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Dimensions of Nodal Liability for Smart Agent

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Abstract

The research explores the concept of liability in the context of smart agents, which are autonomous systems designed to perform tasks and make decisions on behalf of humans or organizations. The study focuses on identifying and analyzing various dimensions of liability associated with these smart agents, particularly in scenarios where they operate independently and make critical decisions. It examines the legal and ethical implications of holding smart agents accountable for their actions, addressing issues such as the attribution of responsibility among the agents, their creators, and users. The research delves into how traditional notions of liability can be adapted to accommodate the complexities of autonomous systems, proposing frameworks and models for determining accountability in cases of malfunction, errors, or unintended consequences. The findings aim to provide a structured approach to managing the legal and ethical challenges posed by the integration of intelligent agents across sectors, and to offer suggested insights into the evolving landscape of technology and liability.

Keywords: Smart Agents, Nodal Liability, Ethical Implications, Legal Accountability.

Introduction

According to policymakers, internet access services are to be provided with respect for a number of principles. One of those principles is related to the business models supporting the internet services and connectivity. The business model principles include the liability of smart agents, and one example of such liability is presented under the title of "liability of smart agents". From liability of entities such as BGP operators, we move to a slightly different dimension of liability, explained also to provide policy-wonks with insight into some of the solutions (Choudhary et al., 2020, Al Dajeh, 2024).

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Study Objectives

The study seeks to shed light on the options, questions and dimensions involved in studying the concepts and activities of smart agents, which require an in-depth analysis of the traditional and proposed image of the accountability of these agents within the scope of the contractual system models, including:

1. Clarifying the nature of contractual liability in the legal and jurisprudential sense.
2. Analyzing and studying the traditional concepts associated with smart agents.
3. Discovering the dimensions of the legal liability of smart agents.
4. Indicating the extent of the compatibility of the traditional contractual system with smart technologies.
4. Developing a vision for the proposed accountability frameworks and systems within the scope of the activity of smart agents.

Study Methodology

The research methodology is based on the analytical approach by examining the factual picture of smart agents' systems and the nature of work and activity by analyzing the different dimensions of responsibility associated with these agents, especially in the frameworks that operate independently to enable them to make decisive decisions, by reference to the jurisprudence and previous studies available.

The study requires understanding and analyzing traditional concepts and what liability exists, while at the same time analyzing the ability to drop proposed frameworks and models for determining legal accountability aimed at overcoming obstacles and challenges by reference to available or hoped legal norms.

Legal Frameworks and Regulations Governing Nodal Liability for Smart Agents

Certain potential responsibility points could involve legal or regulatory responsibilities regarding actions within the smart agent. It is necessary that the smart agent satisfies the regulatory frameworks to minimize the nodal liability of each party involved. Self-licensing is not an option. There are many regulatory frameworks which will consider nodal liabilities between smart agents. If a smart agent claims to have a particular talent, it must meet the skill demands. In industrial environments, there are legislative structures requiring the results being processed, e.g. a sophisticated driver of chess robots vs. a farming robot. When wearing clothes, a smart agent will also meet protection regulations, enabling it to stay free via numerous interfaces. Nodal legal commitments are those nodal legal

laws that create an efficient and legally appropriate balance between the different nodal legal commitments (Beckers & Teubner, 2021).

Nodal legal laws comprise a fundamental prohibition or structure of the Ax-definition, or existence of the renewable base, rather than ordinary-scale rules. Nodal legal prescriptions are those norms that shift nodal legal obligations from agreements. It is therefore advisable to ensure that smart agents' actions adhere to recent legislation or to cause interpretations to bear significant ramifications to consumers, assuming that legal definitions exist, and the hard or softer laws (respectively to interpret) to adhere to recent legislation. The flexibility of legislation allows it to make extensive use of innovation-focused interpretations, still Nodal legal norms preferably allow the comparison of various nodal legal authorities.

Key Concepts in Nodal Liability for Smart Agents

Introduction One of the historical principles of holding networks accountable is the concept of nodal liability. Different dimensions of nodal liability are discussed in academia. This contribution is limited to examining the potential for nodal liability to attach to a smart agent that allocates and intermediates access to system resources. The intention is to evolve a shared foundation of the primary concepts utilized in holding a node having system assets accountable.

Nodal Liability for Smart Agents – A Conceptual Dimension

Nodal Liability In the context of dynamic resource allocation, different types of nodal liability can be differentiated. Nodal liability can take the shape of a social norm when the network becomes the source of public goods. Nodal liability can develop if the network is a legal entity because of a legislative or institutionalized choice to make someone accountable because 'its' network is managed. Then there are general societal expectations that nodes that have acquired a certain position in society are held accountable for their role in harm outcomes. This is un-institutionalized nodal liability. Economic nodal liability is anchored in the specific networked economic function that the entity exercises. Such nodal liability is thus an externality of being granted entry into a specific type of economic activity. Whether the entity has any form of liability is multiple in this third scenario. Generally, such liability will only exist if the network operator acts faulty. However, more strict liability is conceivable and can be made legally enforceable (Maity et al., 2024).

Literature Review

Nodal liability is defined as an agent's sufficient capability for accepting smart contracts and reimbursing the creditors if corresponding duties are endangered. Here, "capable" denotes that an agent has the power of maintaining what it has promised; otherwise, it will not be held responsible to the creditors. To systematically define the node's ability, the author introduced a basic element, i.e., the regional trait of an agent's capability to execute an obligation and to reimburse the creditor. This is expertise, or the extent of practical knowledge, skill, or competence in executing a duty. Hereafter, the term capability will denote expertise. If an agent has sufficient expertise at any given moment, the creditor will have potential for compensation (Dwivedi et al., 2021).

Capability is the appropriateness between an agent's proficiency to craft smart agreements and its competence while doing it. All of these teachings should be provided in axiomatic format to fill the gap in the existing literature on nodal liability. For smart agents, they may be disqualified for proving capability on some obligations. However, they can still be liable to a broad scope of obligations, under certain qualifications. Additionally, one smart agent's superior or inferior capability is in comparison with another's capability. There is no consensus on the superior or inferior capability without comparison. Thus, one node's capability is a relative concept (Lagioia & Sartor, 2020).

As well as Nodal liability can be viewed from different perspectives, also referred to as 'dimensions' or types of liability. It is critical to understand the different forms of nodal liability as these contribute to the conceptual limits of smart and autonomous agents and drawing boundaries for them. The various forms of nodal liability depend on individual situations based upon the kind of agent employed, technology used and its capability, the function it is anticipated to execute, and the authority it holds in a particular transaction. By describing these various dimensions of nodal liability, this article structures the various forms of liability with regard to smart agents.

Depending on the source or the ground of harm or transgression, a smart agent can be subjected to i) hedged liability, ii) strict liability, or iii) criminal liability. Based on the functions performed by the agent, it falls under i) inherent liability or ii) acquired liability. Depending upon legal-personality-related concerns, nodal liability is also categorized into i) delegated or shareholder liability and ii) managerial liability according to the views. Under the ability to initiate the action or discharge obligations, liability is bifurcated into i) principal or initiator liability and ii) agent or non-initiator liability. Based on the rights and

duties conferred upon an agent in given situations, liability can be termed either i) strict or fiduciary liability (Bathaee, 2020).

Technological Advances Impacting Nodal Liability for Smart Agents

The 'smart agent' that we have in mind today is substantially different than those we envisaged ten or even five years ago. It is clear that the evolution of AI and machine learning agents is likely to show similar advances. For instance, there is a trend to combine AI and smart agents in the area of game playing where the agents not only use models in a proactive manner but also develop a deeper understanding of the adversary and their character and intentions. Gaming agents today are encouraged to indulge in making internal inferences as to the state of their own 'mind', for example, strategies that involve deciding that the adversary seems to know that the agent knows that the adversary knows that the agent will play certain cards and so on. At the applied level, such technology is likely to yield substantially improved agents that, due to their 'proactiveness', will have a significant nodal liability (Cioffi et al., 2020).

This is also true for the evolution of 'scene understanding' smart agents that are trusted to interact with their environment. For example, today's smart agents are encouraged to learn and act in an embodied social context. This could allow these agents to meaningfully engage in complex negotiations and other high-level interactions. In terms of liability, a few extra features are relevant. First, currently, the smarter smart agents are designed as learners, that is, they not only use models but are taught models and learn new ones. In addition, they learn from both 'experience' and instruction to build up their knowledge over time. At present, these agents are 'taught' passively. This means they are not let out into the real world to gather experiences, rather their 'education' is restricted to the operation of one simulator (Winkler et al., 2020).

Artificial Intelligence and Machine Learning

Artificial intelligence can be understood as the study of reasoning in machines. Consequently, the term evokes a much broader range of computational methods compared to what it did originally. These days, a primary claim is that all theories of learning and intelligence should be treated on the same footing. This integrative approach goes under the label of machine learning, and it has indeed been largely embraced by the AI community at large. Machine learning primarily deals with computer programs that can improve their performance, based on data, independently of any changes made by a programmer (Fontanella et al., 2021).

The introduction of machine learning techniques in AI research contributes to making it more difficult to ascribe accidents to a defect in the system, and thereby

invoking liability on the part of the system's creator. A computer program generated by machine learning cannot be the object of patenting or copyrighting. However, the deployment or use of an algorithm or software may. As referred to above, if a machine learning algorithm has a fault, it may be very difficult to detect, because the fault is concealed within the complexity of other constraints made by the programmer when selecting the vast range of inputs. In the fast-paced technical area of autonomous driving, various machine learning components on different levels of abstraction lead to self-optimising systems, which learn from consequences of decisions made, in often unforeseeable new complex situations (Choudhary et al., 2020, Al Dajeh, 2024).

Ethical Considerations in Nodal Liability for Smart Agents

Below are the ethical considerations in nodal liability for smart agents

In the liability regime, ethical principles of distributive justice and sustainability become crucial. Distribution itself is a complex concept; it refers to the distribution of liabilities based on what the multiple nodes have contributed - either by action or omission - in causing the final harm. Similarly, the sizing of liability is also based on the concept of the contributive role of various nodes pursuant to the chains of harms emanating. Each node is thus responsible to cause or process or transmit harm till it reaches the final end user. In an ethical drift, different questions are raised. If the conceptualization and methodology designed for determining compensation for harm reiterates that human beings are the intended users, then such a calculation should distill functionalities, desired end states, or generally expected solutions. In the following section, we shall consider the ethical and moral questions generated by the phenomenon of smart agents in tort liability (Ji and Chalkias, 2021).

Moral and Ethical Dimension of Nodal Liability

The 'nodal liability', developed in the preceding section in procedural and functional space of smart agent, also distills the core principles of 'just deserts' and distributive justice. Given the centrality of human beings in all such scenarios, it denotes two things viz. if finally it is going to be the human beings or any legal person/institution who have to pay the final price, then the methodology and calculations should aim at making them eventually avail liabilities as decided by norms of justice and ethics. Besides, at multiple nodes, where such a large cascading transmission or distribution of responsibilities is operationalized, can a Law and Legal possibility, operating from the human social space or at the level of a legal subject, distill such desires, faith, and public goals? This question knows much larger moral and ethical relevance. If such nodes span across different

applications and functionalities of smart agents, they become subject to calculation as per the norms of distributive justice on the basis of action, omission as well as considerations like mens rea and contributory negligence. It also gets dovetailed into other non-retributive welfare-based calculus and normative rationale at the level of justice. Thus, one answer to this ethical/moral question would be to make the larger decalogue of Law, that constitutes the delictual liabilities, into an algorithm of ethical and empathetic distributive justice (Abeywickrama & Ramchurn, 2023).

Challenges and Limitations in Determining Nodal Liability for Smart Agents

The above scenario and the condition of the art raise, however, interesting points and questions, which are relatively unexplored in literature. Moreover, the above problems are prone to a relevant degree of speculation, because the ascribable liability to HA at the beginning and during his activity would deeply depend on the impact and efficiency that, if chosen, toward each or both the co-admissible activities, would have on the overall conduct and choice of interpretation of Eric's future evaluative system. Therefore the challenge of ascribing liability to Eric or Adam/N is still open and other legal and ethical insights have to be addressed in order to reach a more comprehensive assessment (Knote et al., 2020).

However, under a moral, ethical and social approach, if, after having implemented a change above consequence, the robot decides still to cooperate with some probability w toward one (not necessarily the best, in terms of maximizing its expected utility) of the co-admissible activities, thus if its choice has been, coherently with an affective forecasting analysis of its future pleasure and pain signals, in a sense or another, "wrong" or responsible for "damage" towards the other injured People, Ha has to be held eventually morally or economically liable for the above-consequence. Moreover, this conduct should be also considered an unexpected "legal moral" condition of the Tartuffe Hypothesis, as underlined in the hypothesis introduction. Also notice that under "proper conditions" this normally unexpected performance and liability provide a relevant advantage to Eric, which can pretend for a so unconventional access to loan. In the scenario under examination Adam/N has been considered an agent just more skilled than a mere statistical agent in predicting others' future behaviour for what concerns the considered fact, and lacking, therefore, some awareness with respect the intimate reason of the above people. Since according to the Law psychophysical reaction and explicit statement concerning sensitive data have to be always governed by the user's intuition and awareness, however supported by some ex ante dataset statistical analysis, our analysis considers Adam A/N a

perfectly transparent HAs and we should analyse the consequences of his appreciated outcomes in more detail, or conditions and consequences that suggest a critical application of the being-in-default Principle (Huberman, 2021).

Case Studies and Real-World Examples of Nodal Liability Scenarios for Smart Agents

This part of the paper will provide an insight into case studies and real-world examples. Quality of Service. Following this approach, diffusion of responsibility in a system, AI, in particular, would start the default liability attribution at the system level, wrongdoings related to residual risk produced by the model are attributed to the responsible person. However, the agent will be presumed ill-equipped, ill-motivated, largely under the control of other, and at least partially unaware of the implications of the actions, i.e., being smart enough but not fully responsible. With this in mind, the UID would be deflected towards external nodes within the background socio-technical systems (Bleher & Braun, 2022).

Where Does the Air Force Analysis Go Wrong? - Most cases of accidents are determined by a particular node's (people, equipment, tasks, etc.) faulty or inefficient performance. That node is called the "Defining Node" or "Nodal Point". The existence of a nodal point of some kind at the sharp end has long been identified as an important characteristic specific to accidents. A Lethal Mine Clearing Accident - An Overview Fault Tree - The following case is based on a straightforward application of a Fault Tree Analysis (FTA) to the well-documented, real case. Authorization Errors in the ESS - The following case is based on a detailed study, which equips (i) their black-box system, in terms explaining or justifying algorithmic decision, and (ii) the interview of human operators and subjects, in terms of defining their skill set, knowledge, competence, motivation, and factors that increase/decrease the possibility of their liability in case of unwanted events (Lenggenhager et al., 2022).

Comparative Analysis of Nodal Liability in Different Jurisdictions

In recent years, those concentrating on nodal liability have taken an interest in exchanges of different jurisdictions all over the world in order to find a nodal liability applicable to new technologies. In order not to confuse emerging solutions with those already in place.

Scholars and practitioners have different approaches to the subject of interest to them, depending on their academic and professional profile and the time available to get to know the law of a given country. German solutions to liability problems are often used for comparative research due to their consistent

development and centralized lawmaking system. This also explains why German lawyers dominate the distribution of liability publications on nodal liability. Italian and Dutch legal scholars, on the other hand, appreciate Dutch and Italian solutions. In addition, American researchers mostly use American materials for their commentaries, while in the UK English and Scottish materials are the most important. (Van et al.2020)

When trying to make nodal liability suitable for smart agent behavior, we are moving into completely uncharted waters and many lawyers are not yet ready for this jump. For this reason, the author's article is intended to prepare a wider audience of clinicians and researchers to take on this task once the time is right.

Todd D. Rakoff is skeptical of the prospects for a new kind of nodal liability. Even in cases where conduct-based nodes have emerged in our system, such as through negligence rules, the fact that they emerge through common law development means they can be slow in coming and haphazard. Even if a case emerges, priority might slow the development of liability. In relation to new nodes, such as inputs or algorithms, it may be similarly slow. Conduct-based nodal liability depends on an aggregation of individual findings of a 'sphere of autonomy' being 'unreasonably' interfered with, such as with trespass or nuisance. The aggregation of these cases in practice often leads to the aggregate effect of the act being held 'unreasonable'. In addition, although there are cases where we are unaware of who else has been harmed by another's conduct, that number is often very small and we are often aware of the majority of interactions in this decryption. These are missing when dealing with technically generated harm and Bob Jones echoes Rakoff in pointing out the different considerations and exigencies of crafting a response to harm created via intelligent systems rather than conduct-based systems (Rezwana & Pain, 2021).

Future Trends and Implications for Nodal Liability in the Smart Agent Ecosystem

Liability today is allocated based on fault or a combination of factors, including fault and/or capacity to act as a form of insurance. With technological progress, we may see a growing trend towards strict liability, especially in capacity and capability-based ecosystems. More and more entities can be doing more with our information than we are informed. People given information about others make decisions based on their observations. Smart demand-side ancillary service agents may provide consumers with services on the front of the meter as a nodal representative. In addition to the potential intermediary acting as a nodal representative, energy services or financial entities may use these programs to create a "product" that would create a nodal liability relationship. Stiglitz and

Grossman demonstrate that separation theorems don't hold with complete asset markets and sought to explain why service economies can still go bankrupt even when there are complete asset markets (Antonopoulos, 2022).

The market normative (competitive) model assumes the future are rational, the property of homo economicus that assumes that we know the utility of our assets only and that past transactions have no impact on future Alderian "style of life" perception of transactions involving our future. For risk-takers, having a reliable nodal representative can avoid ontological bankruptcy by providing the decision-maker with an actor who assumes the philanthropic and custodian relationship that was existent approximately 100 years ago that could be based on the pillar of reliability that includes empathy without bonding relationships that are normative of despotic protection necessities. When a person who engages in risk seeks a reliable nodal representative, they are seeking a person who can protect transactors of hiring the agent, relies on the information that the reliable nodal representative possesses, and helps the decision-maker to behave in a manner that manages, distributes, or hedges the risk. If the nodal representative fails in these duties, then this could portend risks for a decision-maker who relied on the transactions of the nodal representative to reduce ontological bankruptcy, which was a rivered risk. The utility of nodal representatives can have a risk-ontological or deontological river downstream that is sparse in an atmospheric or provided scarcity of our linear equation enforced world. Nodal services are positioned from a scarcity/non-scarcity Lawrentian, and domain organizational cognition agent services can have a tenuous relationship with the western world linear, such as Derrida's world, relationship with scant theory. Relative to Ontario's engagement with ontological-oriented bankruptcy and citizenry part of law, this memo is devoted to elaborating future trends and implications for a dimension of nodal liability for current and prospective nodal representatives in the smart agent ecosystem. This part of the memo is forward-looking. Ontario has a long-standing institutional relationship with energy services and nodal representatives. This stretch of time has permitted us to examine future trends and potential implications for liability considerations in this space. The emergence of up-and-coming nodal representatives is also the start of our hidden normative society in smart agent representative trade and careers. A nodal representative is sophisticated: a public-private agent cannot be any more different than a private nodal representative agent and public nodal representative agent in the agency theory spectrum or married in accordance with the no-nodal representative norm Instrument, or an amalgam in between. One of the reasons why Ontario has endeavored to take precautions thoughts of liability presents is

because *representative services* can have a problematical ontological impact on the commodities that are currently traded (Cristofari, 2023).

Conclusion

Concluding, it was seen that the tenets of negligence are minimal and straight for nodal voices are called on quite often. Moreover, the smart/autonomous agents have a landing within the liabilities of the system; in fact, it is difficult to call a system smart or autonomous if it did not function in such a manner. One key question that comes up often with the liability of the agent is about personal and non-personal. The technologies we discussed cut across these traditional separations. Smart technologies create new forms of 'liability at the level of bio-power. It can also be concluded that the determinations concerning who or what gets held liable follows more of a socio-political risk-economy than an actual account. Tailoring the determination of liability in such commercial, 'luxurious' technologies using the tools and language of a constitutional liberal democratic model also cements biopolitical anomaly in the system. Technically speaking, the value of WLAN and UPnP is so 'low' in terms of jurisprudential or regulatory standards that they should finally get delisted.

Recommendations

1. The study recommends that traditional legal systems governing the scope of accountability be reviewed within the scope of the smart agents' contractual system and that the personal liability aspect be determined. It has been shown that legal rules need to be developed in order to keep pace with the development of smart technologies that have become an important part of human life.

2. Hold intelligent agents responsible for errors and damages that may result from the process of contracting with others in order to determine the destination of the link of responsibility and then turn to the person in charge of the system.

3. Collaborate with experts and technicians to access a technical system that mitigates the proportion of economic and social risks and conforms to legal and legal disciplines.

4. We inevitably have to introduce legal regimes other than traditional ones that address the challenges involved in smart agents' contracting regimes, at least at the present time, as well as moving towards objective or strict liability.

5. To take seriously the idea of recognizing the legal personality of smart systems within logical limits while remaining the idea of human responsibility for that system.

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