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Democracy out-of-the-box: analysis of compliance with constitutional principles in tax policies that use Artificial Intelligence

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Abstract: The Democratic State of Law emerged with the objective of improving everyone's life, restricting the power of tyrants, who, among other arbitrary acts, unfairly taxed the people. While taxes remain crucial for the State's upkeep, modern rules prevent individuals from enduring excessive burdens. Although new technologies leveraging Artificial Intelligence (AI) hold the promise of enhancing lives, the extent of this improvement raises questions. This study delves into the relationship between individuals and the State, specifically exploring the use of AI in tax-related scenarios. Conducting a comprehensive three-stage investigation, the first stage involved surveying the reasons behind State-imposed limitations on taxation. The second stage identified criteria from computer literature addressing potential AI challenges and strategies for achieving explainability. Additionally, a discussion emphasized the importance of technological models aligning with principles that underpin our society. Then, to understand how actions have been carried out in Public Administration, a Systematic Mapping Study (SMS) was carried out, analyzing works from the ACM Digital Library, SBC OpenLib (SOL) and the ENAP (National School of Public Administration)'s repository (a Gray Literature repository). On the ENAP website, works relating to the Creativity and Innovation Award from the Federal Revenue of Brazil were specifically consulted. In the end, 10 works that met the inclusion criteria were selected. It was concluded that none of them has an AI explainable model, considering the interpretability criteria of models (Rules and logic, Data visualization, and Model documentation). In light of this, it is recommended that studies addressing the use of AI in Public Administration incorporate a dedicated section discussing the explainability of models.

Keywords: Democracy, AI, Taxation, Law, Systematic Mapping Study

1 Introduction

The State, conceived as an abstract entity of human interests, is a construct created by and for humanity [Machado Segundo, 2009]. This form of governance strengthened itself when it devised ways to combat the excesses of kings, especially in tax collection. In this context, taxes are essential for the maintenance of the State and many efforts have been made to make their management, collection, and use more efficient for the common good [Coêlho, 2018].

Nowadays, there are new ways to automate processes that were previously complex, time consuming, or impossible for ordinary people to perform. Among these many uses, the State has employed has employed Artificial Intelligence (AI) tools in a variety of processes and services [Santos, 2024][1]. In general terms, in the pursuit of efficiency, computing technology has been harnessed with the ambition of fostering a more just society [Sperandio, 2018; Nascimento, 2022].

But to what extent may this be right? Is there any limit to the actions of the State? Can machines really solve problems without worsening the situation for individuals?

In a recent editorial, the Nature journal exposes an underlying issue involving AI [Nature, 2024]. Succinctly, it points out something not unknown to those in the field of computing: computers fail. The journal's provocation is: to what extent are the States prepared for this machine fallibility?

In this work, part of this problem is addressed. Here, the analysis focuses on the relationship between individuals and the State mediated by computers. Specifically, the government use of AI in situations involving tax collection is examined.

For this, a three-stage research was conducted. In the first stage, through an *ad hoc* research, it was found that the conception of the State can be seen as a way to fight against excesses of tyrants, that tyranny arises from decisions not properly clear or presented as unquestionable, and that these principles constructed over time are present in the Brazilian reality.

In the second stage, also carried out *ad hoc*, it was found that there are AI models very susceptible to failure, and there are already requirements in the literature for verifying these models, with the indication of some criteria for their analysis.

[1] In 2023, the expansion of possibilities in the use of AI across various domains of social life has been largely characterized. Much of this has been driven by the commercial release of the ChatGPT tool (chat.openai.com) by the company OpenAI (openai.com), subsequently followed by other major corporations such as Google (google.com), which introduced Bard (bard.google.com), and Microsoft (microsoft.com), which launched Bing Chat (bing.com/chat).

There is also a discussion about principles from the Brazilian Constitution, which makes, for the national scenario, a need for adaptation of eventually used AI models.

Finally, in the last stage, there is the search for ways in which the Brazilian State uses AI in tax matters. For this analysis, the Systematic Mapping Study (SMS) method was chosen, analyzing 3 databases, 2 scientific (ACM[2] and SOL[3]) and 1 gray literature (National School of Public Administration - ENAP[4]). In total, 388 articles were analyzed. Ten of them were selected, according to the inclusion and exclusion criteria, and were analyzed for adherence to the verification model found in the second stage. It was concluded here that none of the selected works can be considered as an explainable use of AI.

2 Related works

In this work, a Systematic Mapping Study (SMS) is presented, which is a common practice in the field of Computing. Hence, some previous studies on government and technology prove to be interesting to relate to this.

In Paula and Carvalho [2022], an SMS is presented that seeks papers reporting the experience of participatory budgets in digital environments.

In Vasconcelos and Marques [2023], there is also an SMS focusing on the decision-making process of investments in Information Technologies in public organizations. The research was conducted to identify opportunities for process improvement and optimization of public spending.

In Oliveira *et al*. [2020], the impact of Big Data practices in the Federal Public Administration is analyzed, considering that public institutions share similarities in institutional missions, even in different locations and sectors. The main objective is to gather insights into the objectives and major challenges of implementing Big Data and/or Big Data Ecosystems in Brazilian federal public agencies.

Although all these SMS address electronic government, none of them tackles the aspect of the State's use of AI in fiscal or administrative processes. In this research, we will address both the guiding principles that make AI explainability a necessity and the demonstration of part of the reality through an SMS.

2.1 AI and Law

The subject proposed in this paper is not new. There is, in a way, a propensity to discuss the use of AI within academia, encompassing not only computer science but also legal and other interdisciplinary perspectives.

For instance, within the legal domain, a critical perspective on the use of AI is presented in Costa and Maia [2021]. In this work, there is a conceptualization of AI utilization as a reflection of neoliberal principles, which may offer benefits by enhancing procedural efficiency and access to justice. However, it also carries the potential to commodify the individuals involved in legal processes, perceiving them not as autonomous subjects but rather as components in a broader corporate mechanism.

In this context, Nascimento [2022] presents a positive perspective on the potential to create an environment for monitoring the status of specific constitutional policies. By utilizing AI models, the analysis aims to determine whether a policy is stagnant, progressing, or regressing. However, the work also acknowledges the need to construct a certain degree of legal certainty to prevent potential excesses.

Recognizing the necessity of integrating legal principles into software development as heuristics, Da Costa Nunes [2022] introduces 7 heuristics grounded in consumer law. This proposal aims to facilitate developers' comprehension of legislation by drawing parallels with established industry practices, making it more tangible within the realm of software development.

In Oliveira *et al*. [2023], the study delves into cases within the Court of Justice of São Paulo that revolve around the utilization of facial recognition techniques, predominantly for credit approval in banking services. The analysis sheds light on the judicial responses and their alignment with the computational defenses presented in these cases.

2.2 The use of AI reported by Media

The use of AI has become widespread in the past year, largely due to the introduction of ChatGPT, a product of OpenAI, to the general public. Its usage has proven, at the very least, controversial in various situations, giving rise to moments that are sometimes humorous and sometimes concerning.

A series of journalistic news articles have prominently featured the use of AI. The first one presented is about a Colombian judge who utilized ChatGPT to draft a sentence addressing the rights of an autistic individual. In it, the judge emphasizes the importance of ethical use and the AI's capacity to function as a "secretary", suggesting themes and concepts that ultimately fall under the judge's discretion for final decision [Presse, 2023].

Similarly, another case involves a Brazilian judge, who decided to use ChatGPT, but the tool created judgments and invented non-technical questions. The National Council of Justice (CNJ) has called for the case to be investigated [Jardim, 2023]. In the United States, a lawyer uses ChatGPT, which invents cases, and he ends up being fined five thousand dollars [Fabro, 2023].

Currently, there are already news reports about the use of AI by the Federal Revenue Service. However, the specific methods are not detailed in the news, as exemplified in Santos [2024], where, from the use of AI, it is claimed that more than 25 thousand people did not declare Bitcoins.

Of course, these situations neither present nor encapsulate the entirety of AI usage within a society, but they provide insights into why the topic is relevant. To some extent, there is a lack of literacy regarding the use of these technologies due to their relatively recent introduction to the general public. It falls upon experts, then, to make knowledge more digestible and elucidate appropriate ways for the ethical use of these technologies.

[2] dl.acm.org/
[3] sol.sbc.org.br/
[4] repositorio.enap.gov.br/

3 Methods

For this work, the focus was on a study conducted in three stages.

The first stage involved an examination of works that could explain the functioning of the State, exposing its obligations and how these obligations are communicated to the population. This information can be found in Section 4, *State Against Absolutism*.

In the second stage, on an *ad-hoc* basis, a review of texts and works discussing AI and ways to make them explainable or verifiable was conducted. Building on the findings from the first stage, the primary results of this stage can be found in Section 5, *The Use of AI Technologies in the Context of Administrative Processes*.

As a follow-up to these stages, a discursive proposition was made to demonstrate how constitutional legal principles regarding administrative processes are already sufficient for some AI-utilizing processes to be explainable. This development is presented in Section 6, *Discussion between the Use of AI and the Legal Landscape*.

Lastly, the study selected the taxation as its object of examination. This choice was motivated by the absence of specific legislation for the use of AI by other governmental entities, in contrast to Brazilian judicial bodies covered by Resolution 332/2020 [CNJ, 2020]. In this context, a Systematic Mapping Study (SMS) [Petersen *et al*., 2008] was conducted across two academic databases, ACM[5] and SOL[6], to explore technological applications in taxation. Subsequently, we checked which works deal with the use of AI and analyzed which of these technologies can be considered as explainable uses.

We also conducted a systematic review in grey literature, with the chosen database being the National School of Public Administration (ENAP)[7], where the collection of articles from the *Creativity and Innovation Award of the Federal Revenue of Brazil* (*Prêmio de Criatividade e Inovação da Receita Federal do Brasil* in portuguese) was analyzed.

In total, 388 papers were examined, with 10 selected for in-depth analysis.

4 State Against Absolutism

In this part, we will talk about some important ideas that form the basis for the thoughts in this article. We'll explore how our history has played a big role in shaping the way we understand individual rights and guarantees, which are really important for how our society works today.

While the quality of present-day life may be subject to scrutiny, the historical comparison that follows sheds a positive light on the establishment of the State as a mechanism to prevent arbitrary decisions, lacking both context and information.

So, knowing where we came from is important to figure out where we want to go. In simple terms, we don't want to go back to a time when decisions were made without good reasons and couldn't be questioned.

The ideas in this article are based on the writings of Machado Segundo [2009], who talked about freedom and equality in building a democratic space. We also consider the thoughts of legal experts like Coêlho [2018], who focuses on tax law, and Bandeira de Mello [2009], who talks about administrative law[8].

4.1 The State formation through the lens of safeguarding individual rights

As explained before, the government is something people made. It exists both as an abstract concept and as a tangible reality. The State we talk about today started about 300 years ago. It came about because people needed a way to rule a group of people or a whole country. This happened because they wanted to fight against a ruler having too much power and doing unfair things, like punishing people too much (*jus puniendi*) or taking too many taxes (*jus tributandi*) [Coêlho, 2018; Harada, 2020; Rebouças, 2019].

In those situations, the absolutist [9]or despot-king wielded power based on convenient social justifications, making judgments over those under their control according to their own preferences, without adhering to any moral or legal standards. There was no requirement for them to reveal their decision-making process or explain their motivations; they simply acted based on their own wishes and desires [Coêlho, 2018; Harada, 2020; Rebouças, 2019].

The changes made by the bourgeois reforms were important for rebuilding society and creating a more efficient system that addressed the concerns of emerging power players. These individuals saw unfairness in the arbitrary decisions of a centralized authority, prompting the need for reforms to establish a fairer and more effective model [Coêlho, 2018; Harada, 2020].

So, the State is a social creation formed during a specific period, not lasting forever or staying the same. Its roots lie in the competition for power and a shift away from the absolutist model, with different individuals becoming the main players in this transformation [Coêlho, 2018; Harada, 2020; Rebouças, 2019; Campos, 2013].

This construction was gradual and incremental, involving different cultures in different ways, which can be summarized in the construction of some rights to take away from the monarch the power to decide alone what was fair. It was about giving new meaning to part of the daily actions and establishing legal-social constructions that were closer to the new lifestyle on the rise. The State, then, would be the crystallization of the gregarious need of human beings combined with the maintenance of a minimum of justice (or a new model of justice) when compared to the previous model [Campos, 2013].

[5] dl.acm.org/

[6] sol.sbc.org.br/

[7] https://repositorio.enap.gov.br/

[8] When we talk about law, it's important to understand that one of the sources for supporting judicial decisions is texts written by legal experts, as indicated by the Law of Introduction to Brazilian Law, Decree-Law No. 4,657, from 1942 [Brasil, 1942].

[9] Absolutism was a political movement that lasted until the 19th century. Among other reasons, it was brought to an end by the growing bourgeois revolt of the French Revolution, which saw excesses in the king's actions.

Throughout history, humans, being inherently social, have delegated to the State the responsibility of safeguarding fundamental guarantees. This entails shifting the power to establish and enforce rules from individuals to a collective entity. Regardless of debates on the state's role in relation to individuals or groups, whether involving more or less control, one constant remains: institutionalized norms work to pacify conflicts or potential disputes among the residents of a specific location at a particular time [Campos, 2013].

Beyond the State, new layers of rights have undergone construction, establishing themselves as new guarantees or expanding the horizons of achievement by individuals, as they possessed, at least formally, freedom, equality and fraternity, as desired in the French Revolution [Campos, 2013; Horkheimer and Adorno, 2011].

In this scenario, the law is, beyond the existential and organizational foundation of the State itself, an instrument of social transformation, governing social relations, constraining and guiding state action, applied in an equal and equitable manner, with the Constitution at the top of its hierarchy, within a Kelsenian framework [Machado Segundo, 2009].

In the end, the power to punish and the power to tax were not extinguished from the relationship between humans, but changed hands, leaving the absolutist individuality for the state collectivity. Moving from individual, unmotivated decision-making to a situation in which freedom was the rule and withdrawal from the rule had to be accompanied by express motivations [Bandeira de Mello, 2009].

4.2 Brazilian taxation context

In this sense, with a more attentive focus on Brazil, the *Federal Constitution of 1988* is regarded as the cornerstone of the national legal system. This document serves as the yardstick against which chosen parameters in a given situation will be measured. Despite being temporally distant, it is the lens through which current rules are evaluated and selected, even those established under previous constitutions. It is further observed that the constitution plays a pivotal role in determining the functioning of those responsible for the administration of public affairs in the country. In this scenario, the law serves as the benchmark for understanding what and how things should be done [Ezequiel, 2019; Coêlho, 2018; Harada, 2020].

All tax collection in Brazil must be permitted by the Constitution. In fact, it can only take place with explicit and prior legal permission before the intended taxation situation. In this sense, it becomes more challenging for representatives to engage in excesses [Rebouças, 2019].

As a set of institutional organs, Public Administration divides itself so that it can specialize and achieve its objectives more coherently. To facilitate the collection of taxes, since 1968, the Administration has entrusted the Federal Revenue Service with the responsibility of coordinating the inspection and collection of tax obligations from the population [Rebouças, 2019].

For this purpose, the Federal Revenue Service employs various methods and processes, including AI models, to fulfill the obligation of monitoring and penalizing excesses committed by taxpayers who may potentially engage in wrongdoing [Jambeiro Filho, 2019; Brasílico, 2017; Thompson, 2016; Jambeiro Filho, 2016; Carvalho, 2015].

This use of technological approaches is permitted by the Constitution when addressing Public Administration [Brasil, 1988]. The use of technology is essential to achieve a level of efficiency crucial for the proper functioning of the public machinery, and refusing to adopt new techniques is also a violation of the legal framework [Bandeira de Mello, 2009].

5 The Use of AI in Administrative Processes

Innovation has enabled humanity a range of constructs, techniques, or processes that facilitate life in all aspects. Today, it is easier to perform tasks that once required much more effort from individuals [Carvalho, 2016; Rampazzo, 2019; Grier, 2001].

In fact, faced with the need to scale information processing, AI is conceived. The complexity introduced by building more diverse AI algorithms has enabled the realization of a broader range of possibilities. Emulating a conversation with human beings, analyzing elements of a sample, or diagnosing diseases within algorithmic logic has become less challenging in capturing, analyzing, and responding to various situations [Sperandio, 2018; Bartik, 2013; Mass, 2016].

However, even with this multitude of capabilities, AI still falls short in addressing singular and specific aspects of Human Intelligence [Sperandio, 2018].

It is still impossible to envision an AI with self-awareness, the ability to discern what is ethical, correct or pleasurable. In fact, the condition and capacity for change are still limited and situated differently from humanity. This deficiency is often overlooked in discussions about AI, particularly when outside the realm of computer science [Sperandio, 2018].

In the end, due to the possible misguided choice of the term "intelligence" and the parallels drawn with human intelligence, there are expectations regarding the functioning and results of algorithms and AI that lead to misconceptions [10] [Neiva, 2020; Sperandio, 2018; Mass, 2016].

Despite the importance of innovations for maintaining an efficient environment, it is crucial to anticipate and address problems, especially when it concerns the lives of various individuals who may be significantly affected.

By the end of this section, we hope it becomes clear that some AI models have flaws and that, in accordance with established legal principles, it is essential to present ways to explain AI responses. Additionally, we highlight some criteria for considering an explanation as acceptable.

5.1 Fallibility of AI responses

There may be a belief that algorithms are infallible because they involve mathematics. However, when distorted data is

[10] It is worth noting the complexity associated with expressions of intelligence in both psychology and computer science, with the term not having a passive meaning in either field. However, misunderstandings about terms and conceptual imprecision are inherent in natural language. For those less familiar with the discussion, a simplistic response or a logical slope regarding the operation of AIs may be possible.

presented as truth within a logical model, it is only fair to expect the generation of distorted results, especially in the case of statistical models. Data representing the past perpetuates the maintenance of that past, regardless of whether that past is dark or glorious [Angwin *et al*., 2016; Eco, 2011].

According to Buolamwini and Gebru [2018], gender and racial bias were detected in AI for facial recognition, which exhibited a lower recognition rate for faces of women and Black individuals compared to the recognition rate for faces of Caucasian men.

When training this type of AI by predominantly feeding its database with faces of Caucasian men, the algorithm will establish its criteria for what constitutes a human face, such as having masculine features and lighter skin tone. Consequently, it may fail to recognize some faces of women, whether Caucasian or not, and Black men [Buolamwini and Gebru, 2018].

Furthermore, Steve Wozniak claims that he received ten times more credit limit on the Apple Card service compared to his wife. The co-founder of Apple stated on his social media that he shares his entire wealth with his wife, including bank accounts and active credit lines. Despite this, she fell victim to the algorithmic bias used by the company for credit application analysis. A similar situation occurred with entrepreneur Davis Heinemeier Hansson and his wife when she received a credit limit twenty times lower than her husband from the same service provider [Bangalore, 2019].

The facial recognition program used by the Metropolitan Police in England has an error rate of 81% when identifying potential suspects, according to Fussey and Murray [2019].

In the United States, the state of Florida uses an AI that calculates the risk of a prisoner's recidivism, assigning defendants a score ranging from low to high risk of reoffending, which influenced the final sentence, making them subject to receiving a harsher penalty based on the recidivism risk score. However, Caucasian defendants, compared to Afro and Latino American defendants with more serious criminal records who had committed identical offenses, received a low-risk score in comparison, according to Angwin *et al*. [2016]. It was proven that algorithms are susceptible to biases, whether through their coding, their definition of success, or the data used for their training contained in their database.

5.2 AI Verification Needs for Justice

In addition to the bias to which the data input for machine training is subjected, there are situations in which they are unauditable and irrevocable due to the complexity they assume. When this occurs and a program offers a result, few paths are available: either the result is accepted as certain and unequivocal, or the result is disregarded, as it does not necessarily provide a faithful representation of reality. There is no way to argue with an opaque algorithm, and there is no possibility of arguing with "mathematics" [Sperandio, 2018; Angwin *et al*., 2016; Munárriz, 1994].

During the data processing within a machine learning system, spanning from data input to processing output, the intricate nature and vastness of data often render the decision-making process of AI less than perfectly transparent. This challenge is commonly referred to as the "Black Box Problem" and has become a focal point in research for programmers striving to enhance the explainability of AI [Sperandio, 2018; Munárriz, 1994].

Therefore, the challenge arises to understand and establish an ethical path for AI as it becomes more advanced. Making the "black boxes of the algorithm" accessible ensures that they are functioning as they should. It involves coding values more coherently, understanding why the intelligence arrived at a specific result, and consciously accepting that conclusion [Gray *et al*., 2018; Angwin *et al*., 2016; Munárriz, 1994].

Certainly, the process of identifying incorrect answers and providing feedback to the AI is an integral part of machine learning. It's important to note that an occasional incorrect answer doesn't necessarily invalidate a technology. As products of fallible human creators, systems, techniques, and processes can have flaws. The emphasis of this work is on scenarios where answers must follow a transparent and auditable path. In situations involving large-scale processes, a series of incorrect responses can lead to substantial harm to the freedom of many individuals.

As a human intelligence, a judge has undergone extensive training throughout their academic journey, internships, various courses, and specializations. Their accumulated experience, encompassing practice in the judiciary or other professional roles, contributes to their nuanced understanding. They recognize that even cases with similarities may yield different final judgments. The process involves the consideration or dismissal of specific aspects and the application of certain legal statutes and principles, chosen based on the unique intricacies of each case [Brasil, 1988].

In contrast to inexplicable AIs, a judge, in rendering their judgment while respecting constitutional guarantees, provides a rationale for their decisions. They are obligated to explain why a particular case aligns with a specific legal provision rather than others, why their final judgment prescribes a particular remedy or penalty, and whether the case falls within their jurisdiction, among other considerations [Sperandio, 2018]. This process unfolds even if their output is incorrect, leading to an injustice. The transparency in the judge's reasoning allows those who perceive inconsistencies in the judgment to seek alternative avenues to assert their rights.

This is precisely why the Brazilian legal system upholds a principle (which can be subject to certain exceptions) known as the double degree of jurisdiction. According to this principle, judicial decisions can be appealed to a panel of judges who will scrutinize the factors that influenced the judge in rendering the decision, either denying, reforming, or confirming the judge's decision [Cintra *et al*., 2005].

Undoubtedly, the challenges arising from inherent issues of individual misunderstandings still exist. However, when considering the scale of impact, they are significantly less harmful to the common good. While a judge might make an error in an individual decision between two individuals, AI, by its very nature, has the potential to make mistakes that affect an exceptionally large number of people. When examining a scenario with large volumes of data, even less representative percentages, and smaller ones, can still signify a substantial number of those affected.

When a judge encounters AI, does it actually deviate from their mathematically established decision? As indicated by Oliveira *et al*. [2023], in cases involving facial recognition, judges rarely go against the machine. It's essential to recognize that this work does not aim to pass judgment on the merit of these judicial decisions but underscores the importance of understanding the reasoning behind such decision-making.

5.3 Characteristics of Explanations

Existing research on explainable AI, as well as studies on explanations in human interactions, identifies common themes used to describe explanations, exemplified by Segel and Heer [2010]. By analyzing these themes in conjunction with the analysis of how humans explain their decisions, they provide a significant understanding of the criteria for an explanation. Molnar [2020] proposes the following desired characteristics for good explanations:

1. **Model Interpretability**: This involves making AI models, such as neural networks, more transparent. Techniques like activation maps and saliency help identify which parts of an image or text influenced the model's decision. Such procedures become crucial to understanding how or why a conclusion was reached. By examining images or texts that influenced the model's decision-making, one can decipher the reasoning involved in the selection process. Interpretability is the degree to which a human can understand the cause of a decision or predict consistently the results of the model, as described by Molnar [2020].
2. **Rules and Logic**: Introducing logical rules or explicit heuristics into AI systems can help make their decisions more understandable. This is particularly useful in decision support systems. Systems capable of following well-defined guidelines or heuristics simplify the process of understanding the decision for their users, providing a logical basis for the conclusions reached. The ultimate goal is to have systems that combine flexibility and efficiency: flexibility for modeling a wide range of problems and efficiency for quickly obtaining good solutions, as proposed by Vidal and Geffner [2006].
3. **Data Visualization**: Presenting data and the decision-making process visually can be highly effective. Explanatory graphics offer a clear representation of how the data was analyzed and, consequently, how the conclusions were inferred. This approach assists users in understanding the model's reasoning flow. In addition to simply presenting graphic elements, annotations convey a narrative for each section, providing insights that the viewer would hardly identify alone, as proposed by Segel and Heer [2010].
4. **Model Documentation**: Creating detailed documentation that explains how a model was trained, which data was used, and how it behaves in different situations. The documentation provides users with a broad context that enables understanding the limitations, ideal scenarios, and identification of biases in the model, promoting a deep understanding of capabilities and constraints in AI systems. If we cannot be sure our explanation is correct, we cannot know if we should trust the explanation or the original model, as highlighted by Rudin [2019].

These characteristics will be used later to analyze the technologies used by public administration when it comes to taxation.

6 Discussion between the Use of AI and the Legal Landscape

In a Democratic State of Law, the people have the most power, and they use this power by choosing representatives in elections. These representatives create the laws that apply to everyone. The law not only allows different actions but also wants them to be quick and effective [Coêlho, 2018; Campos, 2001].

It is indeed hard, both in fact and in law, to envisage a scenario in which the government is not increasingly active in the digital realm.

Thus, any technology that elevates society to a higher level is not in the realm of being able to be used; it must be used. The principle of efficiency compels us to use it. This applies to all administration, to the extent that it is applicable and accepted by the community that will utilize it [Campos, 2013; Eco, 2011; Bandeira de Mello, 2009; Machado Segundo, 2009].

In this section, we establish a connection with what was previously presented, explicitly emphasizing the need to adhere to two legal principles: the principle of due process of law and the principle of motivation. This is because it's only possible to fully understand the actions taken when the requirements that shape our reality as a democracy are met.

Additionally, we hope to convey an understanding of how tax administration operates, along with the actions already underway by the State to address and mitigate potential issues.

6.1 The principle of due process of law

The Constitution explicitly mentions the principle of due process of law. This principle is closely tied to the dignity of every individual and the right to personal or property freedom. Protecting it is closely related to the idea of legality, which also restricted the actions of the despotic king and his excesses. The purpose is to make sure that any punishment goes through a fair process, with specific steps that are the same for everyone, aiming for justice [Campos, 2013; Bandeira de Mello, 2009; Machado Segundo, 2009].

This principle serves as the foundation for a Democratic Rule of Law, as it encompasses the proper conduct of coercive acts by the State, especially those that directly impact the freedom of its citizens. Such acts can only be executed after a favorable judicial decision, authorizing state action with proper justification or through an enabling law accompanied by the necessary motivation for the act.

The administrative process, typical of the State, is a succession of administrative acts that tend to a final and conclusive result. The process design, in general, requires a prior determination, all acts need to be based and motivated. They also

need to respect a logical sequence, remaining within the pre-established theme. Finally, they end in an administrative act that resolves the issue, creating an obligation [Bandeira de Mello, 2009; Cintra *et al*., 2005].

In turn, the administrative act is a unilateral manifestation of the will of the Public Administration whose immediate purpose is to acquire, protect, transfer, modify, extinguish and declare rights, or impose obligations on citizens or itself [Bandeira de Mello, 2009; Cintra *et al*., 2005].

The favorable procedural decision, whether granted to the State or any individual, will only be considered valid if it meets specific requirements of due process, fairly ensuring elements such as the right to a full defense, equal treatment by the parties, establishment of an impartial adjudicating body, opportunity for adversarial proceedings, and prohibition of the use of illicit evidence. Thus, even the individual, situated in a hierarchical position subordinate to the State, has their dignity respected, even if their freedom is restricted, as this occurs solely for legal and justified reasons [Sperandio, 2018; Cintra *et al*., 2005].

At the conclusion of the procedure, the rendered decision must be adequately justified, running the risk of invalidation if it fails to meet this requirement. Such determination is explicitly enshrined in the Federal Constitution [Bandeira de Mello, 2009].

6.2 The principle of due motivation

The principle of due motivation for the administrative act is implicitly provided in the Constitution, bearing in mind that in order for the Judiciary's assessment to be possible, the administrative act must be accompanied by its due motivation. It is the combination of the foundations of the Republic: citizenship and that all power emanates from the people, and the right to judicial assessment in cases of threat or injury to rights [Bandeira de Mello, 2009].

The motivation of the administrative act is mandatory for a democratic administration. Conversely, in an authoritarian state, the political leader does not justify their actions, as they are the sovereign subject, holder of power, wield it, and are above any law. In a democratic state, the administered individual is simultaneously sovereign and the ultimate holder of power. While subject to the authority of the administrator, who constitutes and exercises this power on their behalf [Bandeira de Mello, 2009].

The State is the incarnation of public interests, in which the services provided are not subject to the volatility of the individuals who act in its name, and they must act with the objective of serving the public interest. Unlike private law, which is governed by the autonomy of the will, public law takes care of the interests of society as a whole, being an inexcusable legal duty [Machado Segundo, 2009; Campos, 2013].

The role of the State organization is of paramount importance in contemporary society, with the State being responsible for providing essential services such as healthcare, education, transportation, and security. Additionally, it plays a crucial role in promoting societal development and individual well-being, all financed by the taxes paid by its citizens [Machado Segundo, 2009].

With the proper motivation for the administrative acts and the due justification of the decision in the judicial and administrative process, the individual, who is subject to both, is assured, in this way, that he will not be subjected to arbitrary acts, and if they occur, he will have the means to appeal and reverse the dismantling [Bandeira de Mello, 2009; Cintra *et al*., 2005].

Only by understanding the logical reasoning employed to reach a particular decision, the citizen can protest, considering that the basis of the procedural decision acts as a revisional control mechanism for a decision on the merits rendered, enabling debate about the relevance of the motivating elements of the decision or act [Bandeira de Mello, 2009; Cintra *et al*., 2005].

The State carries out various activities to promote and provide services, and most of the funding for these activities comes from tax collection, which comes from the Brazilian tax administration, consisting of tax inspection and collection. It is through tax administration that the State can finance meeting the needs of the people, giving effect to the pursuit of the fundamental objectives of the Brazilian Republic, as established in the Federal Constitution [Bandeira de Mello, 2009; Cintra *et al*., 2005; Bonavides, 2014].

6.3 Tax administration

Tax administration is, therefore, the administrative procedure (a set of administrative acts) focused on the inspection, assessment, and enforcement of tax obligations, and must accordingly adhere to the principles of public administration in its actions. The failure to meet these requirements, as mentioned earlier, alone warrants the invalidation of the act under the scrutiny of the Judiciary. Additionally, the absence, specifically, of the requirement for proper motivation in the administrative act precludes the discussion of its merits [Coêlho, 2018; Harada, 2020; Rebouças, 2019].

The issue arises when administrative acts are solely based on data processing carried out by AI without proper justification, rendering the process hollow since the output of AIs is not accompanied by the reasoning they used to arrive at a particular inference. Therefore, when this matter was addressed during the I Administrative Law Conference, the thematic committee approved a motion declaring administrative decisions made exclusively by AI and lacking justification as invalid [Monteiro and Castillo, 2019; Federal, 2020; Sperandio, 2018].

Machines, like humans, are susceptible to bias, which directly influences their decisions. However, when an individual holds jurisdiction or performs any other function in a public office, the official has a duty to act impartially, regardless of the target of their actions, setting aside personal idiosyncrasies. Nevertheless, as humans are fallible, their biases may permeate their actions, and in these cases, it is possible to assess whether the determining reasons for their decisions are legitimate or tainted through the expression of the act's motivation [Cintra *et al*., 2005].

However, as machines, in addition to being susceptible to bias, also lack the auditability of their outputs, they are incapable of being endowed with exclusive authority to pass judgment, replacing public servants in this role [Monteiro

and Castillo, 2019; Sperandio, Sperandio].

Just as a condemnatory decision cannot be based solely on information from a police investigation, with relevant exceptions in criminal proceedings, given that the criminal inquiry does not afford the exercise of a full defense essential to due process, inferences produced by AIs also cannot exclusively underpin the decision of a public servant. This is because they lack essential requirements of administrative acts, such as the proper motivation of the act. The output of data processing should be used as a tool to verify the administrative decision [Bandeira de Mello, 2009; Federal, 2020].

6.4 State actions on the issue

One can observe two clear actions regarding judicial and administrative decisions by the Brazilian State. The first, conceived by the National Council of Justice (CNJ), is Resolution No. 332, 2020. In it, there are a series of requirements for compliance with legal principles in the development of AI [CNJ, 2020].

Initially, the Resolution considers the possible and desirable use of means to expedite justice for the parties involved, but only if constitutional principles are respected, ensuring non-discrimination, equality, plurality, solidarity, and fair judgment [CNJ, 2020].

In certain situations, the Resolution is firm in indicating that there should be no use of these technologies, such as in criminal matters. The focus is mainly on suggesting predictive decision models. Furthermore, technology should not indicate a pre-decision, in some criminal cases, more severe than a decision made by a human would [CNJ, 2020].

In another aspect, legislative action is evident in Bill No. 2,338, 2023. In this, one can explicitly see what has already been observed in a principled manner in earlier sections of this work [Brasil, 2023].

The bill explicitly provides that anyone affected by a system using AI must be informed in advance. Moreover, decisions involving them must be explainable [Brasil, 2023].

Of course, the proposed legislation is not yet law, and it remains uncertain whether it will become one. However, this already indicates an interest and concern about the direction of technology. Therefore, it is highly relevant for those who are already thinking and working on AI models to consider ways to make these models explainable, especially if there are plans to expose them to the general public [Brasil, 2023].

7 Systematic Mapping Study on AI in the Context of Taxation

To understand in practice the actions taken by the State, focusing on the power to tax, it was decided to analyze the available information on the subject.

The first step in seeking to analyze the applications made for taxation propose was to conduct a search with the aim of finding studies that provided detailed insights into the development of its use. Initially, searches were conducted on the Federal Revenue website[11], but there is no clear indication of its use. Searches were then performed in the tabs and by using the search bar, looking for ”AI”[12].

Unfortunately, detailed reports on how these tools were used were not found.

Therefore, the plan was to conduct a Systematic Mapping Study on academic papers focusing on these uses. The lack of clarity regarding the availability of information could be addressed through the scientific rigor expected in academic papers, especially those selected by peers and undergoing a review process[13].

A Systematic Mapping Study is an analysis method proposed in Petersen *et al*. [2008]. In this regard, it involves a systematic mapping process of the literature, defining research questions based on established objectives. Subsequently, a systematic search is conducted, collecting a set of articles representative of the field of interest. After that, the most relevant studies are selected according to the established objectives, and the data are mapped into categories to structure the field and provide answers to the previously established research questions.

In this method, five stages are included: defining research questions, defining the search protocol, selecting relevant studies, evaluating, and extracting data. Even in a SMS, the search protocol can be conducted as a Systematic Literature Review (SLR), as described in Kitchenham and Charters [2007].

In the next subsections, the implementation of the method is presented, which occurred in two stages: the first in scientific databases and the second in a grey literature database. The choice for this dual approach was motivated by the scarcity of available works when the protocol was executed solely in scientific databases.

The choice of this method instead of a pure SLR was due to the non-observation of the entire scientific scope, as would be required in the execution of an SLR. Throughout this section, the steps and adaptations made for the execution of the research in each database will be presented.

As stated in Mafra and Travassos [2006], it is important to understand the rationale behind choosing this research approach. Here, it was driven by the need for a more empirically grounded perspective, highlighting what was uncovered in the early stages of the research. By comprehending the current state of affairs, we gain a more nuanced view of what needs improvement. Systematically understanding how AI issues have been addressed in a specific scenario like this allows us to plan or act more effectively to prevent unjust excesses by the State, which holds far greater power than individuals alone.

[11] We use this method as a simple way of searching, simulating the approach of an average person who is not specialized in conducting in-depth research or using external tools. As mentioned earlier, there is a need for individuals to understand the reasons behind decisions made against them. Thus, at this specific moment, a broader search was preferred to see if the Federal Revenue itself would provide information for someone conducting such research.

[12] The search was conducted in Portuguese, looking up the expressions ”IA” (AI) and ”Inteligência artificial” (Artificial Intelligence).

[13] Initially, we thought that, given the requirement to provide essential information for an administrative process, as highlighted in the legal correlation discussed here, the Federal Revenue would already have better information available. This would enable an analysis of practices based on public data. However, since this wasn't possible, we chose the path proposed in this method.

Table 1. Inclusion Criteria

Inclusion Criteria
Primary studies
Published and available in full on ACM or SOL
Articles written in English or Portuguese
Studies that address some of the research questions
Articles related to the search terms

Table 2. Exclusion Criteria

Exclusion Criteria
Articles not available in full
Secondary studies
Duplicate articles
Articles unrelated to the search terms

7.1 Scientific Literature Review

One way to systematize a search in a SMS is by executing protocols similar to those of a SLR, as outlined in Kitchenham and Charters [2007], following three research stages: planning, conducting, and reviewing. This method enhances the clarity of a specific topic, providing a catalog of primary works in the area of interest and assessing their impacts [Kitchenham and Charters, 2007].

7.1.1 Research Question

Some analysis parameters were established. Therefore, the following research question (RQ) was proposed: (RQ1): "*How many studies observe the use of AI in the context of Brazilian taxation?*". From this question, some subquestions (SQ) were proposed, with the aim of carrying out a more complete analysis of the issues:

- *SQ1.* How many studies on taxation have been published?
- *SQ2.* What strategies were addressed in these studies?
- *SQ3.* In which states of Brazil are the researchers from the selected studies located?
- *SQ4.* Which institutions stand out in terms of the volume of published papers?
- *SQ5.* Is the taxation perceived in the paper federal, state, or municipal?
- *SQ6.* In what context is AI used?

7.1.2 Preparation for conducting the Scientific Literature Review

As presented by Kitchenham and Charters [2007], the selection of the database is the first step for the successful execution of a Systematic Literature Review. The choice was made based on research opportunities and accessibility for the researchers, leading to the selection of the ACM and SOL databases.

There was no time limitation regarding publication, accepting any work available based on the specified criteria at any time.

The next step is to establish inclusion and exclusion criteria for the works. In the inclusion criteria, as seen in Table 1, an important factor is the availability of works in the ACM Digital Library (ACM)[14] and the SBC OpenLib (SOL)[15].

As for the exclusion criteria, they are listed in Table 2.

Regarding the selection of works, all available papers in both the ACM and SOL databases were included, with the total number listed in Table 3.

Table 3. Number os papers per Repository

Repository	Number of papers
ACM	97
SOL	187

Afterwards, a search string was used to find articles related to taxation, as detailed in Table 4. The keywords chosen for the analysis of titles and abstracts of the articles are listed in Table 5.

The search string was designed to encompass more possibilities by including "tax", considering the likelihood of having few specific works from the Federal Revenue Service (RFB), the State Treasury Department (Sefaz), or another agency focused on taxation. Therefore, it was thought not to be a problem if papers addressing taxation were accepted, even if they did not deal with federal taxes, i.e., the competence of the Federal Revenue Service but rather with state and municipal taxes.

7.1.3 Conducting the Scientific Literature Review

For the this process, the Parsifal tool was used [16]. In it, all the criteria mentioned in the previous step were established.

After that, the tool was used to input all the entries in *.bibtex*, and the software itself organized the authors, title, abstract, and year into tables.

The conducted steps and the quantity of resulting works can be seen in Figure 1, and their description follows in the next subsections.

Figure 1. Paper selection process for ACM and SOL

7.1.4 Initial review

After gathering the 284 works for analysis, the researchers reviewed the titles and abstracts of each, initiating the process with the tool's duplicate identification feature, which flagged 15 duplicates.

Following this initial review, a search was conducted for the keywords outlined in Table 5, and the exclusion criteria from Table 2 were applied, resulting in the removal of an additional 243 articles. This left 26 articles for further consideration. The screening process involved two researchers, with approval from at least one researcher being sufficient for an article to proceed to the next stage.

[14] dl.acm.org/
[15] sol.sbc.org.br/
[16] The tool can be accessed at: https://parsif.al/

Table 4. String per Repository

Repository	String
ACM	[[[Abstract: “brazilian”] OR [Abstract: “brazil”] OR [Abstract: “brasil”] OR [Abstract: “brasileira”] OR [Abstract: “brasileiro”]] AND [[Abstract: “customs”] OR [Abstract: “revenue”] OR [Abstract: “receita”] OR [Abstract: “federal”] OR [Abstract: “tax”] OR [Abstract: “tax colletion”]] OR [[Title: “brazilian”] OR [Title: “brazil”] OR [Title: “brasil”] OR [Title: “brasileira”] OR [Title: “brasileiro”]] AND [[Title: “customs”] OR [Title: “revenue”] OR [Title: “receita”] OR [Title: “federal”] OR [Title: “tax”] OR [Title: “tax colletion”]]]
SOL	((“Abstract”:“Brazilian” OR “Abstract”:“brazil” OR “Abstract”:“brasil” OR “Abstract”:“brasileira” OR “Abstract”:“brasileiro”) AND (“Abstract”:“customs” OR “Abstract”:“revenue” OR “Abstract”:“receita” OR “Abstract”:“federal” OR “Abstract”:“tax collection” OR “Abstract”:“tax”)) OR ((“Publication Title”::“Brazilian” OR “Publication Title”::“brazil” OR “Publication Title”:“brasil” OR “Publication Title”:“brasileira” OR “Publication Title”:“brasileiro”) AND (“Publication Title”:“customs” OR “Publication Title”:“revenue” OR “Publication Title”:“receita” OR “Publication Title”:“federal” OR “Publication Title”:“tax collection” OR “Publication Title”:“tax”))

Table 5. Keywords and synonyms

Keywords	Synonyms
tax	tax colletion; imposto
federal revenue	customs; revenue; receita; receita federal
brazilian	Brazil; Brasil; brasileira; brasileiro

Table 6. Data extraction form

Data extraction form
Which AI method is used?
Which states or countries (if not Brazil) are the authors from?
Which institutions are the authors affiliated with?
Which tax jurisdiction does the work address?

7.1.5 Deep review

In this stage, researchers conducted a thorough analysis of the articles by reading them in their entirety. They scrutinized the content for potential reasons for exclusion and ensured that the remaining articles adhered to the inclusion criteria.

Two researchers independently reviewed the articles, each conducting their analysis without consultation with the other. After completing their individual analyses, the researchers compared their findings and discussed any discrepancies in acceptance. During this phase, 21 articles were excluded, leaving 5 articles for further analysis.

7.1.6 Data extraction

The information from the chosen articles was extracted through a form available in the Parsifal tool. This extraction process aimed to address the research inquiries of this study, with each question providing additional insights that couldn't be readily obtained from ACM and SOL. Consequently, a set of 4 questions was formulated for the form. Researchers utilized open fields to fill in the responses. The specific questions are detailed in Table 6.

7.1.7 Results

In response to the specified research questions, the first inquiry, *SQ1. How many studies on taxation have been published?* revealed that, within the searched databases, 5 papers were identified, as detailed in Table 7.

Regarding the second subquestion, *SQ2. What strategies were addressed in these studies?* It was noted that only 3 papers provided information on the techniques used. The employed techniques are outlined in Table 7, encompassing The Nadaraya-Watson Kernel Regression by Franco *et al*. [2023], LSTM Artificial Neural Network by Dornelas *et al*. [2022], and Case-based Reasoning (CBR) by Barreto *et al*. [2003].

In two papers, it was not possible to identify the technique used, namely Roman *et al*. [2009] and Digiampietri *et al*. [2008].

Regarding *SQ3. In which states of Brazil are the researchers from the selected studies located?*, it was observed that 18 researchers are involved with the topic in Brazil. The majority are in the Southeast region, with 7 in São Paulo, 2 in Minas Gerais, and one in Rio de Janeiro, totaling 10. Next is the Northeast region, with Ceará as the only state, hosting 5 representatives. Finally, the South region has 3 researchers from Santa Catarina.

As for the sub-question *SQ4. Which institutions stand out in terms of the volume of published papers?* the result showed that the most representative institutions in terms of the number of papers are the University of São Paulo (USQ) and the Brazilian Federal Revenue (RFB), both appearing in 2 papers. All other institutions have only one appearance. They are: Federal University of Ceará (UFC), University of Fortaleza (UNIFOR), Federal University of Juiz de Fora (UFJF), State University of Rio de Janeiro (UERJ), University of Campinas (Unicamp), Federal University of Santa Catarina (UFSC), and Campo Limpo Paulista University Center (UNIFACCAMP).

Regarding the question *SQ5. Is the taxation perceived in the paper federal, state, or municipal?* the answer is provided in Table 8. In 3 papers, the research is conducted in a national context. State and municipal scopes each have 1 paper.

To respond to *SQ6. In what context is AI used?*, Franco *et al*. [2023]'s work focuses on combating tax evasion by investigating 6 categories of service providers related to the payment of a municipal tax. As a result of using AI, it identified more than 1800 companies with strong indications of committing crimes.

Dornelas *et al*. [2022]'s work centered on using Artificial Neural Networks, specifically Long Short-Term Memory (LSTM), for projecting the collection of a state tax. The use of LSTM demonstrated effectiveness, with a relative error of 0.41% in the best-case scenario compared to a 9.04% relative error in the human-performed calculation by SEFAZ[17]. No indication of pursuing taxpayers in this situation.

In Roman *et al*. [2009], there is a demonstration of using technologies for detecting fraud in imports. However, this work does not explicitly specify the exact technology em-

[17] State finance secretariat

Table 7. Paper and the method used

Paper	Methods
Franco *et al*. [2023]	The Nadaraya-Watson Kernel Regression
Dornelas *et al*. [2022]	LSTM Artificial Neural Network
Roman *et al*. [2009]	*Not identified*
Digiampietri *et al*. [2008]	*Not identified*
Barreto *et al*. [2003]	Case-based Reasoning (CBR)

Table 8. Competencies per Paper

Competency	Paper
Federal	Roman *et al*. [2009], Digiampietri *et al*. [2008], Barreto *et al*. [2003]
State	Dornelas *et al*. [2022]
Municipal	Franco *et al*. [2023]

ployed.

As seen in Digiampietri *et al*. [2008], similar to the previous work, there is a mention of the HARPIA project that focuses on import fraud. It involves an analysis based on both origin and arrival data.

Finally, in the work of Barreto *et al*. [2003], the objective is to provide personnel at the Brazilian Federal Revenue with a set of information for decision-making aligned with everyone's understanding. The use of AI is linked to organizing this information and providing feedback to the internal users of the Revenue Service.

7.2 Gray Literature Review

Recognizing the limited number of scientific papers in the databases investigated, the subsequent step involved analyzing works on the topic that were produced and published without undergoing peer review in scientific events or journals.

We opted to search the National School of Public Administration (ENAP), which houses a repository of documents potentially relevant to the research. We discovered a collection of works aligned with the award granted by the Federal Revenue Service to encourage the generation of new knowledge within the organization—the *Creativity and Innovation Award of the Federal Revenue Service of Brazil* (*Prêmio de Criatividade e Inovação da Receita Federal do Brasil* in portuguese).

The available works in this collection totaled 106, and all of them were manually analyzed for this study. In this case, the search string was not applied.

Nevertheless, the keywords outlined in Table 5 were adhered to, seeking works that correlated with the inclusion criteria set in Table 1.

The chosen method, thus, bears a resemblance to a Systematic Literature Review, adapted to be executed within a confined scope of works.

7.2.1 Research Question

The research questions could not be fully replicated as proposed in the SMS of Scientific Literature, as there was no need to inquire about the originating institution of the works, given that all of them came from the Federal Revenue. Another sub-question impossible to answer with the data present in the texts concerns the state or country (when not located in Brazil) of each researcher. Lastly, questioning the scope of taxation would not make sense, as the Federal Revenue has only federal jurisdiction.

Therefore, the sub-questions for the gray literature review were:

- *SQ1.* How many studies on taxation have been published?
- *SQ2.* What strategies were addressed in these studies?
- *SQ3.* In what context is AI used?

7.2.2 Conducting the Gray Literature Review

The initial count of identified articles was 106. Following the initial analysis, which involved reviewing the titles and abstracts, 70 articles were excluded based on the criteria outlined in Table 2, leaving 34 articles for further consideration.

In the subsequent stage, during which the selected papers were thoroughly read while closely adhering to the inclusion criteria presented in Table 1, only 5 articles met the criteria and were retained for detailed analysis. Consequently, 29 articles were excluded.

All these stages are visualized in Figure 2.

Figure 2. Paper selection process for ENAP

7.2.3 Results

Initially, it's worth mentioning that the majority of works from the *Creativity and Innovation Award of the Federal Revenue Service of Brazil* primarily delved into innovations related to processes or perceptions crucial for comprehending the activities of the tax authority. In actuality, only a limited number of papers specifically addressed the utilization of AI.

The subquestion *SQ1. How many studies on taxation have been published?* has the answer of 5 selected papers, which can be found in Table 9.

Regarding the methods, addressing subquestion *SQ2. What strategies were addressed in these studies?*, the details

Table 9. Gray Literature Papers and the method used

Paper	Methods
Jambeiro Filho [2019]	Predictive Method
Brasílico [2017]	Machine Learning and Neural Networks
Thompson [2016]	Computer Vision
Jambeiro Filho [2016]	Machine Learning
Carvalho [2015]	Fuzzy Logic

are presented in Table 9. The paper by Jambeiro Filho [2019] employs the Predictive Method. The work by Brasílico [2017] utilizes Machine Learning and Neural Networks. The scope of Thompson [2016] is Computer Vision. Machine Learning is the focus of Jambeiro Filho [2016]. Finally, Carvalho [2015] employs Fuzzy Logic.

To address *SQ3. In what context is AI used?*, the use of AI can be observed in various situations. The work of Jambeiro Filho [2019] employs a fiscal strategy simulator, demonstrating that, for taxpayers with identical tendencies and an equal fiscal strength, some fiscal strategies can effectively combat tax evasion, while others have minimal impact on it. The predictive model used aims to understand the behavior of individuals engaged in tax evasion.

In Brasílico [2017], the utilization of AI techniques, computer vision (CV), data mining, and optical character recognition (OCR) is evident for classification, prediction, pattern scanning, and alerting anomalies or potential threats. The paper proposes an automatic AI control of surveillance images and scanning from various sources.

In Thompson [2016], the objective is to present the approach developed by the Brazilian Federal Revenue to identify international travelers of customs interest in an automated, swift, precise, and standardized manner, using computer vision.

The work Jambeiro Filho [2016] introduces SISAM, a system focused on customs selection that utilizes machine learning. There are indications that it has already detected committed infractions, emphasizing the collaboration between human knowledge and that derived from the machine.

Lastly, in the work Carvalho [2015], information is provided about a system that classifies individuals as criminals or potentially criminal. The paper indicates improvements in the approach and decision-making, reducing the need for human interventions.

7.3 Evaluation of AI Usage

To assess the implementation of AI, four previously outlined criteria essential for explainable artificial intelligence were utilized:

1. Model Interpretability (MI);
2. Rules and Logic (RL);
3. Data Visualization (DV);
4. Model Documentation (MD).

In Table 10 and Table 11, the correspondence with the points above is used, where MI stands for Model Interpretability, RL for Rules and Logic, DV for Data Visualization, and MD for Model Documentation.

Table 10. Analysis of articles from ACM and SOL

Paper	MI	RL	DV	MD
Franco *et al*. [2023]	No	Yes	Yes	No
Dornelas *et al*. [2022]	Yes	Yes	Yes	No
Roman *et al*. [2009]	No	Yes	Yes	No
Digiampietri *et al*. [2008]	No	No	Yes	No
Barreto *et al*. [2003]	No	No	No	No

Table 11. Analysis of articles from ENAP

Paper	MI	RL	DV	MD
Jambeiro Filho [2019]	No	Yes	Yes	No
Brasílico [2017]	No	No	Yes	No
Thompson [2016]	No	No	Yes	Yes
Jambeiro Filho [2016]	No	No	Yes	Yes
Carvalho [2015]	No	Yes	Yes	Yes

The analysis initially focused on the works identified in the SLR, and the results are presented in Table 10.

When examining the works in the gray literature, the results are presented in Table 11.

When examining the presented data, none of the works identified through the systematic review provides sufficient evidence to assert that these technologies are explainable. Indeed, it is possible that they are, but based on the method used and the criteria established in the literature, considering the context of this work, there is no relevance to the established criteria.

The works from the scientific literature all fail to present adequate documentation of the proposed models, which would be crucial for a more comprehensive evaluation of what was presented.

Conversely, the works from the gray literature are better light regarding documentation.

In almost all works, the aspect best addressed is data visualization, with only one work not providing insights on it. Next, the rules and logic implemented are only clear in half (5 out of 10) of the analyzed works.

When examining the subject in which AI is employed, it is evident that in many of the works, there is an indication of individuals who may have committed crimes. However, as none of these technologies prove to be explainable, how can one consider such an allegation fair? How could an individual contest the mathematics proposed by these works? There is no clear answer to this; however, there is a need to delve more deeply into the mitigations of the harms proposed by these AIs, if any, in future research.

8 Threats to validity

As a scientific process, there are factors that can threaten the validity of this work, as proposed by Wohlin *et al*. [2012].

A first threat is related to the construction of this study, as suggested by Wohlin *et al*. [2012]. In a traditional Systematic Review, a search string would be proposed, as suggested by Kitchenham and Charters [2007], which could require a more performative construction, prioritizing the understanding of the information gathered. In this work, to mitigate this problem, it was decided to analyze *a prima facie* all the works present in ACM and SOL, without taking into account the year of publication. Similarly, an effort was made to construct a more comprehensive string to collect the greatest number of related works.

Another possible threat concerns internal validity, as presented in Wohlin *et al*. [2012]. Decisions regarding the choice or qualitative analysis for the selection of works may have been made in a way that hinders an impartial decision about the works. To minimize this situation, a peer review was practiced in which conflicts arising from the analysis were discussed first, and the decision was made afterward.

A third threat, external validity, concerns the representativeness of this work in choosing primary studies that actually represent the topic reviewed in Wohlin *et al*. [2012]. This issue was mitigated with parallel research that served to question or validate the authors' consensus. It is emphasized that peer review helped mitigate this problem.

Finally, the validity of the conclusion may encounter problems, as this work may not have covered all relevant primary studies for the analysis, as discussed in Wohlin *et al*. [2012] and Kitchenham and Charters [2007]. To address this, the process of selecting and analyzing works, considering inclusion and exclusion criteria, was carried out by peers, in parallel and independently. Moreover, the final selection process was discussed and analyzed more thoroughly to ensure the fidelity of the presented conclusion.

8.1 Limitations

This work presents some limitations that restricted a comprehensive view on the subject. Firstly, there are limitations in accessing information, as none of the authors is affiliated with a public tax collection agency, thus limiting the available information to that in the public domain.

Another evident limitation pertains to the number of databases explored, being limited to SOL and ACM, a Brazilian and an international database. In a more extensive systematic review, it would be ideal to search in additional sources. However, this choice was made with a focus on a narrower scope due to limitations in human and temporal resources. Naturally, this weakens the assertion that there are no explainable models when it comes to works on the use of AI in tax administration.

Another limitation was the omission of legal journals specializing in tax law in the systematic literature review, which could have provided valuable insights from professionals in the field through experience reports or similar contributions.

There was no comparison with other tax models in legal terms and the treatment of AI use in those contexts. This omission occurred due to the complexity of each tax legislative choice, requiring individual and specific studies on phenomena beyond simple taxation, such as the historical formation of the country under study.

Another limitation was the inability to find a positive example of model explanation, hindering a tangible illustration of quality for future works. However, this does not suggest that, in this context, other research cannot provide such explanations.

9 Conclusion and Future Work

As we have observed throughout the study, it is an essential right of citizens to understand how decisions that restrict their rights are made, whether in situations where judgments are rendered with or without the assistance of machines.

In a three-stage study, it is important to highlight the contributions made. Firstly, in a certain sense, even if not directly, there are already legal foundations, through principles, governing AI-mediated actions, contrary to what was exposed in the Nature editorial [Nature, 2024], presented in the introduction.

There is a possible legal framework that, at least regarding taxation, urges the creation of verifiable models under penalty of returning to absolutism. On another note, it is already expected that models provide this possibility of explainability.

Nevertheless, there is an ongoing state movement to ensure that all AI are explainable when used in public sectors, along with a clear indication of how they are being used.

In the analysis presented in the text, it is evident that, concerning taxation, there is a lack of representation in the Brazilian article database (SOL). The expression of these technologies being evaluated by peers and present in academic discussions can be a source of debates aiming for a less harmful inclusion in society. Actions taken without scientific backing are prone to significant errors that can harm a wide range of individuals.

With this work, it is concluded that there are indeed uses of AI in the Federal Revenue (RFB) and other taxation scenarios in Brazil. However, its manifestation in the academic scenario does not favor an in-depth analysis of this technology. It is recommended that these technologies gain a Brazilian academic structure so that issues can be critically examined by peers, allowing for an understanding of the complexity, effects, or other factors that may negatively influence everyone's lives. This matter, in particular, addressing themes pertinent to the maintenance of the Brazilian State, should be done inclusively, considering writing in Portuguese as well.

Computers and their technologies, particularly those related to AI, are new mediators in the relationship between public administration and the public. They must adhere to previously established principles to make decision-making by public agents more transparent.

Similarly, for computer researchers wishing to address AI topics related to the treatment of public administration data, it is recommended to include a dedicated section in the study demonstrating the explainability of such technology or, if not,

the means being taken to mitigate or eliminate possible attacks on rights.

It is essential that we, individually as citizens or researchers, strive to maintain a state that preserves individual guarantees, respecting principles established for justice and life, grounded in the dignity of the human person.

In future work, there is a need to delve deeper into the relationships between the people and public administration, with the computer as a mediator, proposing heuristics based on constitutional rights to translate legal jargon into the development environment, fostering a community more aware of their rights and obligations.

To expand the scope of this work, interviews and debates with developers of AI solutions for the government are still planned. This aims to understand how the development of these technologies occurs, their limitations, and how strategies are implemented to overcome them.

It is still interesting to understand, in detail, each technology exposed here, requesting data, possibly judicially, to conduct a proper analysis of each technology.

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Authors' contributions, following the CRediT taxonomy:

- **Erik Henrique da Costa Nunes**: Conceptualization, Data curation, Investigation, Methodology, Project administration, Visualization, Writing – original draft;
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References

Angwin, J., Larson, J., Mattu, S., and Kirchner, L. (2016). Machine bias. In *Ethics of Data and Analytics*, pages 254–264. Auerbach Publications.

Bandeira de Mello, C. A. (2009). Curso de direito administrativo. *São Paulo: Malheiros*, 26.

Bangalore (2019). Cofundador da apple diz que apple card deu a sua esposa limite de crédito mais baixo. urlhttps://www1.folha.uol.com.br/tec/2019/11/cofundador-da-apple-diz-que-apple-card-deu-a-sua-esposa-limite-de-credito-mais-baixo.shtml.

Barreto, A. S., Bueno, T. C. D., and Hoeschl, H. C. (2003). Applying case-based reasoning to knowledge representation of tributary decisions. In *Proceedings of the 9th International Conference on Artificial Intelligence and Law*, ICAIL '03, page 77–78, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/1047788.1047801.

Bartik, J. J. (2013). *Pioneer programmer: Jean Jennings Bartik and the computer that changed the world*. Truman State University Press.

Bonavides, P. (2014). *Ciência Política*. Malheiros.

Brasil (1942). *Decreto-Lei n. 4.657, de 4 de setembro de 1942, Lei de Introdução às normas do Direito Brasileiro*. Brasília, DF.

Brasil (1988). *Constituição da República Federativa do Brasil de 1988*. Brasília, DF.

Brasil (2023). Projeto de lei n. 2338, de 2023. dispõe sobre o uso da inteligência artificial. *Senado*.

Brasílico, I. d. S. (2017). *3º lugar. ANJA - Plataforma de visão computacional e aprendizado de máquina*. Receita Federal do Brasil (RFB).

Buolamwini, J. and Gebru, T. (2018). Gender shades: Intersectional accuracy disparities in commercial gender classification. In *Conference on fairness, accountability and transparency*, pages 77–91. PMLR.

Campos, J. C. D. (2013). *Nomogênese e poder constituinte: fundamentação racional e legitimação democrática da norma constitucional*. PhD thesis, Universidade de São Paulo, São Paulo, SP.

Carvalho, R. L. d. (2016). Inovação intraorganizacional: influência do intraempreendedorismo no fomento à disrupção digital de mercados. Master's thesis, Universidade Federal de Pernambuco, Recife, PE.

Carvalho, S. C. (2015). *3º lugar. MIDCS - um método de inferência difusa para classificação de sonegadores fiscais*. Receita Federal do Brasil (RFB).

Cintra, A. d. A., Grinover, A. P., and Dinamarco, C. R. (2005). Teoria geral do processo.

CNJ, C. N. d. J. (2020). Resolução n. 332, de 21 de agosto de 2020. dispõe sobre a ética, a transparência e a governança na produção e no uso de inteligência artificial no poder judiciário e dá outras providências. *DJe/CNJ, nº 274, de 25/08/2020*.

Coêlho, S. C. N. (2018). *Curso de direito tributário brasileiro*. Grupo Gen-Editora Forense.

Costa, D. F. O. and Maia, R. (2021). Política pública judiciária de inteligência artificial: uma análise dos programas de ia utilizados pelo stj à luz da racionalidade neoliberal. *Revista Inter-Legere*, 4(31):c25024. DOI: 10.21680/1982-1662.2021v4n31ID25024.

Da Costa Nunes, E. H. (2022). Heuristics for computer-mediated human interactions based on consumer rights. In *Proceedings of the 21st Brazilian Symposium on Human Factors in Computing Systems*, IHC '22, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/3554364.3559128.

Digiampietri, L. A., Roman, N. T., Meira, L. A. A., Filho, J. J., Ferreira, C. D., Kondo, A. A., Constantino, E. R., Rezende, R. C., Brandao, B. C., Ribeiro, H. S., Carolino, P. K., Lanna, A., Wainer, J., and Goldenstein, S. (2008). Uses of artificial intelligence in the brazilian customs fraud detection system. In *Proceedings of the 2008 In-*

ternational Conference on Digital Government Research, dg.o '08, page 181–187. Digital Government Society of North America.

Dinamarco, C. R., Grinover, A. P., and de Araújo Cintra, A. C. (2001). *Teoria geral do processo*. Malheiros Ed.

Dornelas, A., Campos, L., and Figueiredo, K. (2022). Modelos para previsão tributária utilizando redes neurais lstm. In *Anais do XIX Encontro Nacional de Inteligência Artificial e Computacional*, pages 95–105, Porto Alegre, RS, Brasil. SBC. DOI: 10.5753/eniac.2022.227595.

Eco, U. (2011). *Apocalípticos e integrados*. Perspectiva.

Ezequiel, M. d. S. (2019). *Receita Federal: 50 years (1968-2018)*. Receita Federal.

Fabro, C. (2023). Advogado usa chatgpt para fazer pesquisa jurídica e É multado em 24 mil reais; entenda.

Federal, J. (2020). I jornada de direito administrativo aprova 40 enunciados. https://www.cjf.jus.br/cjf/noticias/2020/08-agosto/i-jornada-de-direito-administrativo-aprova-40-enunciados.

Franco, W., Alves, E., Sousa, F., Bastos, Z., and Pinheiro, V. (2023). An intelligent model for generating indications of tax gap in service companies. In *Anais do II Brazilian Workshop on Artificial Intelligence in Finance*, pages 61–72, Porto Alegre, RS, Brasil. SBC. DOI: 10.5753/bwaif.2023.230149.

Fussey, P. and Murray, D. (2019). Independent report on the london metropolitan police service's trial of live facial recognition technology.

Gray, C. M., Kou, Y., Battles, B., Hoggatt, J., and Toombs, A. L. (2018). The dark (patterns) side of ux design. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, page 1–14, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/3173574.3174108.

Grier, D. A. (2001). The human computer and the birth of the information age. *Joseph Henry Lecture of the Philosophical Soc. of Washington*, pages 42–43.

Harada, K. (2020). *Direito financeiro e tributário*. Atlas.

Horkheimer, M. and Adorno, T. W. (2011). *A indústria cultural: o iluminismo como mistificação da massa*, page 179–238. Terra e Paz.

Jambeiro Filho, J. E. d. S. (2016). *1º lugar. Inteligência artificial no sistema de seleção aduaneira por aprendizado de máquina*. Receita Federal do Brasil (RFB).

Jambeiro Filho, J. E. d. S. (2019). *2º lugar: gerência da expectativa de retorno do sonegador e simulação de estratégias fiscais*. Receita Federal do Brasil (RFB).

Jardim, L. (2023). Juiz usa chatgpt para escrever uma sentença e se dá mal: Ferramenta inventou jurisprudências.

Kitchenham, B. and Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. 2.

Machado Segundo, H. d. B. (2009). *Fundamentos do ordenamento jurídico : liberdade, igualdade e democracia como premissas necessárias à aproximação de uma justiça possível*. PhD thesis, Universidade de Fortaleza, Fortaleza, CE.

Mafra, S. N. and Travassos, G. H. (2006). Estudos primários e secundários apoiando a busca por evidência em engenharia de software. *Relatório Técnico, RT-ES*, 687(06).

Mass, B. (2016). Cinco exemplos práticos que provam que já vivemos no mundo do big data. https://www.faeterj-rio.edu.br/cinco-exemplos-praticos-que-provam-que-ja-vivemos-no-mundo-do-big-data/.

Molnar, C. (2020). *Interpretable machine learning*. Lulu. com.

Monteiro, M. and Castillo, V. (2019). *Ruined by design: How designers destroyed the world, and what we can do to fix it*. Mule Design.

Munárriz, L. Á. (1994). *Fundamentos de inteligencia artificial*, volume 1. Editum.

Nascimento, I. S. d. M. P. d. (2022). Inteligência artificial e direito: potencial da ia como ferramenta otimizadora da prestação jurisdicional voltada à superação das desigualdades sob a perspectiva do estado de coisas inconstitucional. Master's thesis, Universidade de Brasília.

Nature (2024). Computers make mistakes and ai will make things worse — the law must recognize that. *Nature*, 625(7996):631–631. DOI: 10.1038/d41586-024-00168-8.

Neiva, L. (2020). *Big Data na investigação criminal: desafios e expectativas na União Europeia*. Edições Húmus.

Oliveira, C. G. B. d., de Paula Albuquerque, O., Liene Belotti, E., Ferreira Lopes, I., Brandão de A. Silva, R., and Arbix, G. (2023). Regulation and ethics of facial recognition systems: An analysis of cases in the court of appeal in the state of são paulo. In Naldi, M. C. and Bianchi, R. A. C., editors, *Intelligent Systems*, pages 18–32, Cham. Springer Nature Switzerland.

Oliveira, F., Almeida, C., Monteiro, L., Escobar, F., Otávio, R., Silva, D., and Almeida, W. (2020). Mapeamento sistemático sobre uma análise do impacto das práticas de big data na administração pública federal. In *Atas da Conferências IADIS Ibero-Americanas WWW/Internet e Computação Aplicada 2020*.

Paula, M. and Carvalho, R. (2022). Systematic mapping of the literature of reports of the use of participatory budgeting in digital form. In *Proceedings of the 10th Workshop on Applied Computing in Electronic Government*, pages 49–60, Porto Alegre, RS, Brasil. SBC. DOI: 10.5753/wcge.2022.223258.

Petersen, K., Feldt, R., Mujtaba, S., and Mattsson, M. (2008). Systematic mapping studies in software engineering. *Proceedings of the 12th International Conference on Evaluation and Assessment in Software Engineering*, 17.

Presse, F. (2023). Juiz usa robô chatgpt para redigir sentença em caso de criança autista na colômbia.

Rampazzo, N. L. (2019). *O significado da inovação na indústria de tecnologia: um estudo no Porto Digital de Recife*. PhD thesis, Universidade Federal de Pernambuco, Recife, PE.

Rebouças, M. V. P. (2019). *Elementos para uma teoria da tributação redistributiva para o Brasil contemporâneo*. PhD thesis, Universidade Federal do Ceará, Fortaleza, Ceará.

Roman, N. T., Ferreira, C. D., Meira, L. A. A., Rezende, R., Digiampietri, L. A., and Filho, J. J. (2009). Attribute-value specification in customs fraud detection: A human-aided

approach. In *Proceedings of the 10th Annual International Conference on Digital Government Research: Social Networks: Making Connections between Citizens, Data and Government*, dg.o '09, page 264–271. Digital Government Society of North America.

Rudin, C. (2019). Stop explaining black box machine learning models for high stakes decisions and use interpretable models instead. *Nature Machine Intelligence*, 1(5):206–215. DOI: 10.1038/s42256-019-0048-x.

Santos, S. (2024). Valor não declarado de investimento em bitcoin em 2023 chega a 1,06 bilhões de reais - estadão e-investidor - as principais notícias do mercado financeiro.

Segel, E. and Heer, J. (2010). Narrative visualization: Telling stories with data. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):1139–1148. DOI: 10.1109/TVCG.2010.179.

Sperandio, H. R. d. C. (2018). Desafios da inteligência artificial para a profissão jurídica. Master's thesis, Fundação Getúlio Vargas, São Paulo, SP.

Thompson, R. C. (2016). *1º lugar. Projeto IRIS - Reconhecimento facial de viajantes*. Receita Federal do Brasil (RFB).

Vasconcelos, K. and Marques, J. (2023). A systematic mapping of the literature on the decision-making process of information technology investments in public organizations. In *Proceedings of the 11th Workshop on Applied Computing in Electronic Government*, pages 25–36, Porto Alegre, RS, Brasil. SBC. DOI: 10.5753/wcge.2023.229863.

Vidal, V. and Geffner, H. (2006). Branching and pruning: An optimal temporal pocl planner based on constraint programming. *Artificial Intelligence*, 170(3):298–335.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., and Wesslén, A. (2012). *Experimentation in software engineering*. Springer Science & Business Media.