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Abstract

(EN): Given the enormous and growing proliferation of the various applications of Artificial Intelligence, and acknowledging – alongside the potential benefits – the serious risks they entail, the need for careful ethical and legal oversight is emphasized. Such oversight must be guided by the personalist principle and by full respect for human freedom and dignity. The text highlights the requirements that regulatory activity must meet in this field and the main characteristics it should possess. It also stresses the need for legal scholars to overcome the divide between scientific and humanistic cultures, in the awareness of the fundamental unity of the «two cultures».

(ES): Dada la enorme y creciente proliferación de las diversas aplicaciones de la Inteligencia Artificial, y reconociendo – junto con los posibles beneficios – los graves riesgos que conllevan, se subraya la necesidad de un control ético y jurídico riguroso. Dicho control debe inspirarse en el principio personalista y en el pleno respeto de la libertad y la dignidad humanas. El texto pone de relieve los requisitos que debe cumplir la actividad normativa en esta materia y las principales características que debe presentar. Asimismo, se destaca la necesidad de que los juristas superen la fractura entre la cultura científica y la cultura humanística, en la conciencia de la unidad fundamental de las «dos culturas».

(FR): Compte tenu de la prolifération immense et croissante des diverses applications de l'intelligence artificielle, et en reconnaissant – aux côtés des avantages potentiels – les graves risques qu'elles comportent, la nécessité d'un encadrement éthique et juridique rigoureux est soulignée. Un tel encadrement doit être guidé par le principe personnaliste et par le plein respect de la liberté et de la dignité humaines. Le texte met en lumière les exigences que l'activité normative doit satisfaire dans ce domaine, ainsi que les principales caractéristiques qu'elle doit présenter. Il souligne également la nécessité, pour les juristes, de dépasser la fracture entre culture scientifique et culture humaniste, dans la conscience de l'unité fondamentale des «deux cultures».

(DE): Angesichts der enormen und stetig wachsenden Verbreitung der verschiedenen Anwendungen der Künstlichen Intelligenz und in Anerkennung der – neben den potenziellen Vorteilen – damit verbundenen ernsthaften Risiken wird die Notwendigkeit einer sorgfältigen ethisch-rechtlichen Kontrolle betont. Eine solche Kontrolle muss vom personalistischen Prinzip und vom uneingeschränkten Respekt vor der menschlichen Freiheit und Würde geleitet sein. Der Text hebt die Anforderungen hervor, denen die gesetzgeberische Tätigkeit in diesem Bereich genügen muss,

sowie die wesentlichen Merkmale, die sie aufweisen sollte. Ebenso wird die Notwendigkeit betont, dass Juristinnen und Juristen die Kluft zwischen naturwissenschaftlicher und geisteswissenschaftlicher Kultur überwinden – im Bewusstsein der grundlegenden Einheit der «zwei Kulturen».

(PT): Dada a enorme e crescente proliferação das diversas aplicações da Inteligência Artificial, e reconhecendo – ao lado dos potenciais benefícios – os graves riscos que elas envolvem, destaca-se a necessidade de um controle ético e jurídico rigoroso. Esse controle deve ser orientado pelo princípio personalista e pelo pleno respeito à liberdade e à dignidade humanas. O texto evidencia as exigências que a atividade normativa deve satisfazer nesse campo, bem como as principais características que deve apresentar. Ressalta-se também a necessidade de que os juristas superem a cisão entre a cultura científica e a cultura humanística, na consciência da unidade fundamental das «duas culturas».

(IT): Considerata l'enorme e crescente diffusione delle diverse applicazioni dell'Intelligenza Artificiale, e riconosciuti – accanto ai potenziali benefici – i gravi rischi che esse comportano, si sottolinea la necessità di un attento controllo etico e giuridico. Tale controllo deve essere ispirato al principio personalista e al pieno rispetto della libertà e della dignità umane. Il testo mette in evidenza le esigenze cui deve rispondere l'attività normativa in questo ambito, nonché le principali caratteristiche che essa deve presentare. Si evidenzia inoltre la necessità, per i giuristi, di superare la frattura tra cultura scientifica e cultura umanistica, nella consapevolezza dell'unità fondamentale delle «due culture».

1. The concerns raised by the so-called Artificial Intelligence (AI)

The prodigious and widespread development of new digital and information technologies and their growing impact on individuals' existential sphere as well as on the mechanisms of social interaction, has by now become evident to all, whether or not these technologies fall within the scope of the so-called Artificial Intelligence (hereinafter "AI"), depending on how one chooses to define it [1].

[1] See *infra*, note 6.

Among all the recalled technologies, AI represents, so to speak, the most advanced frontier of them, and it is from its analysis that the reflections intended here may begin.

Virtually all human activities are, in fact, susceptible to being affected by AI applications (and more broadly, by digital technologies). These technologies seem to offer unprecedented and wide-ranging opportunities –whether current, potential, or even merely imagined – for transcending (some of) the many limits that have always defined the inherent finitude of the human being. In doing so, they appear to herald the dawn of a New World [2], in which humanity redefines – on cultural, spiritual, and anthropological levels – its very representation of existential reality, its self-perception, and ultimately, its identity [3].

Ethical and philosophical reflection is thus debating whether this sweeping technological revolution is in fact overturning the classical paradigm of the human/machine relationship: that is, whether technology, having traditionally played a subordinate role as a tool – however powerful – in the service of human decision-making, is now positioning itself as a full substitute for such decisions, thereby bypassing – through its capacity for autonomous choices – its very creator.

In other words, is AI merely a new human technology, operating within a dimension that remains fundamentally anthropocentric, or are we instead facing with a technology that produces an "intelligence" destined to surpass and

[2] The expression «nuovo mondo» is used, referring to AI, by A. PATRONI GRIFFI, *Bioetica, diritti e intelligenza artificiale: una relazione da costruire*, in ID. (a cura di), *Bioetica, diritti e intelligenza artificiale*, Milano-Udine, 2023, p. 9, «come metafora (…) di quella scoperta [dell'America] che dal 1492 rivoluzionò quello che divenne il "vecchio mondo"»; it is indeed – the A. continues – a «straordinaria rivoluzione tecnologica capace di influire profondamente sulla vita dell'uomo e quindi sulle stesse riflessioni della bioetica, proprio nella sua accezione etimologica di etica della vita».

[3] A. PATRONI GRIFFI, *op. loc. cit.*, according to whom «Il punto ineludibile di tensione, su cui si interroga il pensiero filosofico, è se tale rivoluzione sia tanto straordinaria da mettere in discussione la stessa identità umana»; the beloved one Pope Francis also reflected on this point, in the *Address* he delivered on June 14, 2024, at the G7 session on Artificial Intelligence held in Puglia, at Borgo Egnazia, available at *www.vatican.va*, and also reproduced (among other places) in the appendix to the volume by V. PAGLIA, *L'algoritmo della vita. Etica e Intelligenza Artificiale*, Milano, 2024, p. 177 ff.: «Ed è ora lecito ipotizzare che il suo [dell'IA] uso influenzerà sempre di più il nostro modo di vivere, le nostre relazioni sociali e nel futuro perfino la maniera in cui concepiamo la nostra identità di essere umani». For an in-depth (and highly perceptive) philosophical-anthropological analysis of this technological reality in its relationship with human identity, see now *Nota* Antiqua et Nova *sul rapporto tra intelligenza artificiale e intelligenza umana*, a cura dei Dicasteri (della Santa Sede) per la Dottrina della fede e per la Cultura e l'Educazione, Città del Vaticano, 2025.

replace human intelligence, operating independently of it and thereby bringing about a transfiguration of human identity [4]?

This radical and undoubtedly unsettling question seems, at least for now, to find a (temporarily) reassuring answer: there is, in fact, broad agreement – even among those who believe that such a scenario is not intended to remain unrealistic – in holding that, by now, AI is still not capable of letting itself free from the huge amount of data that is considered to be its fuel, data which – together with the algorithms that process it – continues to be provided by humans. In this respect, therefore, one can still speak of a technology that remains completely human [5].

2. The opportunities and risks linked to AI applications (a brief inventory)

And so, if it is a technology that remains under human control, it is essential to ensure that it serves humanity, promoting – rather than hindering – the full development of human freedom and dignity.

From this perspective, there is no doubt that the technologies making up the AI galaxy – which are, moreover, highly diverse from one another, thus raising equally diverse issues and suggesting the need to speak in the plural (artificial intelligences) [6] – might offer many positive opportunities and advantages that are so much important to be ignored [7]. Let's just think, for example, of the reduction of effort and fatigue in many areas of human activity, starting with physically demanding jobs; the important contribution AI can give in improving the efficiency of production processes; the innovations it may enable in agriculture, education, and culture; as well as the improvements in healthcare and the advancement of scientific research, thanks to its immense data-processing capabilities.

History teaches us, however – and it is enough here to recall, as a paradigmatic example in its immeasurable tragedy, the nuclear holocaust – that behind

[4] A. PATRONI GRIFFI, *op. cit.*, p. 11.

[5] A. PATRONI GRIFFI, *op. cit.*, p. 10 f.

[6] This also explains why, in scientific discourse, multiple definitions of the notion of AI recur.

[7] Thus, with specific reference to healthcare, P. BENANTI, *Intelligenza artificiale alleata della salute. Se le regole sono chiare*, in *Avvenire*, July 4, 2024 (supplement «È vita»), who writes: «L'intelligenza artificiale (IA) promette di rivoluzionare l'assistenza sanitaria, offrendo diagnosi più accurate, supporto personalizzato ai pazienti, scoperta di farmaci più rapida ed efficienza generale».

every scientific breakthrough lie many risks: the more serious they are, the greater the operational power of the breakthrough itself is.

Numerous and diverse, then, are the dangers lurking in the various and multifaceted applications of AI, so that it seems appropriate to draw up a brief inventory of the most significant among them [8].

It should be considered, to begin with, *digital surveillance*, which makes it possible to track the traces left by users in cyberspace and, as a result, to map and monitor individuals' mental and relational habits for commercial and political purposes, often without their knowledge, by shaping the flow of information in targeted and persuasive ways (for example think of the so-called *microtargeting*, which poses a serious threat to the integrity of electoral choices).

Subsequently, well-known dangers include targeted *disinformation* campaigns, which spread false information to manipulate public opinion, as well as the serious risks to *privacy* and *intellectual property* protection stemming from the vast collection and handling of data.

It should also be considered that algorithms can extract distorted information, reproducing and amplifying the injustices and biases present in the environments from which they originate. This phenomenon poses a serious threat to the *guarantees of impartiality* required by both public and private decision-makers and raises pressing ethical concerns, especially when the criteria used for decision-making are insufficiently transparent [9]. To grasp how impactful decisions left entirely or predominantly to the domain of algorithms can be, one need only to consider, for example, assessments of a person's creditworthiness when applying for a loan, suitability for a job or position, likelihood of recidivism for a convicted individual, eligibility for political asylum or social assistance, and more broadly, the adoption of *social credit scoring systems*, which inappropriately rank citizens according to opaque and questionable criteria.

Attention must also be drawn to the limitations placed on human freedom and responsibility in decision-making when choices are automatically determined by algorithmic calculations. This concern is particularly acute in contexts such as military command in wartime scenarios, the pervasive spread of

[8] The inventory presented in the text is drawn, for the most part, from the Message *Intelligenza artificiale e pace* by His Holiness Pope Francis for the 57th World Day of Peace, January 1, 2024, available at *www.vatican.va*, and also reproduced (among other places) in the appendix to the volume by V. PAGLIA, *op. cit.*, p. 157 ff.

[9] Not to mention, furthermore, «che gli algoritmi disegnati per risolvere problemi molto complessi sono così sofisticati da rendere arduo agli stessi programmatori la comprensione esatta del come essi riescano a raggiungere i loro risultati»: thus spoke Pope Francis in the Address cited above in note 3.

surveillance, the involvement of police forces in civilian life, as well as to the abyss of the so-called predictive justice entrusted to machines for the adjudication of legal disputes [10]. Not to mention the risks in the field of education, where algorithmic automatisms may weaken – and even extinguish – the capacity for developing *critical thinking*.

It is also important to highlight the significant social impact that AI applications may have on employment. In this regard, it has been observed that we are now facing the risk of mass unemployment among «colletti bianchi» – that is, those engaged in traditional middle-class professions – in a way reminiscent of the displacement of «colletti blu» during the earlier, less advanced phases of the various industrial revolutions [11]. A similar negative impact may also arise in terms of pollution and environmental sustainability, given that these technologies are highly *energy-intensive* and heavily reliant on *rare earth elements*, which are essential for the production of the hardware on which they depend.

Finally, apocalyptic scenarios are evoked with regard to the immensely powerful weapons systems that can be controlled by algorithms – systems whose destructive capabilities could potentially threaten the entire planet, should they escape human control.

3. The resulting need for ethical oversight of algorithms

The scenario just described clearly highlights the necessity, that has continually resurfaced throughout the history of civilization in response to successive scientific discoveries and their technological applications, to subject the various manifestations of AI (and, more broadly, of digital and information technologies) to a careful ethical scrutiny. This is all the more urgent given their formidable capacity to affect social relations and the existential sphere of individuals, as illustrated above. This need is so evident that it has given rise to a new branch of ethical reflection – which has by now been developing for some time –

[10] N. LIPARI, *Il diritto del nuovo millennio tra giurisdizionalizzazione ed algoritmo*, in *Acc.*, 2024, p. 15.

[11] P. BENANTI, *L'Intelligenza Artificiale sia al servizio del bene comune*, in *www.vaticannews.va*: «L'inizio della Rivoluzione industriale ha surrogato la forza muscolare; oggi vorremmo surrogare un po' quella che è la capacità cognitiva dell'uomo. (…) Se la prima Rivoluzione industriale ha impattato i colletti blu rendendoli meno necessari nel processo produttivo, l'Intelligenza Artificiale può impattare e impatterà tantissimo sui colletti bianchi, cioè su quei lavori che formano la classe media e, se non la gestiamo secondo dei criteri (…) anche di giustizia sociale, gli effetti potrebbero essere veramente devastanti o quanto meno molto forti nella capacità di coesione degli Stati democratici».

known as *algorethics*, a term derived from the algorithms themselves [12].

It is, as anyone can see, a matter of ensuring that the immense potential offered by these technologies is directed – to use fundamental moral (and spiritual) categories of meaning – toward the *good*, and not the *harm*, of humanity. That is, algorithms and the various applications of AI (as well as other digital and information technologies) should contribute to enhancing – not diminishing – the level of protection of human rights, individual freedom from the intrusion of public authorities and the arrogance of domestic and international economic and political powers; to promoting the defence of work and workers against all forms of degradation and exploitation; to protecting the most vulnerable and defenceless; to safeguarding the environment; and to advancing social justice.

In the final analysis, efforts must be made to ensure that these technologies become allies, not enemies, of humanity, understood according to the anthropological model embraced – returning now to the legal plane – by the Constitutions of the «dopo Auschwitz» era [13], in defense of its *inalienable dignity* [14]. That dignity is undoubtedly implicated – given the «nesso inscindibile» that mutually unites them – by the personalist principle enshrined in Article 2 of the Italian Constitution, which serves as the *Grundnorm* of the entire legal system [15].

[12] Now firmly embedded in university education – especially, as one would expect, in philosophy degree programs – and in postgraduate studies: see, for example, A. CARRARA, *Dall'algoretica alla roboetica: ecco le sfide*, in *Avvenire*, July 5, 2024, p. 26.

[13] I borrow the evocative expression – rich in symbolic resonance – from A. NICOLUSSI, *Un'ecologia giuridica per il futuro*, in *Vita pens.*, 1, 2012, p. 67; see also A. NICOLUSSI-C. RUSCONI, *Volti e risvolti della dignità umana. A settant'anni dall'art. 1 della Costituzione tedesca*, in *Jus*, 3, 2019, p. 4.

[14] Here stands out in all its moral pregnance the opening provision (Article 1) of the *Grundgesetz* of the Federal Republic of Germany, which solemnly proclaims: «Die Würde des Menschen ist unantastbar» («Human dignity is inviolable»).

[15] See, incisively, V. SCALISI, *L'ermeneutica della dignità*, Milano, 2018, p. 9 (where the A. discusses the «nesso inscindibile tra persona umana e dignità»), p. 22 («tra principio personalista e principio di dignità vi è nesso assai stretto, direi inscindibile, di reciproca e mutua implicazione») and *passim*. C. CAMARDI, *Sulla governance digitale europea: una proposta di confronto*, in *Acc.*, 2023, p. 8, reminds that even the *Declaration on the European Digital Decade: Digital Targets for 2030* – formalized in Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022, establishing the Digital Decade Policy Programme 2030 – «fa perno sulla persona, e ribadisce perciò la primazia del principio personalistico dell'ordinamento giuridico europeo già sancito nella disciplina dei Trattati e della Carta» of Nice. In this same spirit, see now Recital 27 of the AI Act, Regulation (EU) 2024/1689 of the European Parliament and of the Council of 1 June 2024, laying down harmonised rules on artificial intelligence, published in the Official Journal of the European Union on 12 July 2024, which expressly emphasizes the need «che i sistemi di IA [siano] sviluppati e utilizzati come strumenti al servizio delle persone, nel rispetto della dignità umana e dell'autonomia personale (…)» (for an initial commentary on this regulation, see, among

No one can object that history never ceases to teach us that the achievements of science and technology, when perversely exploited in the pursuit of power and profit, risk unleashing destructive force upon the peaceful and orderly coexistence of peoples and nations, upon the preservation of nature and the environment, upon political and social freedoms, and – as mentioned above, and most importantly – upon the very idea of the inalienable dignity of every human being. Without this foundamental idea, the human rights arduously gained over the long course of our civilization's history would see their roots tragically severed, and thus be deprived of the vital lifeblood that sustains them.

And these enormous dangers of the perverse use of technology for purposes of political and/or economic domination – beyond being, in general terms, structurally inherent in the fusion of such technology with the vast machinery of capitalist power, which seeks to subordinate the entire organization of the world and the lives of its inhabitants to its own needs [16] – are, in the specific case of AI, amplified to an extraordinary degree by the fact that the entire system of such technologies is controlled by an oligopoly of nine global companies, none of which are European. These entities wield immense economic power [17] and – directly or indirectly, depending on the case – political power as well.

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others, A. MANTELERO, *L'AI Act: la risposta del legislatore europeo alle sfide dell'intelligenza artificiale*, in *Acc.*, 2024, p. 191 ff.).

[16] The fusion between capitalism and technology (in Italian philosophical-legal literature, refer to N. IRTI-E. SEVERINO, *Dialogo su diritto e tecnica*, Roma-Bari, 2001) has by now become a fundamental topic in any serious reflection on the subject: within the vast literature, see most recently and notably, M. BARCELLONA, *Il diritto neoliberale dell'economia globalizzata e della società liquida*, in M. BARCELLONA-B. MONTANARI, *Potere e negoziazione. Il diritto al tempo del post-pensiero*, a cura e con prefazione di A. Lo Giudice, Roma, 2023, p. 30 ff., who evocatively describes the present era as «il tempo degli sponsali tra capitalismo e tecno-scienza». According to a well-known thesis, the «digital revolution» would have altered, in a very significant way, the characteristics of the mass production economic system, reshaping it into what has been called «Surveillance Capitalism»: S. ZUBOFF, *The Age of Surveillance Capitalism. The Fight for a Human Future at the New Frontier of Power*, New York, 2019 (trad. it. a cura di P. Bassotti, *Il capitalismo della sorveglianza. Il futuro dell'umanità nell'era dei nuovi poteri*, Roma, 2019); the different term «Informational Capitalism» is used instead by J.E. COHEN, *Between Truth and Power. The Legal Constructions of Informational Capitalism*, Oxford, 2019, a term considered «più convincente» by G. RESTA, *Contratto e persona*, in *Tratt. contr.* Roppo, VI, *Interferenze*, 2ª ed., a cura di V. Roppo, Milano, 2022, p. 56, nota 13. This formulation has also been taken up by A. KAPCZYNSKI, *The Law of Informational Capitalism*, in 129 *Yale LJ*, 2020, p. 1460 ff.

[17] Consider that all the recalled nine multinational corporations have a market capitalization exceeding the amount of one trillion dollars. To grasp the scale, one need only note that the entire GDP of the United Kingdom amounts to 3.3 trillion dollars. This information is drawn from P. BENANTI, *L'Intelligenza Artificiale sia al servizio del bene comune*, cit.

4. The unavoidable subjection of digital technologies to the control of the existing legal system and the challenges of ensuring effective protection

This latter consideration clearly reveals, in the opinion of the writer, the groundlessness – and indeed the danger – of those ideological positions, which are not always innocent, that seek to exempt new digital technologies – and thus, ultimately, the economic giants behind them – from the rule of law [18].

Regardless of the creation of *ad hoc* regulatory frameworks (some of which already existing and others in varying stages of development), the first strategy to be pursued in order to counter this drift consists in bringing, as far as possible, the various technological applications under discussion back within the scope of existing legal norms and principles. This would allow us – at least to the extent permitted by their flexibility – to make use of the conceptual categories built around them. Indeed, the capacity of existing law to adapt to these emerging phenomena through interpretative evolution should by no means be underestimated [19].

In order to lend a degree of concreteness to the discussion at hand, it seems appropriate to propose a paradigmatic example which, from the perspective of civil law [20], may be identified here in the so-called *Smart Contract* [21].

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[18] The opinion is widely shared: see, among others, *Alla ricerca del paradigma regolativo ottimale. La* governance *dell'I.A. tra legislazione e regolazione*, in *Tecn. dir.*, 2024, p. 279 ff.; K. FIORENZA, *Tecnologia e diritto. Una* odissea *negli spazi extracontrattuali*, Napoli, 2024, p. 24 f.

[19] On this point, reference may be made – in place of many others and also for further bibliographic leads – to the clear and persuasive pages of U. RUFFOLO-A. AMIDEI, *Diritto dell'Intelligenza Artificiale*, I, *Responsabilità. Contratto. Regolazione. Veicoli autonomi*, Roma, 2024, p. 69 ff.

[20] For an overall reflection on the relationship between AI and civil law, see most recently, P. PERLINGIERI, *Diritto civile e Intelligenza Artificiale*, in *Tecn. dir.*, 2025, p. 135 ff.

[21] Although *Smart Contracts* do not necessarily presuppose the use of AI-based technologies – on this point, see, among others, U. RUFFOLO-A. AMIDEI, *op. cit.*, p. 227 ff.; see also F. DI GIOVANNI, *Attività contrattuale e Intelligenza Artificiale*, in E. GABRIELLI-U. RUFFOLO (a cura di), *Intelligenza Artificiale e diritto*, in *Giur. it.*, 2019, p. 1677 ff. –, they nonetheless should be taken in consideration as a paradigmatic object of observation within a broader discourse on the relationship between law and digital technologies. It is well known that the debate surrounding the notion of *Smart Contract* (for an initial general overview of the concept, see G. SALITO, *Smart contract*, in *Dig. disc. priv.*, *Sez. civ.*, Agg. XII, Torino, 2019, p. 393 ff.) is highly animated and far from reaching a univocal definition (for a broader survey, see, among others, I. MARTONE, *Gli* Smart Contracts. *Fenomenologia e funzioni*, Napoli, 2022, *passim* e spec. pp. 53 ff. and 71-106). Without delving into the matter here, it suffices to note «che la posizione che pare preferibile è che non esiste una sorta di ontologia dello *smart contract*; gli *smart contract* sono protocolli di transazione che possono riguardare sia la fase di conclusione e di esecuzione di un contratto, che

The principal peculiarity of this figure lies in its self-executive nature [22], which stems from the automatic execution mechanisms it enables, due to its integration with distributed ledger technologies (DLT) [23] and, in particular, with the blockchain system [24].

This characteristic reveals a fundamental ambivalence: on one hand, it provides «certezza» (certainty) to contractual relations, ensuring with near-absolute reliability the actual performance of obligations (at least when the contract is executed entirely on-chain) [25]; on the other hand, however, it

solo quella di esecuzione di un contratto, così come quella di esecuzione di protocolli che nulla hanno a che fare con il contratto»: thus, among others, C. SCOGNAMIGLIO, *Lo* smart contract *in ambito bancario*, in M. PROTO (a cura di), *Intelligenza artificiale e rapporti bancari. Umano e non umano nelle relazioni tra intermediari e clienti*, Pisa, 2024, p. 35. This discussion refers specifically to the first two cases just described.

[22] The expression «autoliquidante» is used, among others, by A. D'ADDA, Smart contract *e diritto generale dei contratti*, in *Oss. dir. civ. comm.*, Speciale/2022, p. 105 ff.

[23] Mari. MAUGERI, Smart Contracts *e disciplina dei contratti*, Bologna, 2021, p. 20, testo e nota 6, rightly recalls that «spesso le nostre [dei giuristi] competenze sono insufficienti (…). A ciò si aggiunga che non abbiamo possibilità di verificare con facilità se la descrizione tecnica dei nuovi fenomeni corrisponda o meno a realtà». While keeping this *caveat* in mind, the clear attempt to frame the operating mechanisms of this type of technology made by I. MARTONE, *op. cit.*, p. 39 ff., nonetheless appears undoubtedly useful. This attempt includes abundant references to the literature and specific discussions on *Blockchain*; on the latter, see also, among others, N. TRAVIA, *La tecnologia Blockchain*, in E. BATTELLI (a cura di), *Diritto privato digitale*, 2ª ed. in collaborazione con G. D'Ippolito e T. Pellegrini, Torino, 2024, p. 329 ff.; G. PASCUZZI, *Il diritto dell'era digitale*, V ed., Bologna, 2020, p. 279 ff.; A. QUARTA-G. SMORTO, *Diritto privato dei mercati digitali*, Firenze, 2020, p. 22 ff.

[24] While one may concede the widely acknowledged point that the phenomenon of *Smart Contracts* does not necessarily coincide with DLT technologies (see, among others, and with specific reference to *Blockchain*, U. RUFFOLO-A. AMIDEI, *op. cit.*, p. 239), there is no doubt that these technologies – as I. MARTONE, *op. cit*., aptly observes – represent «a tutti gli effetti il "cuore pulsante" della contrattazione algoritmica» (p. 41), «il vero e proprio "trampolino di lancio" dello *Smart Contract* nella dinamica negoziale moderna» (p. 42). What holds true in general for DLTs is therefore also true, in particular, for Blockchain, which – as I. MARTONE, *op. cit*., notes – «rappresenta senz'altro la *species* più diffusa» (p. 42) of the former.

[25] A widely shared observation: see, among others, A. D'ADDA, *op. cit.*, p. 106; C. FERRARI, *Esecuzione del contratto e Intelligenza Artificiale*, in *De Iustitia*, 2024, p. 6; F. LONGOBUCCO, *Utopia di un'autonoma* Lex Criptographi(c)a *e responsabilità del giurista. Dallo* smart contract *al "*giusto rimedio*" del "*re-coding*" tra "*testo informatico*" e "*regolamento definitivo*"*, Napoli, 2023, p. 35 (work reviewed by L. COPPO, in *Tecn. dir.*, 2023, p. 469 ff.).

It has been observed, however, that the concrete possibility of non-performance or defective performance cannot be absolutely ruled out in cases involving the intervention of an oracle (for its notion, see below, note 56), particularly where malfunctions occur in its operation or it provides an incorrect assessment (P. CUCCURU, Blockchain *ed automazione contrattuale. Riflessioni sugli* smart contract, in *Nuova giur. civ. comm.*, 2017, II, p. 111). Such a possibility may

implies a significant rigidity into this contractual model, precisely due to its inexorably automatic execution effects as a consequence of the inflexible logic embedded in the *if this, then that* sequence typical of computer code [26].

The model just described, while generating numerous and delicate legal issues [27], is nevertheless exalted by a radical ideological approach («cripto-anarchico») [28], which, leveraging the aforementioned automaticity of execution, tends to celebrate the "*Smart* paradigm" precisely for its alleged ability to legitimate itself *ex se* through the irresistible force of accomplished fact. This, in turn, would appear to place it ultimately beyond the reach of legal oversight [29], in a renewed (and enhanced) version of the *lex mercatoria*, reconfigured as *lex cryptographica* [30].

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also arise from the fact that the execution mechanism might fail to take into account the regulatory integrations pursuant to Article 1374 of the Italian Civil Code: in this sense, among many others, see, Mari. MAUGERI, *Contratto e nuove tecnologie*, in *Trattato del contratto* Roppo, VI, *Interferenze*, cit., p. 1166 ff.; non-performance may also occur in cases where the execution of a contract concluded *on-chain* involves the delivery of physical-world goods (E. BIVONA, Smart Contracts *e "interferenze" con la disciplina sui contratti: il sistema dei rimedi alla prova degli algoritmi*, in *Pers. merc.*, 2021, p. 795), due to the circumstance that «la pressoché assoluta garanzia dell'esecuzione del contratto (…) funziona solo in quanto le prestazioni riguardino oggetti digitalizzabili (come ad esempio criptovaluta)» (F. DI GIOVANNI, *op. cit.*, p. 1680).

[26] This sequence, upon closer examination, perfectly corresponds to the *if A, then B* scheme traditionally used by jurists to describe the logical structure of legal norms in general theory. For this notation, see M.F. CAMPAGNA, *Gli scambi attraverso algoritmi e il problema del linguaggio. Appunti minimi*, in *An. giur. ec.*, 2019, p. 154.

[27] For their analysis and the relevant bibliographic references, allow me to refer to V. VERDICCHIO, *Lo* smart contract *tra autonomia e autotutela*, in *Oss. dir. civ. comm.*, 2025, p. 3 ff.

[28] References in A. D'ADDA, *op. cit.*, p. 107; di «movimento cripto-anarchico *cypher-punk*» discusses Mari. MAUGERI, Smart Contracts *e disciplina dei contratti*, cit., pp. 25 (nota 9) and 55, who defines it as a «movimento socio-culturale (…) che teorizza la scelta della crittografia come modo per scardinare l'ordine esistente e avere una nuova democrazia»; on this point, see also, most recently, N. TRAVIA, *op. cit.*, p. 329 ff.

[29] In other, more evocative words, «Il *Νόμος* (…) si dovrebbe arrendere dinanzi alla *Τέχνη*»: thus, even though in a critical view, F. LONGOBUCCO, Smart Legal Contract *e "*giusto rimedio civile*" del* re-coding*:* Legal Protection by Design *e nuove declinazioni del* favor contractus, in *Jus civ.*, 2024, p. 767, who also speaks, again from the same perspective, of «dominio della tecnica sulla norma».

[30] F. LONGOBUCCO, *Utopia di un'autonoma* Lex Criptographi(c)a *e responsabilità del giurista*, cit., *passim*; E. BIVONA, *op. cit.*, p. 792 f. U.S. legal scholarship (L. LESSIG, *Code and Other Laws of Cyberspace*, New York, 1999) has expressed this line of thought through the now-famous formula *Code is Law*, which quickly spread worldwide and aims precisely to emphasize the (alleged) autonomy of computer code from the state legal system. In this regard, reference is also made to the concept of *lex informatica*: see, for example, M. GIULIANO, *La Blockchain e gli* Smart Contracts *nell'innovazione del diritto del terzo millennio*, in *Dir. inf.*, 2018, p. 995). For

From this point of view, with the advent of the *Smart Contract*, law would be imprisoned into the fact, and «la tecnica si fa[rebbe] contratto» – bearing in mind that, according to this view, we are not merely dealing with a contract executed through a new technical modality [31].

In this context, the elegant theoretical-sociological notion of *non-droit*, originally proposed some sixty years ago by Jean Carbonnier in his essay on "flexible law" [32], has been recalled and reinterpreted [33]. That is, a form of law that retreats to make room to the domain of facts, as they unfold in social reality – which, in this case, is understood as technological reality. In the phenomenon under discussion, to summarize, law would effectively disappear, since a *Smart Contract* could never give rise to issues of non-performance, not even in cases where the contract is affected by nullity.

As already noted, the *non-droit* approach is an ideological-epistemic perspective that, however, cannot be accepted. The legal system cannot remain indifferent to phenomena involving the circulation of wealth and exchanges – including those carried out through *Smart Contracts* – which, having general socio-economic implications and thus implicating, to some degree, the sphere of economic public order, cannot escape legal relevance and, consequently, to the reach of the law. This is all the more true when such transactions take place in sectors such as banking, finance, or energy, which are subject to intensive oversight by regulatory authorities that cannot be bypassed [34].

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an overview, see, among many others, G. ALPA, Code is law*: il bilanciamento dei valori e il ruolo del diritto*, in *Contr. impr.*, 2021, p. 386 ff.

[31] A.M. BENEDETTI, *Contratto, algoritmi e diritto civile transnazionale: cinque questioni e due scenari*, in *Riv. dir. civ.*, 2021, p. 413; R. PARDOLESI-A. DAVOLA, *"Smart contract": lusinghe ed equivoci dell'innovazione purchessia*, in *Foro it.*, 2019, V, cc., p. 195 ff., spec. p. 195; C. SCOGNAMIGLIO, *op. cit.*, p. 34.

[32] J. CARBONNIER, *L'hypothèse du non-droit*, in *Arch. phil. dr.*, 1963, p. 55 ff. (cited by G.B. FERRI, *Il negozio giuridico tra libertà e norma*, V ed., Rimini, 1995, p. 80; ID., *Il diritto statuale e il suo* doppio, in *Quadr.*, 1993, p. 17); *amplius*, ID., *Flexible droit. Pour une sociologie du droit sans rigueur*, 10ª ed., Paris, 2001, (I ed., 1969; the VII French edition of 1992 was translated into Italian: *Flessibile diritto*, a cura e con un saggio di A. De Vita, Milano, 1997). For an in-depth reflection on the thought and works of the distinguished French jurist and sociologist, see the monograph by F.S. NISIO, *Jean Carbonnier*, Torino, 2002.

[33] F. DI CIOMMO, *Smart contract e (non-)diritto. Il caso dei mercati finanziari*, in *Nuovo dir. civ.*, 1-2019, pp. 257 ff., espec. p. 290 ff.

[34] Thus, among all, see C. SCOGNAMIGLIO, *op. cit.*, p. 39. On the use of *Smart Contracts* in the financial market and in the electricity sector, see Mari. MAUGERI, *Contratto e nuove tecnologie*, cit., respectively pp. 1174 ff. and 1182 ff.; For the insurance, banking, and financial markets, see also E. BATTELLI, *Le nuove frontiere dell'automatizzazione contrattuale tra codici algoritmici e* big data*: gli* smart contracts *in ambito assicurativo, bancario e finanziario*, in *Giust.*

It is therefore clear that the circulation of wealth via *Smart Contracts* cannot elude the grasp of the legal order [35]. Thus, even if the «autoliquidante» nature of such instruments precludes the use of traditional preventive remedies [36], and even if it is not possible to coercively interfere with the *Blockchain* – for example, to reverse undue transfers – this does not mean that there would be no reason to exclude remedies that were outside the blockchain environment [37].

From this perspective, remedial techniques that may still come into play – albeit only *ex post* and outside the blockchain environment – are quite evidently restitutory and/or compensatory, in response to economic operations that in some respect do not conform to legal standards [38]. Of course, this comes with all the well-known difficulties involved in actually securing of such forms of protection [39], since it is a universally shared knowledge that it is better not to make an undue performance in the first place than to attempt to recover it afterward or obtain compensation.

The example just discussed allows us to conclude that there is no reason to

civ., 2020, p. 681 ff.; G. GITTI, *Emissione e circolazione di criptoattività tra tipicità e atipicità nei nuovi mercati finanziari*, in *Banca borsa tit. cred.*, 2020, I, p. 13 ff.; also in ID., *Disciplina contrattuale del mercato e decisione robotica*, Brescia, 2020, p. 271 ff.

[35] Another crucial and sensitive issue – which cannot be explored in detail here – concerns the identification of the applicable legal system, since these contracts are often, so to speak, delocalized: see, among others, G. GITTI, *Tecnologie digitali, persona e istituzioni*, in *Riv. dir. civ.*, 2020, p. 1244 (also reproduced in ID., *Disciplina contrattuale del mercato e decisione robotica*, cit., p. 251), who discusses of «carattere "apolide" della tecnologia digitale e dell'algoritmo»; E. BIVONA, *op. cit.*, p. 792 ff.

[36] This refers to the dilatory exceptions provided for in Articles 1460-1462 of the Italian Civil Code.

[37] Mari. MAUGERI, Smart Contracts *e disciplina dei contratti*, cit., p. 52 f. Echoing these views, among others, are F. LONGOBUCCO, Smart Legal Contract *e "*giusto rimedio civile*" del* re-coding, cit., p. 770; L. REGAZZONI, *Alcune questioni in tema di* smart contracts *«assicurativi»: tra istanze di innovazione tecnologica e principi inderogabili dell'ordinamento giuridico*, in *Oss. dir. civ. comm.*, Speciale/2022, p. 133. For a general overview of smart contracts from a remedial perspective, see A. CINQUE, *Smart Contract: Legal Nature and Contractual Remedies*, *ivi*, p. 639 ff.

[38] C. SCOGNAMIGLIO, *op. cit.*, p. 37; Mari. MAUGERI, *op. ult. cit.*, p. 53.

[39] The problems concerning the effectiveness of legal remedies (for a thorough general examination of the principle of effectiveness, see, among others, G. VETTORI, *Effettività fra legge e diritto*, Milano, 2020, as well as the reflections on the subject by V. VELLUZZI, *Effettività della tutela e giustificazione delle decisioni giudiziali. Riflessioni su* Effettività fra legge e diritto *di Giuseppe Vettori*, *in Riv. int. fil. dir.*, 2024, p. 479 ff.) become even more pronounced in the case of *Smart Contracts* executed through decentralized DLTs, due to the anonymity these systems generally guarantee to the contracting parties. This anonymity also makes it difficult to verify whether the parties possess legal capacity: see, among others, Mari. MAUGERI, *op. ult. cit.*, p. 56 ff.

totally exclude the application of existing law to new technologies, nor to deny its at least partial regulatory adequacy. At the same time, however, it reveals the limitations that the *jus conditum* may sometimes display – particularly in terms of the effectiveness of remedies – when tasked with governing digital and information technologies. This, in turn, calls for the development of new, specifically designed regulatory frameworks.

5. The underlying needs of digital technology regulation and the methods and characteristics of rulemaking

The reasons for rejecting the ideological approach that would seek to remove new technologies from the control of the legal system have already been identified.

Those reasons lead to the conclusion that the identified need for (new) regulation cannot be satisfactorily met by a system of rules, so to speak, «autoprodotte» by the operators of the sector themselves – such as codes of self-regulation and other forms of *soft law*. Even if one were to concede – drawing, for instance, on the Italian experience of the advertising self-regulation code [40] – that such an approach might offer some degree of utility [41], it nonetheless appears in all its evidence, in light of the enormity of the potential risks posed by these technologies, that it is in itself largely inadequate, and that ultimately it cannot dispense with a framework of (also) *heteronomous* regulation.

But how should we proceed in this direction? The limited scope of the present paper allows for no more than a few brief and general observations.

First and foremost, it must be acknowledged that – given the global relevance of the phenomenon under consideration – the ideal regulatory dimension should correspond to the spatial extent of the object to be regulated [42].

In this regard, although the well-known political, cultural, and interest-based divergences among States make it difficult – at least for now – to envision a truly global agreement, they have not prevented the recent conclusion of an important framework convention that establishes a clear set of principles aimed at ensuring

[40] It is sufficient, in this context, to refer – by way of brief mention – to G.F. CAMPOBASSO, *Diritto commerciale*, 1, *Diritto dell'impresa*, VII ed., a cura di M. Campobasso, Torino, 2013, p. 262 f.

[41] For some reflections on the matter, see, among others, U. RUFFOLO-A. AMIDEI, *op. cit.*, p. 51 ff.

[42] For some considerations, see G. FINOCCHIARO, *Intelligenza artificiale. Quali regole?*, Bologna, 2024, p. 51.

a balanced relationship between technological development, on the one hand, and the protection of human rights, democracy, and the rule of law, on the other [43]. This convention represents the first international treaty on AI; while it sets out important and binding reference standards, it will need to be implemented by the signatory States with a more or less broad margin of discretion.

In this direction – and necessarily narrowing the focus to domestic and EU law – the cornerstone of any regulation of digital and information technologies, starting with those associated with so-called AI, must be the respect for the *personalist principle* – briefly recalled above – enshrined in the Italian Constitution and, albeit with nuances not always perfectly aligned, also present in the founding Treaties of the European Union. As a consequence, the jurist – whether in the role of legal adviser to the Legislator or, more typically, as interpreter of the law – bears the responsibility of being guided by the North Star of human dignity and the principles of freedom and solidarity it entails.

The second key point to consider is that political and regulatory choices – while remaining faithful to the personalist principle and ensuring a sufficient set of legal guarantees – must also necessarily take into account that AI is, after all, a highly significant industrial sector, both economically and, even more so, strategically, with evident repercussions on the geopolitical stage. Accordingly, there is a need to construct a regulatory framework that enables – and, where possible, encourages – the strengthening of national and European business presence in this field, which, as previously noted, is dominated by global players from outside the European context (a Sino-North American oligopoly). It appears that this is precisely the path being pursued at the EU level by the so-called *AI Act*, which is based on a reasonable risk management approach – one that offers sufficient safeguards without deterring investment in the sector [44].

[43] This refers to the *Council of Europe Framework Convention on Artificial Intelligence and Human Rights, Democracy and the Rule of Law*, signed on 5 September 2024 by Andorra, Georgia, Iceland, Norway, Moldova, San Marino, the United Kingdom, Israel, the United States of America, and the European Union. The Convention imposes on the signatory States the obligation to regulate the entire life cycle of artificial intelligence systems, with particular emphasis on *transparency*, *accountability*, and *privacy protection*.

[44] See, among others, A. MANTELERO, *op. cit.*, p. 196, who observes that «l'approccio adottato dal legislatore europeo si connoti per un notevole pragmatismo, guardando ad una regolamentazione incentrata sui rimedi *ex ante*, in chiave di gestione del rischio ed approccio *by-design* al prodotto, piuttosto che sui rimedi risarcitori *ex post* (…). Questo perché il rimedio tradizionale della responsabilità civile mal si concilia con un contesto connotato da complessità tecnologica, operatori globali con grandi capacità finanziarie, polverizzazione dei danni e, nell'ottica di stimolare la fiducia nelle nuove tecnologie (la c.d. *trustworthy AI*), necessità di garantire ambienti tecnologici sicuri piuttosto che rimedi in caso di disastrose conseguenze». The A. further emphasizes the need to provide residual rules on tort law.

Having said that, it is often asserted that regulation of the technological sector in question should be framed in terms of principles rather than rules [45]. The reasoning behind this claim is that the pace of ordinary legislative processes – carried out through political assemblies – is incompatible with the rapid and continuous evolution of these technologies. As a result, rules produced in this way run the risk of becoming quickly obsolete, if not already outdated at the moment of their enactment, and in any case of arriving consistently too late [46].

It must be observed, on the other hand, that while a good regulation cannot stand without clear guiding principles – principles to which, of course, should also be given proper weight at the interpretative and applicative levels – it likewise cannot dispense with a set of more detailed rules. Such rules serve to give (so to speak) shape and measure to the principles to be implemented, while also governing their mutual interactions (and possible collisions), thereby containing within acceptable limits the practical uncertainties inevitably generated by their intrinsic structural indeterminacy – which, at times, may even verge on vagueness [47].

In their absence, such principles would inevitably be interpreted and applied differently by each interpreter and – even before that, and more importantly – by each addressee of the regulation [48]. This would undermine the unavoidable

[45] This refers primarily to the principles set out in the European Union's 2019 document *Ethics Guidelines for Trustworthy AI*, which also clearly inspired the *AI Act*. These include: human agency and oversight; technical robustness and safety; privacy and data governance; transparency; diversity, non-discrimination and fairness; societal and environmental well-being; accountability (see, among others, G. FINOCCHIARO, *op. cit*., p. 47). These parameters appear to be grounded in the broader precautionary principle.

[46] These widely shared and persuasive observations (see, among others, M. ANGELONE, *op. cit*., p. 287) clearly show that, although detailed regulation is indeed necessary, it cannot be entrusted solely to the ordinary legislative activity of elected parliamentary chambers (see *infra* in the text).

[47] If it is largely undisputed that every legal provision – even when formulated through a regulatory legislative technique (i.e., based on sufficiently detailed rules) – entails a certain degree of indeterminacy and vagueness, it appears equally evident, however, that these features are present to an even greater extent in a regulatory framework based exclusively on principles. While such principles are indispensable for providing both the axiological and rational foundation of the rules – and for enabling a sufficiently flexible interpretation during their application (a role also fulfilled, from another angle, by general clauses) – they are not sufficient on their own: «L'assenza di una griglia di regole più minute consegna l'ordinamento all'arbitrio individuale, che forse (…) è un male peggiore dell'eccesso di regolamentazione»; thus, ultimately, everything depends on finding the right balance between overarching principles and detailed rules (G. TERRANOVA, *Il diritto e il suo linguaggio. Metodi, teorie, parole del diritto commerciale*, Milano, 2020, p. 55).

[48] Illustrative in its clarity is the example – recalled by G. TERRANOVA, *op. cit*., p. 187 (and drawn from F. SCHAUER, *Di ogni erba un fascio. Generalizzazioni, profili, stereotipi nel mondo della giustizia*, Bologna, 2003) – offered by a concrete North American experience: «In una certa fase storica, nel Montana si pensò di sostituire ai limiti di velocità per il traffico stradale, indicati

requirement of at least a tendential *certainty* of the law – which is itself, it should be noted, a fundamental (value and) normative principle. This requirement is all the more necessary in the field at hand in order to implement that by design form of preventive regulation which, as is well known, is essential to legally shape digital environments from the outset. And such regulation can hardly do without the presence of (at least a minimal number of) clear and detailed rules [49], particularly of a *technical nature* [50].

That being established, the aforementioned criticisms of detailed regulation enacted through legislative processes nonetheless prove to be far from unfounded. In addition to what has already been noted regarding the slow and often inadequate pace of parliamentary response, it must also be considered that, «in campi o materie caratterizzati da una spiccata spinta evolutiva, i procedimenti normativi scontano forti *deficit* informativi e di competenze/conoscenze, necessitando per contro di informazioni dettagliate, granulari, attendibili che sono sovente inaccessibili ovvero nell'esclusiva disponibilità degli stessi destinatari della regolazione» [51].

These considerations support the need to entrust the governance of AI to one or more independent authorities, endowed with the classic prerogatives – regulatory, administrative, supervisory, adjudicatory, and sanctioning powers (whether monetary or otherwise) – that such bodies typically exercise in so-called «settori sensibili» (*domaines sensibles*) placed under their oversight [52].

All of this must, of course, be framed within a clear structure of guiding principles and boundaries, which – and here rightly so – must be established by ordinary legislation, in keeping with the political responsibility of Parliament [53].

in appositi cartelli, un principio generale, che si limitava a imporre una guida prudente e ordinata. L'esito dell'esperimento fu disastroso, giacché ogni conducente interpretava a modo suo i predetti limiti prudenziali, con la conseguenza che si moltiplicarono a dismisura gli incidenti automobilistici e i morti su strada. A causa di questa tragica esperienza si tornò alla disciplina preesistente».

[49] Well known is the observation that the digital sphere is governed «soprattutto [da] "forme" architettoniche. (…) il dispositivo principe di governo dello spazio digitale è il codice informatico che può erigere steccati, impedendo e/o facilitando l'accesso soltanto a determinate condizioni; in altri termini è lo strumento per eccellenza in grado di governare la rete e orientare i valori cui si ispira» (thus, among all, K. FIORENZA, *op. cit.*, p. 27 f.). It follows that, if the law wishes to influence digital reality, it must do so primarily by design – that is, by regulating the way in which digital ecosystems are to be built through the computer codes that shape them. And it seems clear that for this to be achieved effectively, principles and general clauses – though absolutely necessary – are not sufficient on their own; specific technical rules are also required.

[50] Among all, U. RUFFOLO-A. AMIDEI, *op. cit.*, p. 70.

[51] M. ANGELONE, *op. cit.*, p. 287.

[52] M. ANGELONE, *op. cit.*, p. 287 f.

[53] See, among others, once again, M. ANGELONE, *op. cit.*, p. 287.

6. Legal scholars and legal science facing the digital revolution: towards the definitive overcoming of the «two cultures»

The reflections developed so far prompt a final consideration, this time concerning the impact that new digital and information technologies are having – or, in any case, ought to have – on the role of the jurist and on the method of legal science.

To explore this aspect more deeply, it seems useful to return once again to the example of the *Smart Contract* [54].

The inescapable «autoliquidante» mechanism previously discussed places significant strain on the systemic devices of invalidity and regulatory integration under Article 1374 of the Italian Civil Code. On the one hand, it results in the automatic execution of the agreement as encoded by the parties in the software code – even in cases where the agreement is unlawful or otherwise null and void. On the other hand, such execution does not take into account regulatory integrations, not even those deemed mandatory, as provided by the combined provisions of Articles 1339 and 1419(2) of the Civil Code, which introduce heteronomous norms into the content of the contract.

Furthermore, the aforementioned «autoliquidante» nature of the Smart Contract tends, in practice, to neutralize the legal relevance of supervening events, since its automatic execution is generally incapable of adapting to changes in the original factual circumstances. This characteristic also disrupts the overall structure of the ordinary system of judicial and extra-judicial remedies: on the one hand, there is an inherent and almost ontological difficulty in raising dilatory exceptions under Articles 1460-1462 of the Civil Code; on the other hand, there is a tangible risk that the weaker party may be exposed to an excessive – so to speak – self-help advantage wielded by the stronger party.

The negative consequences identified – stemming from the immutability, irreversibility, and unstoppable nature of *Smart Contracts* – ultimately risk causing a significant impairment of the protections established by the legal system, as well as a disruption of the underlying balance of interests.

It is therefore understandable that the European Parliament has expressed concern and has emphatically urged the Commission to provide, in relation to such contracts, for mechanisms capable of *halting* and *reversing* their execution and the related payments [55]. Similarly, the recent Regulation (EU) 2023/2854

[54] For the in-depth legal analyses of the *Smart Contract* issues explored immediately after in the text, reference is made to V. VERDICCHIO, *op. cit.*, p. 3 ff.

[55] European Parliament Resolution of 20 October 2020, containing recommendations to the Commission on the Digital Services Act, in *G.U.U.E.*, 6 October 2021, C-404, pp. 31 ff., esp.

(the so-called *Data Act*) has identified, as a necessary requirement for smart contracts, the provision of «[…] b) safe termination and interruption, to ensure that a mechanism exists to terminate the continued execution of transactions», estabilishing «that the smart contract includes internal functions which can reset or instruct the contract to stop or interrupt the operation, in particular to avoid future accidental executions (…)» [art. 36 (1)].

Indeed, the technical feasibility of incorporating functions capable of halting execution and modifying the terms of *Smart Contracts* has been the subject of reflection for some time. There have even been proposals – admittedly ambitious – to assign the function of oracle [56] to a state judge or (less irrealistically) to a private arbitrator, thereby enabling them to manage the critical issues associated with this contractual model [57].

It is not possible here to dwell on a detailed description of the proposed technical solutions [58], but it is clear that the design and potential implementation of

37 (point no. 35). Mari. MAUGERI, Smart Contracts *e disciplina dei contratti*, cit., p. 64, considers this request too intrusive, as it is «distonic[a] rispetto al modello di funzionamento dello Smart Contract», which is characterized by speed and efficiency.

[56] On the notion of the oracle, which constitutes the only means of linking external reality to the otherwise entirely self-referential technological and informational reality, see, among others, I. MARTONE, *op. cit.*, p. 60; as well as Mari. MAUGERI, *op. ult. cit*., p. 34 f.: «Si definisce oracolo la macchina o l'umano che manda l'*input* di ricezione alla macchina. L'oracolo è, dunque, un'entità terza che manda l'*input* al sistema. Si distingue fra oracolo automatico, ad esempio un sensore connesso con il *web site*, e oracolo uomo, si pensi al corriere che ha consegnato il pacco o a un esperto con poteri di valutazione. Axa, ad esempio, ha immaginato un contratto con il quale in caso di ritardo dell'aereo si avrà automaticamente il pagamento di una somma. In questo caso l'oracolo sarà il sistema di comunicazione degli orari di arrivo degli aerei, che verrà consultato e determinerà l'immediato trasferimento della somma in caso di ritardo». On the subject, see also M. EPIFANIA, *Questioni aperte in tema di* Smart Contract *e* Blockchain*: il «problema dell'oracolo»*, in *Corti salern.*, 2022, p. 621 ff.

[57] With regard to the intervention of third-party institutions, it has been noted, moreover, that there is a «contrasto con la natura che si vorrebbe tendenzialmente disintermediata delle piattaforme DLT, luogo di naturale sviluppo dello *smart contract*»: thus, among others,, A. D'ADDA, *op. cit.*, p. 113.

[58] For the identification of which, reference is made – including for the necessary bibliographic insights – to the following recent studies: C. ATTANASIO, *Inadempimento dello* smart contract*, sistema rimediale e tutela effettiva*, in *Riv. dir. civ.*, 2024, p. 732 ff.; T. PELLEGRINI, *Gli* smart contract, in E. BATTELLI (a cura di), *Diritto privato digitale*, cit., p. 371 ff.; F. LONGOBUCCO, Smart Legal Contract *e "*giusto rimedio civile*" del* re-coding, cit., pp. 762 ff., espec. 768 ff. This A. – following the proposal advanced by M. ZALNERIUTE-L. BENNETT MOSES-G. WILLIAMS, *The Rule of Law 'By Design'*, in *Tulane LR*, 95 (5), 2021, p. 1063 ff. – argues that should be «incoraggiati tutti i fenomeni incentrati sulla *Rule of Law by design*»; see also ID., *Utopia di un'autonoma* Lex Criptographi(c)a *e responsabilità del giurista*, cit., p. 102 ff.; to manage disputes relating to smart contracting E. BIVONA, *op. cit.*, p. 796 f., suggests adapting *Online Dispute Resolution (ODR) systems* to the blockchain environment; for an initial general overview of these systems, see, among others, E. MINERVINI (a cura di), *Le* online dispute resolution (ODR), Napoli, 2016.

technological mechanisms capable of adequately addressing the complex legal issues raised by smart contracting cannot proceed without a joint effort – and thus an ongoing dialogue – between programmers (IT specialists and other tech professionals involved) and jurists [59]. Such collaboration is essential in order to develop technological artefacts capable of operating in harmony with the rules and principles of the legal system [60].

This reflection can quite evidently be extended beyond the specific domain of *Smart Contracts* to encompass the entire scope of new technologies – first and foremost, those that embody the complex and multifaceted phenomenon of so-called Artificial Intelligence.

This new pervasive reality calls for a shift – indeed, an epistemological paradigm shift – on the part of jurists and legal science; and the same, conversely, may be said of computer scientists and other scholars in the «hard sciences» who are engaged in this technological revolution [61].

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[59] F. LONGOBUCCO, Smart Legal Contract *e "*giusto rimedio civile*" del* re-coding, cit., p. 771 (where further bibliographic references can be found) calls for the specialization of the jurist as a *Legal Engineer*, capable of engaging in a «dialogo costante con lo sviluppatore che è chiamato a "disegnare" *ab origine* una architettura informatica» compatible with legal rules and principles, in line with the *Rule of Law by design approach* (see the immediately preceding note); on the evolution of legal professions in relation to the digital reality, see, in greater detail, ID., *Utopia di un'autonoma* Lex Criptographi(c)a *e responsabilità del giurista*, cit., p. 35 ff.; see also what is noted in the subsequent footnote 68.

[60] The insightful perspective of M. PROTO, *Funzioni delle 'macchine intelligenti' e compiti dell'interprete*, in ID. (a cura di), *Intelligenza artificiale e rapporti bancari*, cit., p. 11, highlights, moreover, that law itself also represents, so to speak, an artificial technique, «che faticosamente costituisce regole osservando la realtà e tipizzandola, cioè convertendola in norme generali e astratte»; thus making it, in this sense, comparable to technological reality.

[61] It is reassuring to note that the aforementioned need for discussion and dialogue is also well recognized by scholars of computer science; emblematic, in this regard, are the words spoken by G. CANFORA during the *Institutional Greetings* at the Conference «Piattaforme online, dati e intelligenza artificiale tra interessi pubblici e garanzie dei privati», held in Benevento on June 13-14, 2024, at the University of Sannio (where he serves as Rector), as reported in *these Review*, 2025, p. 135 ff.: «Si sente spesso dire che abbiamo bisogno di più ingegneri, ed è indubbiamente vero! Ma abbiamo bisogno che i nostri ingegneri sviluppino un'attitudine umanista, dobbiamo dare loro gli strumenti concettuali per maturare piena consapevolezza delle conseguenze delle scelte tecnico-scientifiche sulla società e sulle vite delle persone. Al contempo, abbiamo bisogno che chi si occupa di discipline non tecniche, gli avvocati, i filosofi, i letterati, i sociologi, gli economisti, per fare qualche esempio, conosca più da vicino le tecnologie digitali, per comprendere fino in fondo la portata dei cambiamenti che emergono dall'interazione fra le tecnologie e dai modi in cui queste vengono utilizzate». Naturally, this need is increasingly recognized by legal scholars as well: for an initial reference, see, among others, E. MINERVINI, *Note brevi sull'intelligenza artificiale*, *ivi*, p. 195; F. LONGOBUCCO, Smart Legal Contract *e "*giusto rimedio civile*" del* re-coding, cit., p. 775; G. GITTI, *Presentazione*, in *Oss. dir. civ. comm.*, Speciale/2022, p. 5 ff.

From the perspective of jurists – both theorists and practitioners – this implies the need to deepen their understanding of the *technological domain* that law aspires to regulate [62]. To be clear, the era of purely doctrinal legal theories are long gone. For quite some time now, jurists have been fully aware that theirs is a practical science, and that in order to perform their task effectively, they must engage in dialogue with other disciplines that enable them to comprehend the social environment subject to legal regulation. Consequently, for just as long, jurists have been in conversation with philosophy, history, sociology, economics, political science, and more broadly, with the other social sciences [63].

What is now required is a step forward – the dismantling of the wall of separation (and mutual incomprehension) between scientific and humanistic culture, a divide famously denounced by C.P. Snow as early as 1959 in his seminal book *The Two Cultures* [64]. Jurists must jump over the fence – a task they have already begun to undertake, for instance, by engaging with genetics, biology, and medicine in its various branches when addressing bio-legal questions relating to the beginning and end of life. What is now needed is the recognition that «[p]er comprendere davvero i temi posti dalle nuove tecnologie, ancor più dall'intelligenza artificiale, e trovare risposte e regole, occorre aprirsi alle conoscenze dei diversi punti di vista e prospettive della cultura scientifica» [65], allowing it to engage in dialogue with law and the other social sciences. What is ultimately required is an awareness of the unity of the «due culture» [66].

[62] «La conoscenza del fenomeno è quindi pregiudiziale ad ogni valutazione [*sub specie juris*] dello stesso»: thus E. GABRIELLI-U. RUFFOLO, *Introduzione*, in ID. (a cura di), *Intelligenza Artificiale e diritto*, cit., p. 1657. The programmatic manifesto of such a cultural commitment could be encapsulated in the evocative formula «forma giuridica e materia tecnologica», reminiscent – *mutatis mutandis* – of the title of a famous essay by L. MENGONI, *Forma giuridica e materia economica*, in *Studi in onore di Alberto Asquini*, III, Padova, 1963, p. 1075 ff.; e in *Jus*, 1966, p. 5 ff.; and, more recently, in ID., *Diritto e valori*, Bologna, 1985, p. 147 ff.

[63] To cite just one example, A. QUADRIO CURZIO, *Presentazione*, in A. CARLEO (a cura di), *Calcolabilità giuridica*, Bologna, 2017, p. 7, speaks of «antica e importante complementarità tra le scienze giuridiche e le scienze economiche»; however, on closer examination, there are those who, on this very point, instead denounce «la disgiunzione tra il sapere tecnico-economico e la conoscenza giuridica» as «uno dei problemi più complessi e discussi del nostro tempo» (thus G. LEGNINI, *Introduzione*, in the aforementioned volume, p. 11). For a comprehensive examination of the relationship between law and economics, most recently, G. AZZARITI-S. BAGNI-M. CARDUCCI-A. SOMMA (a cura di), *Mercato istituzioni e regole. Sul difficile dialogo tra diritto ed economia*, Roma, 2025.

[64] C.P. SNOW, *The Two Cultures and the Scientific Revolution*, Cambridge UP, 1959.

[65] A. PATRONI GRIFFI, *op. cit.*, p. 12.

[66] For an overview, most recently, T. BONGO-G. CAPASSO-A. EREDITATO-M. FARISCO-O. SAMPIETRO (a cura di), *L'unità delle due culture. Studi offerti a Ortensio Zecchino per i suoi ottant'anni*, I-II, Soveria Mannelli, 2023. And see also J. BROCKMAN, *The Third Culture*, New York, 1995 (trad. it. di L. Carra, *La terza cultura*, Milano, 1995).

The stakes are exceedingly high. For the dialogue and mutual understanding just invoked – beyond fulfilling the important gneosological and methodological need just highlighted – is likely also essential to prevent the «marginalizzazione totale» of the specific knowledge tradition embodied in legal science [67]. If it fails to rise to this challenge, legal science risks being overwhelmed by the expansive rise of modern technologies and the diverse bodies of knowledge cultivated by the techno-sciences that underpin and fuel them [68].

[67] Thus Mari. MAUGERI, *Contratto e nuove tecnologie*, cit., p. 1150, to whom the expression quoted in the text is attributed. Although particularly serious in the present time due to the noted powerful rise of techno-sciences, the issue of the marginalization of legal knowledge «nella più generale storia della cultura di un popolo» – and, consequently, of the role of jurists and of legal science «nella comune considerazione» – is, however, a very recurrent concern in legal literature and far more longstanding, to the point of arguably representing an authentic τόπος (tòpos). See, by way of example, G.B. FERRI, *Il diritto statuale e il suo* doppio, cit., p. 21 (to whom the preceding quotations belong). Equally longstanding, moreover, are the attempts made by the most forward-looking members of the legal community to redeem this branch of knowledge from isolation or, at the very least, from subordination to broader cultural trends, through the deliberate implementation of initiatives inspired by methodological openness grounded in multi- and transdisciplinary dialogue. Among the many possible examples, it is worth recalling here the cultural project that took shape with the publication, beginning in 1972, of the *Quaderni fiorentini per la storia del pensiero giuridico moderno*, published by Giuffrè: as stated in the *Pagina introduttiva* of the first 1972 volume, always signed by Paolo Grossi (now reproduced in ID., *Trent'anni di pagine introduttive. Quaderni fiorentini 1972-2001*, Milano, 2009, p. 3 ff., from which this passage is quoted), one of the guiding motivations of that successful and commendable editorial undertaking was precisely the aspiration to take «un primo passo nella strada (…) che ha, al suo sbocco finale, la sottrazione della scienza giuridica dai margini della cultura nei quali è oggi relegata»; see also the preface – significantly entitled *I segni dei tempi* – by P. CAPPELLINI to the above-mentioned volume, which, in recalling the founding journey of the Quaderni, reports (p. XIX ff.) on a letter sent to Paolo Grossi by his first student, Mario Sbriccoli, who underscored the necessity «del recupero della scienza giuridica alla cultura», while also seeking to identify the underlying reasons for the «perifericità» of that body of knowledge.

In Italian-language literature, is now available, in the form of a comprehensive treatise (*Trattato e-Agorà*), an in-depth interdisciplinary study – primarily devoted to digital platforms – which jointly examines the technological, philosophical, and legal aspects of the issue, with the latter articulated across the various branches of legal scholarship: R. BOCCHINI (a cura di), *Le piattaforme digitali*, Torino, 2025.

[68] This necessity must, of course, be reflected in the educational system, primarily at the university level, which, however, has already begun to move in this direction and continues to do so in our country. There are now several examples of law degree programs in Italy that include specific tracks – under various designations – aimed at providing an in-depth study of the relationship between law and technology.