TECHNICAL ANNEX

1. EXCELLENCE IN S&T AND NETWORKING

A. MAIN CHALLENGE

The widespread reliance on software and digital systems has prompted both local and international efforts to regulate its operation through legislation. Paradigmatic examples are European laws such as the General Data Protection Regulation (GDPR) or the AI Act, the UK Data Protection Act, the French Loi pour une République Numérique. Also, regulatory aspects of digital systems and software are present in different sectors such as e-finance, health systems, education, etc. A very cogent issue is the ethical imperative on AI, the human rights perspective, its ecological impact, its geo-political implications, etc.

In the following, we will refer to digital systems and software, as well as, hardware and physical devices as **digital artefacts**.

Legal texts and regulations are technical and strive for being formal and precise, yet they can be subject to multiple interpretations as they are framed in natural language. For instance, this is the case with several regulations designed to prevent the manipulation of consumers of digital services: [1]

the EU regulation 2022/2065 on a Single Market For Digital Services prescribes that "the maximum amount of the fine that may be imposed for the supply of incorrect, incomplete or misleading information, failure to reply or rectify incorrect, incomplete or misleading information and failure to submit to an inspection shall be 1% of the annual income or worldwide turnover of the provider of intermediary services or person concerned in the preceding financial year";

the GDPR forbids *unfair* data processing techniques;

the AI Act forbids practices aimed to "the placing on the market, the putting into service or the use of an AI system that deploys subliminal techniques beyond a person's consciousness or purposefully manipulative or deceptive techniques".

Besides introducing coordination and interpretation in conjunction with other legislation (such as the competition law), this proliferation of regulations shows that there is an extremely high level of complexity in the precise legal boundaries of (properties and requirements of) digital systems [1]. Moreover, the form of these documents can be more *descriptive/permissive* (defining rights, statuses, or situations without imposing action) than *normative* (defining duties, obligations and how to ensure them), also depending on their position in the hierarchy.

In contrast, digital artefacts must be defined in formal languages in order to meet their requirements when used in the field. This fundamental mismatch hinders effective enforcement of legal aspects and can result in the misapplication of the law.

The aim of this Action is twofold in order to fill the significant gap that remains between *legal frameworks* and the *digital artefacts*: on one hand to validate digital artefacts against the legislation governing them and, on the other hand, to develop approaches to support legal processes through sound digital artefacts.

A number of specific problems are being addressed by different communities:

P1. What are the models amenable to automation and suitable to support formal and precise human-based analysis

P2. How to extract algorithmic models for normative aspects of legal texts.

P3. How to determine inconsistencies and inadequacies in the models extracted.

P4. How to assess efficiency and efficacy of the verification methods use in terms of decidability, complexity, resource requirements, modularity

P5. How to determine if algorithmic solutions should be applied or not?

P6. How to establish the adequacy of state-of-the-art digital artefacts for supporting the realisation of legal requirements?

Addressing these problems requires a coordinated effort. We need a community building initiative to create the critical mass to understand these problems both from the regulators and from the digital developers point-of-view. As observed in [2] "debating some issues intelligently required not just a knowledge of law or of technology, but of both. That is, some problems cannot be discussed purely on technical grounds or purely on legal grounds; the crux of the matter lies in the intersection."

Despite the fact that Computer Science (CS) has important legal applications (and it is offered to students in some departments of humanities subjects as an optional module), it is far apart from Law or Socio-Political and Human Sciences. Telling, in that respect, is the fact that in Law Departments the so-called "Legal CS" is taught more often by legal scholars (frequently possessing a rather limited technical knowledge of CS) than by researchers with an expertise in (general) CS. As a result, no real attempt has been made up to now to bridge the disciplinary gaps between CS, on the one hand, and the Humanities (broadly conceived), on the other. The construction of common grounds starts from the reconciliation of the different interpretations of seemingly similar concepts adopted in these disciplines. A paradigmatic example is the notion of 'formality' which in CS refers to mathematical and logical rigour amenable to the development of computational systems while in e.g., Law 'formality' may primarily refer, especially when legal practitioners and academics use it in argumentation either of legal concepts constituting the structure of law or of authoritative sources [3]. Ultimately, our aim is to propose approaches and tools to make sure the adoption of digital artefacts leads to practices following the laws regulating them.

B. OBJECTIVES

The Action aims to bridge the gap between digital artefacts and the legal frameworks that govern them. To achieve this goals, we focus on two key intermediate components:

Models that suitably represent regulations, such as logical rules in the case of laws, or workflows in the case of judicial and administrative procedures;

Verification/Audit methods that ensure these formalised regulations are upheld by digital artefacts, such as consistency checks or *on-field* monitoring.

Specifically, our scientific objectives are:

SO1. *Extract normative key elements from regulations*. Laws for digital artefacts comprise *neustic* components (i.e., normative parts) that need to be told apart from *phrastic* ones (i.e., descriptive parts) and be turned into prescriptive requirements in order to give tangible mandatory obligations that can be automatically converted in checking tools. Like Taxation Law is algorithmic, and thus automatically calculatable, law in this domain should clearly identify what needs to be enforced. We aim to identify approaches to automatically tackle such mandatory obligations (cf. P1).

SO2. *Support the analysis of descriptive regulations*. As noted, not all legal requirements can be faithfully captured within digital artefacts – many laws set out general principles or rights that usually can hardly be given a computational interpretation. We will define mechanisms (tools, procedures, best practices) to bridge this gap, enabling digital artefact designers to work with legal experts and social scientists in assessing compliance with such principles. For example, while a law might broadly require "fairness" or "transparency" in an AI system, our Action will produce guidelines and adaptive software components that help auditors and domain experts judge whether those qualitative standards are met in practice. This interdisciplinary approach (cf. P1, P2) ensures that even high-level legal expectations can be monitored and verified in digital artefacts with appropriate human judgement involved.

SO3. *Realise law-compliant digital artefacts*. The introduction of legislation like the EU Data Act or GDPR imposes that new digital artefacts guarantee their norms. Current practices to assess compliance include ISO certifications and auditing. However, these usually concern aspects of software that are weakly related with its behaviour, often falling short of guaranteeing that the code follows the law. This

advocates either for - effective tools to build and automatically assess the compliance of digital artefacts to such obligations (cf. P1 and P3), whenever these can be formalised; or - approaches based on, e.g., check-lists, experts' analysis, users' feedback, etc., when formalisation of some criteria is not possible/desirable (cf. P5 and P6).

SO4. *Assessing how digital artefacts respect regulations*. It is commonplace for stakeholders to claim compliance with various sort of regulations without clear evidence. Existing tools are still experimental and there is no consensus on which elements and requirements need to be included. This calls for identifying and enhancing auditing processes, developing tools and (semi-)automatic techniques to assess such claims, to identify pitfalls, and to verify that legal requirements are respected. Moreover, interoperability issues of digital artefacts have to be taken into account. Besides, this objective requires the development of common vocabularies (cf. P4).

The Action will create an inclusive network of European researchers and foster lasting collaboration beyond its lifetime that will shape future interdisciplinary research, promote excellence, and support Early Career Investigators and increase their visibility. This will be achieved pursuing the following organisational objectives:

OO1. *Knowledge advancement*. Build reference methods for the specification, analysis, and implementation of legal aspects of digital artefacts as well as news about publications, and tools (such as guidelines, good practices, software tools, tutorials, illustrative use cases, etc.)

OO2. *Community building*. Bring together members of the different European communities working on legal aspects of digital artefacts, specifically the communities around symbolic and data-driven AI, natural language processing, formal methods, law (including financial regulations and taxation), political sciences, and social sciences.

OO3. *Training*. Ease access to the topics of the Action in education and other areas of science, by organising training courses, summer schools, workshops, and publishing technical papers, position papers, and tutorials.

OO4. *Networking*. Foster interdisciplinary collaborations among participants of the Action through intensive use of Short Term Scientific Missions (STSM) and educational programs. Support young researchers in developing their research network for a fruitful career in an international environment.

OO5. *Transfer knowledge*. Create the opportunities to transfer expertise, scientific tools, and human resources across the different disciplines, between academia and industry, and between academia/industry and public administration.

OO6. *Inclusiveness*. Support young researchers, under-represented groups, and teams from regions with less capacity, allowing them to establish scientific collaborations with leading groups across Europe, participations to scientific events, involving them in the initiatives of the Action.

OO7. *Communication and Dissemination*. Foster the impact of the Action by disseminating its results to the scientific community and communicating it to other stakeholders in industry, certification bodies, European institutions, and the general public.

C. STATE-OF-THE-ART

We are looking for input to set a panorama and identify gaps (with few refs) on

Nowaday, digital artefacts are often ensambles of components, each developed for a specific purpose, and interacting with people or even the physical environment. This yields a high degree of complexity that sets digital artefacts among the most elusive critical infrastructures of modern societies. In fact, guaranteeing the correctness of digital artefacts is notoriously very challenging. In particular, legal and regulatory requirements add further challenges to this endevour because, on the one hand, such requirements are described in technical jargon that developers can understand only with intense liasons with domain experts and, on the other hand, the adoption of digital artefacts is sometimes decided without properly pondering the feasibility or the impact on other technical and societal facets. The following quotes are representative of this state of affaire:

- "Today, all privacy regulations around the world are based on the 50-year-old paradigm of notice and consent. It no longer works. The systems we deal with—web pages with their multiple levels of advertising, the Internet of Things, and more—are too complex; consumers have no idea what sites they are contacting nor what their privacy policies are." [5]

- "A legal rule may have multiple semantic annotations, where each annotation can represent a different legal interpretation." [4]

Another example is given by digital artefact supporting administrative procedures. Most research in this domain focuses architectural aspects and coordination [21]. Known frameworks (e.g. pipefy.com, flowWright.com) are mainly based on run-time analysis (simulation, monitoring). Very little research has been conducted on this front in the context of behavioural specifications (cf. P1). The approaches in [22–24] are rather restrictive as they consider a notion of realisability tailored to a very specific execution context (point-to-point communication) and neglect properties such as privacy or unintended information flows. Elicitation of procedural models (cf. P2) from informal documents is receiving researchers' attention [25–28]. The two main approaches consist in analysing the logs from messaging systems, such as e-mails and chats, (see the survey [27]) and in applying large language models (LLMs) [28]. The former require access to large message archives, which are only available in some domains, e.g. collaborative software development, but not, for instance, in healthcare. The latter produce models that cannot be relied upon to ensure correctness (cf. P3, P4) since LLMs do not provide explicit traceability between their input text and the models they produce.

D. RATIONALE FOR CHOOSING NETWORKING TO ADDRESS THE MAIN CHALLENGE

This would be the very first Action addressing the complexity of the problems discussed above. There is a pressing need for this Action due to two main factors: (i) the ample gap between CS and humanities, and (ii) the fragmentation and lack of efficacy of regulatory and legal practices among different sectors and countries. These factors have a negative impact on building digital artefacts that correctly and effectively realise the intentions of regulators. Moreover, these factors are the cause of current practices seemingly verify the adequacy of digital artefacts. Besides the impact on economic costs, not tackling this problems can cause distortion in democratic processes, in the application of human rights, in correct relations between citizens and institutions.

A networked approach is essential to tackle the main challenge because of its interdisciplinary and pan-European nature. The gap between legal frameworks and digital artefacts is too broad and complex for any single research group or field to handle. Only a concerted network can assemble the necessary critical mass of expertise –from legal theorists and CS communities and developers to sociologists and domain experts– to address all facets of the problem.

A COST Action is the ideal instrument: it enables collaboration across countries and disciplines, ensuring that solutions are not one-dimensional or siloed. By networking, we avoid duplicate efforts and instead coordinate research and create the opportunities to identify and study research themes that could have hardly been discovered by separated communities. For example, one working group can develop formal models of laws while another tests those models on real software systems, providing immediate feedback on the one hand while, on the other hand, spotting the limits of traditional techniques and practices that can be overcome only by developing new approaches.

The Action will facilitate this via frequent workshops, cross-disciplinary working groups, and Short-Term Scientific Missions (STSMs) that allow researchers to visit each other's institutions to transfer knowledge and tools. The Action will also develop a new generation of researchers with interdisciplinary skills through the planned training activities, the mentoring activities, and the schools. All this activities are crucial to build a community involving experts, Non-Governmental Organisations (NGOs), human rights activists, etc. that will systematically investigate the borders between regulatory frameworks and theoretical and applied CS.

These instruments will knit together a community that speaks a common language across law and tech. Furthermore, the challenges and their solutions have a strong European dimension. Regulations like the GDPR or AI Act must be implemented uniformly across Member States; sharing methods through a European network ensures that a tool or guideline developed in one country can benefit all. The network will include participants from across Europe (with particular encouragement to those from less research-intensive countries) to maximize diversity of perspectives and to build capacity where it's needed – reflecting COST's mission of spreading excellence.

E. CRITICAL MASS OF THE NETWORK

The Action's network of proposers consists of 13 COST countries, 7 of which are ITC (Cyprus, Czech Republic, Greece, Malta, Portugal, Serbia, and Ukraine) and include scholars with a proven track-record of high-impact publications in several fields ranging from (non-)symbolic AI, NLP, theoretical CS, formal methods, Law, Antropology, Philosophy of Law, Logics and Metamathematics, and medical physics distributed over 24 institutions.

Many secondary proposers have established relations with institutions hosting relevant stakeholders such as NGOs, human rights activists, medical sectors, economy. Also, many proposers have collaborated in the context of past other COST Actions and MSCA networks (in some of which they had leadership roles). In particular, the Action involves proposers specializing in technology law (data protection, AI regulation, cybersecurity law, etc.) and public policy experts. This will ensure that the Action's outputs will be grounded in legal reality and aligned with European and national legislative contexts. For instance, team members with backgrounds in European studies and public administration will connect the Action's work with EU digital strategy and governance frameworks.

This varied consortium will actively seek out for new participants to grow the critical mass with particular attention to gender and geographical balance and, quite crucially, striving to engage young researchers. For instance, the institutions already involved in the Action are the network already is around 1/3 of female proposers. The Action's main aim is to create a long-lasting community and a new generation of researchers with interdisciplinary competences that can tackle the challenges described above. All the proposers are well-known and renowned academics in their field. The initial network therefore ensures a good balance of emerging and innovative talent and established expertise.

2. IMPACT

A. IMPACT RELATED TO OBJECTIVES

Impact on Governance, Trust and Society (O2 & O4).

The Action's work on handling descriptive regulations and auditing (O2 and O4) will directly impact how AI and digital systems are governed and perceived in society. We will propose practical processes for human-in-the-loop auditing of algorithms – empowering regulators, certification bodies, or independent auditors with better techniques to inspect and certify AI systems. For example, outcome of O4 could be a guideline or even a prototype "AI Compliance Certificate" that stakeholders can use as evidence of adherence to laws (aligning with mechanisms like GDPR's voluntary certification and the AI Act's conformity assessments). This boosts transparency and accountability of digital artefacts, helping to increase public trust. Citizens and end-users ultimately benefit because they can be more confident that certified systems respect their rights (no unlawful bias, proper data protection, etc.). Moreover, by involving social scientists and ethicists, the Action will ensure that notions of fairness, transparency, and accountability are translated into technical criteria – this can inform policymakers' ongoing efforts to operationalize ethics in AI. The broader societal impact is a contribution to "Trustworthy AI" in Europe: technology that is not only innovative but also aligned with legal and ethical norms, thereby fostering social acceptance.

original version
The ultimate impact result we aim at, in the timeframe of the action, is a set of formal guarantees developers should provide to show they abide to EU regulations, namely to the GDPR or the Data Act.

These guarantees will be proposed to constitute a certificate of conformance

and should be simple to automatically extract from critical parts of the code dealing with the sensible data. The required tools should be developed and validated according to reccomendations resulting from the work of this action.

Regarding objective O1,

TO BE DEVELOPED

B. INVOLVEMENT OF STAKEHOLDERS

The Action intends to foster the involvement of stakeholders from different communities by establishing a Stakeholder Advisory Board (SAB) to ensure that the Action's methodologies align with regulatory expectations.

NGOs

Standardisation Organisation The Action will liaise with European standardisation organisations to raise their attention and support them in developing specifications and standards. For instance, according to the Data Act the European Commission may demand European standardisation bodies to harmonise standards to enable vendors of smart contracts to establish data-sharing agreements for the correct data manipulation from third parties. The Action's results can attract such standardisation bodies also through existing collaborations with some of the Action proposers.

Regulators and Policymakers The Action will include liaisons with European and national regulatory bodies. We intend to involve representatives from the European Commission (for instance, officials working on the AI Act and Data Strategy) and national Data Protection Authorities or AI oversight agencies. The Action will invite members of the European Data Protection Board (EDPB) or EU's High-Level Expert Group on AI (or its successor bodies) to provide feedback on our "formal guarantees" approach. Engaging regulators early means our proposed certification or audit frameworks could be considered in future policy refinements.

Industry and Public Sector Among the Action's proposers there are researchers that collaborate with companies, public administrations, and no-profit organisations that will be involved on the SAB.

C. COMMUNICATION, DISSEMINATION AND VALORISATION

The dissemination strategy will hinge on OA publications and a public website collecting the Action's results, advertising events related to the Action's topics, and linked to popular social media.

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