Three Roads to Complexity, AI and the Law of Robots: On Crimes, Contracts, and Torts

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Abstract. The paper examines the impact of robotics technology on contemporary legal systems and, more particularly, some of the legal challenges brought on by the information revolution in the fields of criminal law, contracts, and tort law. Whereas, in international humanitarian law, scholars and lawmakers debate on whether autonomous lethal weapons should be banned, robots are reshaping notions of agency and human responsibility in civil (as opposed to criminal) law. Although time is not ripe for the "legal personification" of robots, we should admit new forms of both contractual and tort liability for the behaviour of these "intelligent machines." After all, this is the first time ever legal systems will hold people responsible for what an artificial state-transition system "decides" to do.

Keywords: Accountability, Agency, AI & Law, Complexity, Contracts, Criminal Law, Liability, Responsibility, Robot, Tort Law.

1 Introduction

This article examines the impact of robotics technology on contemporary legal systems and, more particularly, how the production and use of robots affect some tenets of criminal law, contractual obligations, and tort law. First used by Isaac Asimov in the 1942 novel Runaround [1], the word "robotics" concerns a panoply of disciplines such as computer science and cybernetics, physics, mathematics and mechanics, electronics, neuroscience, biology and more. Some argue that robots are machines basically built upon today's "sense-think-act" paradigm in AI research [2]. Others, as the director of the AI Laboratory at Stanford, CA., Sebastian Thrun, reckon that robots have to do with the ability of a machine to "perceive something complex and make appropriate decisions" [4]. While some others stress that robots should be able to learn and adapt to the changes of the environment, it is crucial we distinguish a number of applications as different as humanoids, adaptive service robots, unmanned underwater vehicles, drones, and so forth. Such differentiations are critical when ascertaining the impact of robotics technology on contemporary legal systems, because it is likely that drones and other types of autonomous (lethal) weapons mainly affect legal fields such as international humanitarian and criminal law, whereas other applications such as, say, da Vinci robot-surgeons mostly raise matters of contractual obligations and strict liability rules.

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The exponential curve of advancement in the field of robotics technology, e.g., the current rates of doubling amounts of computation also known as the "Moore's law," have nevertheless induced some scholars to exaggerations which are also popular in the legal field. Some argue that the current information revolution inexorably shapes the destiny of human beings and their societies. This sort of determinism is illustrated by the thesis of a distinguished researcher from Carnegie Mellon, Hans Moravec, who announced some years ago that intelligent robots will succeed humans and that we, as a species, would face extinction [4]. In other words, technology would decree robots replacing humans as the next step in evolution [5], so that lawyers should be ready to discuss a new generation of cases such as challenges to national sovereignty and robot revolutions [6], robotic sex crimes [7], or robots that choose to commit and, ultimately, carry out the crime, e.g., the adventures of the "Robot Kleptomaniac" [8]. According to these perspectives, new types of crime would emerge with robots accountable for their regrettable actions: the self-consciousness of the robot would not only materialize Sci-Fi scenarios as imagining a robot revolution and, hence, a new cyber-Spartacus. Furthermore, the meaning of traditional notions such as stealing and killing would change, since the culpability of the agent, i.e., its mens rea would be rooted in the artificial mind of a machine "capable of a measure of empathy" and "a type of autonomy that affords intentional actions" [9].

In order to prevent misunderstandings, this paper suggests we should grasp the new frontiers of complexity, AI and legal robotics, by reverting to the terra cognita of jurisprudence and its civil law-counterpart in Europe, i.e., "general theory of law." Since the late 1800s, after all, the "Law of the Automaton" has been a popular topic among legal scholars: Günther's Das Automatenrecht was published in 1891, Ertel's Der Automatenmissbrauch und seine Charakterisierung als Delikt as well as Schiller's Rechtsverhältnisse des Automen were printed in 1898, down to Neumond's Der Automat in 1899. More than a century later, a relatively strong consensus still exists about key legal notions regarding the production and use of robots: the common viewpoint excludes the criminal accountability and the "legal personality" of robots. For the foreseeable future, in fact, these machines will be held legally and morally irresponsible because they lack the set of preconditions for attributing liability to someone in the realm of criminal law. Since consciousness is a conceptual prerequisite for both legal and "moral agency" [10], it follows that even when Robbie CX30 assassinated Bart Matthews in Richard Epstein's story on The Case of the Killer Robot, the homicide remains a matter of human responsibility, for robots are not aware of their own conduct like "wishing" to act in a certain way [11].

However, we need not evaluate robots with Turing tests in order to admit a new generation of legal cases involving human liability as well as robots accountability [12]. Regardless of Sci-Fi scenarios where robots are provided with consciousness, free will and emotions, it is likely that "in a few years we are going to cohabit with robots endowed with self knowledge and autonomy in the engineering meaning of these words" [13]. Although robots do not raise new legal issues per se, e.g., homicides and other cases of criminal law, some applications

really challenge the "completeness" of legal systems, i.e., the Hilbert-like capacity to decide every legal problem through the use of analogy (and the general principles of the system, according to the European civil law-tradition). It is enough to mention military applications of robotics technology and the civilian use of unmanned vehicles (UVs) as drones, besides the forthcoming generation of robot-traders, robot-doctors, robot-nannies and, why not?, sex robots [14], to stress that they challenge "the boundaries and efficacy of existing legal frameworks and raise a range of social and ethical constraints" [15]. In order to tell hard cases from routine cases, the paper proposes to tackle the new frontiers of complexity, AI & law, by distinguishing matters of criminal law, contracts, and strict liability in the design, production and use of robots.

In section 2, I examine the production and use of robot soldiers, and how they affect current principles of criminal law and, moreover, of international humanitarian law. In section 3, I take into account the 2004 "World Robotics"-report of the UN Economic Commission mainly focused on robots of peace such as industrial robots, surgical robots, edutainment robots, etc., so as to shed light on matters of risk and predictability in contractual obligations. In section 4, I consider issues of extra-contractual responsibility and strict liability induced by such "robots of peace" [16]. The conclusion is that the increasing autonomy and even "intelligence" of robotic behaviour impact on the complexity of legal systems, by altering the basis on which the principles of human responsibility and accountability are traditionally grounded. Although time is not ripe for the "legal personification" of robots, new forms of liability for artificial agents in the field of contracts [17–20], as well as models for distributing risk in tort law [15, 21], should be mentioned. This is in fact the first time ever legal systems will hold people responsible for what a robot "chooses" to do. Since robots are here to stay, the aim of the law should be to wisely discipline our mutual relationships.

2 Crimes

I mentioned the common legal standpoint that hooks "autonomous" and "intelligent" robots off all claims of criminal responsibility. Robots indeed lack psychological components such as intentions or consciousness, i.e., the set of preconditions for attributing liability to someone in the case of violation of criminal law. However, it is highly debatable to claim that robots lack all types of agenthood: after all, we already have a generation of proper "artificial agents" (AAs) that respond to stimuli by changing the values of their properties or inner states and, furthermore, that improve the rules through which those properties change without external stimuli. These robots suggest we are dealing with a new source of agency, in that they properly are interactive, autonomous, and adaptable [22]. Like animals, children and, obviously, adult human beings, robots can cause morally qualifiable actions such as good and evil [23]. Moreover, robots may represent a meaningful target of censorship as in the case of "monitoring and modification, removal to a disconnected component of cyberspace" or "deletion without backup" [12]. If it seems appropriate to extend the class of morally

accountable agents so as to include the artificial agency of robots, however, we should further distinguish between this form of agency and the criminal liability of robots, that is, between the source of relevant moral actions and the evaluation of agents as being morally responsible for a given behaviour. This is what typically occurs with children's actions and the behaviour of animals: even though we assume that some sort of moral accountability is a necessary requirement for legal responsibility, the former does not represent a sufficient condition of the latter, because respondents ought to be subject to the ordinary process of moral appreciation in order to determine whether or not they are guilty in the name of the law. This is why, according to the current state-of-the-art, it would be pointless to debate before a judge whether a robot should be considered a "killer," a "robber," and so on. Simply consider the reasons underpinning the legitimacy of inflicting punishment in modern criminal law such as the theory of retribution, of special and general prevention, that, in the case of robots, would be devoid of meaning: Can we reckon robots paying their debt to society? Can we correct their moral character so that such machines fully understand why they ought not to repeat an evil action? Should we punish robots so as to dissuade human beings (and other robots) from committing similar wrongs?

However, there is another way robots affect today's principles and provisions of criminal law. As the field of computer crimes has shown over the past two decades, robotics technology makes possible what simply was unthinkable few years ago. In the mid 1990s, for example, the Legal Tender project claimed that remote viewers could tele-operate a robotic system to physically alter "purportedly authentic US $ 1000 bills" [24]. Since the early 2000s, research and development of new "robotic systems" have been particularly massive in military robotics (more than 50% of the American R&D in AI is sponsored by the U.S. Army). Similarly to previous technological advancements in chemical, biological and nuclear weapons, robots are already affecting a number of legal fields such as the laws of war, rules of engagement and provisions of international humanitarian law. Military applications of robotics technology such as MQ-9 Reapers and C-3PO Terminators are in fact challenging principles of military conduct like proportionate use of force or discrimination between soldiers and civilians. According to several scholars [25–27], what makes the use of such robots critical depends on the technical difficulty to design them so as to let machines distinguish between friends and foes. In their 2010 reports to the UN General Assembly, Philip Alston and Christof Heynes have significantly stressed that legal provisions are silent on two key points. Not only is analogy inadequate to determine whether certain types of "autonomous weapons" should be considered unlawful as such, but it is also far from clear the set of parameters and conditions that should regulate the use of these machines in accordance with the principle of discrimination and immunity in ius in bello [28]. In the first hypothesis, i.e., the case of a ban, political and military authorities would be responsible for AI soldiers violating principles of ius belli: once established what types of robotic weapons should not be permitted, e.g., autonomous lethal machines with no human supervision, it follows that their design and construction should be interpreted as a crime. In the second hypothesis, i.e., a UN-sponsored

agreement defining the set of parameters and conditions that discipline the use of robot soldiers, the aim is to determine when the design, production and employment of military robotics technology are lawful.

Still, the production and employment of robot soldiers are not only provoking a number of loopholes in crucial fields as the laws of war, rules of engagement and provisions of international humanitarian law. Besides the impact of robotics technology on national security, public order and what is necessary in a democratic society in the interests of public safety (in the phrasing of art. 8.2 of the 1950 European Convention on Human Rights), the increasing unpredictability and autonomy of robotic behaviour are affecting legal notions of "causation" and "reasonable foreseeability." Some argue that this capacity of robots to operate in the real world without human control concerns a very core principle of the law, because no human could ultimately be held responsible [25]. In the hypothesis of a robot that causes serious harm by taking its own decisions on the battlefield, "this would indeed be a very tricky case legally. The only solution would be to simply withdraw all of the AW [autonomous weapons] of this particular design" [29]. Moreover, by affecting the idea of individual fault and the doctrine of "proximate causes" in deciding where to cut the chain of responsibility, some have suggested a "failure of causation," since it would be hard to predict what types of harm may supervene [17].

Yet, legal notions of "causation," "reasonable foreseeability," "apportioned liability," and more, do not only concern possible illegal uses of robotic applications. Even in military robotics, we should pay attention to the design and construction of such machines: when humans use robots in order to apply force in disproportionate ways, no lawyer doubts that the fault has to be attributed to the user of such robot, notwithstanding "unforeseeable" or "unpredictable" behaviour of the machine. But, when machines do not properly work within the limits of a given set of parameters, the fault will be attributed to the manufacturers of such artefacts, e.g., the case of the unintended movements of the Sword unites employed by the U.S. Army and the producer's claims to avoid liability [30]. In this latter case, focus should be on determining fault in complex software and hardware applications for autonomous AAs, pursuant to conditions, terms, and clauses that depend both on the voluntary agreement between private individuals that a court will enforce, and the commercial or non-commercial nature of that agreement. Let me deepen this different look at robotics, in connection with a new generation of "civilian robots" such as business-makers, AI traders, and their contracts: rather than the legitimacy of the ends, what is at stake in the next section concerns the means of robotics technology.

3 Contracts

The design and production of robots are disciplined by conditions, terms, and clauses established by the parties to a contract. Here, legal issues have to do with "causation," "foreseeability," and "apportioned liability" that depend on the range of goals and set of parameters of a given artefact. Consider the very

controlled setting of operatory rooms in the case of the da Vinci surgical robots, which raise engineering problems that scholars routinely address as part of their research. On the basis of the probability of events, their consequences and costs, lawyers examine matters of unpredictability and risk provoked by such robots, as they did with previous technological innovations. For example, work on the da Vinci robot shows that only 9 out of 350 interventions (2.6%) could not be completed due to device malfunctions of the artificial doctor [31]. Likewise, others claim that only 4,8% of the malfunctions occurred in a New York urology institute, from 2000 to 2007, would be related to a patient injury [32]. However, the more we widen settings and goals of robotics programs, the more it is likely we will be dealing with growing amounts of complexity; but, the more the amount of computation is exponentially increased, the more the risks that emerge as a consequence of robotic behaviour. In order to cast light on matters of contractual liability, foreseeability and causation for some riskier robotics applications than the da Vinci, some words on the Zero Intelligence (ZI)-agents are necessary.

Archetypes in "double action markets" [33, 34], ZI agents are programmed to "generate bids and offers selected randomly from a uniform distribution subject only to the constraint it cannot deliberately lose money" [35]. Such agents are rudimental in that they are oblivious of their environment and do not control the timing of their actions: ZI agents even lack the capability of taking action so as to compensate their inability to respond to the environment. Since the robot tournaments at the Santa Fe Institute in 1990, it turned out that markets populated only by ZI agents have nonetheless the tendency of human markets to generate average prices and quantities of what economists traditionally present as a "competitive equilibrium." These artificial agents seem to confirm Hayek's idea that, in some circumstances as with social (i.e., contractual) interaction, "intelligence" emerges from the "rules of the game" rather than individual choices [36]. The level of autonomy that is insufficient to bring robots before judges and have them declared guilty in criminal courts is enough to have relevant effects in the field of contracts, where "the intentional stance represents usually the only possible viewpoint to explain and foresee the behaviour of complex entities that can act teleologically" [20]. After all, ZI agents achieve sophisticated goals as outperforming untrained human traders in double-oral auctions [37], so that, in "shopping around" or "planning ahead," the performance of ZI agents has been improved and "the design of a special-purpose agent that can trade in the simple asset markets examined in this article as well as, if not better than, humans seems clearly within grasp" [35].

Yet, even ZI agents may be risky and dangerous: their eagerness to trade has suggested troubling similarities with the greediness of human speculators and "real life" bubbles in markets, in that agents are overwhelmed by the complexity of the environment and appear extremely "inexperienced." By considering that, in many other cases, robots are "good" in decreasing the informational entropy of the system or enriching its informational properties [38], e.g., the new generation of "robot traders" which the UN Economic Commission illustrated in the 2004 "World Robotics"-report [39], it is thus necessary to address people's claims not

to be ruined by their own robot's activities and intentions, that is, business run by ZI agents. In the light of how robots can be extremely fruitful in making contracts, or establishing rights and obligations between humans, e.g., cognitive automata in the form of software agents [20], how could we forestall any legislation that might prevent the use, rather than the production, of "robots traders" due to their risks?

Some scholars have proposed to introduce forms of limited responsibility through "personal accountability of robots" so as to discipline transactions mediated by artificial agents and tomorrow's smart ZI agents [18]. The wisdom of ancient Roman law suggests a kind of "artificial accountability" with the mechanism of "peculium": in the phrasing of the Digest of Justinian, it was "the sum of money or property granted by the head of the household to a slave or son-in-power. Although considered for some purposes as a separate unit, and so allowing a business run by slaves to be used almost as a limited company, it remained technically the property of the head of the household" [40]. In the case of robots, the aim should indeed be the same lawyers pursued in Ancient Rome: whilst some Roman slaves were estate managers, bankers, or merchants, though not "humans," rights and obligations established by robots could be guaranteed by the robot's own portfolio. The parallelism between robots and slaves is hence attractive, because a "digital peculium" guarantees that people would not be ruined by the "decisions" of their robots and that robots' counterparties would be protected when making business with them [21]. Besides further mechanisms of distributing risk through insurance models [17], or authentication systems [18], new forms of accountability such as the digital peculium might avert any legislation that prevents the use of robots due to the excessive burden on the owners (rather than, say, on the producers and designers) of these machines.

Legal issues concerning the design, production and use of autonomous robots, however, not only regard clauses and pacts between humans and "robot traders." Further robotics applications suggest that lawyers will increasingly discuss problems of extra-contractual responsibility, e.g., robots damaging "third parties" rather than affecting their contractual "counter-parties." This scenario transcends the mechanism of peculium and involves what Roman jurists defined in terms of Aquilian protection, namely, the form of responsibility which stems from the general idea that people are held liable for unlawful or accidental damages caused to others due to personal fault [41]. In the first case of "damages," we are still dealing with the technical difficulties of the project and clauses of the agreement between the parties, i.e., the design and construction of Swords, Warriors, Da Vincis, ZI agents, etc. It is noteworthy that work on robot trading in auction markets, as the Penn-Lehman Automated Trading project, showed relevant failures in programming ZI agents capable to effectively speculate against smart humans (sponsored by the University of Pennsylvania and Lehman Brothers, the project was suspended in 2005, that is, 3 years before Lehman Brothers' own collapse). Vice versa, in the hypothesis of extra-contractual responsibility, lawyers discuss obligations between private persons imposed by the government so as to compensate "damage" done by wrongdoing. After contractual obligations, let me examine what common lawyers define as torts.

4 Torts

In the field of extra-contractual responsibility, lawyers traditionally distinguish between intentional torts, negligence-related tortuous liability, and faultless liability or strict liability. In the first case, there is liability for an intentional tort when a person has voluntarily performed the wrongful action. Next, liability is based on lack of due care when the "reasonable" person fails to guard against "foreseeable" harm. Finally, faultless liability or strict liability is established, e.g., liability for defective products, when there is no illicit or culpable behaviour but, say, a lack of information about certain features of the artefact. In the field of robotics technology, the tricky part of this framework depends on the fact that, for the first time ever, legal systems will hold people responsible for the behaviour of expert systems that gain knowledge and skills from their own "decisions." A forthcoming generation of robot toys, "robot nannies," and even intelligent cars or UGVs [15], will learn from the features of the environment and, as any other proper agent, tomorrow's robot toys, robot nannies and even robot chauffeurs will improve the rules through which the values of their own properties change without external stimuli. The result is that the same model of AI "toy," AI "nanny," or AI "car," we will be possibly buying next Christmas, is going to behave quite differently after few days or weeks: in the event the machine causes harm to someone in the roundabouts, who is liable?

Leaving aside the hypothesis of intentional torts, we have to determine how social risk should be distributed via (new) clauses of extra-contractual responsibility for the behaviour of our robots. In some cases, e.g., unmanned ground vehicles or UGVs, we might address today's loopholes of the law by establishing forms of strict liability as in the aforementioned case of product liability for the damages caused by people's own dangerous activities, that is, regardless of the intent of the subject or her use of ordinary care. Employers, for example, are often held liable for any illicit action the employees engage in under their working contract activities. Such a policy could obviously be mitigated in the case of robots, so as to avert the risk that people think twice, before producing and using robots at all. We could perhaps make insurance compulsory as we have done in most legal systems with traditional cars. We might also extend the mechanism of peculium by determining that human extra-contractual liability should be limited to the value of their own robots portfolio (plus, eventually, the compulsory insurance set above). Yet, there are some other types of artificial agents, e.g., "robot toys" and "robot nannies," that suggest a different approach to tort policies: some claim that lawyers should frame human relations with such robots, as we do with animals rather than tin machines or smart fridges [23]. In the event that an "intelligent nanny" causes harm to someone in the roundabouts, people's liability would ultimately depend on how we treated our machine, rather than the ways, say, that machine was designed and constructed. In order to illustrate the ways such a responsibility may be established, it is important to understand how the burden of proof is allocated in these cases.

In fact, legal systems provide for some limits to the aforementioned clauses of faultless liability, as it typically happens to parents who evade responsibility for

their children's behaviour, when they prove they could not prevent their children's actions. Likewise, this is what occurs to the owners of animals when they prove that a fortuitous event happened. While regarding the set of dangerous activities, some legal systems exclude liability when it is proved you have taken all the "appropriate measures" in order to prevent any sort of damage, we may guess what sort of limited responsibility fits this type of robot. Once the main legal issue revolves around how we educate, treat, or manage our autonomous machines, rather than around who owns, built or sold them, people's extra-contractual responsibility for the behaviour of their robots depends on the typology of the human-robot relation and, of course, on the circumstances of the case. As lawyers discuss in most legal systems, should we deny liability when it is proved that a fortuitous event occurred, i.e., robots disciplined as "pets," or should we deem that individuals fairly evade responsibility only when they prove it was not possible to prevent a machine's action, i.e., robots considered as "children"?

Such issues are particularly complex, in that answers would require more information than that conveyed by the same question [36]: for instance, it is more than likely that robots will raise psychological problems related to the very interaction with humans as matters of attachment and feelings of subordination, trust, reliability, and deviations in individual emotions. Back to the field of military robotics technology and the use of artificial agents on the battlefield, it is telling what The Economist reported in October 2010, that is a Lebanese newspaper editor declaring that "Americans and Israelis are cowards to send machines to fight for them," although the article recalls "another story of an officer in Iraq, so moved by the sacrifice of a bomb-disposal robot that he wrote a letter of condolence to its manufacturer . . . " [42]. Despite conspicuous work on how robotics technology affects human psychology, we have not enough data on the probability of events, their consequences and costs, so as to determine levels of risk on which insurance models may hinge for the use of new artificial companions and helpers at home, e.g., robot toys and robot nannies programmed to provide love and take care of children and the elderly. Contrary to some robotics applications like the aforementioned da Vinci surgeons and different models of unmanned vehicles (UVs) undertaking repairs to oil rigs in the Caribbean Sea, or inspecting atomic plants in Japan, it is an open question the kind of tort liability-policy we should endorse to tackle the unpredictability of our multiple artificial agents' behaviour.

Still, from a legal viewpoint, we should not miss the crucial point: whether under forms of negligence-related tortuous liability or strict liability-rules, humans are going to be held responsible for what robots autonomously do. This is not the first time legal systems provide for the responsibility and agency of some "artificial persons" like governments, organizations, companies or corporations; yet, this is going to be the first time such a liability is not reducible to an aggregation of human beings as the only relevant source of their action. As previously stressed, besides cases of responsibility for the behaviour of their children, pets, and even employees, a new generation of robots induce novel types of human responsibility for others' actions. Whereas this latter kind of responsibility

suggests we have to take into account multiple types of robot interacting with humans for different purposes, some argue that such machines should be deemed as actors in current legal systems [43]. Leaving aside the debate on whether robots represent "the" new actors of todays complex networks[5], it is crucial to determine what type of legal agency robots might have.

5 Conclusions

Let me sum up the analysis on how robotics technology is affecting today's legal systems, with research in network theory and the complexity of the law. Besides regulatory frameworks for the design, production and use of robots, we should in fact understand how current rates of doubling amounts of computation and widening of operational goals are challenging key tenets of the law, as it is shown by the debate on the "legal personification" of artificial agents [20, 43–45]. In particular, focus should be on how information is created and distributed in a given network through the "nodes," so that a system is complex when collective behaviour emerges from large webs of individual components with no central control or simple rules of operation. As work in "evolutionary algorithms," "adaptive social networks," and the "normative emergence" from a multi-agent system perspective illustrate [46], it is not necessary to grasp the nodes of the network from an anthropological point of view, thereby reducing such nodes to an aggregation of human beings as the only relevant source of their action. What matters, here, is the sophisticated signalling and information processing of the nodes, whether "natural" or "artificial," so as to adapt to the environment through learning and evolutionary processes that lead to "decisions." Whilst the class of morally accountable agents may legitimately include the artificial agency of robots as a source of "good" and "evil" [12], the class of legal personhood may analogously be expanded through, for example, the "actants" or "hybrids" of Latour's network theory [47]. In the phrasing of Günther Teubner, "the result is that the law is opening itself for the entry of new juridical actors [such as the] electronic agents" [43].

However, dealing with the legal "agency" and "accountability" of robots, we should distinguish three levels of analysis, that is, whether robots have to be considered as new legal "persons," "actors" or, rather, "sources" of novel sorts of legal responsibility. Although such different levels of analysis are interconnected, we should keep crucial distinctions firm: indeed, regardless of the legal personhood of robots and whether they should properly have "rights" and "duties," it is a matter of fact that such machines are affecting basic assumptions of the law because, like slaves in Ancient Rome, robots are "things" that, nevertheless, can play a crucial role in fields as different as family contexts, edutainment environments, or trade, commerce, and business [39]. Whereas lawyers needed more than 2000 years to recognize the human personhood of slaves, vice versa, the legal personification of robots does not represent a necessary condition for the acknowledgment of new forms of accountability and contractual responsibility for (some types of) robots. Likewise, as the mounting autonomy of robots is defining new "nodes of the network" in the field of extra-contractual responsibility,

lawyers will increasingly discuss further types of liability for others' behaviour, besides the traditional human responsibility for damages caused by their children, animals, or employees. At the end of the day, even by considering robots as simple means or "objects" as it occurs in criminal law, it is evident that new critical issues will emerge in human rights law, international humanitarian law, rules of engagement in laws of war, and so forth. Accordingly, the paper aimed to pinpoint how robotics technology challenges the complexity of the law at three different levels.

The first challenge regards whether robots should be deemed as "legal actors," according to the set of preconditions for attributing liability to someone in criminal law. By averting some popular Sci-Fi scenarios, the paper stressed that robots cannot certainly be deemed as "guilty," that is, criminally liable, although they can represent a meaningful target of human censorship.

The second challenge concerns whether robots should be welcomed as "legal persons," having the faculty to autonomously establish rights and obligations in the field of contracts: insurance models, authentication systems, and mechanisms of accountability such as the "digital peculium," showed ways of distributing risk by making robots liable for (some of) their actions.

The third challenge has finally to do with robots as the "source" of human liability in social interaction, so that we should discern multiple types of robots when determining different forms of extra-contractual responsibility, i.e., negligence-related tortuous liability or faultless responsibility for the behaviour of robots.

All in all, this threefold notion of robotic agency as a new "node of the network" represents one of the most relevant topics for further research in complexity, AI & the law. Since robots are here to stay, the aim should be to wisely discipline our mutual relationships in connection with the new frontiers of crimes, contracts, and torts, brought on by the information revolution.

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