TIME, LAW AND TECHNOLOGY: an explanatory typology of strategies for the regulation of Artificial Intelligence

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Abstract: Artificial Intelligence systems for automation of decision-making constitute an innovation that challenges regulatory initiatives. The specificity of the regulatory problem derives from the atypical relationship between the type of technology, the legal norm and time. Generally speaking, there are characteristics, inherent to Artificial Intelligence systems, and not present in other technologies, that can make regulatory solutions dynamically inconsistent. The assumption is that Artificial Intelligence is an infinite game and regulation, a finite game. The ontological differences between such types of games have implications for the options of models and strategies that can be adopted to regulate Artificial Intelligence, since (i) Artificial Intelligence, (i.1) in its continuous improvement process, does not recognizes externally established limits and presupposes the constant challenge to possible restrictions to its continuity, (i.2) indicates that the process is not only continuous, but it is not possible to anticipate when (and if) it will reach its end and (i.3) presupposes that the future is continually open and, thus, the past does not necessarily function as a reference for the development of future actions, as it is constantly updated in light of the development of technology; (ii) regulation, (ii.1) in its decision-making process, presupposes the existence of rules related to the establishment of limits regarding the participants authorized to participate, as well as spatial and temporal criteria, (ii.2) it is entirely guided by rules that determine the procedures and possible courses of action, with the participants fully linked to them, and (ii.3) represents a process of iterative iterations between the participants, in which previous experiences have a relevant weight in the actions taken carried out for decision-making purposes. Thus, the ontological misalignment between the two types of games implies recognizing the possible limitations of the existing regulatory instruments and thus, it is not required (or if expect) something that goes beyond those limits inherent to

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regulation, avoiding mistakes in regulatory designs. The explanatory typology proposed here starts with the explanatory variables — in this case, the epistemic dimension (risk and uncertainty) and the regulatory policy prioritization dimension (guarantee of fundamental rights and innovation) — to propose hypothetical results related to regulatory strategies (types) that prevail in a given context. The comprehensive concept (regulatory strategy) would comprise four types — precaution, flexibility, anticipation, and rigidity — resulting from the intersection between explanatory variables, which would shape the profile of the regulation that may be applied in each context. For this reason, this article intends to propose an explanatory typology that indicates how strategies regulatory for the regulation of Artificial Intelligence systems will relate to the temporal element and the dynamic character of the technology.

Content

ETERNIDADES
La serpiente que ciñe el mar y es el mar,
el repetido remo de Jasón, la joven esposa de Sigurd.
Sólo perduran en el tiempo las cosas
que no fueron del tiempo.[2]

1. Introduction

The use of terms linked to new technologies — such as Artificial Intelligence, blockchain, big data, disruption, among others — has become commonplace in several fields of knowledge. And Law is not immune to this phenomenon.

However, it is important to point out that the innovative nature of new technologies — for instance, Artificial Intelligence — is not to be confused with the novelty of the problem[3], that is, whether there should be (or not) a specific regulation and, if so, which strategies, designs and regulatory instruments would be more appropriate.

The specificity of the regulatory problem, it is argued here, derives from the atypical relationship between Artificial Intelligence, the legal norm and time[4]. In general terms, there are characteristics, inherent to Artificial Intelligence systems — and not present in other technologies — that can make regulatory solutions dynamically inconsistent.

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[2] BORGES, Jorge Luis. *Obras Completas* - Volume II - 1952-1972. Rio de Janeiro: Globo, 1999.

[3] Similar concerns have arisen, for example, regarding the risks and unanticipated consequences arising from the development of nuclear energy, genetic experiments and the use of biotechnology and nanotechnology.

[4] RANCHORDÁS, Sofia; ROZNAI, Yaniv (eds.). *Time, Law and Change: an interdisciplinary study.* Oxford: Hart, 2020.

For this reason, this article intends to propose an explanatory typology[5] that signals — from variables related to the epistemic dimension and the dimension of policy prioritization — how regulatory strategies for regulating Artificial Intelligence systems will relate to the element time and with the dynamic character of technology itself.

It should be noted that it is not the objective of the article, therefore, to empirically analyze proposals and regulatory initiatives already in progress, nor to compare them, at that moment, with the proposed typology.

The article is structured in 05 sections, including the introduction. In Section 2, the main concepts used in the analysis will be presented. The third section explains the specific nature of the approach to new technologies — the relationship between technology, law and time — as well as the methodology used. In the fourth section, the typology is detailed. Finally, the conclusion will be presented.

2. Concepts

The impact of new technologies in law does not arise with models of Artificial Intelligence, in other words, with the techniques that allow machines to "imitate" human intelligence, using logic, "if-then" rules, decision trees or machine learning techniques.

This is because it is possible that Artificial Intelligence[6] has only highlighted some challenges[7] (basically, the unexpected consequences of its implementation in

[5] This option derives from the fact that the alternative approach (descriptive typology) presupposes, for its operationalization, a series of available observations (in this case, regulatory initiatives) that make it possible to exemplify the broader concept under study. COLLIER, David; LAPORTE, Jody; SEAWRIGHT, Jason. Typologies: Forming Concepts and Creating Categorical Variables. In BOX-STEFFENSMEIER, J.M.; BRADY, H.E.; COLLIER, D. (eds.). The Oxford Handbook of Political Methodology. Oxford: Oxford University Press, 2008, p.153.

[6] It is important to point out that, to a large extent, the current challenges do not refer to the so-called *General Artificial Intelligence* (which seeks to develop a system that is capable of performing a myriad of tasks with different degrees of complexity, mimicking the adaptive profile of the human being), but to *Applied Artificial Intelligence*, which seeks to solve limited problems, surpassing human performance. PASCHEN, Ulrich, PITT, Christine, KIETZMANN, Jan. Artificial Intelligence: building blocks and innovation typology. *Business Horizons*, v.63, n.2, mar-apr., 2020, p.153.

[7] Usually, the algorithms are developed in order to allow full traceability of their rules and results. However, the development of more complex algorithms — such as machine learning algorithms, deep learning, and reinforcement learning, among others — has brought opacity regarding the parameters that such algorithms use (since they, by their structure, have the ability to "learn" over time, as they are confronted with new problem situations) to arrive at the results presented to the decision-makers.

institutions and society), mainly with regard to the feasibility and adequacy of regulatory solutions.

The mere use of algorithms — understood as a finite sequence of rules and operations that, when applied to a set of data, allows solving similar classes of problems — would not be, therefore, a sufficient reason to mobilize the state apparatus around a proposal of regulation. However, when we are faced with Artificial Intelligence algorithms, especially those that use machine learning techniques and models, which aim at automating decision-making (both in the public and private sectors), specific questions arise.

Artificial Intelligence models include statistical techniques that allow computers to improve their performance in certain tasks from previous experience and can be roughly divided into three categories:

(i) machine learning algorithms with supervision that, from a dataset with correct answers, previously provided, presents answers about new cases (deals with classification and prediction problems);

(ii) unsupervised machine learning algorithms that, from a dataset without any classification or label, seek to identify "order" in that data (deals with "distance identification", "set construction", neural networks) ; and

(iii) reinforcement learning algorithms, which seek to learn which is the best course of action to adopt, depending on the circumstances in which this action will be performed, and for that they receive rewards or punishments, as the agent achieves the previously defined objective.

Such models have a peculiar characteristic: their continuous use can reinforce and potentiate preexisting problems (such as biases and discriminatory treatments, for example), as their structure is subject to feedback loops. In other words, starting from a reality in which inequities exist (and which are, as they usually are, reflected in the databases that will be used by those models), the implementation of Artificial Intelligence systems produces results that reflect the original biases and, as such results will return to the system as inputs for future analyzes and decisions, those inequities are crystallized, in an unvirtuous circle of reiteration and confirmation of biases.

The model, therefore, not only mimics, but also, in the long run, changes the reality in which it is used, as it consolidates and expands preexisting problematic situations[8]. And, given these specific characteristics, as well as the fact that it is used to mediate the relationship between individuals, on the one hand, and the State and/or companies, on the other,[9] Artificial Intelligence models can have deleterious impacts on the economy and for the society.

In this sense, the way in which the epistemic framework of the phenomenon of Artificial Intelligence is presented is a key variable to understand how decisions about regulatory strategies and instruments will be managed by the State. Thus, the concepts of risk and uncertainty[10] are presented as analytical alternatives that make it possible to develop the proposed typology.

The concept of risk would characterize situations and phenomena in relation to which it would be possible to calculate, a priori, the probability of their occurrence, based on induction based on experience and empirical evaluation.

It starts from the assumption that the world would be composed of elements that, under certain conditions, would always behave in a certain way and, thus, it would be possible to estimate the probability of certain phenomena occurring in a given time interval. The calculation of risk would always be an alternative available to the regulator, since in the decision-making process the situation would be neither one of scientific certainty nor of complete ignorance[11].

Uncertainty, on the other hand, occurs in situations in which traditional risk analysis may be inadequate to deal with non-quantifiable risks, given the inexistence of valid bases for classifying new events, implying the need to make estimates and, thus, to live with ignorance.

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[8] But such a diagnosis is not univocal, or rather, it does not result in a unit as to the preferred strategies to deal with the problem. Thus, it would be possible to identify two communities that would predominate among researchers, developers and users in the area of Artificial Intelligence: on the one hand, the one that would be more concerned with the ethical risks, currently experienced, arising from the use of such technologies (for example, the low accuracy of facial recognition systems or the biases of systems used to implement public policies) and, on the other hand, another that would be more focused on the future dangers that would arise when artificial intelligence systems became ubiquitous and responsible for decisions that affect our private relationships, our life in society and our relationship with the State.

[9] Since, in terms of complexity, they do not differ from other issues that have also challenged the law, such as nuclear energy, genetics, biotechnology and nanotechnology.

[10] KNIGHT, Frank. *Risk, Uncertainty and Profit*. Las Vegas: Pantiano Classics, 2021.

[11] MAJONE, Giandomenico. What Price Safety? The precautionary Principle and its Policy Implications. *Journal of Common Market Studies*, v. 40, 2002.

These are, to a large extent, problems that we do not yet know will exist, that we do not even know how to formulate, or in relation to which we do not yet have the vocabulary to express them.

But there is a non-trivial assumption in the concept of uncertainty, namely, that catastrophic events would be extremely rare. However, in some sets of phenomena, mainly those in which feedback loops processes are verified, the rarity is directly proportional to the impact and severity of the possible damages caused[12].

In the same way, prioritizing certain objectives of regulatory policy is relevant to understand the ongoing initiatives: on the one hand, there are regulatory proposals that defend the preservation of an environment that guarantees innovation[13], as a guideline for regulatory policy, starting from of the assumption that the development of Artificial Intelligence systems will bring, when their results are considered in aggregate form, benefits for the economy and society.

Understood as the pioneering implementation of an idea, through new processes, products or services, that bring improvements in technological, social and/or economic terms, innovation seeks to overcome a preexisting reality, giving rise to a new solution to known problems. .

Therefore, any regulatory initiatives aimed at limiting the innovation potential of Artificial Intelligence would imply, in the long term, a reduction in the net benefits to society.

On the other hand, there are proposals that argue that the design of any regulatory initiative should give preference to mechanisms aimed at guaranteeing the fundamental rights of individuals, based on the assumption that cases of bias, discriminatory treatment and abusive use of personal data tend to to occur, exponentially, from the continued use of technology.

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12 The so-called Power Law goes against the intuition that the world would consist of routine outcomes, disturbed by small random fluctuations. FARBER, Daniel. Uncertainty. *Georgetown Law Journal*, v. 99, p. 901-959, 2010.

13 The assumption is that innovation, combined with creativity and entrepreneurship, allow a given country to follow an (inexorable) path towards economic growth. RANCHORDÁS, Sofia, Does Sharing mean Caring: Regulating Innovation in the Sharing Economy, 16 Minn. J.L. Sci. & Tech. 413, 2015, p.425-426.

Therefore, any regulatory initiatives aimed at imposing controls on Artificial Intelligence would imply, in the long term, protection to society and individuals, preventing harmful effects from being potentiated (and disseminated) over time.

After presenting the main concepts, we move on to the description of the approach and methodology.

3. Approach and methodology

Artificial Intelligence[14] is an infinite game. Regulation, on the other hand, is a finite game[15].

The assumption here is that the ontological differences between such types of games have implications for the options for models and strategies that can be adopted to regulate Artificial Intelligence.

The only aspect of identity between the finite game and the infinite game is the fact that, in both, the players are free to choose to participate, or not, in the game.

Finite games have a precise beginning—with externally defined time, space, and participant limits—and are played with the purpose of winning.

Infinite games are played with the purpose of continuing to play, with no time, space or number of participants limits: the only objective is to prevent the game from ending, keeping everyone playing.

Regulation, in its decision-making process, presupposes the existence of rules related to the establishment of limits regarding the participants authorized to participate[16], as well as spatial[17] and temporal[18] criteria. And, at the end of the

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[14] The possibility that other technologies share this characteristic with Artificial Intelligence is not excluded, although such discussion is not the object of this article.

[15] The approach will largely be based on the reflections contained in CARSE, James. P. *Finite and Infinite Games*: a vision of life as play and possibility. New York: Free Press, 2012.

[16] Even the recent movement to expand this participation, usually through public hearings that allow the participation of civil society, is based on strict rules regarding the procedure and content of contributions.

[17] In this case, these are the limitations inherent to the territoriality of the regulator's action.

[18] In temporal terms, the regulatory process would end with the publication of the procedural or substantive rule.

process, regulation issues decisions that, even if they seek to compose divergent interests, tend to privilege a certain initial position and, thus, produce winners[19].

On the other hand, Artificial Intelligence — understood here as a set of techniques aimed at producing solutions that allow the machine to learn and improve its performance over time — does not face those limitations. The characteristic of technology (which, in essence, aims to change itself, improving over time, and does not recognize borders in territorial terms) and of the developer community itself (who base their work on sharing the techniques and incremental improvements) indicate that the process is not only continuous, but it is not possible to anticipate when (and if) it will reach its end.

The finite game comes to an end when someone wins, which is when the players agree on who the winner is. The internal limitations on what each player can do are established by the rules of the game, which only restrict the players' freedom, but give them a wide range of choices within those limitations. The rules of a finite game are the contractual terms by which players can agree on who has won: the rules of the game must be publicized before the game begins, and the players must agree to them. The players' agreement on the applicable rules constitutes the ultimate validation of those rules: the rules cannot change during the game and the players play within these limits.

The infinite game is defined internally, as the game rules can change during the game, to prevent it from reaching the end. Players can test the limits of the game, as the rules are designed to deal with threats to its continuity. Players use the rules to delineate the way in which they will force, within the infinite game, the limits that are being imposed on them.

Regulation, therefore, is entirely guided by rules that determine the procedures and possible courses of action, with the participants — who accepted them — fully bound by them, which gives legitimacy to the decision as to the outcome of the process.

On the other hand, Artificial Intelligence, in its continuous process of improvement, does not recognize externally established limits. The models and

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[19] Victory does not necessarily imply the existence of a zero-sum game — in which one party (the regulator, for example) has its proposal approved, to the detriment of the proposal of the other party (the regulated party, for example) — as the victory may result (i) both a compromise solution (in which the parties distance themselves from their initial position), (ii) and a negotiation regarding the regulatory model to be adopted (for example, self-regulation instead of responsive regulation).

development process presuppose the constant challenge to possible restrictions to their continuity.

Surprise is a crucial element in finite games, as surprising the opponent increases the probability of victory: in finite games, surprise is the triumph of the past over the future. The player in a finite game is trained not only to anticipate every future possibility, but to control the future, to prevent the future from altering the past. In the finite game, training prepares against surprise, because training allows you to see the past as finished and the future as being finished. Such a process leads to self-definition: training repeats a past, already completed, in the future.

Infinite game players continue to play with the expectation of being surprised: if surprise is no longer possible, the game is over. In the infinite game, surprise is the triumph of the future over the past: and as the future is always surprising, the past is always changing. In the infinite game, learning prepares for surprise, as learning discovers a growing richness in the past: it sees, there, what is unfinished. Such a process leads to continuous self-discovery: learning continues from the unfinished past into the future.

Regulation, therefore, represents a process of iterative iterations among the participants, in which previous experiences have a relevant weight in the actions carried out for decision-making purposes.

On the other hand, Artificial Intelligence assumes that the future is continuously open and, thus, the past does not necessarily work as a reference for the development of future actions, as it is constantly (re)updated in the light of the development of technology[20].

Finally, it is important to note that finite games can be played within an infinite game, but an infinite game cannot be played within a finite game[21].

Thus, what is proposed here is the ontological misalignment between the two types of games: on the one hand, Artificial Intelligence (as an infinite game) is

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20 It is not assumed here that the evolution of Artificial Intelligence necessarily points to the constant improvement of results. It is even possible that deleterious aspects prevail, in an aggregate way, in the long term. What is argued is that the development of such technology does not allow a clear end point in the process to be identified.

21 In the case of regulation, the need for decision-making — and even non-decision — represents an endgame and defines winners. Regarding Artificial Intelligence, there may be a goal (to develop General Artificial Intelligence or to achieve excellence in a specific task), but the existence of a goal does not imply the definition of the endgame.

intrinsically dynamic and challenges the limits that they try to impose on it; on the other hand, regulation (as a finite game) tries to get involved in that infinite game, but its characteristics do not allow it to transcend the temporal limits that conform it. Recognizing this reality, therefore, allows both the recognition of the possible limitations of the existing regulatory instruments — and thus, something that is not required (or expected) that is beyond those limits inherent to regulation — and the avoidance of mistakes in regulatory designs.

In this sense, the construction of an explanatory typology presents itself as adequate for the study of Artificial Intelligence regulation, mainly due to the fact that there are few official proposals and/or regulations in force[22].

The explanatory typology starts from the explanatory variables — in this case, the epistemic dimension (risk and uncertainty) and the dimension of prioritization of regulatory policy (guaranteeing fundamental rights and innovation) — to propose hypothetical results related to the regulatory strategies (types) that would prevail in certain context[23].

The comprehensive concept (regulatory strategy) would comprise four types — precaution, flexibility, anticipation and rigidity[24] — resulting from the intersection between the explanatory variables, which would shape the profile of the regulation perhaps applied in each context.

It is therefore intended that the proposed types are not only mutually exclusive (in other words, there are no intersections between them), but also collectively exhaustive (ie, they cover all possible alternatives[25]).

That said, we move on to the description of the typology, dimensions and types proposed.

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22 In other words, a descriptive typology would not find enough observation units to allow its operationalization.

23 COLLIER, David; LAPORTE, Jody; SEAWRIGHT, Jason. Typologies: Forming Concepts and Creating Categorical Variables. In BOX-STEFFENSMEIER, J.M.; BRADY, H.E.; COLLIER, D. (eds.). The Oxford *Handbook of Political Methodology*. Oxford: Oxford University Press, 2008, p.153-156.

24 These are nominal types, that is, there is no hierarchy between the proposed types. Since empirical research on regulatory initiatives has not yet been carried out, it cannot be said that the proposed types will survive the comparison with observation units: there is, therefore, the possibility that they can be reduced to a conceptual pair with an underlying continuum (for example, rigidity versus flexibility).

25 GOERTZ, Gary. *Social Science Concepts and Measurement*. Princeton: Princeton University Press, 2020, p.215-243.

4. Typology

Regulatory initiatives, encompassing their institutions, the characteristics of the regulatory policy and the form of implementation and enforcement, seek to modify certain behaviors and, thus, obtain certain results[26].

With regard to the regulation of decision-making automation systems based on Artificial Intelligence, (i) the form of epistemic framing of the phenomenon and the prioritization of certain results of the regulatory policy (ii) influence the way in which the development will take place and the implementation of Artificial Intelligence algorithms and, thus, (iii) shape the results they can provide for the economy and society.

However, the misalignment between, on the one hand, Artificial Intelligence[27], which is intrinsically dynamic and defies the limits that they try to impose on it, and, on the other hand, regulation[28], whose characteristics make it difficult to transcend the temporal limits that conform it, imposes the need to identify elements that make it possible to carry out the consequent analysis of the phenomenon.

And admitting such a reality, therefore, allows for the recognition of possible limitations of existing regulatory instruments and, thus, something that is not required (or expected) that is beyond those limits inherent to regulation and, in the same way, that mistakes are avoided in regulatory designs.

The explanatory typology starts from the explanatory variables — in this case, the epistemic dimension (risk and uncertainty) and the dimension of prioritization of regulatory policy (guaranteeing fundamental rights and

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[26] OECD. *Measuring Regulatory Performance: Evaluating the Impact of Regulation and Regulatory Policy.* (ed. Cary Coglianese). Expert Paper No. 1, aug., 2012.

[27] Artificial Intelligence, understood as a set of techniques that aim to produce solutions that allow the machine to learn and improve its performance over time, does not face temporal limitations, since the characteristic of the technology (which, in essence, aims to change itself, improving over time, and does not recognize borders in territorial terms) indicates that the process is not only continuous, but it is not possible to anticipate when (and if) it will reach its end. In its continuous process of improvement, it does not recognize externally established limits: the models and development process presuppose the constant challenge to possible restrictions to their continuity.

[28] Regulation, in its decision-making process, presupposes the existence of rules related to the establishment of limits regarding the participants authorized to participate, as well as spatial and temporal criteria. Regulation, therefore, is entirely guided by rules that determine the procedures and possible courses of action, with the participants, who accepted them, being entirely bound by them, which gives legitimacy to the decision regarding the outcome of the process.

innovation) — to propose hypothetical results related to the regulatory strategies (types) that would prevail in certain context[29].

The comprehensive concept (regulatory strategy) would comprise four types (precaution, flexibility, anticipation and rigidity), resulting from the intersection between the explanatory variables, which would shape the profile of the regulation perhaps applied in each context[30].

It is therefore intended that the proposed types are not only mutually exclusive (in other words, there are no intersections between them), but also collectively exhaustive (ie, they cover all possible alternatives)[31].

The proposed typology, presented in Figure 1, starts from the epistemic dimension (risk and uncertainty) and from the dimension of prioritization of regulatory policy (guaranteeing fundamental rights and innovation) to suggest the type of regulatory strategy aimed at regulating Artificial Intelligence systems that will prevail in a given context. Preliminarily, however, it is necessary to justify the choice of these dimensions, as well as the underlying variables.

The relevance of the prioritization dimension for understanding the phenomenon of regulation of Artificial Intelligence initiatives for decision-making automation derives from the fact that it conforms an element related to the ultimate ends of a given regulatory policy.

In other words, it is assumed that a given regulation seeks to define, a priori, a list of objectives that it intends to achieve from the establishment of principles and norms that aim to guide the performance of agents in a given market.

Thus, in the proposed typology, the regulatory objectives are shaped in the aforementioned dimension, allowing, from their identification, it is possible to operationalize the purposes of the regulatory policy[32].

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29 COLLIER, David; LAPORTE, Jody; SEAWRIGHT, Jason. Typologies: Forming Concepts and Creating Categorical Variables. In BOX-STEFFENSMEIER, J.M.; BRADY, H.E.; COLLIER, D. (eds.). The Oxford *Handbook of Political Methodology*. Oxford: Oxford University Press, 2008, p.153-156.

30 Despite the fact that we did not adopt an explanatory typology, given the limitation of existing observation units, this does not imply the impossibility of carrying out comparative analyzes between the cases.

31 GOERTZ, Gary. *Social Science Concepts and Measurement*. Princeton: Princeton University Press, 2020, p.215-243.

32 For the operationalization of the concepts, it will be necessary to define the second order dimensions of the respective indicators.

The relevance of the epistemic dimension comes from the fact that it makes it possible to understand how regulators assess the possible consequences of implementing Artificial Intelligence initiatives to automate decision making.

Therefore, the way in which regulators frame the phenomenon allows us to assess the extent to which they understand the scope and depth of the potential consequences of the use of new technology for society and the economy.

Thus, in the proposed typology, the consequences of the use of technology are shaped in that dimension, allowing, from their identification, it is possible to operationalize the assumptions of the regulatory policy.

Regarding the prioritization dimension, two variables were chosen, namely, guarantee of fundamental rights and innovation. It is important to point out that, as objectives of a regulatory policy, both are not necessarily antagonistic. However, it is argued that it would be possible to assess which of the objectives is prevalent in a given regulatory initiative.

The assumption, in this sense, is that the guarantee of fundamental rights, as a priority, implies the imposition of more severe restrictions on the development of new technology and, in the opposite direction, prioritizing innovation would result in greater freedom to expand its use and its dissemination.

Regarding the epistemic dimension, we chose to work with risk and uncertainty variables. As ways of framing the regulatory problem, both would make it possible to assess how the consequences of using the new technology are understood by the regulator.

The assumption, in this case, would be that regulatory approaches based on risk value the present (as a source of elements that allow calculating the probability of future events), while those based on uncertainty privilege the future (to prevent the occurrence of catastrophic events).

The intersection between the two dimensions and their respective variables will give rise to the explanatory typology of regulatory strategies for Artificial Intelligence, as shown below:

Figure1 - Typology of regulatory strategies

		Epistemic dimension	
		Risk	**Uncertainty**
Prioritization dimension	**Guarantee of fundamental rights**	Rigidity	Precaution
	Innovation	Anticipation	Flexibility

The typology, therefore, seeks to establish a list of regulatory strategies for Artificial Intelligence (types) that would be expected in each context, vis-à-vis the prevailing regulatory objectives (prioritization dimension) and the way in which actors frame the possible consequences. of the use of new technology (epistemic dimension).

The four proposed types (precaution, flexibility, anticipation and rigidity) would represent different regulatory strategies and, consequently, would shape the way in which a particular Artificial Intelligence regulatory initiative would understand the relationship between the development of technology, the consequences of its widespread use for society and the economics, regulatory objectives and instruments available to the regulator.

The four types derived from the proposed typology are presented and described below:

a) Type 1 - Precaution: guarantee of fundamental rights & uncertainty

If a given regulatory proposal prioritizes the guarantee of fundamental rights and interprets the development and implementation of Artificial Intelligence from the perspective of uncertainty, the regulatory policy will be based on precaution.

The search for the protection of fundamental rights will start from the understanding that the deleterious effects of the use of Artificial Intelligence systems for decision-making automation, both in the private and public sectors, are not subject to prior probability calculation and, therefore, that it would not be possible to deal with new problems from past experience.

In this sense, the adage "better safe than sorry"[33] would be valid, applying precaution in the context of uncertainty, since the public power would not need, in order to take preventive measures, that any adverse effects materialize in order to legitimize its action[34].

It is important to point out that precaution is not understood here as an equivalent of inaction or as a synonym for prohibition. Precaution can be implemented in a way that both avoids the deleterious effects of the worst-case scenario and guards against losing the possible benefits of the best-case scenario[35]: in other words, it seeks to balance our hopes (for the best) and our fears (worst) around the widespread use of Artificial Intelligence.

In this way, precaution would form a balance between optimistic scenarios ("what is the best result that is plausible enough to be considered?") and pessimistic scenarios ("what is the worst result that is worth considering?"), having as a goal the context of decision making and the objectives of regulation ("how optimistic or pessimistic should the decision maker be when balancing such possibilities?").

Thus, the precaution, in the design above, would allow, based on the transparency regarding the criteria used in the balancing, not only the accomplishment of supervision, but also of eventual revision regarding the proposed regulatory instruments.

b) Type 2 - Flexibility: innovation & uncertainty

If a given regulatory proposal prioritizes innovation and interprets the development and implementation of Artificial Intelligence from the perspective of uncertainty, the regulatory policy will be based on flexibility.

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33 LÖFSTEDT, Ragnar E. The swing of the regulatory pendulum in Europe: from precautionary principle to (regulatory) impact analysis. Journal of Risk and Uncertainty, v. 28, n. 3, p. 237-260, 2004.

34 The following general principles in the application of precaution are highlighted, based on the experience of the European Union: (i) proportionality (measures must enable the achievement of adequate levels of protection), (ii) non-discrimination (equal situations must not be treated differently), (iii) consistency, (iv) cost-benefit examination (comparison between the most likely positive and negative consequences, as well as with inaction), (v) examination of scientific developments, and (vi) reversal of the burden of proof.

35 FARBER, Daniel. Uncertainty. *Georgetown Law Journal*, v. 99, p. 901-959, 2010.

When what is wanted (and what is not wanted) is difficult to determine directly and completely, we are faced with a situation of ignorance and, therefore, regulatory instruments need to deal with environments of uncertainty[36].

Here, one must be prepared to, from a prospective perspective, handle regulatory instruments that are future-proof[37], that is, that are simultaneously sustainable, resilient and that adapt to the complex changes inherent to the development of Artificial Intelligence systems.

In other words, to ensure an environment conducive to innovation, regulation must provide regulatory instruments that are capable of (i) meeting the requirements of the present, without neglecting the demands that will arise in the future, (ii) suffering shocks, arising from the inherent changes to the development of Artificial Intelligence, without losing its intrinsic characteristics and (iii) facing contextual changes without losing the ability to provide answers to regulatory problems.

However, as concerns about the long-term impacts of the use of Artificial Intelligence systems presuppose the recognition of the impossibility of calculating the probability of occurrence of future events, as they involve unknown risks, a regulatory strategy based on flexibility must be able to provide instruments appropriate to the dynamics of technology development.

In this way, flexibility is not to be confused with precaution (since it does not seek to establish previous scenarios about the development of technology and its consequences for society and the economy), nor with anticipation (since it does not seek to identify the probability of occurrence of future events that impede the development of technology), but it consists of a regulatory strategy that seeks to establish parameters that allow the constant adaptability of rules to changing contexts.

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[36] In this case, ignorance prevails regarding problems that we don't even know will exist, that we still don't know how to formulate or for which we may not even have the vocabulary to express.

[37] REHMAN, O.U., RYAN, M.J., EFATMANESHNIK, M. *Future Proofing Process*. INCOSE International Symposium, 27 (1), p.921-934, 2017.

c) Type 3 - Anticipation: innovation & risk

If a given regulatory proposal prioritizes innovation and interprets the development and implementation of Artificial Intelligence from the perspective of risk, the regulatory policy will be based on anticipation.

Here, from the estimation of risks based on previous experience, regulators will seek to identify possible obstacles to the development of technology and, thus, will develop regulatory instruments that allow innovation to flourish.

Anticipating the occurrence of potential limitations to the development of technology contains an aspect of bet, even if justified, as it seeks to estimate the probability of the emergence of eventual restrictions and, thus, propose regulatory solutions that enable their confrontation.

In this way, it is not confused with precaution, as it does not consider scenarios, but seeks to be based on past experience regarding the problems faced by technological innovations and the solutions already tested.

In the same way, it does not have a flexible nature, as the definition of regulatory instruments is done in order to anticipate problems that have already been faced. In other words, it is about transposing tested solutions (in the past) to problems that are likely to occur (in the future).

Thus, anticipation consists of a strategy that aims to preserve an environment conducive to the development of technology, extrapolating previously tested solutions to future situations that may hinder innovation.

d) Type 4 - Rigidity: guarantee of fundamental rights & risk

If a given regulatory proposal prioritizes the guarantee of fundamental rights and interprets the development and implementation of Artificial Intelligence from the perspective of risk, the regulatory policy will be based on rigidity.

The strategy here assumes that the world is composed of elements that, under certain conditions, will always behave in a certain way, which, in the limit, would always make it possible to calculate the probability of the occurrence of certain phenomena, such as the deleterious effects of technology with society and individuals[38].

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[38] In other words, they will be able to manage risk-based tools, forging regulatory instruments capable of preventing the same mistakes from being repeated in the future. Regulatory governance, therefore, will analyze the present through a retrospective look, in which uncertainty finds no shelter.

In this way, regulatory instruments will disregard the dynamic characteristic inherent to Artificial Intelligence systems, crystallizing past solutions as subject to application in future situations.

Such a strategy is based on the assumption that the rigidity of the rules would not only solve future problems, but would also reduce the probability of institutional changes that would alter the priority (guaranteeing fundamental rights) established by decision-makers[39].

Since the regulatory response aims to prevent eventual developments in technology from violating fundamental rights (and given the impossibility of predicting how that evolution will take place, in terms of consequences and impacts on those rights), the strategy would move towards vetoing, in advance, , any uses that potentially affect a defined set of rights[40].

In this sense, the rigidity of the strategy derives from the option for a peremptory response that aims at the a priori establishment of a certain set of rights that could not be affected by Artificial Intelligence.

Here, the calculation of the probability of the occurrence of new events, based on problematic situations that have already been verified, conforms to an extrapolation from the past towards the future: the answers already tested become the preferred solution for new regulatory problems. Rigidity, therefore, prevents old problems from resurfacing, but it can also impede new developments in technology.

4. Conclusion

The emergence of new technologies presents itself as a challenge for regulatory initiatives that seek to deal with the effects of the implementation of those innovations.

In this article, a specific approach was proposed for the studied phenomena (Artificial Intelligence as an infinite game, regulation as a finite game), in order to enable the identification of their ontological differences — mainly regarding the way in which both phenomena deal with the time and change — and, based on the

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[39] *Vide* SPILLER, Pablo T., TOMMASI, Mariano. *The institutional foundations of public policy in Argentina*. Cambridge: Cambridge University Press, 2007, p.28-47.

[40] Thus, the regulatory initiatives are designed to allow the prediction of their deleterious impacts and enable the timely correction of such impacts.

framework adopted, a typology of regulatory strategies related to the regulation of Artificial Intelligence was developed.

A typology of regulatory strategies related to the regulation of Artificial Intelligence was proposed: starting from explanatory variables — the epistemic dimension (risk and uncertainty) and the dimension of prioritization of regulatory policy (guaranteeing fundamental rights and innovation) — four types of hypothetical regulatory strategies were elaborated (precaution, flexibility, anticipation and rigidity) that would shape the profile of the regulation perhaps applied in each context.

However, it should be noted that this article represents a first step in a broader research project. It is therefore expected that this first approximation will be minimally consistent and be in the right (at least methodologically) direction[41].

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[41] In this way, it is possible to advance some future methodological developments that, from here, it is intended to develop: (a) identify and collect the regulatory initiatives that may exist (whether those still in the design phase or those already approved), the transcripts of debates occurred during the legislative process and/or public hearings held and the official reference documents; (b) advance in the definition of the second level dimensions and respective indicators, in order to make it possible to assess the validity of the inference to be made: in other words, if from the analysis of the observations (regulatory initiatives) it is possible to identify the generalizable characteristics of the phenomenon under study; (c) select evidence; (d) identify biases related to the spatial aspect (given the diverse institutional realities in which regulatory initiatives for Artificial Intelligence are verified); and (e) since observations may include regulatory initiatives for new technologies (wider category) and inferences are made in relation to more specific technology (such as Artificial Intelligence), build strategies to avoid problems in comparison.

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