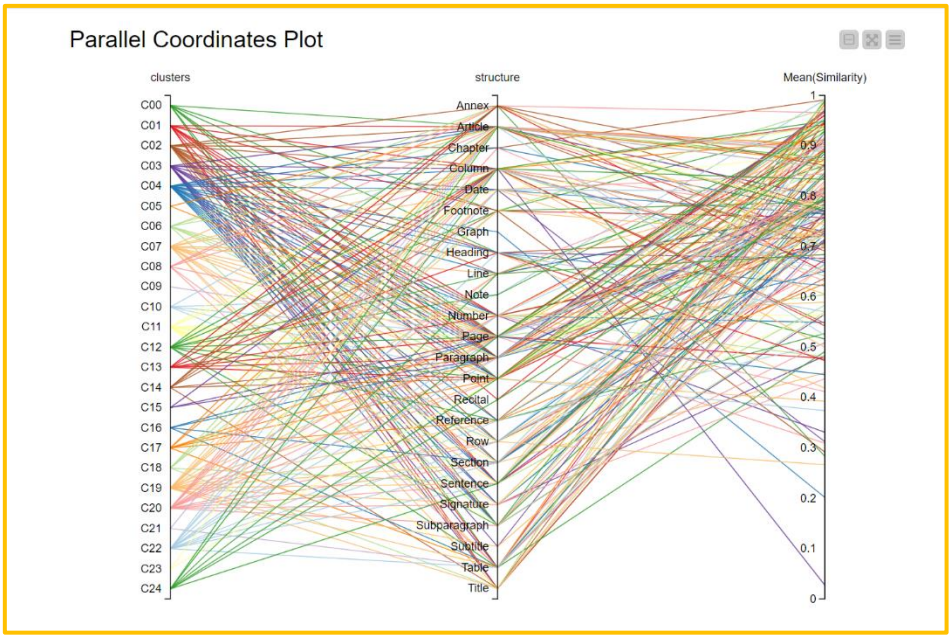

Figure 13 – Levenshtein Distance in relation to the categories and the partition affected by corrigenda.

Case Study 2: Transposition of EU directives

Case Study 2 explores how AI can be used to document the transposition and consolidation of EU law into Member States. The plan is to take the transposition of some directives into Italian domestic legislation and to compare them in order to measure the relationships between the different articles and so identify where the two document diverge.

Dataset

The dataset examined several directives. In particular, we focused our attention on Directive2014/89/EU establishing a framework for maritime spatial planning.[45] We took the FORMEX 4.0 file of this directive from CELLAR database. We converted it into Akoma Ntoso using the Formex2AKN service.[46] We did the same extracting from Normattiva,[47] the Italian legislative portal, using the corresponding implementating Legislative Decree 201/2016,[48]

[45] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014L0089
[46] bach.cirsfid.unibo.it/formex2akn-v2/
[47] https://www.normattiva.it/
[48] https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:2016-10-17;201

and we converted it into Akoma Ntoso. We then extracted all the articles of the two documents using Xpath queries.

Methodology

We created an experiment using KNIME, producing a Cartesian product between each article of the directive and each article of the national law: 17 articles of the EU directive combined for each of the 12 articles in the National Law, for a total of 204 rows. We created pairs that we fed to different similarity AI algorithms (e.g., Levenshtein, Jaro-Winkler, e-gram overlap distance, etc.) for measuring the distance between the articles. We then selected the pairs with the maximum value of similarity, creating a matrix. The matrix is visualized using different graphs connecting on one side the Member State's implementation number of the article and on the other side the article of the directive that has the highest similarity index. In the middle we find the similarity index. We can notice that we have a connection, in all the metrics used, between art. 3 and art. 6 with the lower similarity index.

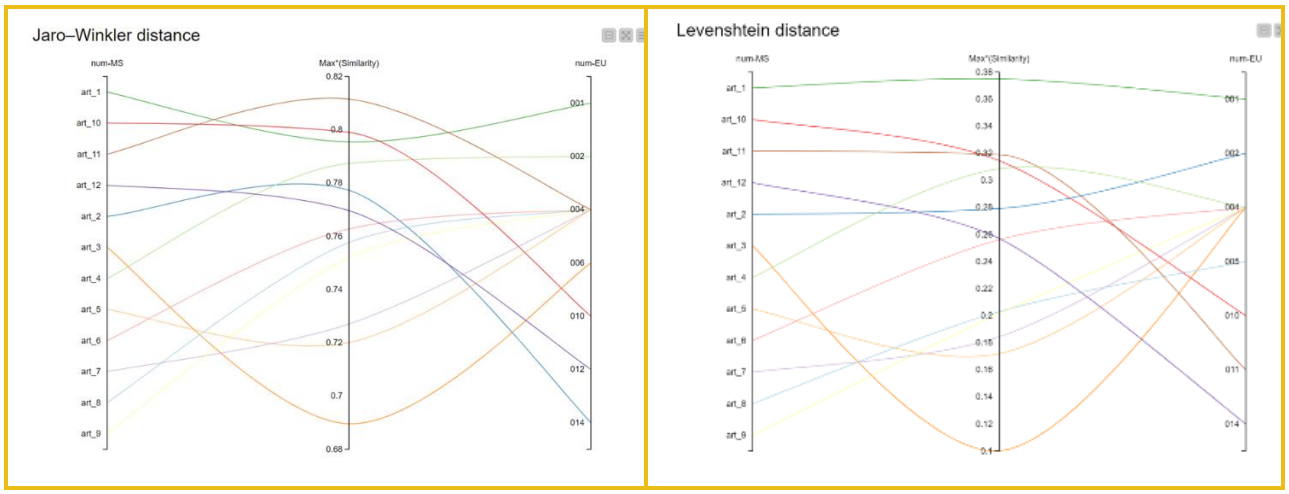

Figure 14 – Jaro-Winkler and Levenshtein Distance between the EU directive and its national implementation.

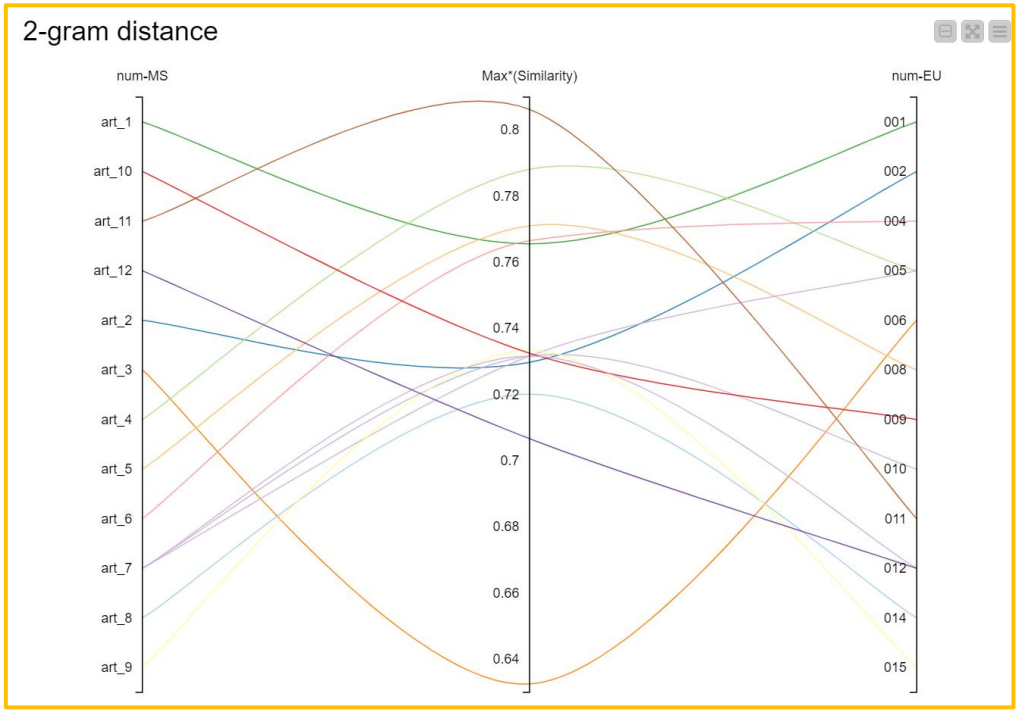

Figure 15 – 2-gram Distance between the EU directive and its national implementation.

Additionally, we correlated the similarity index (see Figure 16), and we noticed that there is a concentration of similarity around articles 5, 6, 7, and 8, but not on the final part of the directive. This is quite normal, considering that a European directive presents the main principles and values in the first part of the provisional norms, and in the final part it usually provides only recommendations and delegation to the Member States' domestic law.

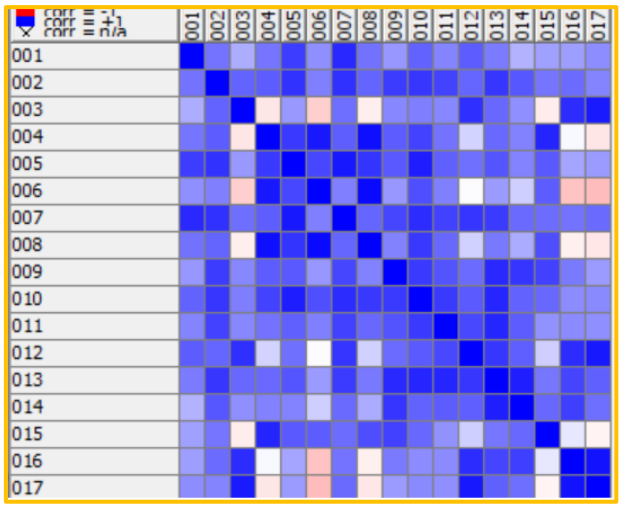

Figure 16 – Linear correlation between the similarity index related to the articles of the EU directive.

Another example is Directive 2014/53/EU, implemented in Italy with Legislative Decree 128/20164.[49] Both documents, the directive and its Italian implementation, are composed of 52 articles. In the following figure we can see the analysis of the similarity index using a Cartesian product. It is evident that there are indexes of a large portion of the text converging with the original directive.

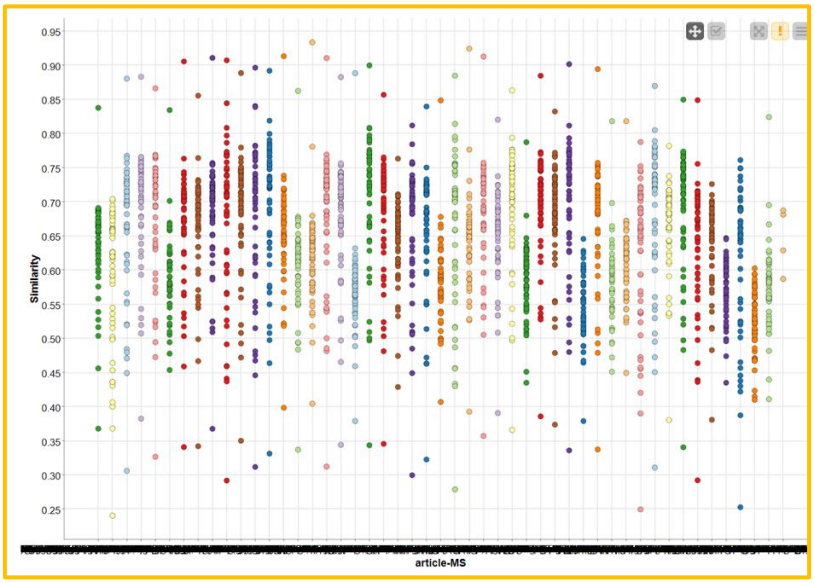

Figure 17 – Distribution of the similarity index using the Cartesian product of 52 articles of the EU directive and 52 articles of the Italian transposition law.

Similarly, to the previous case, we can find that the most similar part of the implementation is on the first part of the normative provisions, and the last articles do not find real

[49] https://www.gazzettaufficiale.it/eli/id/2016/07/14/16G00137/sg

correspondence in the Italian implementation. It is very evident that art. 6 is not implemented in the Italian legislation with the same normative flavour. In fact, art. 6 delegates the appropriate norms (like arts. 35, 37, and 38) to each Member State.

> 'Article 6
>
> Making available on the market
>
> Member States shall take appropriate measures to ensure that radio equipment is made available on the market only if it complies with this Directive.'

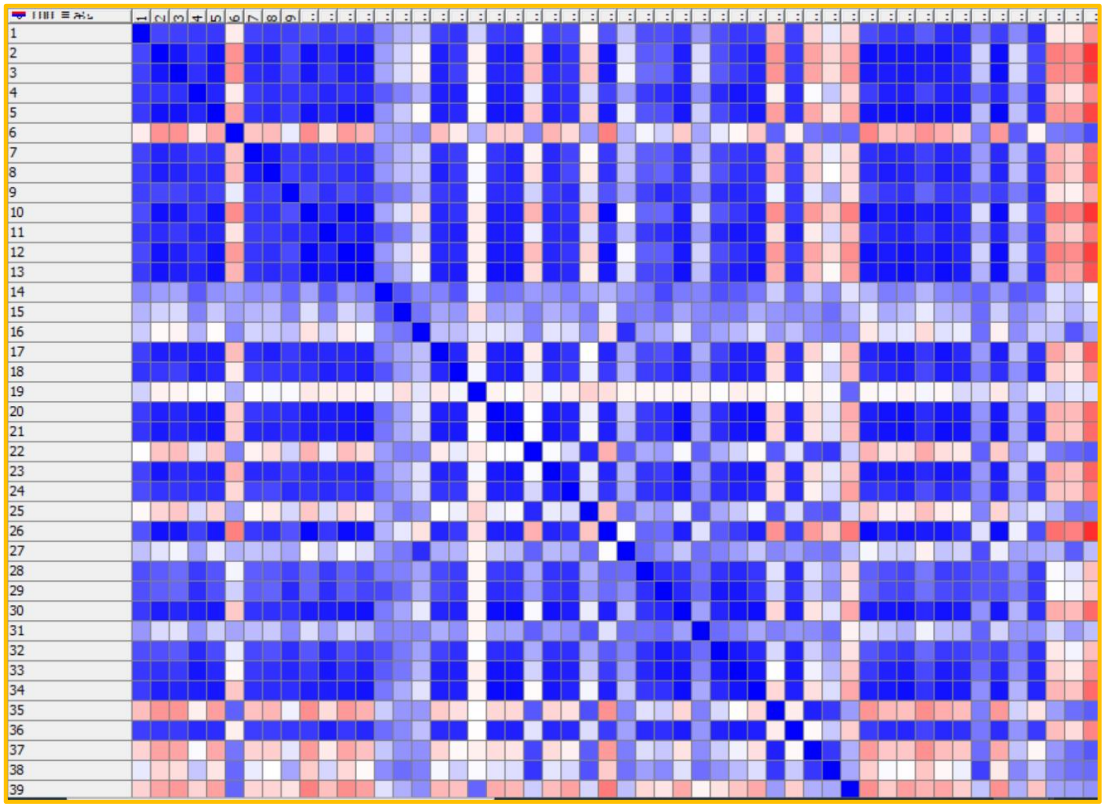

Figure 18 – Linear Correlation of the most relevant articles of the EU directive and the similarity index.

Conclusions: Case Study 2

We have used different graphs, but it is interesting to note that we can see a sort of convergence on some pairs of articles that are correlated. For instance, using the graph in Figure 8, we could visualize the correlation between Member State legislation and the EU directive at article level. In Figure 11 we can notice that some articles are not correlated with anything, and those articles are mostly related to the part of the EU directive where the European legislator delegates the regulation to domestic law. However, this approach should be refined in cases where different directives are implemented in the same legislative document or in the converse case, where different legislative acts implement a single directive. This last case is more difficult to manage, considering the fragmentation of the provisions into different acts, probably with extra noise owed to different purposes.

Case Study 3: Derogations and transitory provisions

Here we wanted to explore how AI classification can detect derogations and connect them with the initial obligations. We also wanted to detect the temporal parameters, when they are declared in the text, and the conditions when the derogation is applicable.

Scenario

A derogation is a legislative tool that makes it possible to create particular subcases starting from a basic obligation, permission, or right. The derogation is frequently connected with the action of 'disapplication', limited to a specific interval of time or related to some special categories of addresses regulated with the specifications of conditions. As we know from legal theory, this instrument is very relevant in preserving rule-of-law principles all the while making for flexibility in some circumstances like the COVID-19 pandemic. However, derogations are difficult to retrieve in the text and across the common legal databases. It is more difficult to track modifications over time. Legal experts and the legal drafters therefor struggle to follow the chain of derogations and thus obtain clear and transparent legal information. Here is an example of a modification of a derogation introduced in response to COVID-19:

> **in Article 13(1), the following subparagraph is added:**[50]
>
> 'By way of derogation from the first subparagraph, the deadline for the submission of the annual implementation report for the year 2019 shall be 30 September 2020.';

Preliminary taxonomy of derogations

Using EUR-LEX, a legal expert isolated 15 categories of derogations along four axes:

1. Frequent linguistic formulations
2. Temporal parameters
3. Relationships between EU legislation and Member States
4. Relationships between primary legislation and delegated acts

We accordingly defined the following categories using the previous four criteria:

Rule for detecting text fragments	Classification	Example
by way of derogation from/to <partition>	derogation_pattern_1	By way of derogation from Article 15(1) of Regulation (EU) No 1380/2013, fish caught in the NAFO Regulatory Area above catch limits allocated by a legally

[50] Art. 1 of Regulation EU 2020/559, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020R0559&from=EN

		binding Union act shall not be retained on-board.
Without prejudice to the obligations defined by <partition>	derogation_pattern_1b	Without prejudice to paragraph 1, any proposal or amendment to a proposal submitted to the legislative authority containing derogations from the provisions of this Regulation other than those set out in Title II…
derogation applied in accordance to/with derogation from/to the <partition> referred to in <partition>	derogation_pattern_1c	Where the Commission considers that the manufacturer is eligible for a derogation applied for under paragraph 1 and is satisfied that the specific emissions target proposed by the manufacturer is consistent with its reduction potential, including the economic and technological potential to reduce its specific emissions of CO.
derogation from	derogation_pattern_1d	In order to ensure an exact follow up of the quantities to be exported, a derogation from the rules regarding the tolerances laid down in Regulation (EC) No 376/2008 should be laid down.
derogation to application	derogation_pattern_2	Derogation to the application of prudential requirements on an individual basis (inside of the heading)
derogation applied in accordance with	derogation_pattern_3	The derogations applied in accordance with paragraph 2 shall be inversely proportional to the availability of the relevant assets.
Good candidate for a derogation / use of the verb ‘may’	derogation_pattern_potential	For the purposes of point (vi) of point (a) of the first subparagraph, derogation may be made in the case of participation of international organisations.

Exception	exception_pattern_1	In any case, all operators and groups of operators, with the exception of those referred to in Articles 34(2) and 35(8), shall be subject to a verification of compliance at least once a year.
Good candidate for exception	exception_pattern_potential	The Member States must use the Transit Customs Office List (COLsome of the customs offices might be missing although this will be the exception. In that case the Member State shall provide the name of the customs office in full.
'shall not apply'	notapply_pattern_1	Article 19 of this Directive shall not apply where a bundle within the meaning of Directive (EU) 2018/1972 includes elements of an internet access service as defined in point (2) of Article 2 of Regulation (EU) 2015/2120 of the European Parliament and of the Council
Good candidate of 'shall not apply' / double negation	notapply_pattern_potential	This new scheme of authorisations for vine plantings should not apply to Member States not applying the Union transitional planting rights regime and should be optional for those Member States where, although the planting rights apply, the vine planting area is below a certain threshold.
derogation AND 'adopt delegated' acts OR 'Delegated Regulation'	pattern_delegatedsActs	The Commission shall adopt delegated acts in accordance with Article 264 concerning the special rules referred to in paragraph 1 of this Article regarding derogations from the requirements provided for in Article 229(1) and Articles

		233 and 237 and imposing additional requirements for the entry into the Union of the following:
derogation AND Member States may/shall	pattern_memberState	Member States shall regularly review derogations under this paragraph taking into account good practices in separate collection of waste and other developments in waste management.
Derogation AND 'The Commission shall, at the request of a Member State'	pattern_memberStateReq	At the request of a Member State, the Commission may allow a derogation from the prohibition set out in Article 13(1) of Regulation (EC) No 1967/2006, provided that a number of conditions set out in Article 13(5) and(9) are fulfilled.
temporary derogation	pattern_temporaryDer	Upon Commission's initiative or in response to a request from a beneficiary country, a beneficiary country may be granted a temporary derogation from the provisions of this section where:

Dataset of derogations

The dataset is made up of legislative acts in the span of time from 2010 to 2020 for a total of 15,328 documents. Each document is a package with a main document and possible further attachments and annexes. The documents are converted into Akoma Ntoso, and using the taxonomy we came up with 13,587 partitions involved in the derogation, using a preliminary 'indicator' taxonomy for extracting the text involved in the experiment.

Akoma Ntoso conversion of Formex

During the conversion we detected the part of the wording involved in the derogation: citations of the main obligation that is derogated from, temporal parameters, and the particular scope being derogated from. Additionally, we have modelled the derogation in Akoma Ntoso metadata in order to reuse them for further statistical elaborations.

Formex	Akoma Ntoso

	<scopeMod type="exceptionOfScope"> <source href="body__art_2__al_3__content__mod_1"/> <destination href="/akn/eu/act/regulation/2012-02-17/965-2012/!main/annex_III"/> <force> <date date="2014-02-20"/> </force> <duration> <date date="2017-02-17" refersTo="#endDate"/> </duration> <condition/> <domain/> </scopeMod>
<ALINEA>By way of derogation from the second paragraph, Member States may choose not to apply the provisions of point ORO.FTL.205(e) of Annex III to Regulation (EU) No 965/2012 and continue to apply the existing national provisions concerning in-flight rest until <DATE ISO="20170217">17 February 2017</DATE>.</ALINEA>	<alinea eId="body__art_2__al_3"> <content eId="body__art_2__al_3__content"> <mod eId="body__art_2__al_3__content__mod_1"> By way of derogation from the second paragraph, Member States may choose not to apply the provisions of point ORO.FTL.205(e) of <ref eId="ref_1" href="href="/akn/eu/act/regulation/2012-02-17/965-2012/!main/>annex_III">Annex III to Regulation (EU) No 965/2012 </ref> and continue to apply the existing national provisions concerning in-flight rest until<date date="2017-02-17" refersTo="#derogationTime">17 February 2017</date>. </mod> </content> </alinea>

We first isolate any and all elements that in the sentence relate to derogation. Thus we isolate the following:

- destination of the derogation <ref> (normative references connected with the derogation in order to produce a graph of all the derogations and the relative norms)
- conditions (e.g., only for the bank, only for the COVID-19 pandemic situation)
- jurisdiction (e.g., only for Denmark)
- temporal parameters (e.g., for six months).

We then model everything in AKN in order to fix the knowledge and to reuse it for the search engine, the semantic web filter, or other sophisticated application.

AI applications

We applied RegEx to classify at first glance the relevant part of the text and analyse the results using the methodology of legal analysis.

Figure 19 – Distribution of the derogation in the interval from 2010 to 2020.

Figure 20 – K-Means classification for types and partitions.

Conclusions

The derogation analysis provided much important information that could be used for better regulation:

- 6% of derogations are delegated to Member State legislation. This is interesting because we can detect the parts of derogations from the EU legislation that involve national law (relationship between EU and Member State law).
- A minimal part is connected with temporal conditions.
- Another minimal percentage is connected with 'delegated acts'. Also, this is relevant in the relation between primary and secondary law in EU sources of law.

Three patterns win out, linguistically speaking, in virtue of how useful they turn out to be in LEOS modelling for harmonizing derogations and markup (this is useful for the search engine):

- "By way of derogation from/to <partition>" - 26%
- "shall not apply" - 20%
- "By way of exception" - 11%

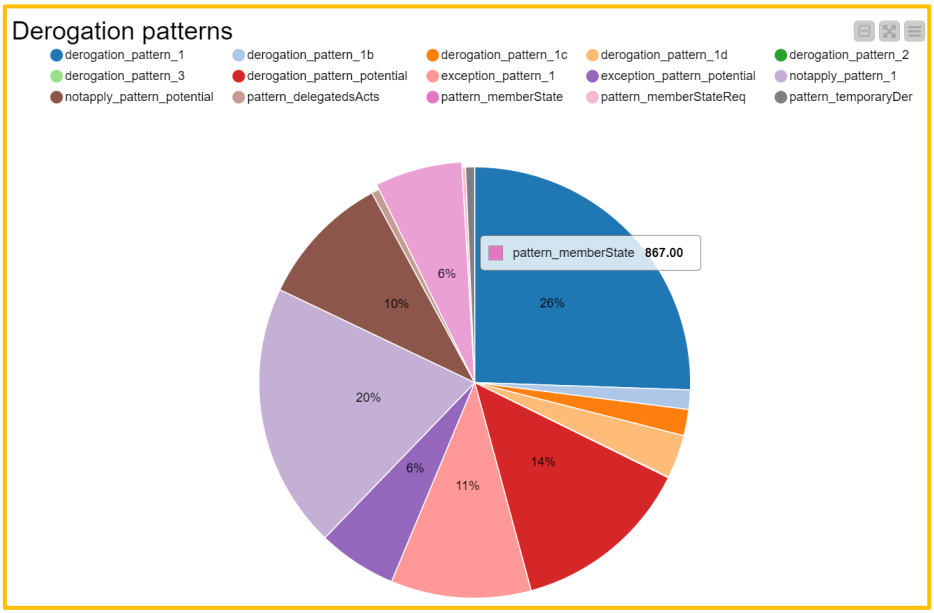

Figure 21 – K-Means classification for types and partitions

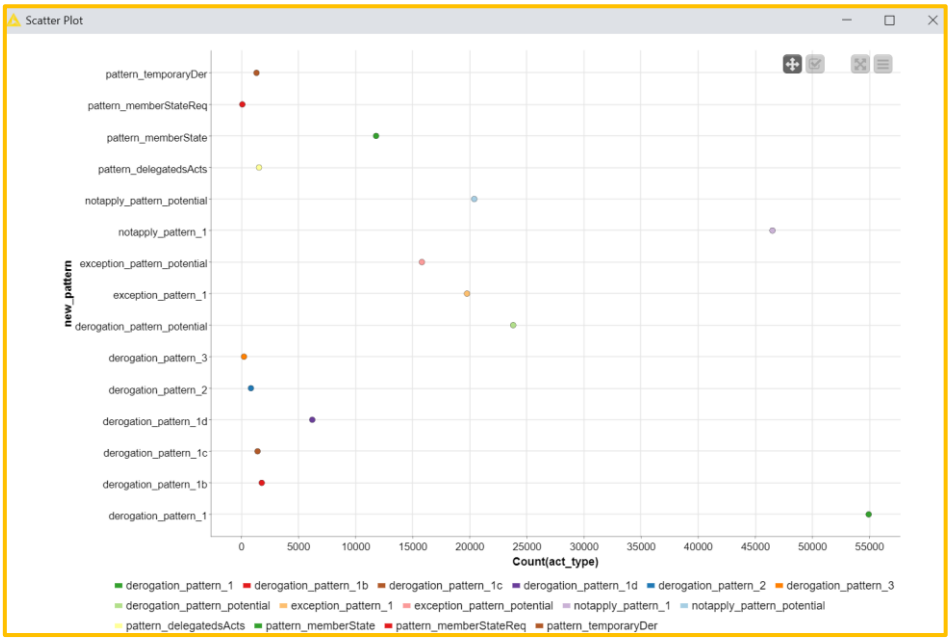

Figure 22 – K-Means classification visualization for types and partitions.

Case Study 4: Checking for digital readiness

Here we set out to explore how to support the assessment of an act's digital readiness: policies and legislative acts are digital-ready if they enable smooth and digital-by-default policy implementation through best use of digital technologies and data. We have three main subgoals in this proof of concept:

1. to calculate an index related to a specific document in relation to the concept 'digital-ready';
2. to calculate how pervasive an effect normative citations and definitions have on the normative system (propagation effect of some definition when it is used a normative citation instead to repeat the definition);
3. to develop a predictive model in order to calculate the index of a new document while drafting small fragments of text.

Dataset

As our dataset, we used European legislation from 2010 to 2020 extracted by CELLAR, comprising 14,369 documents, 78,685 articles, and 2,360.550 rows comparing lists of 'positive' and 'negative' words in view of our 'digital readiness' goal.

This is the index's distribution over time relative to the date of the document: 0 means quite neutral, blue means good for 'digital-ready', red means old-fashioned document. This means that LEOS could integrate this functionality for digital readiness, for 'gender-balancing terms', or for any other important topic you want to monitor through keywords.

This is the distribution of the 'digital-ready' index over the span of years taken into account. Detecting the keyword we can annotate them in AKN within the text and detect them in case of massive modification (e.g., changing 'paper' to 'digital file' or 'male' to 'person'). All the documents were converted in Akoma Ntoso and each article was isolated using the XPath query.

Methodology

We created a preliminary taxonomy of 'positive' and 'negative' words for measuring the digital-readiness index of the text applying TF-IDF at article level. Using the articles of the text in Akoma Ntoso, we detected new terms to add to the list of positive and negative words.

Positive example	Preliminary list
Article 21[51] General requirements for the pharmacovigilance system master file 1. The information in the pharmacovigilance system master file required under Article 77(2) of Regulation (EU) 2019/6 shall be accurate and reflect the pharmacovigilance system in place. 2. The contractual arrangements between marketing authorisation holders and third parties concerning pharmacovigilance activities shall be clearly documented, detailed and up-to-date. 3. Marketing authorisation holders may, where appropriate, use separate pharmacovigilance systems for different categories of veterinary medicinal products. Each such system shall be described in a separate pharmacovigilance system master file.	electronic identification electronic signature electronic seal electronic signature web electronic tickets e-book e-reader non-cash payment electronic payment digital means of exchange file database Wi-Fi

[51] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0128

	digital service digital certification digital content
New candidate:	informatics system, open format, open data

Negative example	Preliminary list
Article 4[52] Requirements for certificates for terrestrial animals and germinal products 1. The official veterinarian shall complete certificates for consignments of terrestrial animals and germinal products in accordance with the following requirements: (omissis) (c) the certificate must consist of one of the following: (i) a single sheet of paper; (ii) several sheets of paper where all sheets are indivisible and constitute an integrated whole; (iii) a sequence of pages with each page numbered so as to indicate that it is a particular page in a finite sequence;	certified copy cheque courier stamp facsimile fax hard copy in writing ink mail microfiche newspaper original copy paper pen pencil post print printout scan seal telex written person identification

[52] http://publications.europa.eu/resource/cellar/267982c7-9218-11eb-b85c-01aa75ed71a1.0006.03/DOC_1

	signature paper documentation paper tickets cash payment digital service durable medium
New candidate:	page, sheet, certificate

After this we used regression AI to predict the index of a new text. Here after the graph of the index for type of document. Blue means good score and good use of the language for the digital transformation, red means bad score and old fashion use of the language.

AI applications

We have applied TF-IDF at article level because a legal document can discuss several topics. In this way we isolated only the articles where the terms are present, and we compensated the positive-word frequency with the negative-word frequency. This is because when presenting a new digital procedure, we often also mention the old process. So when the word 'paper' comes up, it could not mean that the article is defining an old paper-based procedure: it may present the past methodology just to introduce an innovation in the workflow. In the future, this index could be also integrated with specific weights depending on the partition where the word is contained. For example, if the word is contained in a definition, we know that the propagation of this concept is very effective. Similarly, if the word is contained in the heading of a partition is more significant rather than if the word is contained in the recitals. Additionally, we can also consider whether partition X includes citations. In this case the weight is augmented, considering that citations can propagate the effect.

The 'digital-readiness' index is calculated in this manner:

$$I_{dr} = \sum_x [\text{TF-IDF}(X, \text{positiveWord}) - \text{TF-IDF}(X, \text{negativeWord})] * \text{weight}(X)$$

Weights could be as follows:

- Definition 1.5
- Heading 1.4
- Citation 1.5
- Recital 0.5

In a graph we put the value of the index in relation to the time. A negative index means that a document was drafted using with old-fashioned procedures; a positive index means that it was drafted using new digital procedures.

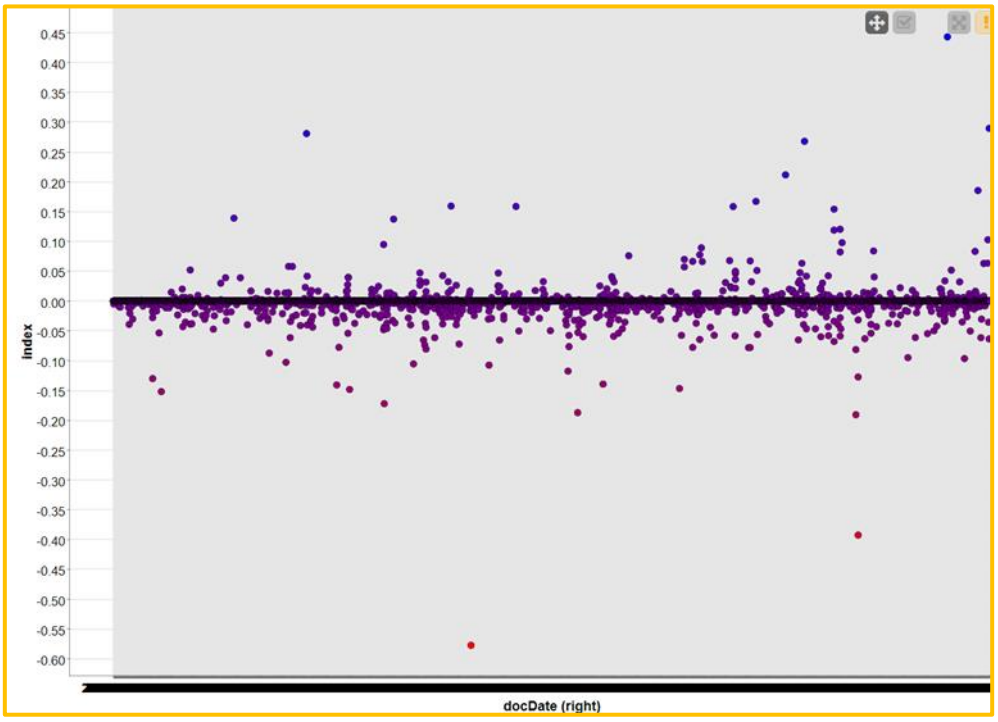

Figure 23 – Distribution of the index.

It is also interesting to analyse the I_{dr} index, indicating relationship between the original document and the citations that could propagate the concept, as well as the reverse citations received. In the following graph we can see the original document being evaluated, the I_{dr} index, and the index of related documents cited.

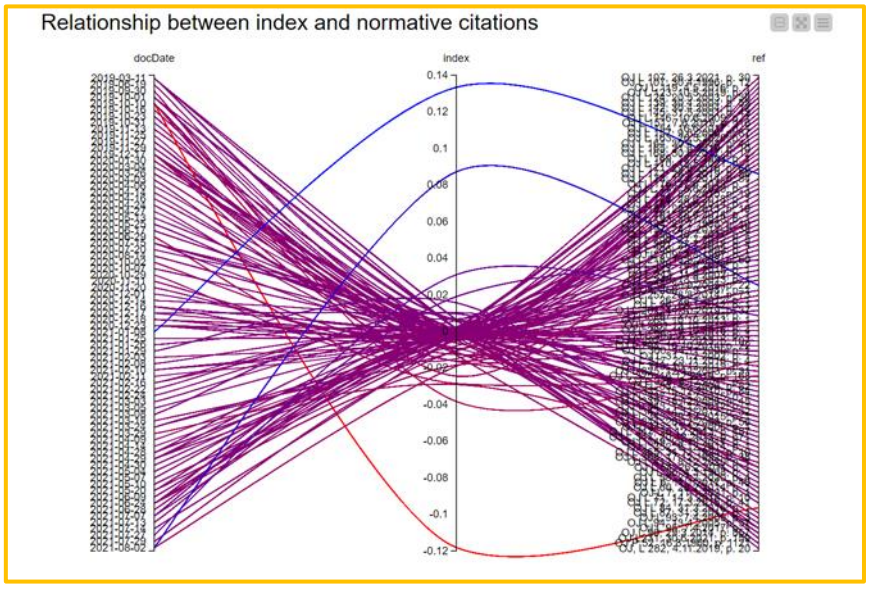

Figure 24 – Relationship within the document, the index I_{dr} and the citations.

We can notice a concentration of the phenomena in regulation instruments.

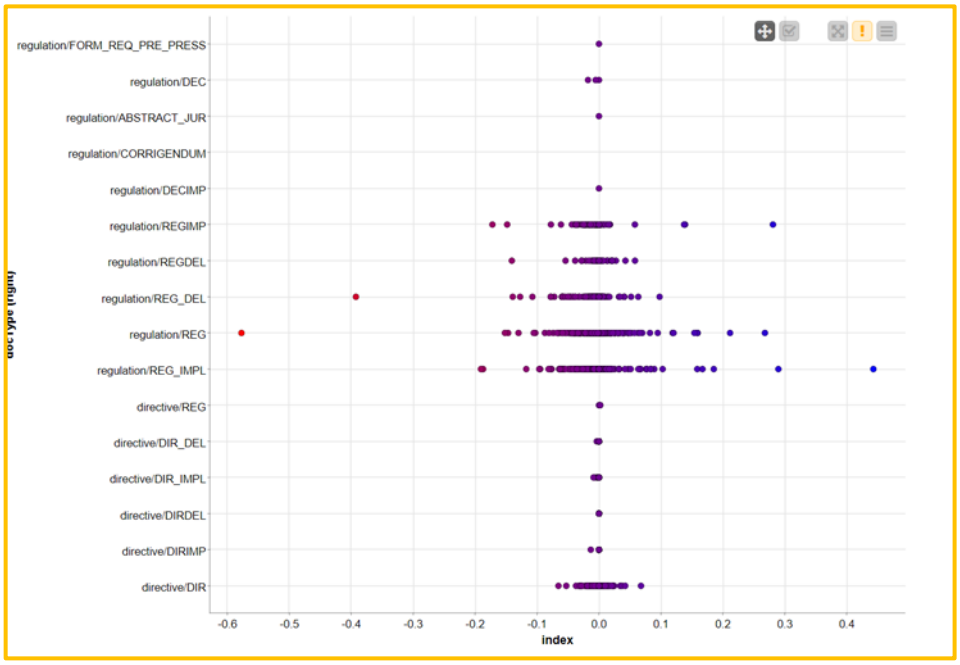

Figure 25 – Distribution of the I_{dr} index and the document type.

On the basis of our classification, we trained a regression-tree algorithm in order to predict whether a new text could be a derogation. This is important when it comes to integrating this functionality in LEOS and in working on small fragments of text in legal drafting and suggesting whether there is a derogation. If a derogation is detected, LEOS can use NLP tools to detect all the portions of the derogation in the language and to serialize all the necessary metadata in Akoma Ntoso XML format. The following graph presents the result of the training set and the testing partition (40% training and 60% testing). The trend is very similar of the previous graph, which records the data without prediction.

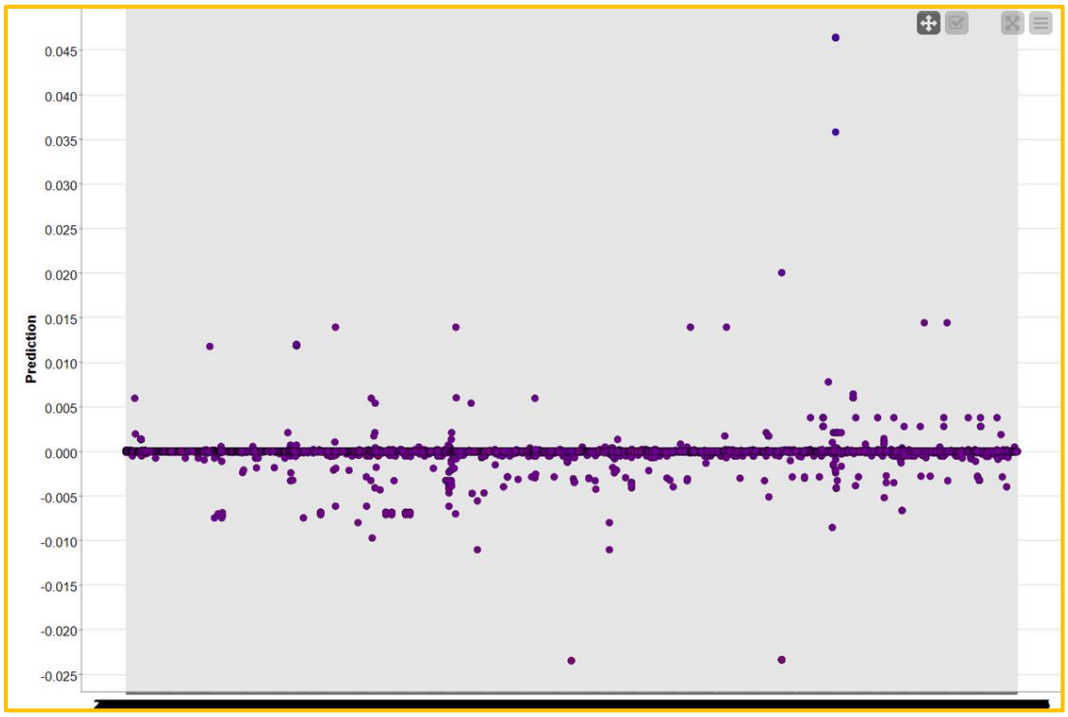

Figure 26 – Predictive output using a regression-tree algorithm.

Conclusions

This case study is promising, and we can create a good tool for monitoring the digital-readiness index ex-ante in the law-making process. A lot of work has been done to extract large amounts of big data, clean them, test different algorithms, compare performance, and evaluate results from a legal point of view. However, the methodology demonstrates how to mitigate some common bias of Data Anlaytics/AI working at article level and considering the citation propagation. The experiment underlines a robust and sound pipeline for preserving legal principles and peculiarities (e.g., article level, following normative references, considering parts of speech). On the other hand we should distinguish part of the text where there is a modification, because the text is devoted to be moved to a modified document, we should also to consider that new digital procedure explain also the old one that has been replaced, the Eurovoc should be calculated on the article not at document level. The same methodology could be applied to different policy goals (e.g., gender balance, people with disabilities). We suggest setting up a task force in responsible for defining a larger taxonomy.

14. Use cases: Benefits

We tested four case studies dedicated to different areas in which AI techniques can be applied, and we identified the following likely benefits resulting from the introduction of these functionalities in the legal drafting workflow:

Use cases	Quality Benefits	Efficiency Benefits
Case Study 1: Learning from examining corrigenda	Textual clarity The ex-post automatic classification of the corrigenda makes it possible to apply them in a more granular manner and to provide better information to the legal drafter amending the same act.	Reducing manual, error-prone work by using patterns. The classification of the typology of most frequent corrigenda makes it possible to create in the LEOS editor a function for preventing the errors. This is an ex-ante functionality.
Case Study 2: Transposition of EU directives	• Facilitating the implementation of law by the Member States, tracking the transposition of law, and supporting adoption. This functionality could visually support Member States in implementing EU directives and could facilitate compliance	• Reducing errors in the definitions during transposition. • Supporting the creation of a harmonized *Acquis Communautaire* across Member States. • Maximising reuse of similar legal concepts.

	with deadlines. Each Member State's autonomy in implementing EU directives is a fundamental legal principle governing the relation between national sovereignty and supranational regulation. These AI applications can underline the corresponding articles between national law and EU directives and can provide a better political tool for implementing local strategies in light of the *Acquis Communautaire*.	• Assisting the implementation of policy priorities in legislation in comparison with European regulations.
Case Study 3: Derogations and transitory provisions	Textual clarity supporting legal drafters and end-user presentation, including accessibility and visualisation (legal design). Linguistic variants and managing temporal versions of each type of legislative document. Logic reasoning using legal norms expressed in the legislative document.	Increasing transparency and searchability up to norms including the different derogations over time. Exceptions are very frequent in the legislative domain, and it is useful to have the ability to make queries to detect them with all the contextual parameters (e.g., jurisdiction and temporal interval of applicability).
Case Study 4: Checking digital readiness	Textual clarity supporting legal drafters in the law-making process, especially implementing the EU Commission's new usage and style guidelines. Supporting the factual implementation of EU policy on the fair use of the language or supporting the digital transformation.	Assisting the implementation of policy priorities in legislation (e.g., digital readiness).

15. Mock-ups

In order to make the functionalities identified in the questionnaire tangible, we are providing the mock-ups below. These mock-ups fall into in two areas, namely, 'Legal Drafting Support' and 'AI for Legal Consistency and Better Regulation'.

The drafting assistant:

Introduction

The feature is deactivated by default.

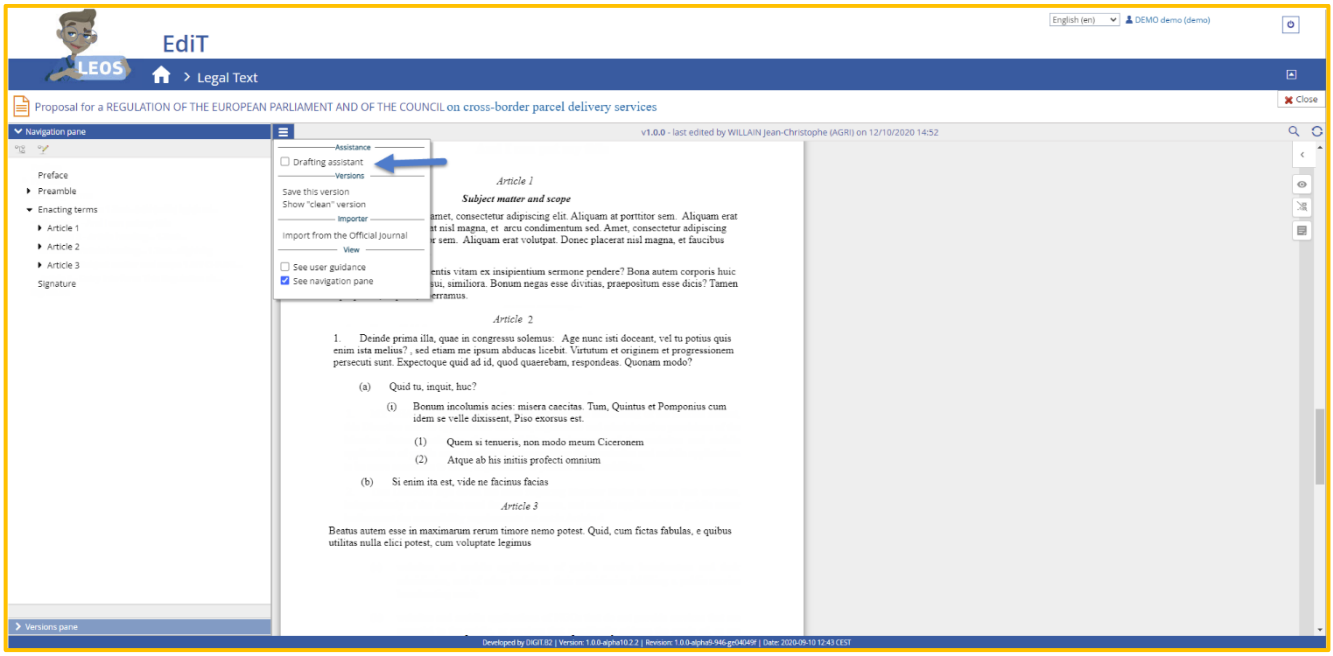

Figure 27 – Activation of the drafting assistant.

On activation, the Assistant Service will, on the basis of an analysis of the proposal, show the places where advice or suggestions for improvement are available.

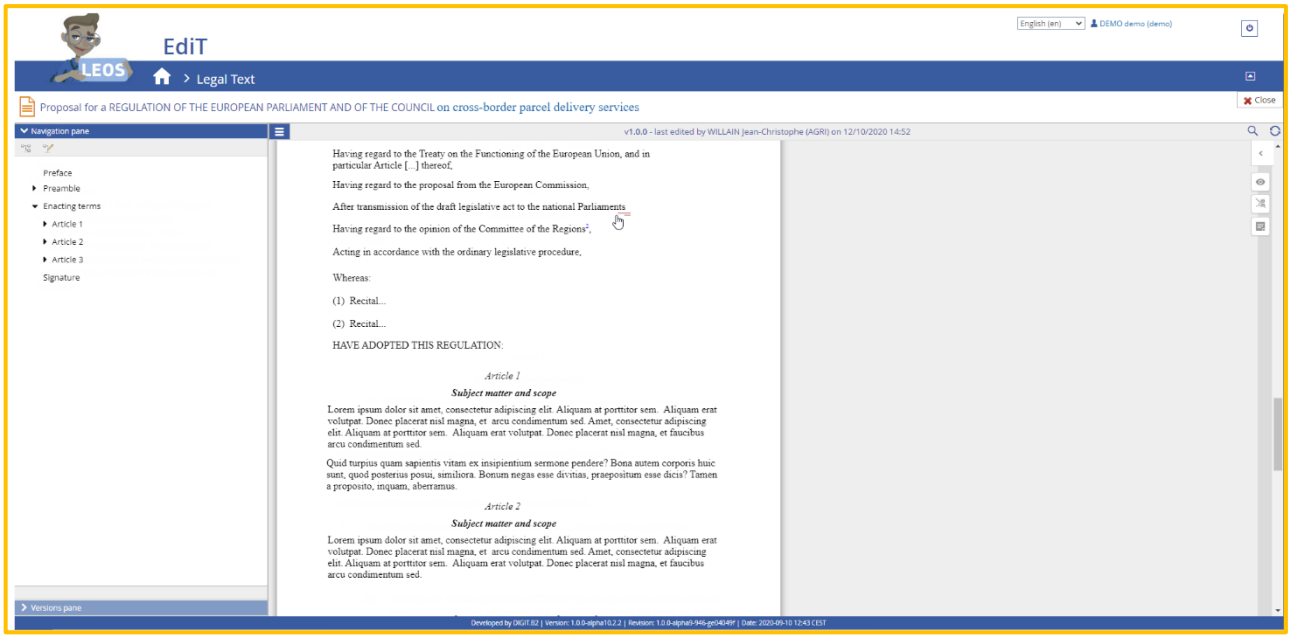

Figure 28 – Visual representation of the advice/suggestions provided by the drafting assistant.

Placing the cursor over these places will display the advice and suggested improvements.

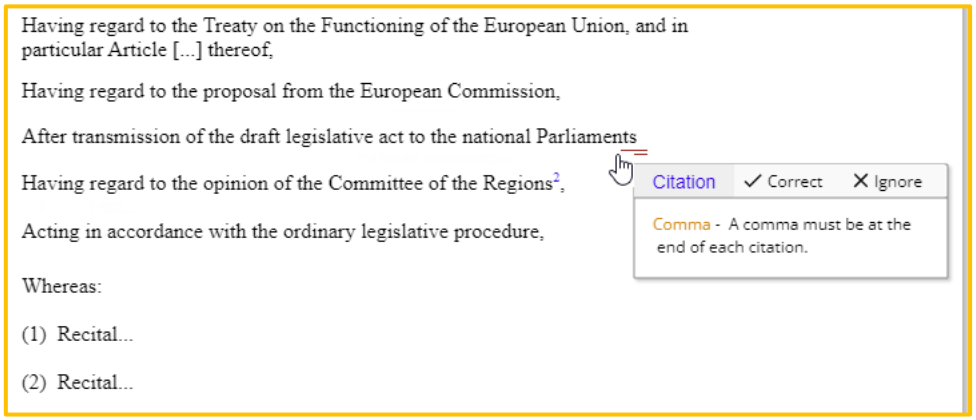

Figure 29 – Actions available on advice/suggestion provided by the drafting assistant.

Legal drafting task support (LDTS)

Description

- Context-aware verification of correct usage of, e.g., citations, references, or the legal lexicon, also detecting similar rules.
- Granular tracking of changes or modifications.
- Legal assistance whilst drafting an act, e.g., to detect and avoid structures that could create issues in legal interpretation, or to spot incompatibilities in temporal parameters, or to identify explicit or implied obligations.
- Discovery of practices, e.g., by classifying corrigenda.

Examples

Case 1: Citations - text autocompletion

If the drafting assistant is activated as the user type, a textual suggestion is offered based on the context and the content typed.

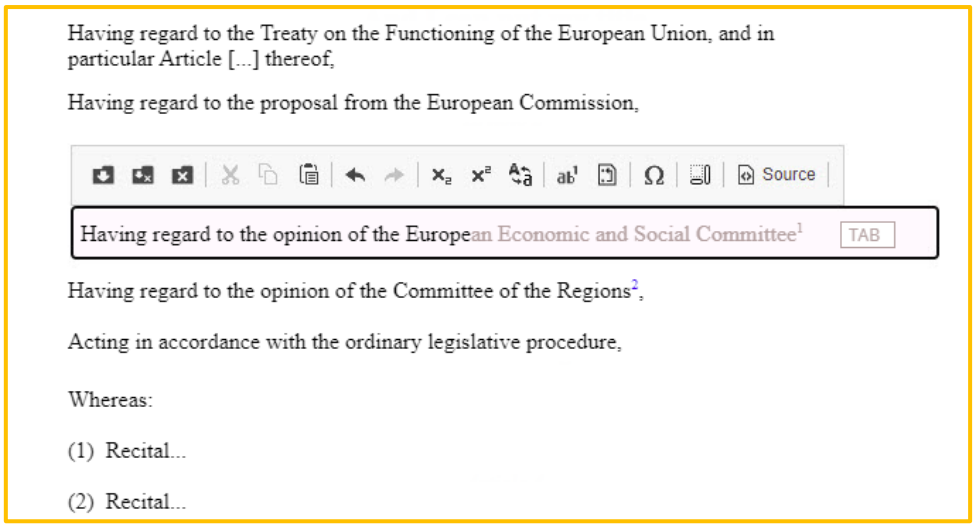

Figure 30 – Autocomplete feature inside the edition area.

In this example, taking into account the position of the text and what the user has already typed, only one suggestion was possible. It is displayed with a small TAB icon next to it. Clicking on TAB would insert the suggestion in the text.

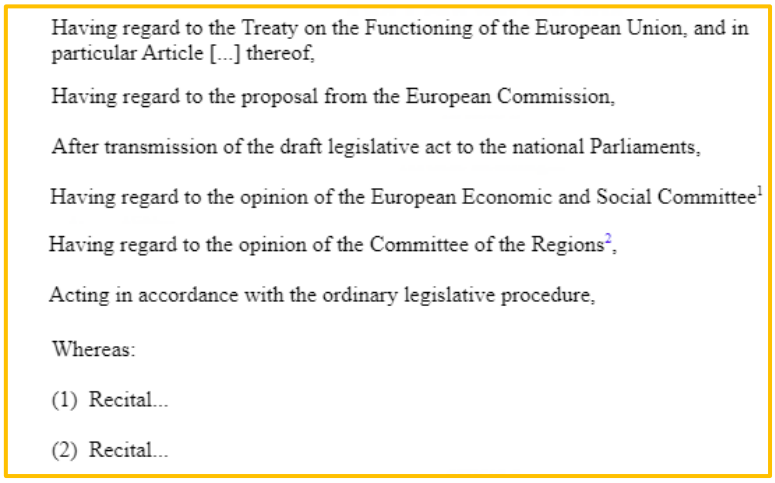

Figure 22 – Final text saved after use of the autocomplete feature

Case 2: Reference – detection of mistyped references

This feature would detect mistyped references based on predefined patterns and offer the proper correction.

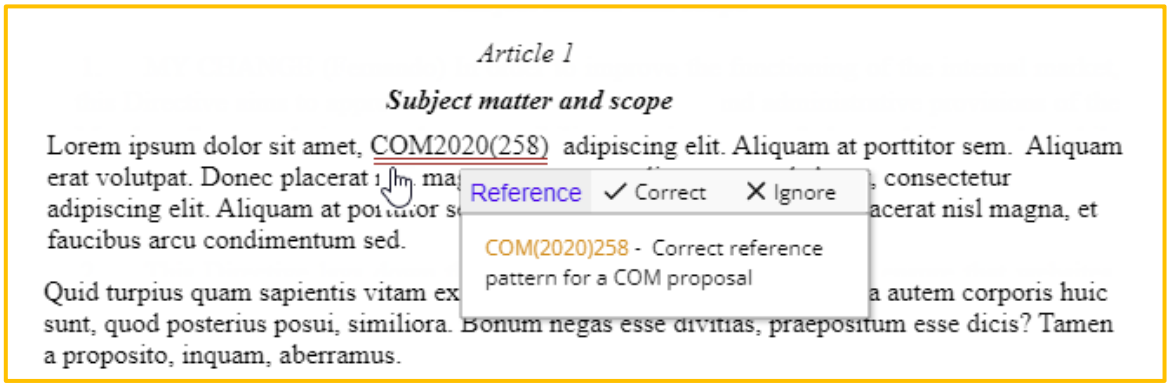

Figure 31 – Mistyped reference detected by the drafting assistant.

Case 3: Syntax - quality correction

In case of syntax mistake, like forgetting a comma at the end of a citation, the tool would notify the user and offer the correction.

Figure 32 – Quality correction detected by the drafting assistant.

Case 4: Proper drafting - legal reasoning

On the basis of context and proper wording or usage, proper usage can be suggested.

Figure 33 – Proper wording proposal by the drafting assistant.

Case 5: Definition check

On the basis of context, definitions can be checked and compared with ones in an already adopted proposal.

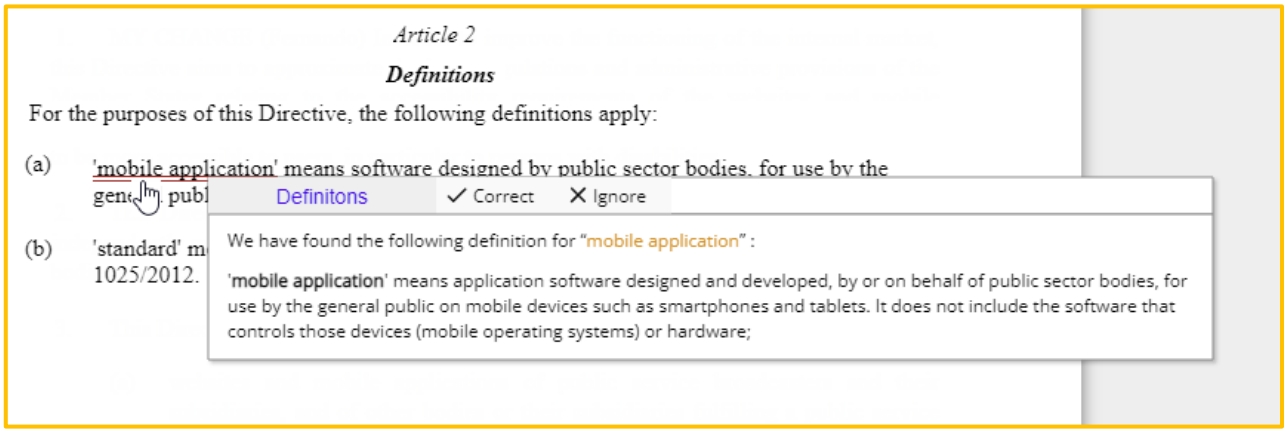

Figure 34 – Reuse of a definition proposed by the drafting assistant.

Case 6: Up-to-date term use: proper term use based on actual legislation

Example: 'eligible liabilities' terms evolved in some particular situation in 'bail-inable liabilities' over time, so the drafting tool could propose the correct lexicon according to the modifications that occurred in the legislation.

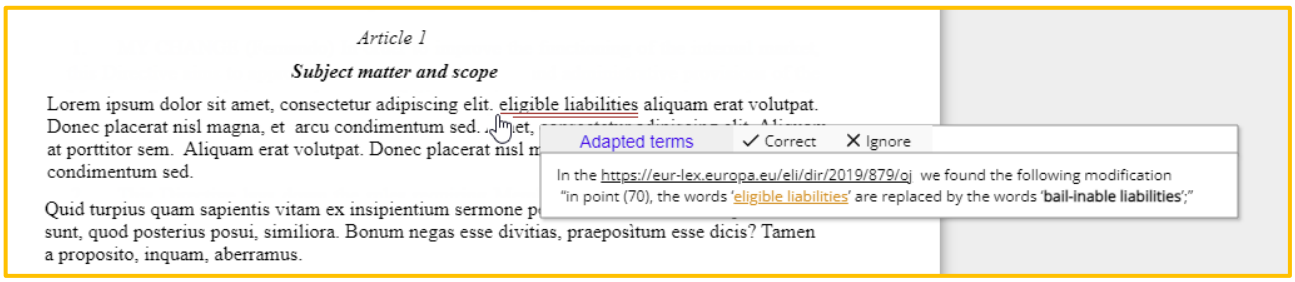

Figure 35 – An alternative term proposed by the drafting assistant.

AI for Legal Consistency and Better Regulation

Description

- Linguistic support in correct formulation in accordance with the EC's *English Style Guide* or support offered by detecting divergences between different language translations.
- Legal assistance within the act by detecting implicit or incomplete modifications or identifying obligations, rights, permissions, and penalties.
- Supporting semantic annotation during legal drafting in an easy way by user-friendly HCI interfaces. This helps legal drafters better retrieve the information necessary to their work and find hidden relationships between connected regulations.
- Supporting gender-neutral language, digital-ready wording, and the nondiscrimination linguistic formulation.

Examples

Case 1: Suggestion: new formulation proposal

On the basis of context and IA textual analysis, other formulations can be suggested to the user.

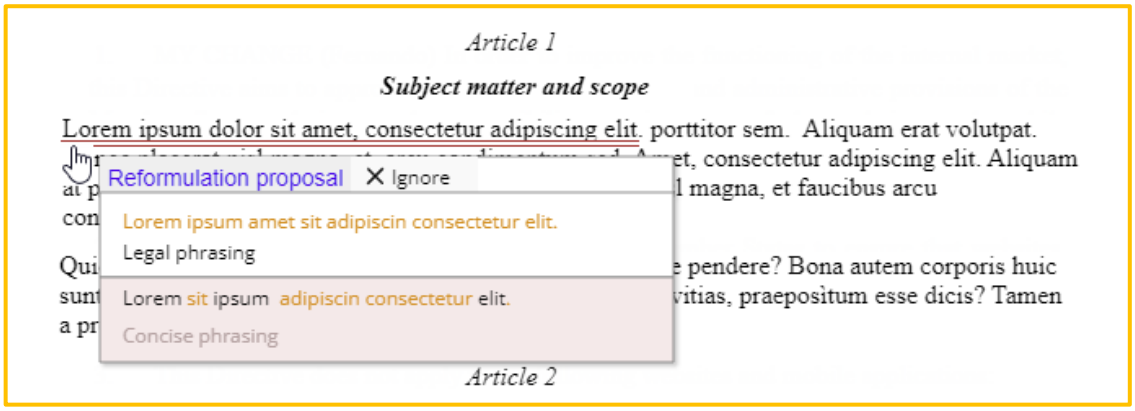

Figure 36 – Reformulation proposed by the drafting assistant.

Case 2: Proper drafting: gender-balanced drafting

General proper usage can be suggested.

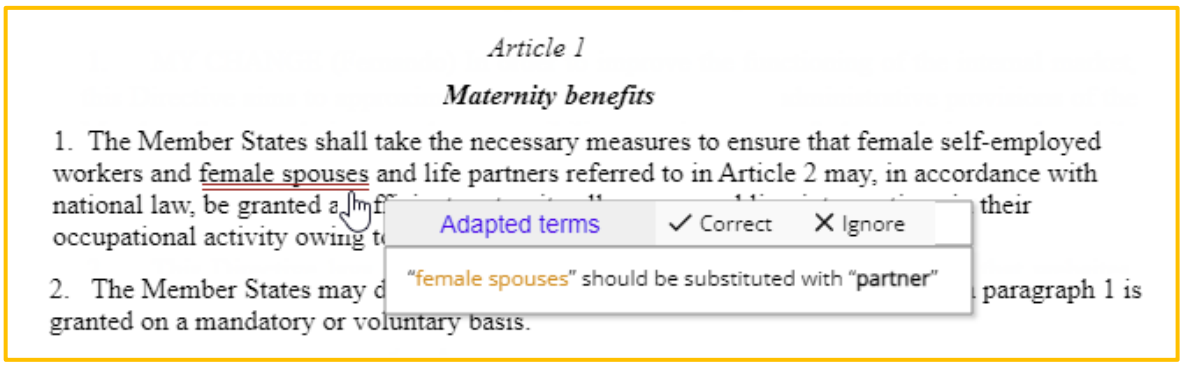

Figure 37 – Gender-balance proposal by the drafting assistant.

Setting priorities

The limited time and budget available for the study meant that we could not develop a process for setting priorities for which functionalities should be implemented as a matter of urgency and which ones would be less worthy of implementation. In principle, functionalities

and their priorities could be identified considering two main factors: business value and feasibility. These could be defined as follows[53]

- Value criteria
    - Potential – What is the possible value potential from a financial and a nonfinancial perspective?
    - Time to impact – How quickly could the benefits be realized?
    - Strategy – Does this align with one's strategic goals as a broader business enterprise?
- Feasibility criteria
    - Effort – Do we have the time needed to prove the case with the current budget?
    - Data – Do we have the right volume, variety, veracity, and velocity of data?
    - Technology – Do we have the required systems, infrastructure, and computing power?

16. Obstacles

Roadblocks

This Section closely follows work done in the OECD.

There may be **institutional and cultural barriers**, a particularly unsuitable legal and regulatory framework, resistance to change, and insufficient **political commitment**, in part due to three factors as follows:

- **Risk aversion:** An unwillingness to take risks and so to try out new technologies that may yield benefits or to explore novel means to pursue strategic goals. **Countermeasure:** Running a small proof-of-concept test or case-study so as to provide a better analysis of the potential risks and benefits.
- **Resistance to change:** Fear of failure or being replaced by automation and disintermediation technologies; fear of offering full transparency brought about by technologies; lack-of-innovation mindset due to a biased perception of the potential offered by innovation; inadequate incentive structure; and rigid institutional setups, as well as organisational rules that discourage experimenting with new approaches or different governmental agencies from cooperating. **Countermeasure:** Codesigning solutions is a good approach for engaging people from the outset.
- **Regulatory challenges** and ethical issues in terms of privacy, security, and fairness. **Countermeasure:** Bringing into the development team legal and ethics experts who can work using law-by-design or ethics-by-design to preserve the legal principles.

Technical and practical challenges, such as the availability of quality data, lack of common standards, and the degree of interoperability between different IT systems.

- **Data quality:** The data extraction from different databases, cleaning activity, and synchronization from a semantic point of view are fundamental steps, and it is not easy to carry out these operations. **Countermeasure:** Converting all the information

53 See Deloitte – study on the use of AI in the domain of documentation

into Akoma Ntoso makes it possible to have a common standard for representing the information, the content of the official text, and the metadata.

- **Data availability and interoperability:** Data availability is the hard part of implementing the AI techniques presented in this report. **Countermeasure:** Conversion into Akoma Ntoso and making the data available as open data.
- **Legal expert team** dedicated to performing some steps of AI (e.g., annotation, supervision, evaluation). The case studies have shown that unsupervised research in the legal domain is still immature; supervised annotation and analysis of the data is a fundamental step in the methodology for reaching sound results. **Countermeasure:** For this reason, it is essential to have a legal expert team dedicated to formulating goals, preparing the dataset, validating the results, and interpreting the outcomes.
- **Human-computer interaction** techniques for implementing the principles of explicability are fundamental. **Countermeasure:** Including HCI validation heuristics for validating software solutions.
- **Ethical analysis** of all the solutions in order to avoid discrimination, build awareness, and take proper action to avoid biases is another important pillar of the methodology in order to achieve compliance with European data and artificial intelligence acts. **Countermeasure:** bringing ethics experts into the team of developers.

Resource and capacity constraints, such as a lack of specific skills, low digital literacy in society, and an inadequate level of investments and funding for R&D or early experiments. A distinction should be made between *developing* the technology and *using* it.

- **Awareness of the technology and its potential:** It is important to offer courses, form focus group, and present the use cases for creating trust in the new technology and critical thought for preventing misuse.
- **Digital capabilities and capacity:** A training plan to improve data literacy and build the capacity to autonomously assess the use of AI.
- **Adequate funding:** It is essential to allocate adequate funding and resources (time, teams, data) to cope with the expected goals. This could be done by allocating a budget to AI in legislation.
- **Specific skills:** Specific skills for data analytics, AI, and manipulation of data in the legal domain are required in order not to support wrong hypotheses and also to engage in counterfactual thinking to test the robustness of findings.
- **New forms of cooperation:** Coworking, codesign, and teamwork are new forms of cooperation that can be tried by pooling resources and setting up interdisciplinary teams.
- **Other aspects** are as follows:
    - Using digital technologies to correctly capture the complexity and multidimensional nature of law and the conflicts it may give rise to; adequately considering the vagueness and ambiguity of legal terms and the problems associated with the use of discretion; paying attention to the diversity of factors that are relevant in making decisions; adhering to the rule of law; enhancing transparency; and properly assigning responsibility for decisions.

Enabling factors

These include the following:

- **Public sector commitment**, most importantly political support, followed by cultural commitment (to innovation and reforms), civil-servant creativity, and a sound legal framework.
    - The implementation of emerging technologies needs open mindsets, leadership, and skills to secure commitment to a sustainable and an inclusive digital transformation.
- **Partner engagement**, from the private sector as technology provider and codeveloper and from various stakeholder communities to leverage progress in advanced digital technologies and to support open innovation.
- **Technological maturity**, creating a dynamic academic environment that spurs creativity, promotes innovation clusters, and encourages advanced research hubs.
- **Education and societal readiness**, as measured by the population's level of digital literacy, the expertise of public servants, buy-in into emerging technologies, and the degree of digitisation in different sectors of society.

17. Implementation considerations

Architecture

It is essential to define an architecture to allow the implementation of an IT ecosystem around an 'Augmented LEOS'. The architecture will be centred around LEOS and will facilitate its integration in decision-making solutions, while allowing for a modular development/evolution of a rich set of 'on-demand' services/plugins.

The swift implementation and deployment of complementary, standardised, and interoperable ICT solutions is a critical element in driving innovation, ensuring sustainability, increasing reusability, reducing fragmentation, and avoiding duplication of efforts. The current LEOS architecture could easily BE extended to support the new functionalities that have been described in this study.

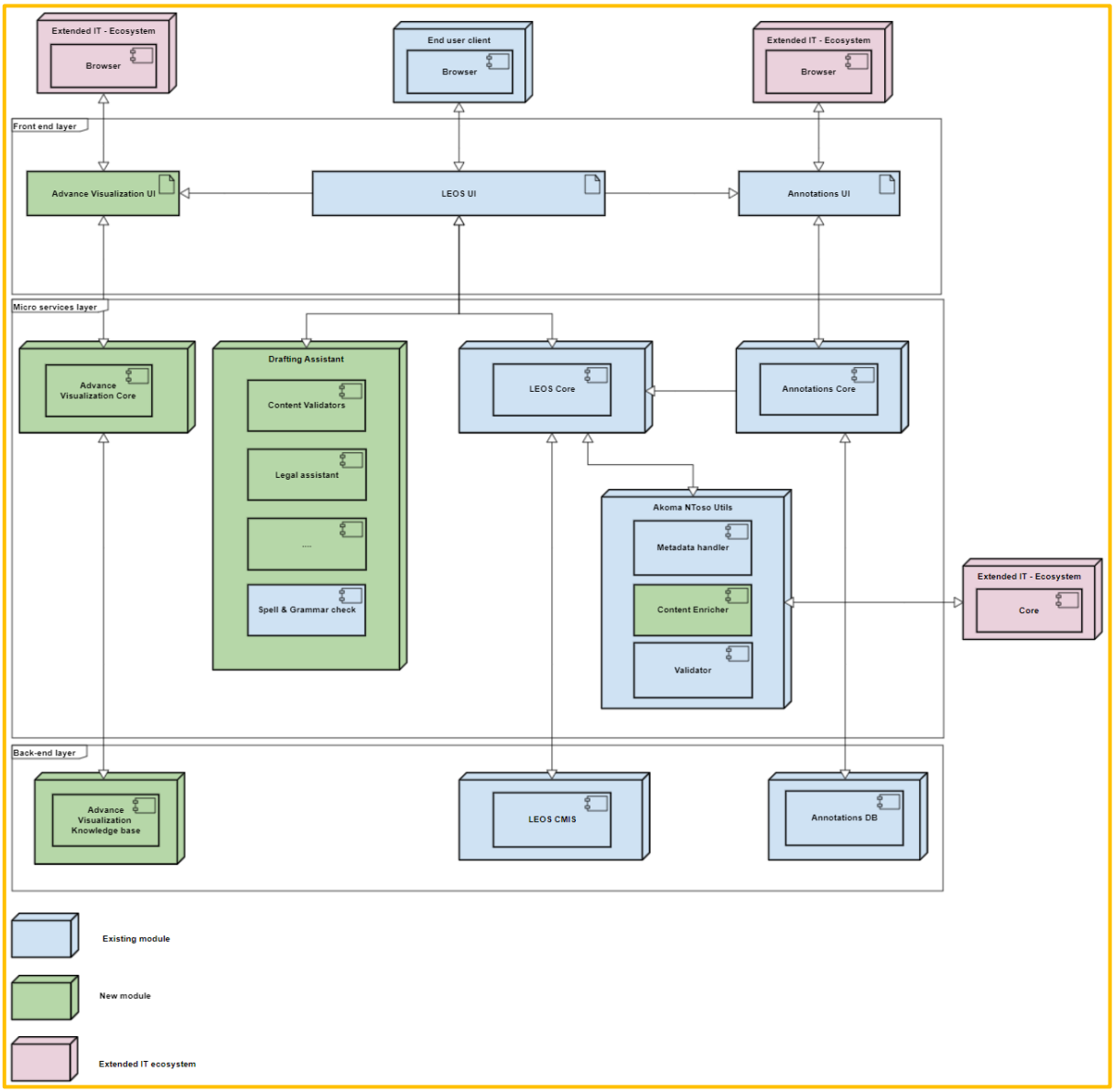

Figure 38 – Architecture representation of Augmented LEOS.

Note: 'Extended IT – Ecosystem' refers to other IT tools around LEOS that handle Akoma Ntoso files, i.e., workflow tools for the decision-making process.

Three areas of extension have been identified:

A. Drafting assistant

A new module to be created in LEOS. This module will contain the implementation of different types of drafting assistants. Submodules could be plugged into the drafting assistants in different phases and aligned with the Agile development strategy.

The drafting assistant will be activated from the 'LEOS UI'; it will scan the current document being drafted and will assist the drafter in different ways:

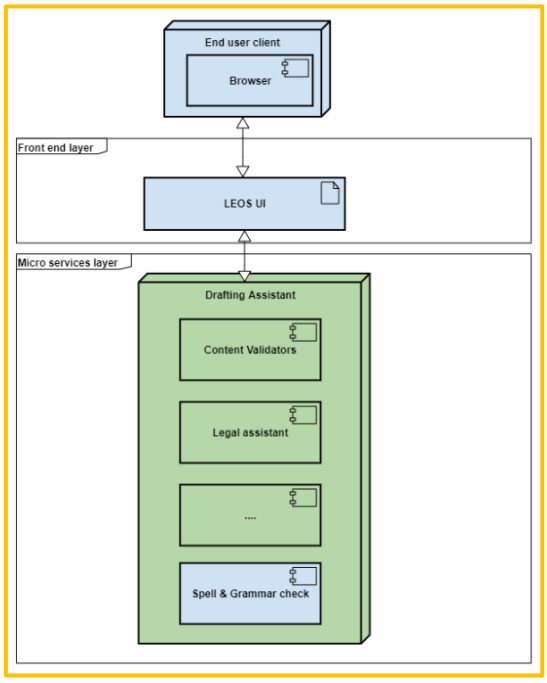

Figure 39 – Drafting assistant architecture of modules and layers.

1. Content validators
    i. For detecting and annotating implicit or incomplete modifications.
2. Legal assistant
    i. For detecting obligations, rights, permissions, and penalties in the text and for permitting 'light legal reasoning' (e.g., if there is an obligation, it is necessary to have a penalty provision that includes citation to the obligation in clear and explicit language).
3. Spell & grammar checker
    i. This submodule already exists in LEOS; it will be added to the drafting assistant module.
    ii. The spell & grammar checker follows the *English Style Guide: A Handbook for Authors and Translators in the European Commission* in order to detect issues in legal drafting.

B. Content enricher

The Akoma Ntoso *utils* module had been created to handle all the different requests to process the inner structure and content of Akoma Ntoso files.

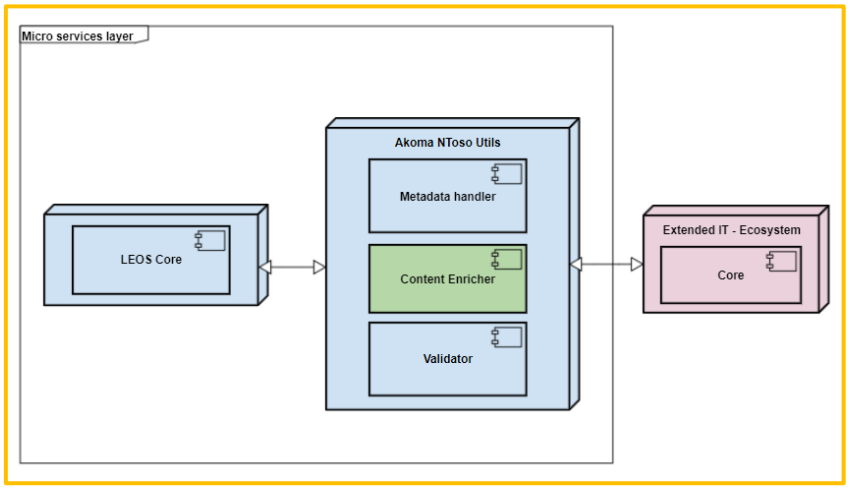

Figure 40 – Content enricher integration in the existing Akoma NToso Utils module.

This module currently already contains two *utils*: (i) 'Metadata Handler' for metadata management, i.e., at the adoption phase of an Akoma Ntoso document the metadata and content have to be updated to reflect the adoption date, location, signature, etc., and (ii) 'Validator', which validates Akoma Ntoso files against the Akoma Ntoso schema.

A new submodule called 'Content ENRICHER' will be added to enrich the content of the files by creating metadata and attributes that would be tedious for drafters to generate by hand; this submodule will be called up from the 'LEOS Core' and from the 'Extended IT – Ecosystem'.

C. Advance visualisation

IT enables smart visualization of legislative content and can be used to (i) summarise complex legal text in simple plain language, (ii) add context around the legal document being drafted, and (iii) visualise consolidation versions, among other functions.

The advance-visualisation architecture will follow the same pattern as the annotations module.

It will have its own user interface that will be called up from the 'LEOS UI' or from the 'Extended IT – Ecosystem'. The Advance Visualization UI will call up the Advance Visualisation Core, where different IT techniques for producing the advance visualisation will be applied. The Advance Visualisation Core needs a backend with a knowledge base that can be used during the processing and generation of the different visualisation outputs.

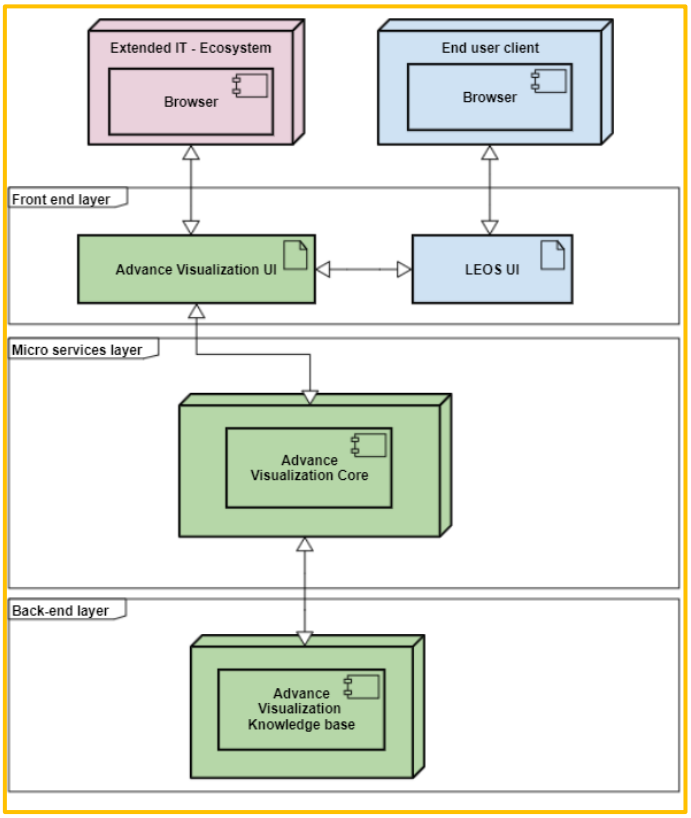

Figure 41 – Advance visualisation architecture of modules and layers.

Implementation strategy and approach

LEOS is driven by an agile, efficient, and pragmatic technical approach that combines established and emerging standards, industry-best practices, and state-of-the-art technologies to empower the delivery of high-quality and highly reusable software products that can be either used in isolation or composed together to implement interoperable ICT solutions. Reliable and sound ICT solutions are essentially achieved by composing independent products (components and services, and even applications), leading to strong architectures and resilient systems. These are better prepared to deal with failures by providing graceful degradation of the affected capabilities and guaranteeing overall system availability. Software components (frameworks or utility libraries) should be implemented in at least one mainstream programming language (e.g., Java, Angular), with the possibility of providing bridge application programming interfaces (APIs) for other languages. This strategy ensures sustainable development of a main reference implementation, high reusability through thin bridge APIs, and lower maintenance efforts. Software services (SOAP web services, RESTful services, or micro-services) should exchange data in well-defined open formats. The focus is on the exchange of rich data structures, where data, together with its schema, is fully self-describing. This strategy ensures easier consumption and a flexible composition of services, independently of programming languages and execution platforms. The performance, resiliency, scalability, and availability of the Augmented LEOS architecture needs to be assured; new modules need to be Cloud-agnostic and to adhere to Cloud Native Application Architecture principles such as

Containerisation. Micro-services and containerization support the agility and dynamism of Cloud-native applications by making it easier to deploy the different modules independently and in different languages or frameworks so as to avoid conflicts or downtime.

Adoption of an open-source approach

It is our desire to turn LEOS into an open-source project 'at scale', on which different teams will 'gladly' contribute code and which is 'broadly' and extensively used in Europe (in EU institutions and bodies and possibly also in Member States). The aim is to 'create a self-driven partnership of committed actors'. This can be done by (i) building/animating an active welcoming community of IT policymakers, IT developers, and users and (ii) setting up a modern IT platform for co-designing, co-developing, and co-deploying an IT ecosystem around an Augmented LEOS.

Our belief in the success of such a project is based on the following:

- Public sector bodies have very similar needs; hence many functionalities are common.
- Only by pooling scarce resources will it be possible to achieve a sufficiently complete IT ecosystem.
- In several Member States a genuine interest already exists that should therefore be nurtured.
- The development of this IT ecosystem would be a unique flagship project—'walk the walk'; the Commission has recently adopted an open-source strategy.
- The time is right, the political climate is technology- and open-source-friendly, and there is an overriding encompassing drive toward digital transformation.

Several prerequisites need to be fulfilled. These include the following:

- A go-ahead in principle by the Commission and, by implication, buy-in from all actors, including the Council.
- A commitment to resource the project over a longer period, meaning several years, consistently with the current Multi-Annual Financial Framework.
- A shared understanding of the scope of the project.
- A common appreciation of the implication of adopting an open-source approach and the cultural change this will require.

In view of the aim pursued by the project, we would make three proposals as follows:

- developing a 'truly' open-source approach 'at scale';
- actively promoting the project as an example to illustrate the Commission's ambition to take up an open-source approach; and
- seeking resourcing (ideally in cooperation with other EU institutions and Member States) under the Digital Europe Programme or HORIZON Europe, for example.

We believe that now is the right time to start by

- upscaling the community-building and partnering effort;
- proceeding to deploy an open-source IT development environment; and
- developing and establishing an appropriate organisational structure.

PART III: ROADMAP AND RECOMMENDATIONS

18. Roadmap

The knowledge gained that was described in Part I and Part II will make it possible to develop a high-level roadmap for action to advance toward the vision of an IT ecosystem around an Augmented LEOS.

Specifically, the study provides inputs concerning the dataset and the tasks of defining goals, training the AI, validating the results, interpreting the output, tuning the model, deploying the technology, integrating the solution with the other IT solutions, and updating the same model. A sample roadmap could look as follows:

Step 1

Step	Creating a common dataset in AKN
Preconditions	Formex4 or editable files in any version, including intermediate versions
Outcomes	Open data dataset in AKN, validated and interoperable

Step 2

Step	Creating a task force for the hypothesis and for formulating the case study
Preconditions	Interdisciplinary teams, with knowledge of legal drafting, data analytics, AI and Law, and LegalXML and expertise in ethics and the law
Outcomes	Validation of results

Step 3

Step	Creating a task force for understanding the end-user
Preconditions	A laboratory dedicated to data analytics and AI tools, for providing a set of libraries as platform in the legislative sector for different usage Involving the end-user with a focus group Legal experts, Ethics experts, HCI experts
Outcomes	An agile methodology for prototyping

Step 4

Step	Community of practice
Preconditions	A set of end-users who can use, reuse, and develop the solutions
Outcomes	An open-source community

Step 5

Step	Periodic assessment
Preconditions	Legal experts Domain experts Developers Data scientists Ethics experts HCI experts
Outcomes	Measurement of the results and tweaking of objectives

19. Recommendations

The following is a preliminary list of recommendations. The list will be discussed and reviewed when presenting the study's results in different forums in the Commission and with stakeholders.

1. Within the Commission, we recommend seeking high-level management support for the direction of travel, embracing innovation while proceeding with caution. Embracing innovation, beyond the status quo implies accepting an increased level of risk, a willingness to explore and engage with new ideas and technologies and to take on a leadership role, where necessary changing our culture and ways of working. This also means a long-term commitment and making relevant resources available in time.

2. We advocate a pondered and thoughtful use of AI in law-making, seeing that the potential contribution this may make to the ongoing digital transformation could be very significant, translating to improved quality and increased efficiency. By 'pondered and thoughtful' we mean the kind of hybrid AI approach argued for in this study.

3. Now is the right time to act: we recommend acting now to do more experimentation and piloting 'closer to business' and 'at scale'. We believe that a solid ground for this start can be found in the work done in the study on the use cases and the mock-ups.

4. In working toward the goal of effective legal drafting in the era of artificial intelligence we could also more concretely start by setting up a multi-skill, multi-domain team devoted to studying how such an ambitious agenda might best be implemented, and we think the roadmap outlined in this study provides a good starting point, even if more work will have to be done to operationalise the roadmap.

5. To this end it seems important to us to strengthen cooperation between services in the Commission and between EU institutions. Several complementary initiatives are ongoing, and there is scope for synergies.

6. Equally crucial, we think, is the need to obtain buy-in from lawyers and policymakers in the Commission. This will require a comprehensive communication plan.

GLOSSARY

ELI - European Legislation Identifier

https://eur-lex.europa.eu/content/help/eurlex-content/eli.html

ECLI - European Case Law Identifier (ECLI)

https://e-justice.europa.eu/175/EN/european_case_law_identifier_ecli?init=true

AKN – Akoma Ntoso OASIS Standard, vocabulary.

CDM - Common Data Model

https://op.europa.eu/en/web/eu-vocabularies/dataset/-/resource?uri=http://publications.europa.eu/resource/dataset/cdm

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REFERENCES

Allen, Layman E, and Engholm, C Rudy. 1978. Normalized legal drafting and the query method. Journal of Legal Education, 380–412.

Allen, Layman, and Saxon, Charles. 1987. Some problems in designing expert systems to aid legal reasoning. Pages 94–103 of: Proceedings of the 1st international conference on Artificial intelligence and law. ACM.

Alschner, W., Keyes J. M. (2020). Translatability of Law and Legal Technology – Findings from Corpus Analyses and Bilingual Legal Drafting in Canada in: The Oxford Handbook of Translation and Social Practices.

Arnold-Moore T. (1995). Automatically Processing Amendments to Legislation. ICAIL 1995, pp. 297-306.

Ashley, K. (2017). *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age*, Cambridge University Press.

Ashley, K., Atkinson, K., Branting, L. K., Francesconi E., Grabmair, M., Walker, V. R., Waltl, B., Wyner, A. Z.: Proceedings of the Fourth Workshop on Automated Semantic Analysis of Information in Legal Text held online in conjunction with the 33rd International Conference on Legal Knowledge and Information Systems, ASAIL@JURIX 2020, December 9, 2020. CEUR Workshop Proceedings 2764 (2020).

Ashley, Kevin D. (1991). Reasoning with cases and hypotheticals in HYPO, International Journal of Man-Machine Studies, Volume 34, Issue 6, 1991, Pages 753-796,

Athan, T., G. Governatori, M. Palmirani, A. Paschke, A. Z. Wyner, et al. (2014). Legal interpretations in LegalRuleML. in *SW4LAW+DC@ JURIX*.

Athan, T., G. Governatori, M. Palmirani, A. Paschke,and A. Wyner (2015). Legalruleml: design principles and foundations. In *Reasoning web international summer school*, 151–188. Springer.

Atkinson K, Bench-Capon, T. J. M. (2020). Danushka Bollegala: Explanation in AI and law: Past, present and future. Artif. Intell. 289: 103387.

Bench-Capon, T. J. M, Araszkiewicz, M., Ashley, K. *et al.* (2012). A history of AI and Law in 50 papers: 25 years of the international conference on AI and Law. *Artif Intell Law* 20**,** 215–319.

Bench-Capon, T. J. M., and G. Sartor (2003). A model of legal reasoning with cases incorporating theories and values. *Artificial Intelligence*, 150:97–142.

Bench-Capon, T.J.M. (2017). HYPO'S legacy: introduction to the virtual special issue. *Artif Intell Law* **25,** 205–250 (2017).

Bench-Capon, T.J.M., Coenen, F.P. (1992). Isomorphism and legal knowledge based systems. *Artif Intell Law* 1**,** 65–86.

Blum C. and Zuber C. I. (2016). Liquid democracy: Potentials, problems, and perspectives. J. Pol. Philos. 24, 2 (2016), 162–182.

Branting, L. Karl, Craig Pfeifer, Bradford Brown, Lisa Ferro, John Aberdeen, Brandy Weiss, Mark Pfaff, and Bill Liao. (2021). Scalable and explainable legal prediction." Artificial Intelligence and Law 29, no. 2 (2021): 213-238.

Breuker, J., A. Gangemi, D. Tiscornia, and R. E. Winkels, eds. (2004). Ontologies for law. *Artificial Intelligence and Law*, 19:239–455.

Breuker, J., and R. Hoekstra (2004) Epistemology and ontology in core ontologies: FOLaw and LRI-Core, two core ontologies for law. In *Proceedings of the EKAW04 workshop on core ontologies in ontology engineering*, 15–27.

Broersen, J., and L. van der Torre (2012). Ten problems of deontic logic and normative reasoning in computer science. In Bezhanishvili and V. Goranko (Eds.), *Lectures on Logic and Computation. ESSLLI 2010*, 35–88. Springer.

Brownsword, R. (2011). Lost in translation: Legality regulatory margins and techno-logical management. *Berkeley Technology Law Journal*, 26:1321–1365.

Casanovas, P., M. Palmirani, S. Peroni, T. Van Engers, and F. Vitali (2016). Semantic Web for the Legal Domain: The'next step, *«SEMANTIC WEB»*, 7:213–222.

Casini, G., Di Caro, L., Governatori, G., Leone, V., Markovich, R. (2019). Proceedings of the 4th International Workshop on MIning and REasoning with Legal texts co-located with JURIX 2019.

Chalkidis, I., Androutsopoulos, I., and Aletras, N. (2019) Neural Legal Judgment Prediction in English. https://arxiv.org/pdf/1906.02059.pdf.

Cummins, John, and Christopher Clack. (2020). Transforming Commercial Contracts through Computable Contracting. arXiv preprint arXiv:2003.10400.

Deakin, S. and Markou, C.: Is law computable? Critical perspectives on law and artificial intelligence, Hart Publishing, (2020).

DGT Translation Quality Guidelines, Brussels/Luxembourg, 26.11.2015 DGT.IS/IP/DH/GH/th-(2015)5977178.

Dimyadi, J., G. Governatori, and R. Amor (2017). Evaluating legaldocml and legalruleml as a standard for sharing normative information in the aec/fm domain. In *Proceedings of the Lean and Computing in Construction Congress (LC3)*.

Ebers, M., Standardizing AI - The Case of the European Commission's Proposal for an Artificial Intelligence Act (August 6, 2021). The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics (2021).

ELI Task Force (2018) ELI implementation methodology: good practices and guidelines. Publications Office.

Filtz, E., Kirrane, S. & Polleres, A. The linked legal data landscape: linking legal data across different countries. Artif Intell Law (2021).

Filtz, Erwin, María Navas-Loro, Cristiana Santos, Axel Polleres, and Sabrina Kirrane. (2020). Events Matter: Extraction of Events from Court Decisions. Jurix: 33-42.

Fitsilis F. (2021): Artificial Intelligence (AI) in parliaments – preliminary analysis of the Eduskunta experiment, The Journal of Legislative Studies.

Flood, Mark D., and Oliver R. Goodenough. "Contract as automaton: the computational representation of financial agreements." Office of Financial Research Working Paper 15-04 (2017).

Floridi L. (2014). *The fourth revolution, How the Infosphere is Reshaping Human Reality*. OUP

Francesconi, E. (2018). On the Future of Legal Publishing Services in the Semantic Web. *Future Internet*, 10, 6:48.

Gandon, F., G. Governatori, S. Villata (2017). Normative Requirements as Linked Data. In *Proceeding of the JURIX Conference Legal Knowledge and Information Systems*, Wyner, A., G. Casini, Eds. IOS Press.

Gangemi, A., M.-T. Sagri, D. Tiscornia (2005). A constructive framework for legal ontologies. In *Law and the Semantic Web*, Benjamins, V. R., et al., Eds., 97–124. Springer-Verlag.

Gordon, T. F., H. Prakken, and D. N. Walton (2007). The Carneades model of argument and burden of proof. *Artificial Intelligence*, 171:875–96.

Governatori, G., A. Rotolo (2019.) Legislative Dialogues with Incomplete Information. In *Proceedings of JURIX 2019*, 93–102.

Governatori, G., A. Rotolo, R. Riveret, M. Palmirani, and G. Sartor (2007). Back to the future: Variants of temporal defeasible logics for modelling norm modifications. In *Proceedings of Eleventh International Conference on Artificial Intelligence and Law*, 155–159. ACM.

Governatori, G., and A. Rotolo (2010). Changing legal systems: legal abrogations and annulments in defeasible logic. *Logic Journal of IGPL*, 18:157–194.

Governatori, G., P. R. Casanovas, L. de Koker (2020). On the Formal Representation of the Australian Spent Conviction Scheme. In: Gutiérrez-Basulto, V., T. Kliegr, A. Soylu, M. Giese, D. Roman, Eds. *Rules and Reasoning*. RuleML+RR 2020. Lecture Notes in Computer Science, vol 12173. Springer.

Greenleaf, G. (2011). Free access to legal information, LIIs, and the Free Access to Law Movement, In Danner, R., and J. Winterton (eds.). *The IALL International Handbook of Legal Information Management*. Ashgate.

Greenleaf, G., A. Mowbray, and P. Chung (2020). Strengthening Development of Rules As Code. Submission to the OECD's OPSI on Cracking the Code (June 23, 2020).

Greenleaf, Graham, Andrew Mowbray, and Philip Chung. "Strengthening development of Rules as Code: Submission to the OECD's OPSI on Cracking the Code." Available at SSRN (2020) (citing CSIRO Data 61 research tools such as 'Parse IT').

Guidotti, R., A. Monreale, F. Turini, D. Pedreschi, and F. Giannotti (2018). *A survey of methods for explaining black box models*. arXiv:1802.01933v2.

Guidotti, R., A. Monreale, F. Turini, D. Pedreschi, and F. Giannotti (2018). *A survey of methods for explaining black box models*. arXiv:1802.01933v2 [cs.CY].

Haapio, H., M. Hagan (2016). Design patterns for contracts. In *Networks. Proceedings of the 19th international legal informatics symposium IRIS*, 381-388.

Haapio, H., M. Hagan, M. Palmirani, A. Rossi (2018). Legal design patterns for privacy. In *Data protection/ LegalTech. Proceedings of the 21th international legal informatics symposium IRIS*, 445-450.

Hagan, M. (2020). Legal Design as a Thing: A Theory of Change and a Set of Methods to Craft a Human-Centered Legal System, *Design Issues* 2020 36:3, 3-15.

Hildebrandt, M. (2018). Law as computation in the era of artificial legal intelligence. speaking law to the power of statistics. *University of Toronto Law Journal*, 68:12-35.

Hildebrandt, M.: Code-driven Law: Freezing the Future and Scaling the Past, in Deakin, S. and Markou, C. Is law computable? Critical perspectives on law and artificial intelligence, Hart Publishing, (2020).

Hoekstra, R., J. Breuker, M. Di Bello, A. Boer, et al. (2007). The LKIF core ontology of basic legal concepts. *LOAIT*, 321:43-63.

https://journals.latrobe.edu.au/index.php/law-in-context/article/view/125/199

Huggins, Anna, Alice Witt, Nicolas Suzor, Mark Burdon, and Guido Governatori.(2021). The Legal and Coding Challenges of Digitising Commonwealth Legislation: Select Senate Committee on Financial Technology and Regulatory Technology Issues Paper Submission.

Leone, V., L. Di Caro, S. Villata *(2020).* Taking stock of legal ontologies: a feature-based comparative analysis*. Artif. Intell. Law, 28, 2:207-235.*

Liga, D., M. Palmirani (2019). Classifying argumentative stances of opposition using Tree Kernels. In *ACAI 2019: Proceedings of the 2019 2nd International Conference on Algorithms, Computing and Artificial Intelligence*, 17-22.

Liga, D., M. Palmirani (2019). Detecting "Slippery Slope" and Other Argumentative Stances of Opposition Using Tree Kernels in Monologic Discourse. In *Rules and Reasoning. Third International Joint Conference, RuleML+RR 2019*.

Livermore, M. A., Rockmore D. N. (2019). Law as Data: Computation, Text, and the Future of Legal Analysis, Santa Fe Institute Press.

Macagno, F., Walton, D., and Sartor, G. (2017). Pragmatic maxims and presumptions in legal interpretation. *Law and Philosophy*. On line first: 1-47.

Marmor, A. (2014). *The Language of Law*. Oxford University Press.

Merigoux Denis, Nicolas Chataing, Jonathan Protzenko. (2021). Catala: A Programming Language for

Micheler, E., Whaley, A. (2020). Regulatory Technology: Replacing Law with Computer Code. Eur Bus Org Law Rev 21, 349-377.

Monarch, R.M. (2021). Human-in-the-Loop Machine Learning: Active learning and annotation for human-centered AI. Simon and Schuster.

Monarch, R.M: Human-in-the-Loop Machine Learning: Active learning and annotation for human-centered AI. Simon and Schuster (2021).

Moroni, S., G. Lorini (2016). *Graphic rules in planning: A critical exploration of normative drawings starting from zoning maps and form-based codes*. Planning Theory.

Moroni, S., G. Lorini (2020). Multiple functions of drawings. *Journal of Urban Design*.

Muthuri R., G. Boella, J. Hulstijn, S. Capecchi, L. Humphreys: Compliance patterns: harnessing value modeling and legal interpretation to manage regulatory conversations. *ICAIL 2017*: 139-148

Navarro, P. E., and J. L. Rodríguez (2014). *Deontic Logic and Legal Systems*. Cambridge University Press.

Nay, J. (2018). Natural Language Processing and Machine Learning for Law and Policy Texts. In https://ssrn.com/abstract=3438276 or http://dx.doi.org/10.2139/ssrn.3438276.

Nazarenko, A., Lévy, F., Wyner, A. (2016). Towards a Methodology for Formalizing Legal Texts in LegalRuleML. *JURIX 2016*: 149-154.

Nazarenko, A., Lévy, F., Wyner, A. Z. (2018). An Annotation Language for Semantic Search of Legal Sources. *LREC 2018*.

Oster, J. (2021). Code is code and law is law—the law of digitalization and the digitalization of law, *International Journal of Law and Information Technology*.

Palmirani, M. (2011). Legislative change management with Akoma Ntoso. In *Legislative XML for the semantic Web*, 101–130. Springer.

Palmirani M., Sovrano F., Liga D., Sapienza S., Vitali F. (2021). Hybrid AI Framework for Legal Analysis of the EU Legislation Corrigenda. JURIX 2021, IOS Press.

Palmirani, M. (2019). Akoma Ntoso for Making FAO Resolutions Accessible. In *Knowledge of the Law in the Big Data*, 159–169. IOS Press.

Palmirani, M., and F. Vitali (2011). Akoma-ntoso for legal documents. In *Legislative XML for the semantic Web*, 75–100. Springer.

Palmirani, M., Bincoletto G., Leone, V., Sapienza, S., Sovrano, F. (2020). Hybrid Refining Approach of PrOnto Ontology, in: Electronic Government and the Information Systems Perspective, Cham, Springer, LNAI 12394, pp. 3 - EGOVIS 2020.

Palmirani, M., F. Vitali, A. Bernasconi, and L. Gambazzi (2014). Swiss federal publication workflow with akoma ntoso. In *Proceedings of JURIX 2014*, 179–184.

Palmirani, M., G. Governatori, A. Rotolo, et al. (2011). Legalruleml: Xml-based rules and norms. In *Rule-based modeling and computing on the semantic web*, 298–312. Springer.

Palmirani, M., G. Governatori, T. Athan, H. Boley, A. Paschke, and A. Wyner (2017). Legalruleml core specification version 1.0. OASIS standard, May 2017.

Palmirani, M., L. Cervone (2014). Measuring the Complexity of the Legal Order over Time. In Casanovas, P., U. Pagallo, M. Palmirani, G. Sartor (Eds.). *AI Approaches to the Complexity of Legal Systems*, 88–99. Springer.

Palmirani, M., L. Cervone, F. Vitali. (2009). *Legal metadata interchange framework to match CEN metalex. I*n *Proceedings of the 12th International Conference on Artificial Intelligence and Law*, 232–233.

Palmirani, M., L. Cervone, O. Bujor, and M. Chiappetta (2013). Rawe: An editor for rule markup of legal texts. In *Proceedings of RuleML 2013*.

Palmirani, M., M. Martoni, A. Rossi, C. Bartolini, and L. Robaldo (2018). Pronto: privacy ontology for legal reasoning. In *International conference on electronic government and the information systems perspective*, 139–152. Springer.

Palmirani, M., R. Sperberg, G. Vergottini, F. Vitali (2018). Akoma ntoso version 1.0 part 1: Xml vocabulary. OASIS standard, August 2018.

Palmirani, M., Sovrano F., Liga, D., Sapienza, S. and Vitali, F. (2021). *Hybrid AI Framework for Legal Analysis of the EU Legislation Corrigenda, JURIX2021, IOS.*

Pasquale, F. (2015). *The black box society: the secret algorithms that control money and information*. Harvard University Press.

Peroni, S., M. Palmirani, and F. Vitali (2017). Undo: the united nations system document ontology. In *International Semantic Web Conference*, 175–183. Springer.

Pertierra, Marcos A., Sarah Lawsky, Erik Hemberg, and Una-May O'Reilly. (2017). Towards Formalizing Statute Law as Default Logic through Automatic Semantic Parsing." In ASAIL@ ICAIL. 2017.

Prakken, H., and G. Sartor (2015). Law and logic: A review from an argumentation perspective. *Artificial Intelligence*, 227:214–245.

Robaldo, L., Villata, S., Wyner, A. et al. (2019) Introduction for artificial intelligence and law: special issue "natural language processing for legal texts". *Artif Intell Law 27*, 113–115.

Rodríguez-Doncel, Víctor & Ponsoda, Elena. (2020). LYNX: Towards a Legal Knowledge Graph for Multilingual Europe. Law in Context. A Socio-legal Journal. 37. 175-178. 10.26826/law-in-context.v37i1.129.

Rossi, A., Palmirani M. (2020). *Can Visual Design Provide Legal Transparency? The Challenges for Successful Implementation of Icons for Data Protection, Design Issues 2020; 36 (3): 82-96.*

Russell, S. J., and P. Norvig (2010). *Artificial Intelligence. A Modern Approach*. Prentice Hall.

Russell, S., D. Dewey, and M. Tegmark (2015). Research priorities for robust and beneficial artificial intelligence. *AI Magazine*, 105–114.

Sartor, G. (2005). *Legal Reasoning: A Cognitive Approach to the Law*. Springer.

Sartor, G. (2009b). Legal concepts as inferential nodes and ontological categories. *Artificial intelligence and Law*, 17:217–251.

Sartor, G., M. Palmirani, E. Francesconi, and M. Biasiotti (Eds.) (2011). *Legislative XML in the Semantic Web. Principles, Models, Standards for Document Management*. Springer.

Savelka, J., G. Trivedi, and K. Ashley. "Applying an interactive machine learning approach to statutory analysis." In Proc. 28th Ann. Conf. on Legal Knowledge & Info. Systems (JURIX'15). IOS Press. 2015

Savelka, J., Grabmair, M. and Ashley, K. (2021) "A Law School Course in Applied Legal Analytics and AI". *Law in Context*, 37 (1): 1-41.

Savelka, J., H. Xu, and K. Ashley. "Improving Sentence Retrieval from Case Law for Statutory Interpretation." Proc. 17th Int'l Conf. on Artificial Intelligence and Law, pp. 113-122. 2019.

Savelka, Jaromir. Discovering sentences for argumentation about the meaning of statutory terms. Diss. University of Pittsburgh, 2020.

Seracini, F. L. (2020). The Translation of European Union legislation. A corpus-based study of norms è un libro di pubblicato da LED Edizioni Universitarie.

Sotiris Leventis, Fotios Fitsilis,and Vasileios Anastasiou, Diversification of Legislation Editing Open Software (LEOS) Using Software Agents—Transforming Parliamentary Control of the Hellenic Parliament into Big Open Legal Data

Sovrano, F., M. Palmirani, F. Vitali. Deep Learning Based Multi-Label Text Classification of UNGA Resolutions. ICEGOV2020.

Sovrano, F., Sapienza, S., M. Palmirani, F. Vitali (2021). A Survey on Methods and Metrics for the Assessment of Explainability under the Proposed AI Act. JURIX2021, IOS.

Surdeanu, M., Nallapati, R., Gregory, G., Walker, J., and Manning, C. 2011. Risk analysis for intellectual property litigation. pp. 116–120 Proc. 13th Int'l Conf. on Artificial Intelligence and Law. ACM.

Swee Won Lo, Yu Wang, and David Kuo Chuen Lee,Blockchain and Smart Contracts, Design Thinking and Programming for FinTech, SingaporeUniversity of Social Sciences - World Scientific Future Economy Series: Volume 4 (2021);

Teubner, G. (1988). *Autopoietic Law: A new approach to law and society*. de Gruyter.

the Law. Proceedings of the ACM on Programming Languages, ACM, 2021, 5 (ICFP), pp.77:1-29.

Tom Barraclough, Hamish Fraser, Curtis Barnes, Legislation as Code for New Zealand (2021) (citing CSIRO Data 61 researchers);

Van Opijnen M., Palmirani M., Vitali F., Van Den Oever J., Agnoloni T. (*2017).* Towards ECLI 2.0. Conference for E-Democracy and Open Government CeDEM (2017), 135-143.

Veale, M., Zuiderveen Borgesius, F.: Demystifying the Draft EU Artificial Intelligence Act 22(4) Computer Law Review International, (2021).

Verheij, B. (2020). Artificial intelligence as law. *Artif Intell Law* 28**,** 181-206 (2020).

Vitali, F., M. Palmirani, and V. Parisse (2019). *Akoma ntoso naming convention version 1.0*. OASIS standard, February 2019.

Vitali, F., M. Palmirani, R. Sperberg, and V. Parisse, et. Alt. (2018). *Akoma Ntoso version 1.0. part 2: Specifications*. OASIS standard, August 2018.

Walker, V., K. Pillaipakkamnatt, A. Davidson, M. Linares, and D. Pesce. "Automatic Classification of Rhetorical Roles for Sentences: Comparing Rule-Based Scripts with Machine Learning." In ASAIL@ ICAIL. 2019.

Walker, Vern R., et al. "Semantic types for computational legal reasoning: propositional connectives and sentence roles in the veterans' claims dataset." Proc. 16th Int'l Conf. Art. Intel. and Law. 2017.

Walker, Vern R., Parisa Bagheri, and Andrew J. Lauria. "Argumentation Mining from Judicial Decisions: The Attribution Problem and the Need for Legal Discourse Models." ASAIL Workshop. 2015.

Waltl, B., J. Muhr, I. Glaser, G. Bonczek, E. Scepankova, and F. Matthes. "Classifying Legal Norms with Active Machine Learning." In JURIX, pp. 11-20. 2017.

Wyner, A. Z., W. Peters (2011). On Rule Extraction from Regulations. In *Proceedings of the International Conference on Legal Knowledge and Information Systems*, 113-122.

Xu, Huihui, Jaromir Savelka, and Kevin D. Ashley Using Argument Mining for Legal Text Summarization,. Jurix 2020.

Zhang, Paul, Silver, Harry, Wasson, Mark, Steiner, David, and Sharma, Sanjay. 2014. Knowledge Network Based on Legal Issues. pp. 21–49 of: Winkels, R., Lettieri, N., and Faro, N. (eds.) Network Analysis in Law. Collana: Diritto Scienza Tecnologia/Law Science Technology Temi, 3. Napoli: Edizioni Scientifiche Italiane.

Zhang, Paul. 2015. Semantic Annotation of Legal Texts. Invited Talk, ICAIL 2015 Workshop on Automated Detection, Extraction and Analysis of Semantic Information in Legal Texts.

Zhong, Linwu, et al. "Automatic Summarization of Legal Decisions using Iterative Masking of Predictive Sentences." Proc. Seventeenth Int'l Conf. on Artificial Intelligence and Law. 2019.

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