RIVISTA ITALIANA DI INFORMATICA E DIRITTO
PERIODICO INTERNAZIONALE DEL CNR-IGSG

ISSN 2704-7318 • n. 1/2025 • DOI 10.32091/RIID0205 • articolo sottoposto a peer review • pubblicato in anteprima il 10 apr. 2025

Fabrizio Corona – Moreno Ferrarese

The future without a Judge

Is it possible to replace the judge's decision with an algorithm? This paper explores the computational evidence regarding the use of Opinion Mining Sentiment Analysis and lexical spinners by computational machines, highlighting the challenges associated with the use of algorithms in a quali-quantitative predictive context. The research focuses on the implementation of an advanced algorithm designed to replace the judge in the judicial activity by adopting an approach that integrates the intensity variables of cognitive stimuli into the parametric analysis through a combination of qualitative and quantitative methods, thus minimising the errors associated with the quantitative-predictive method in isolation. Such an approach allows for the accurate replication of the judge's writing style and decisions, guaranteeing an accurate and unbiased interpretation of legal facts.

Nuncupative language – Entropy and syntropy of language – Algorithm – Lexical machines – AI approach

Il Futuro senza giudice

È possibile sostituire la decisione del Giudice con un algoritmo? Questo articolo esplora l'evidenza computazionale riguardante l'impiego dell'Opinion Mining Sentiment Analysis e degli spinner lessicali da parte di macchine computazionali, evidenziando le sfide associate all'uso di algoritmi in un contesto predittivo quali-quantitativo. La ricerca si concentra sull'implementazione di un algoritmo avanzato, progettato per sostituire il giudice nell'attività giudiziaria adottando un approccio che integra le variabili di intensità degli stimoli cognitivi nell'analisi parametrica attraverso una combinazione di metodi qualitativi e quantitativi minimizzando, così, gli errori legati al solo metodo quantitativo-predittivo. Tale approccio, permette di replicare accuratamente lo stile di scrittura del giudice e le sue decisioni, garantendo un'interpretazione precisa e imparziale dei fatti giuridici.

Linguaggio nuncupativo – Entropia e sintropia del linguaggio – Algoritmo – Macchine lessicali Artificial Intelligence

Fabrizio Corona is post-doc researcher at University of Brescia, adjunct professor in Legal informatics at LUISS Guido Carli and adjunct professor in Legal informatics at Giustino Fortunato University

Moreno Ferrarese is teaching fellow at the Department of Sociology and social research at University of Trento

M. Ferrarese wrote paragraphs 1, 3, 4, 5, 6. F. Corona wrote paragraphs 2, 7, 8, 9. Paragraph 10 results from common considerations

Summary: 1. Strengths and weaknesses of the *inanimate judge*. – 2. The *Noetics* of the judge. – 3. The *legal constraints* for a non-human judge. – 4. Communication *Meta-referents for a Robotic Judgement*. – 5. *Algorithms* for a Robotic Justice. – 6. *Keywords* as headwords for robotic judgments – 7. The *acceptance* of judgments. – 8. The physiological limits of the human judge. – 9. Will there ever be a *just judge*? – 10. Concluding reflections.

"A robot may not injure a human being or, through inaction,
allow a human being to come to harm.
A robot must obey any orders given to it by human beings,
except where such orders would conflict with the First Law.
A robot must protect its own existence as long as such protection
does not conflict with the First or Second Law".

Isaac Asimov, *Handbook of Robotics*, 56th Edition 2058 A.D.

1. Strengths and weaknesses of the *inanimate judge*

The dialectical structure of the proceedings requires that the interested parties addressees of the effects of the *petitum* always participate in the preparatory phase of the measure, and that, in the procedural phase of the trial, powers, faculties and duties relating to the distributive exercise of the rule between the participants in the procedural action are represented, in order to implement an effective correspondence and equivalence between the positions represented.

Therefore, the dialectical development of the Italian trial, as conceived by the codes, coincides with a symmetrical structure of the subjective positions, their mutuality and substantial parity that translates, for each of the participants, into the right to exercise a set of controls, relations and choices and the duty to undergo the controls and relations of others during the procedural eloquence, whether cartular with the new Cartabia trial, or oral with the traditional rite.

For such an extensive formulation of the search for balance, Pierre Bourdieu[1] explained that institutions, as such, tend to develop collective and organised defence mechanisms, which are the result of many individual, independent, yet structurally connected actions that contribute to their own self-preservation.

Cassese defines the shape of the judicial institution as "… a judicial body composed of people who are on average well prepared, but closed in on itself, corporative, which cannot find in its experience the ideas to correct itself and which seems incapable of maturing proposals for better systems and of dialogue with culture, the professions, the political world…"[2].

The autonomy of the judiciary, which constitutes a cornerstone of the rule of law and democracy, has given rise to a series of self-referential mechanisms, feeding an ever-increasing number of privileged conditions, if not constituting lobby. The judiciary in our country has increasingly expanded its sphere of influence, often engaging in

1. Bourdieu 2005, p. 101.
2. Cassese 2022, p. 88.

innovative interpretations of the principle of taxativity of criminal cases. This is due to the belief that the judiciary has been entrusted with a social mandate to oversee ethical conduct. The aforementioned point has been corroborated by Beria di Argentine, who notes that historical circumstances have reinforced this belief at times. We could argue that sometimes the court system can be flawed, leading to the perception that justice is not always served. There may be a variety of factors at play, such as bias, prejudice, and unfair expectations, that can create an atmosphere that is disconnected from true justice. Yet, the institution of free conviction has been used precisely to achieve the opposite effect.

The need to identify "instruments for assessing the professional aptitude of the magistrate" was ruled out because it would have violated the principle of free conviction and, therefore, the autonomy and independence of the judiciary. Free conviction "ended up turning into a grossly potestative principle capable of legitimising the arbitrariness of judges".

The overall picture it gives us of the situation of criminal guarantorism in Italy is certainly not edifying. And in the thirty years that have elapsed since these reflections, judicial decisionism has expanded as a result of increasingly vague facts and interpretative processes that, particularly in the criminal sphere, resort to a nonchalant use of extensive interpretation, continually eluding the prohibition of the taxativity of criminal cases.

The law, as we know, is not scientific for the sake of science: being scientific as a means to an end, it must be judged by the results it achieves, not by the subtleties of its internal structure; it must be assessed by the extent to which it achieves its end not by the beauty of its logical processes or the rigour with which it displays its rules[3]. But as the margins of interpretative autonomy have increased, so has the expansion of judicial power interpenetrated with the constant need to define a deontological framework through which to guarantee that affirmation and protection of rights that is entrusted to the judiciary.

Thus, instead of providing a series of principles, we offer a description of certain sensitivities. These include objectivity, comprehension, logical structure, conventional structure, clear and objective language, appropriate formatting, a formal register, clear structure, balance, precise word choice and grammatical correctness. The recognition of the dreadful and repugnant nature of judicial power; the acknowledgement of the relative and uncertain nature of procedural truth and, as a result, the existence of an inevitable margin of illegitimacy in the execution of jurisdiction; the significance of doubt and the realisation of the constant possibility of factual errors; the readiness to consider opposing opinions and the dispassionate search for truth. The principles of equity and singular case assessment must be upheld, while respecting all parties. The ability to instil confidence in all parties, including defendants, is crucial. Magistrates must maintain confidentiality in their trials and avoid any political influence or accusations thereof[4].

The Italian judiciary has undergone a series of deformations over time. Issues within the judiciary system encompass the politicisation of the courts, a narrow view of their duties, slow trial proceedings, misuse of pre-trial detainment, as well as telephone and environmental surveillance, the influence of particular magistrates, consistent breaches of investigative secrecy, and an overtly powerful public prosecutor's office that is exacerbated by the obedience of the overseeing judge.

In the context of the relationship between democratic balances and the autonomy of judges, the interplay between virtue and politics exposes the inadequacy of an unaccompanied professionalism devoid of moral sensitivity and/or social responsibility guided by free will. This represents an additional vulnerability for human judges, despite the need to disregard convictions, states of mind, and passions that may adversely affect decisions in order to uphold legal ethics. Article 54 of the Constitution states that "citizens entrusted with public functions have a duty to perform them with discipline and honour".

There is no public function more delicate than the exercise of justice. If we were to interpret Article 54 of the Constitution correctly in light of this assumption, we would have to conclude that it is not virtue that justifies function, but function

3. Pound 1908, p. 605.

4. Ferrajoli 2013; Nordio 2022, p. 98.

that produces virtue. Paradoxically, our legal culture has not addressed the question of whether the guardians of virtue' should themselves be virtuous or, at least, what qualities they must possess in order to be entrusted with such a delicate task.

According to Article 37(1)(b) of the Code of Criminal Procedure, the judge is only objectionable if he has conditioned the trial with specific acts that are the result of an undue manifestation of his ideas, but it is irrelevant if, in the course of the proceedings, he has shown prejudice, emotion, irritation or intolerance[5].

The judge should be all the freer in his decision-making processes the more responsible he is to the institution he represents and to society. Independence is not an end in itself but is meant to increase the protection of fundamental rights. The Recommendation No. 12 of 17 November 2010 of the Committee of Ministers of the Council of Europe "On Judges: Independence, Effectiveness, Accountability" seems to fully entrust the Superior Council of the Judiciary with the custody of constitutional balances.

The Recommendation does not discuss the judges' quality, except for a clear reference to merit as a means of selecting and evaluating careers. It emphasizes that the external independence of judges is not a personal prerogative or privilege but is essential for the rule of law and for everyone who seeks and expects impartial justice.

The independence of judges must, therefore, be seen as a guarantee of freedom, respect for human rights and the impartial application of the law. Supplanting the inefficiency of the legislature in the face of rapid economic, social, and technological changes, however, ends up by eliding the horizons of legal certainty and the principle of equality.

The absence of both external and internal boundaries detracts from the fundamental tenets of the judiciary, leading to a potential loss of independence. This risk can manifest in a multitude of ways, such as self-governance, pure and simple exercise of power, or the privilege of power. Thus, there is a reversal of assumption from having greater political autonomy to protect citizens to making a claim of autonomy over society.

This is done regardless of the very citizens that were supposed to be safeguarded, if not in opposition to them. In particular, it seems that our culture shows a lack of systematic reflection on the role and identity of the judge and the professional dimension of judging. Two simple questions always arise in the ethics of judging: "who is a good judge?", "is judging a profession?", questions that could help us to assess to what extent the current judicial set-up may not receive an effective critical stimulus from the emergence of digital justice itself, avoiding most of these declining mechanisms.

The growth of social expectations in the protection of fundamental rights, the rapid technological changes, the slowness and inefficiency of legislative systems, the trans-nationalisation of legal flows, the overbearingness of organised crime, the increase in wealth with the growth of speculative mechanisms and the tendency to corruption, and the intrusiveness of the market, have placed a burden and responsibility on the judiciary that is unprecedented in history.

The increase in the power to intervene in social spheres imposed from outside has been matched, to a greater or lesser extent in the various countries, by a centralisation of power within and a progressive isolation whereby the exercise of justice now appears to be the prerogative of a *small and highly specialised intelligentsia*[6].

If we are to set aside the ideal of the good judge, in order to rely on the mystique of the contest and the technical skills of a bureaucrat, there is less and less reason to reject the mathematical rigour of an algorithm. The impetus provided by the digital alternative could lead to an overall rethinking of the situation before us, imposing a radical reflection on how far the ideal of an exercise of justice guaranteed by human wisdom is increasingly out of touch with reality.

The algorithms of digital justice record and do not "listen"; they are adept at syntactic reconciliations, but indifferent to semantic subtleties; they are unable to empathise with the human condition; they are affected *by* the biases of unknown programmers; they are not transparent, because the technology at our disposal often does not allow

5. Lanza 2011, p. 367. De Tocqueville already posed the problem: "Should the jury, which represents society, have more power than the very society whose laws it enforces?" (de Tocqueville 1840/1968, p. 297).

6. Van Caenegem 1991, p. 137.

us to understand how certain effects are produced (*black box effects*). As Luhmann teaches, social systems also produce *black box effects*: "they develop forms of access to complexity that are not accessible to the analysis of scientific simulations"[7].

We should, first of all, put aside the man/machine dualism to make a comparison between the shortcomings of a corporation, because the difficulty in stemming the growth of corporate tendencies in the judiciary is undeniable, and the limits of a digital system. If that of the judges were increasingly "their" justice, it might be useful to ask ourselves to what extent it would be possible to correct this distortion by starting to rely on an alternative system in the hypothesis that it would be able to recover the essential function of settling disputes in a swift and certain manner, without fuelling the privileges, ambitions and arrogance of power that are characteristic of human organisations.

Faced with the obvious limitations of computerised automatisms, we run the risk of ignoring the equally obvious limitations of our institutions, constructing an abstract image of human capabilities. All the most pressing expectations and the most intense aspirations placed in the anxiety for justice have poured into the figure of the judge, rejecting the idea that he is a bureaucrat among others. These are unintended consequences resulting from the fallibility of human nature: the politicisation of the judiciary, an excessively limited approach towards performing one's obligations, the sluggish pace of trials, aberrant use of procedural tools (such as pre-trial detention and telephone and environmental interceptions), the desire for visibility (ranging from a wish for self-promotion to the continued infringement of investigation confidentiality), and the excessive power of the public prosecutor's office.

The digital judge will always be far from the "good judge", if we idealistically think that the sentence is the nexus "by which the order is welded to life and realised as life". Experience, however, confronts us with a very different reality in which the flaws, rather than the merits, of human actions often emerge. Bureaucratic repetitiveness fosters indifference and irresponsibility fuels self-reference. Moreover, the current set-up of our judiciary does not seem to seek virtue or even presuppose it. This is why we must not reject the hypothesis of a justice entrusted, at least in part, to algorithms.

We must free ourselves from the "anthropocentric" prejudice whereby we imagine a world of machines that act and think like us. These are artificial entities absolutely different from our nervous system and yet preordained to participate in "affective" dynamics with human beings on the basis of extremely complex data reconnection models to which ethical codes will have to be incorporated and refined over time.

The co-evolution of humans and actual social robots will necessarily include a dimension of ethical invention, innovation and "discovery": since law is not "olympic philology", we can expect from a computer an extraordinary capacity for data reconnection, but it is difficult to assume that it would know how to go beyond this technical accuracy. We would have "a deciding without judging", an *agere sine intelligere*. Is this a risk or an opportunity? We can approach this problem from two perspectives, either by claiming the specificity of human sensitivity and creativity as opposed to the aseptic automatisms of a delegation to machines, or by analysing the way in which, today, the judicial apparatus as a whole responds to the fundamental needs of society and protects fundamental rights.

That is to say, we can make an individual assessment of human capabilities or a "system" assessment, comparing the merits and shortcomings of the activities that we attribute to the entity "judiciary", as a complex and self-referential organism, with the possible positive or negative aspects of a combination of algorithms.

For our purposes, we can define AI as the technology that enables a computer to analyse large amounts of data and, on the basis of the knowledge and experience gained, adopt intelligent behaviour or propose decisions. In other words, it is a technology that enables a machine to perform functions traditionally only recognised as human capability[8].

7. Luhmann 1990, p. 81.

8. Boden 2018, according to whom AI is the technology that seeks to "make computers do the sorts of things that [human] minds can do". Cf. also Goodfellow–Bengio–Courville 2016, p. 9.

Among the many technologies that may fall under this broad definition, those based on self-learning systems or "machine learning" are particularly relevant[9]. Every computer operates on the basis of algorithms, i.e., mathematical instructions (or codes) that are used to solve problems, answer questions or perform certain functions. In contrast to traditional computers, which operate on the basis of algorithms or codes established by the programmer, and which can only be modified by the programmer himself, the new "machine learning" systems continuously and automatically derive algorithms that will then be used in their own operation through statistical analyses of large quantities of data. The main feature of the new AI systems, therefore, is that they operate autonomously. The new "robotic" systems, it has been observed, could help to satisfy that need for "calculability of law", pointed out by Max Weber and taken up by those who consider it indispensable to guarantee the citizen's trust in legal certainty[10].

The replacement of judges by automated predictive justice tools, however, raises numerous questions, on which a wide-ranging debate is open[11]. However, there is a widespread need for tools to make the outcome of legal disputes more predictable. Notwithstanding the widespread awareness of the impossibility of entrusting to a machine evaluations that the law entrusts to the judge's prudent appreciation, there remains a need to provide citizens with greater transparency on the possible duration and probable outcome of certain disputes, also in order to limit unnecessary recourse to justice. The so-called "robot judge", in fact, is not equipped with conscience, i.e., with metaphysical awareness of the before, the after, from existence in life as an epiphenomenon, and without a neurochemical pattern of feelings that are fundamental to "feeling" the human soul and capturing its weaknesses.

Some initiatives have been taken in other Courts of Appeal, on whose website links are posted, usable by all, to thematic pages aimed at providing indications on consolidated case law regarding frequently recurring issues[12]. On a technical level, the idea that AI can help eliminate or diminish errors or prejudices that can influence the outcome of the decision-making process has long been effectively challenged. According to some studies, the errors, and biases inherent in human thinking can be reproduced and even exacerbated by AI techniques, as confirmed by the COMPAS affair. In fact, the proper functioning of the system can be affected by learning problems, i.e., by the so-called training data. If this data has not been collected correctly or contains errors, the reliabili-

9. Shalev-Shwartz–Ben-David 2014, pp. 34-45.

10. Irti 2019, p. 17 ss. On "legal calculability" and the relevance that jurisprudential precedents may hold IA purposes of "legal calculability" see the contributions collected in Carleo 2017 and Carleo 2018.

11. Casonato 2019, p.101 ff., as well as the numerous contributions collected in Gabrielli–Ruffolo 2019, p. 1657 ff.; see also Celotto 2019; Fasan 2019; Quatrocolo 2019; Solum 2019; Simoncini 2019; D'Aloia 2019. On the evolution of AI systems see Kaplan 2018, p. 14 ff.; Bernstein 1990, p. 19 ff.; Fasan 2019, p. 102 ff. On the need for a specific regulation for robotics and artificial intelligence and the establishment of an independent body for robotics (as hypothesised in the Recommendations concerning civil law rules on robotics, adopted by the European Parliament at its sitting of 27 February 2017) see Stradella 2019, p. 73 ff. On this topic, see also Garapon–Lassègue 2018; Nieva-Fenoll 2019 and there in extensive and updated bibliography on the topic. On this topic see also Dalfino 2019.

12. Project "Predictability of decisions", approved by decree of 5 October 2016 of the President of the Third Civil Section of the Court of Appeal of Bari. The decree entrusted the preparation of the case studies and the drafting of the sheets to the section's trainees and postgraduates, under the supervision of the entrusted councillors or another councillor designated by the President of the section; it reserved the assignment of the topics to the trainees and postgraduates to the President of the section; it established that the work "will be coordinated by the President of the section and the sheets will be approved by the section councillors during the meetings pursuant to Art. 47 quater Ord. Giud, in which the following may be invited to participate: magistrates, including honorary ones, from other sections; magistrates, including honorary ones, from other offices and other levels of judgement; experts in particular sectors being dealt with (road accidents, forensic medicine, engineering, agriculture, etc.); representatives of the Bar or University lecturers".

ty of the results subsequently offered by the system is inevitably compromised[13]. A second factor that may affect the reliability of the results offered by the software may be due to "statistical discrimination", i.e., the existence of influences determined by previously performed statistical surveys.

Discrimination based on statistical surveys is commonplace, even in the absence of AI systems. This is often due to decision-makers substituting missing information with other available data in order to reach a conclusion on a particular issue. However, the Council of State[14] has expressed the most significant praise by overturning the trial judge's approach and highlighting the undisputed benefits of efficiency and cost-effectiveness in administrative action resulting from the automation of the administration's decision-making process through algorithms that are computer-enabled to assess and grade numerous questions.

Systems of this nature enable the administration to accomplish its goals while utilizing minimal resources and streamlining and accelerating the procedural process, in accordance with the constitutional principle of efficient administrative action (Article 97 of the Constitution) and the obligation to guarantee conformity with the principles of administrative procedure (such as transparency, publicity, reasonableness, and proportionality).

It is necessary for the administration to undertake ex ante activities of mediation and interest composition for acts requiring administrative discretion. This includes consistent testing, updating, and improving the algorithm, especially in situations involving progressive and deep learning. In this regard, it is crucial to confirm the algorithm's knowability across all aspects, from its authors and elaboration process to the decision mechanism, its priorities during evaluation and decision-making, and the selection of relevant data[15]. A direct corollary concerns the reviewability of the algorithm by the administrative judge, in order to be able to assess the correctness of the computer process and the logicality and reasonableness of the "rule" that governs the algorithm[16].

Once the possibility of assessing the reliability of an AI system has been acknowledged, what legal obstacles could hinder its application in the judicial sector? The "predictive" software has been extensively under scrutiny and advancement, aiming to establish the likelihood of success or failure of a particular case presented to a judge. To eliminate the prospect of solely implementing robotic judges, it has been noted that, currently, it is impractical to link the vast range of legal facts that require consideration by algorithmic computing's abstract schemes.

The judge, in resolving disputes, does not limit himself to a simple syllogism, but is called upon to make a series of evaluations that often require complex choices that cannot be predetermined a priori. Moreover, it does not appear to be possible, with today's algorithms designed on the quantitative analysis of cases on *big data*, to replace with an algorithm the judicial motivation of the decision,

13. On a technical level, the idea that AI can help eliminate or diminish errors or biases that can influence the outcome of the decision-making process has long been effectively challenged. According to some studies, in fact, the errors and prejudices inherent in human thinking can be reproduced and even increased by AI techniques, as was confirmed by the case of the COMPAS system, an AI programme designed by a private company to calculate people's risk of reoffending and social dangerousness.
14. Section VI, Judgment No. 2270 of 8 April 2019. The principle according to which "the use of computerised procedures cannot be a reason for circumventing the principles that shape our legal system and regulate the conduct of administrative activity" was subsequently reiterated by the Council of State in a number of decisions that confirm, also by referring to textual references, what had already been sanctioned in Judgment No. 2270 of 2019 (see Council of State, Section VI, Judgments Nos. 8472, 8473 and 8474 of 13 December 2019).
15. On this subject, see already TAR Lazio, Sec. III-*bis*, judgment 22 March 2017, no. 3769, which recognised the right of access also with reference to the so-called "source code" of the programme used in the administrative procedure. On the decision see Simoncini 2019, p. 77; Otranto 2018.
16. On the procedural problems arising from the adoption of computerised administrative acts, and in particular on the possibility of contesting the software independently or only together with the final act, see for example Orofino 2002, p. 2256 ff.; Saitta 2003. On the problems arising from the fact that the holder of the public function does not coincide with the computer-programmer who materially prepares the software see Viola 2018, p. 10 ff.

which substantiates the heart of the constitutional permits of the trial and the very impartiality of the judging body.

In this perspective, the Constitutional Court has deemed illegitimate, in various circumstances, decision-making automatisms provided for by the legislature. Ultimately, the use of the IA alone instead of the judge would affect the constitutional ensures pertaining to jurisdiction, such as the effectiveness and fullness of the parties right of defence, the quality of the jurisdictional decision, the judge's ability to bring out the irreducible peculiarity of the facts and to calibrate the decision on them, and the obligation to state reasons.

2. The *Noetics* of Judging

Does the shield of impartiality allow the judge to prevent emotions from influencing his decision, as if it were an impenetrable barrier to emotional impulses while wearing his robe? The most accepted answer in legal science is affirmative, as it grounds rationality as the core of judicial decision-making. At least from the point of view of procedural rules, it is assumed that the influence of emotions is rejected, as they can distort the cognitive process. When impressions, intuitions and feelings creep into the decision-making process, jurists believe that this leads to a deficiency in the proper formation of legal argumentation, a kind of pathology to be avoided and counteracted in the pronouncement of judgment.

In a work written by Forza, Menegon and Rumiati, the roots and outcomes of the cultural context described above are placed at the centre of the analysis[17]. Using the advanced tools of neuroscience and psychology, the book sets out to take an important step: to decisively and convincingly overcome the traditional separation between reason and emotion. In this perspective, Homo Cogitans, the human being who prepares to make decisions, is not conceived as confined within an enclosure impermeable to the influences of the emotions, crushed by a massive and inaccessible rationality. On the contrary, the authors lead us towards a more multifaceted view of the human being, who can integrate reason and emotion into a richer and more complex decision-making process. They recognise that emotions are not strangers or adversaries of reason, but rather essential partners. Emotions are traced back to their role as legitimate and meaningful influences in decision-making, capable of interacting fruitfully with rational thought. This dynamic interaction between reason and emotion, according to the authors, is fundamental to improving the quality of cognitive operations and thus of the decisions taken by Homo Cogitans[18].

In addition to examining intuitionism in its purest form, the portrayal of the judge as an "emotional judge" offers a more comprehensive view of what we might call "virtuous emotionality"; these emotional virtues emerge from a harmonious combination of different psychological dimensions. In the context of this vision, the figure emerges of an individual endowed with a remarkable social intuition that enables him to grasp not only the external aspects but also the mental states of others, opening the door to a deeper understanding of the people around him. However, this ability is not the only characteristic that contributes to virtuous emotionality; self-awareness is also a key element in this equation.

The individual with virtuous emotionality is aware of his emotions and understands the physical sensations that accompany them. This personal awareness helps him not only to understand himself better but also to be more sensitive to the emotions of others. In addition, focused attention with a high degree of concentration on a specific goal is a distinctive trait of the virtuous emotionalist. This ability to focus intensely on a specific goal enables the judge to thoroughly examine complex situations and make well-considered decisions.

In summary, virtuous emotionality is based on honed social intuition, self-awareness of personal emotions, and focused attention. These personal characteristics create ideal conditions for judgement functions, contributing to a deeper and more compassionate understanding of others and facilitating informed and wise decisions.

In the context of "deviant emotionality", Forza, Menegon and Rumiati present us with a detailed

17. Forza–Mengon–Rumiati 2017, p. 244.

18. On the topic addressed by Forza, G. Mengon, R. Rumiati, it is possible to elaborate with: Goleman 1995, p. 368; Ledoux 1998, p. 384.

analysis of the mental states that can lead to miscarriages of justice, with particular attention to the most serious of them, termed "tunnel vision". This condition is characterised by the rigidity of the decision maker's attention, oriented solely in a specific direction, preventing him from widening his field of vision to the surrounding circumstances[19]. This restrictive behaviour can be compared to a tunnel, the outlet of which often leads in the wrong direction. An emblematic example of this dynamic has been highlighted in cases of miscarriages of justice such as the Tortora case and the Rignano Flaminio court case, in which five kindergarten teachers were falsely accused of child abuse and subsequently acquitted with a broad formula. In these cases, mental rigidity and narrow focus prevented an accurate assessment of the available evidence, leading to serious miscarriages of justice.

Another aspect of "deviant emotionality" concerns the so-called "emotional short-circuit". In this situation, the decision maker jumps to conclusions without carrying out any proper rational verification. This behaviour leads to the creation of narratives based solely on limited and immediate information, often leading to erroneous judgements[20]. The cost of such hasty conclusions is high in terms of the reliability of judicial decisions. This type of mental approach facilitates the manifestation of stereotypes and prejudices, which in turn negatively influence the conclusions reached.

In summary, "deviant emotions" represent a scenario in which judicial errors can occur due to biased or hasty decision-making processes. These dynamics endanger the accuracy and fairness of the justice process, underlining the importance of addressing these issues to improve the quality of decisions in the justice system.

The legislature is also fully aware of the dangers that can arise when the judge is influenced by distorted or deviant emotions. Therefore, the legal system has provided remedies such as abstention and recusal to address this issue. These remedies were established to prevent judges from finding themselves in situations where their impartiality is compromised.

Lawyers, on the other hand, are particularly attentive to the emotional style of the judge[21]. They know that the effectiveness of their defences in a trial depends largely on their ability to adapt their strategy to the psychological profile of the judge in charge of the charge. The choice of evidence and arguments to present in court, the technique used in questioning witnesses, as well as the tone and style of their final argument, are all influenced by a careful balance between legal reasoning and emotional considerations. Lawyers seek to adopt an approach that takes into account the inclinations and sensitivities of the judge to maximise the likelihood of obtaining a favourable result for their client.

In this context, understanding the judge's emotional style becomes a crucial element for lawyers, as it directly influences the defence strategy and persuasiveness in the judicial process. This underlines how important not only legal judgement is, but also the management of emotional dynamics in the context of justice.

It is not at all uncommon for newspapers and major national television networks to "report" on trial events related to crimes that shock the common sense of readers or viewers. True, journalists specialised in judicial reporting and TV talk show hosts may not have the same competence as professional magistrates to assess trial matters. However, what may come as a surprise is that it is sometimes the magistrates themselves who comment on trial matters after they have concluded with a verdict.

These considerations are not intended to criticise the judgment, since judicial decisions are not subject to public criticism, but rather to emphasise the procedural regularity and rigorous logical process that the magistrate necessarily followed in his complex work[22]. What rarely emerges from these considerations is the hypothesis just mentioned that, beyond the procedural correctness to which the magistrate must adhere, there may be a risk that he or she has committed one of the so-called

19. Gulotta 2011. On the subject see also: Gulotta 2014; Findley–Scott 2006, pp. 1-17.

20. Maslach–Schaufeli–Leiter 2001, pp. 397-422. On the topic see also: Lustig–Karnik–Delucchi–Tennakoon 2007, p. 14.

21. Brady 2013, p. 216.

22. Bin 2013, p. 112.

"devious errors". These errors of judgement have been well known to decision psychologists for over forty years and represent traps that can be scattered at different stages of the proceedings.

These pitfalls can emerge from the moment the suspect is brought in as a suspect and continue during the course of the trial during the acquisition and examination of evidence, the questioning of witnesses, up to the stage of the judicial decision and the drafting of the motivation. These insidious, often systematic errors can influence the judgement of the magistrate in subtle but significant ways, leading to erroneous decisions that do not reflect the reality of the facts. Awareness of these risks and the need to mitigate them are crucial to ensure justice and fairness in the judicial process.

It is extremely rare for a magistrate to admit to being influenced by emotions during the different stages of judicial proceedings. The professional training he has received often leads him to believe that his conduct must be guided exclusively by rationality. For centuries, emotions were considered in opposition to rationality, creating a dichotomy that limited the full expression of emotions and hindered the achievement of intended goals.

However, thanks to evidence from cognitive science and neuroscience, we have begun to understand that emotions are an intrinsic element in decision-making and judgement[23]. This means that emotions can play a significant role in influencing the perceptions and evaluations of subjects or situations that are to be judged. And this applies not only to judges, but also to all individuals involved in decision-making processes.

Emotions can have a positive or negative impact on our ability to objectively assess situations; they can be an important source of intuition and sensitivity, but at the same time they can lead to errors in judgement when they are too strong or not managed appropriately.

Therefore, while it is important that magistrates receive rigorous training on rationality and the law, it is equally essential to recognise that emotions are an integral part of decision-making and that their conscious management can contribute to more balanced and equitable decisions. In other words, emotions should not be ignored or relegated to the background but should be understood and managed in a way that supports fairer and more accurate justice.

It is undeniable that the magistrate, although trained to follow rational conducts, is also susceptible to the influence of emotions. The question becomes crucial when considering cases of extreme brutality and atrocity, where the evidence presents particularly violent aspects, and the testimonies are charged with emotional impact. In these situations, it is legitimate to question whether the magistrate can remain completely immune to the surrounding emotional wave and possible mental traps.

It is not at all uncommon for some judicial decisions, relating to cases that have become classics, to appear to be heavily influenced by the emotions underlying the human case rather than by an exclusively rational assessment based on the objectivity of the evidentiary data. It is precisely the emotional impact that can guide the judge's decision-making process, pushing him towards options that may not be verbally explicit but that reflect the deep-seated impressions of the object of evaluation.

Under these circumstances, the concept of "intuitive judgements" mentioned by the cognitive scientist Daniel Kahneman, Nobel Prize winner for economics in 2002, becomes relevant. These intuitive judgements are not necessarily the result of a rational and objective process, but rather reflect the individual's impressions and affective feelings about the situation[24]. Judges, when called upon to make decisions, may incur "biases" (preconceptions), "thinking heuristics" (simplified mental strategies) and, in general, cognitive traps. These influences may stem from the emotions and affective feelings that arise during the decision-making process. Recognising the importance of these

23. Fiandaca 2013, p. 215.

24. Kahneman 2012. Other relevant works by the author on the subject are: *Prospect Theory: An Analysis of Decision under Risk* (1979) – This is one of Kahneman and Tversky's most famous articles, in which they presented the prospect theory, which revolutionised the understanding of human decision-making under uncertainty; *Judgment under Uncertainty: Heuristics and Biases* (1982) – Another fundamental article written with Amos Tversky, which introduced the concept of heuristics and biases in decision-making.

dynamics is crucial to better understand how to improve decision-making and promote fairer and more balanced justice.

3. *Legal constraints* for a non-human judge

If our constitutional principles preclude, but only at present, entrusting the exercise of the judicial function to a legal machine, it is, on the other hand, possible to hypothesise the use of AI in an instrumental and auxiliary function for the judge or its multiplication. For instance, modern AI systems could certainly facilitate the activity of searching for precedents.

They could, that is, provide new and more powerful search engines that would enable litigants to assess whether or not to initiate a trial, and the judge to more easily find the framework of precedents that can be used for decision-making purposes. Indeed, there is an emerging need to adapt traditional legal categories to a new reality, in which many decisions are taken not by human beings but by algorithms that can make unpredictable choices.

The new "robotic" systems, it has been observed, could help satisfy that need for the "calculability of law", pointed out by Max Weber and taken up by those who consider it indispensable to guarantee the citizen's reliance on legal certainty[25]. For example, it has been proposed in doctrine to provide for a preliminary phase before the commencement of a judgment, based on the use of an AI system, aimed at establishing the probable outcome of the judgment.

The parties would have to decide whether to accept the immediate robotic decision or to proceed before the court with a different time frame. In such a case, the losing party for not having followed the AI system's "suggestion" should, according to the proposal, be ordered to pay damages for reckless litigation under Article 96 of the Code of Civil Procedure.

In addition, the use of the new AI tools could prove valuable in the application of the new "appeal filter" mechanism, which requires the College to declare inadmissible an appeal that does not have a "reasonable likelihood" of being upheld[26], just as it could prove to be a valuable tool, for instance, to quickly make compliant precedents available to the adjudicating body, for the possible referral of the decision to the United Sections – in a faster and more efficient manner – the activity of "perusal" of judgments for the purpose of applying the admissibility filter for appeals to the Court of Cassation or Appeal[27] (in these cases the final decision as to the admissibility of the appeal would still be left to the judge).

AI systems could, moreover, offer an aid in any case in which it is necessary to make technical evaluations aimed at determining monetary amounts in the context of civil judgments also to reconstruct factual data to be used for decision-making purposes, or for the preparation of draft orders or for the handling of simple, serial, repetitive, entirely documentary cases, within the limits allowed by the applicable legislation.

The use of new information technologies could also, "if properly governed and accompanied by professional and training measures, assist policies to improve the efficiency of judicial governance". Finally, AI systems can be used in alternative dispute resolution procedures, including, for instance, those involving so-called *small-claims*, i.e., matters of bagatelle or low economic value that would be unlikely to be enforced before a judge. Part of the doctrine, however, still seems to be highly sceptical about the possibility of allowing judges to use AI tools, especially if they are predictive in nature, to support their decisions.

25. Irti 2019, p. 17; see also the contributions collected in Carleo 2017 and Carleo 2018.

26. Article 348-*bis* of the Code of Civil Procedure (c.p.c.), introduced by Law Decree No. 83 of 2012 converted into Law No. 143 of 2012. Art. 384-*bis* c.p.c. would legitimise predictive justice algorithms as a consequence of law, because it sanctions with inadmissibility the appeal that does not have a reasonable probability of being upheld, thus sanctioning the use of probabilistic automated decision-making processes for the purposes of the judge's decision; but this is denounced by Art. 22 of GDPR 679/2016 which states: "The data subject shall have the right not to be subject to a decision based solely on automated processing, including profiling, which produces legal effects concerning him or her or significantly affects him or her in a similar way". Higher-ranking European norm derogates from the lower one given by Art. 384-*bis* c.p.c.

27. De Renzis 2019, p. 150.

The problem, it has been observed, relates to the "overwhelming practical force of the algorithm", which would end up inducing the judge to follow the choice suggested by the computer, thus ending up conditioning its motivation.

The risk posed by the adoption of AI in the decision-making process is that the data offered by the "intelligent" instrumentation would no longer have an indicative or persuasive value, but an almost prescriptive one, causing the operator to apply the solution offered by the machine without examining it in the light of the particularities of the concrete case.

In other words, if the judge, in deciding, were to end up uncritically resting on the algorithm's proposals, the mechanical reproduction of decisions would risk leading to a dangerous crystallisation of jurisprudence to the detriment of its evolution. Such risks must be decisively avoided.

The autonomous assessment of the judge, who is exclusively responsible for the interpretation of the applicable law and the assessment of the peculiarities of the case at hand, is, above all, to be regarded as an inalienable social value. Once an automatic decision-making system has been introduced into a human decision-making process, it has been observed, "the automatic system tends, over time, to capture the decision itself", also in view of the "practical" force of any evaluative automatism that, on the one hand, relieves the decision-maker of the burden of motivation, the burden of examination and motivation; on the other, allows him to "qualify" his decision with the chrism of "scientificity" or "neutrality" that today surrounds algorithmic evaluation and confers on it a peculiar – how unfounded – authority[28].

The mere *tout court* substitution of the judge (but not his cloning) with AI systems cannot, however, currently be admitted in the Italian legal system, because it is contrary to constitutional principles, this, above all, because the Constitution was constructed not as a balance between values, with the consequence of favouring subjectivity over objectivity and, therefore, the human being over "other".

Article 102 of the Constitution, which entrusts the exercise of the judicial function to magistrates established and regulated by the rules on the judicial system, and Article 111 (due process), second paragraph, of the Constitution, which requires every trial to be held before a third and impartial judge, postulate a human judge. Article 101, paragraph 1 of the Constitution, in providing that judges are subject only to the law, excludes that the judge can be bound by the outcome of algorithmic procedures that place the legal practitioner in front of dangerous application automatisms.

Article 25 of the Constitution itself, in guaranteeing the right to a "natural judge pre-established by law", evidently refers to a judge-person. Article 51 of the Code of Criminal Procedure (abstention of the judge) postulates, unequivocally and perhaps more than others, the human nature of the judge; in this article, observing the trial as a whole, one can infer a principle of symmetry between judge and parties, in the sense that they must have the same human nature, differing only in role and/or power. These provisions clearly exclude the possibility of an artificial intelligence system replacing the judge.

The replacement of the judge by automated dispute resolution mechanisms would, moreover, compress the parties' right of defence. A robot judge, of deontic implementation, always needs a robust logical-legal theory to demonstrate its ability to issue "just" judgments by virtue of automated algorithms with a broad consensus, which would seem to undermine the recognition of a particular status – such as that of a legal subject – to a robot judge.

The EU Parliament resolution of 16 February 2017 recognising the importance of the world of robotics and artificial intelligence in need of regulation is concerned about this. The guarantee of every citizen's right to an independent and impartial judge is moreover also reaffirmed by the ECHR (Art. 6(1)) and the Charter of Fundamental Rights of the European Union. In this perspective, the *Committee of Experts on Internet Intermediaries* of the Council of Europe published the study *Algorithms and Human Rights* in March 2018.

In view of the "growing importance of AI in modern society" and the "expected benefits once

28. Simoncini 2019, p. 81. See also Barbaro 2018, p. 194, according to which the use of predictive tools could have repercussions on the impartiality of the magistrate, given the likely reluctance of judges to shoulder the burden of deciding against the prediction of an algorithm.

its potential is also used to serve the efficiency and quality of justice", a few months later the European Commission for the Efficiency of Justice (CEPEJ), established by the Committee of Ministers of the Council of Europe, adopted the *European Ethics Charter for the Use of AI in Justice Systems*[29].

The Ethics Charter sets out some basic guidelines for "public and private actors responsible for the design and use of AI tools and services". The basic idea that emerges from the Ethics Charter is that AI, if used as a tool not to replace, but to assist the judge, can, in certain circumstances, promote predictability in the application of the law and uniformity of jurisprudential orientations.

This is the first instrument in Europe that identifies the fundamental principles to which the use of AI in judicial systems should adhere: respect for fundamental rights, non-discrimination, quality and security of the system, transparency, and user control. Compliance with these principles should be ensured right from the design and learning phase of the system, according to an "ethical-by-design" or "human-rights-by-design" approach. Compliance with these principles should be ensured by an independent authority with certification and monitoring tasks.

The Charter contains, in an appendix, a study on some AI applications being tested in some European states, a recommendation on the use of such applications, a glossary and a self-assessment checklist, aimed at enabling a check on the level of adherence to the principles set out in the ethical charter. Although the Ethics Charter is non-binding in nature, it is called upon to play a guiding and guiding role in ensuring that AI systems, from the design phase to practical application, guarantee respect for fundamental rights and data protection regulations.

Finally, in this context, it is worth mentioning the Artificial Intelligence Regulation (AI Act), which is a binding legal instrument that expands and concretizes many of the principles already enunciated by the Charter of Ethics. The AI Act aims to create a regulatory framework that regulates the use of AI in a manner proportionate to the risk that such technologies may pose to fundamental rights, security, and democratic values.

This regulation aims to strike a balance between technological innovation and the need to protect fundamental rights, security, and democratic values. In a context where AI plays an increasingly pervasive role in society, the AI Act aims to prevent the risks associated with these technologies by ensuring that they are used responsibly and transparently[30].

A central aspect of the AI Act is its risk-based approach, which classifies AI systems into four main categories, depending on their impact on fundamental rights and safety. This classification allows rules and obligations to be calibrated in a manner proportionate to the level of risk, thus ensuring a balance between technological innovation and the protection of fundamental rights.

The AI Act, therefore, not only seeks to reduce the risks related to AI but aims to bring about innovation. By establishing clear and consistent rules at European level, the regulation aims to create an environment of trust that incentivizes the development of safe, ethical, and human rights-respecting AI solutions.

4. Communication meta-referents for *robotic judgement*

The legal system is not reducible to a pure biological system, i.e., of mere living forms and devoid of questions about the meaning of before and after and the metaphysical why of life. The genealogy of law represents law as bound to the relationship of unconditional and universal recognition between men, which overcomes that of exclusion, based on pure factuality, and a legal relationship allows for the reciprocity of the encounter, recognising and preserving the originality and uniqueness with which each individual is branded from his or her origins.

When then, the rational human process acts in a theoretical sense as a source of obligation and moral authority, it becomes a norm for every human being. The legislation of reason is finally exhausted in a single rule operating with the formal

29. A few months later, the European Commission for the Efficiency of Justice (CEPEJ), established by the Committee of Ministers of the Council of Europe, adopted the *European Ethics Charter for the Use of AI in Justice Systems*.

30. Iaselli 2024, p. 436.

and selective criterion of universal law. Coercive actions become legitimate only when they are necessary to the logical consequences of actions that, through an invoked legal principle, are recognised as necessary and, therefore, assigned as a legal duty.

The fulfilment of legal law thus legitimises itself as the primordial condition of categorical imperative, specialising in the conformation of duties that can be demanded by force. While in its moral form, it demands that we act according to sayings and adages that can likewise be expressed through their validity as ethical laws, in its legal form it is represented as the principle of what is logically just. Law thus becomes an indispensable tool for organising correct social relations, preventing the onset of social conflict that could arise from the concentration of at least two different appetites on the same "good-life", or, should the conflict arise in any case, restoring, through the application of the legal rule, that social order disturbed by the head-on clash of the two competing and opposing appetites, which confirm the inseparability of law with the anthropic society that generated it.

If law is always constituted of utterances and propositions that, in terms of communicative intentionality, assume functions relative to the purposes that the speaker proposes to achieve, the task of legal logic is the study of *lógos*, of legal thought and language, as a search for rationality and logic in utterances with normative value. While logic claims to formalise its research products in a logical language with Boolean functions, law does not operate on a purely syntactic level, i.e., by means of series of symbols or rules of logical elimination formation, but accuses its own semantic domain[31], in order to explicate certain legal entities with rationality and to account for the behaviour as a logical sub-species of these entities in the legal universe[32]. Indeed, in logic, conditional modular structures are used with mixed modes: alethic; deontic; epistemic; these modes always present the character of "provisionality, vagueness, paraconsistency, non-monotonicity, polyvalence"[33].

Kelsen argued in this regard that "there is no need for special logics to account for judicial decisions"[34], which contrasts with the position of those who hold, on the other hand, that classical logic is not sufficient to account for the rationale of legal reasoning[35] at least in the motivation part of the judgment. At present, it is clear that artificial intelligence lacks the ability to exercise discretion and make judgments. To evaluate the compatibility of AI with the deontic logic of decisional legal reasoning in the context of digital expression, it is important to note that the question remains purely theoretical, and that there is still much to learn about cognitive sciences. It is necessary to observe, however, that the use of a typified logic of the information process could be a potential area for AI application[36].

A robot judge, of deontic implementation, requires, as anticipated, a robust logical-legal theory that demonstrates its ability to make "just" judgments by virtue of automatic algorithms with a

31. An idea that is provocatively supported, also in relation to manipulation by computers, by: Alchourrón–Martino 1990, p. 25.

32. The language of law has a structure open to hetero integrations since it expresses statements that, in principle, can be integrated. There can only be integration if the utterances are capable of revision and if its truth values are rooted. Law is always constituted of utterances and propositions that, in terms of communicative intentionality, assume functions relative to the purposes that the speaker sets out to achieve. The task of legal logic is the study of lógos, of legal thought and language as a search for ratio in statements with normative value. While logic claims to formalise its search products in a logical language with Boolean functions, law does not operate on a purely syntactic level, i.e., through series of symbols or rules of logical elimination formation, but accuses its own semantic domain, in order to explicate certain legal entities with rationality and to account for the behaviour as a logical sub-species of these entities in the legal universe.

33. Hughes–Cresswell 1996.

34. Mazzarese 1996; Alchourrón–Martino 1990, pp. 46 67.

35. Kelsen argued in this regard that "there is no need for 'special logics' to account for judicial decisions", which contrasts with the position of those who hold, on the other hand, that classical logic is not sufficient "to account for the rationale of legal reasoning" at least in the motivation part of the judgment.

36. On this subject, Sartor 2003.

broad consensus, which would seem to prejudice the recognition of a particular status – such as that of a legal subject – proper to a robot judge. In the words of Giovanni Sartor, "man is naturally inclined to apply to artificial entities, and especially to A.I.'s, those interpretative models that normally apply between human beings, particularly by explaining the behaviour of given entities by attributing to them mental states proper to human mental mechanisms, precisely"[37]. Such a reference to humanising mental states would entail a behaviourist application to be adopted specifically for artificial entities[38].

The path of further study, which is being taken by frontier legal informatics, concerns the interpretation of neutral and flexible mental concepts, applicable to special categories of artificial entities, allowing the preservation of the unity of law for an automated information process[39]. Without addressing the potential psychic and cognitive mental states, the issues regarding granting legal subjectivity to AI can be resolved using two theories, namely Savigny's theory of fiction. The concept utilises a legal fiction to confer subjectivity upon non-human social entities, particularly beneficial in the case of automata which cannot be classified as humans or personal property.

Gierke's theory of legal reality assigns subjectivity to social entities that demonstrate traits similar to humans, indicative of a sociological identity and consciousness. This second theory upholds the legal status of automata, recognizing their similarity to human beings to a greater extent than social bodies. Both theories were eventually superseded by the dualistic case theory, thus opening up new avenues for the recognition of legal subjectivity by the legislature but also limiting itself to the recognition of an instance manifested in time[40].

If logic[41] claims to formalise its own research products in a logical language[42] with Boolean functions[43], law does not operate at a purely syntactic level, i.e., through series of symbols or rules of logical elimination formation, but accuses its own semantic domain[44], in order to explicate certain legal entities with rationality and to account for the behaviour as a logical sub-species of such entities in the legal universe[45].

In the search for the connection of the logic of language to the analysis of the mind, Russell[46] introduces the concept of "propositional attitudes", i.e., the attitude of a subject towards the proposition, as a representation of the meaning to be shared between different utterances, as the connection of a particular written or uttered utterance with the state of mind that induced that particular utterance itself, as Searle put it[47].

Quine posits that the indeterminacy resulting from our capacity to translate disparate linguistic expressions into a singular concept exemplifies the fallacy of positing the existence of mental states that manifest intentionality as a tangible phenomenon. Consequently, the behaviourist analysis of human behaviour can be reduced to a simple holistic interpretation. Quine argues that the indeterminacy resulting from our ability to translate diverse linguistic expressions into the same concept demonstrates the fallacy of believing in the existence of mental states that are indicative of intentionality as a tangible phenomenon. Consequently, the behaviourist interpretation of humans can be

37. Sartor 2005.
38. *Ivi*, p. 4.
39. *Ibidem*.
40. In this regard, the EU Parliament resolution of 16 February 2017 recognising the importance of the world of robotics and artificial intelligence in need of regulation.
41. Strawson 1961.
42. Agazzi 1980.
43. Mangione–Bozzi 1993.
44. An idea that is provocatively supported, also in relation to manipulation by computers, by Alchourrón–Martino 1990.
45. Wittgenstein 1967.
46. Russell 1914.
47. Searle 1984.

seen to amount to a straightforward holistic explanation, as put forth by Davidson[48] and Putnam[49].

Finally, Ryle[50] distinguishes between the physiological processes that occur in the individual for which physiological vocabularies are used and the mental vocabulary that is adopted to communicate behaviour, so much so that Wittgenstein[51] remarked on the possible emergence of linguistic confusion. Mental terms, such as justice, punishment, reward, are for Ryle and Wittgenstein objects of learning in a public context. However, it is difficult to identify the precise point at which intentionality emerges as a precursor to behaviour in everyday life, as mental terms do not necessarily cause behaviour. Furthermore, mental states are also intertwined with behavioural states, making it challenging to distinguish between them. This difficulty is reflected in the legal world, particularly in the penal system, which employs the τετρακτύς ideation-preparation-execution-consummation model for crime[52].

The fundamental rule used by the human race to illustrate the individual behavioural perimeter stretching towards the area of collective coexistence is the linguistic act *tout court*. Many linguistic acts do not merely reflect the state of the world but rather aim to transform it in accordance with the contents of the linguistic act. When a judge orders witness testimony or hires a professional to provide expert opinions, or when a prosecutor assures the victim of a wrongdoing of their intervention to prolong the investigation to find the perpetrator, the aim is not to state the objective truth of the world but rather to change it through a linguistic act intended to effect change.

When the purpose of the order is to produce obedience, the promise, on the other hand, drives one to cause its fulfilment. In these cases, the purpose formed by the linguistic act is not already an agreement with a reality existing independently of it, rather, it aims to change reality so as to adapt it to the content of the linguistic act. If one promises to contract marriage, the aim of this utterance will be to produce a change in the reality of the conjugands, creating a reason for the utterer to contract marriage, which induces the promisor to keep his promise.

If one orders anyone to present themselves in court, the aim is to induce them to present themselves by virtue of obedience to the precise order, to allow their behaviour to harmonise with the content of the linguistic act: the world must change to correspond to how it is described in legal language by an order, and orders are not true or false, but obeyed or disobeyed.

In this sense, the language of law, which translates categorical imperatives into linguistically competent forms of principles of justice, represents the communicative expression of precise needs of society, formalised in the verbalisation of collective wills that is expressed in the brocardo *ubi societas ibi ius*[53]. The juridical language thus appears to be one of the languages with the most tradition and tetragonous to modernisation, inasmuch as "with respect to the changing influences and linguistic fashions found in technical-scientific languages, the juridical lexicon […] has remained fairly stable over time. […] The social prestige of the language of law is ancient; it is an expression of power and institutions and is part of the connective tissue between law and behaviour, thus, between the abstract norm and the citizen"[54].

The language of law, however, is also the same natural language that is uttered by people, so it is a conventional language rather than a formal language, that is, it is entirely natural and as such it is affected by common linguistic polysemies and the different functions they perform. The language of

48. Davidson 1980, pp. 207-224.

49. Putnam 1987.

50. Ryle 2009.

51. Hadot 2007.

52. Mittermaier 1846, p. 265.

53. In Aa.Vv. 1986, p. 7. *Ubi societas ibi ius* is a Latin locution meaning "where there is a civil society, there is law". Every society can only be rooted in law and no civil society exists without self-regulation. The locution is derived from the full sentence: *Ubi homo, ibi societas. Ubi societas, ibi ius. Ergo ubi homo, ibi ius*, a principle of Romanesque origin indicating that man needs legal rules to be able to live.

54. Trifone 2009, p. 265.

law and its transformation into law, touches almost every aspect of the citizen's life through laws and acts of legal relevance, according to the principle that *ignorantia legis non excusat*: the language of law, that is, becomes the language of all, without distinction, and the social actor constantly performs legal activities, such as buying property or renting a house, and in performing these actions uses the language of law. By extension, the language used by the judge can be seen as a means of pacification and conciliation to put an end to disputes between cives, *so it must be* made comprehensible.

Legal language therefore has a fundamental function for mankind precisely because it is directed to all members of the community to regulate acts, facts, and events. The language of law has a structure that is open to hetero integrations because it expresses statements that, in principle, can be integrated. There can only be integration if the utterances are capable of revision and if its truth values are entrenched. At this stage, the statements of law are ratified as standards, which means they create a specific connection between human conduct identified based on a fact and society's response in the form of a positive or negative sanction. In certain cases, new social practices are created, resulting in the formation of social facts. The rules of physics, referred to as norms, also play a significant role in producing social reality by identifying facts which then lead to a precise set of consequences. In certain cases, new social facts are created, i.e., "practices" are produced[55] and the norms, like the rules[56] of physics[57], produce a "social reality", i.e., they identify "facts"[58] i.e., they identify facts from which a precise set of consequences follows[59].

5. Algorithms for *Robotic Justice*

Words, therefore, guide actions, directing behaviour and, thanks to effects known as *priming* and *nudging*, partisan legal acts can guide judgmental action, and judgmental action is described in the legal act par excellence that is the judgment. The *priming* effect[60] is the phenomenon whereby exposure to certain stimuli guides humans into subsequent behavioural types referable to the same domain as those stimuli.

The *nudge* effect[61] alters people's behaviour in a predictable way, although apparently without

55. Viola–Zaccaria 2003.

56. Schauer 2000.

57. von Wright 1989.

58. Searle 1995.

59. Hart 1961; Ross 1965.

60. *Priming* is an unconscious mnemonic recognition by primitive exposure, which allows a stimulus, even a primitive one, to be identified during subsequent evocative exposures without having any awareness of it, posing severe problems on the interpretation and evaluation of the information received. In English, to prime means to trigger that is, to activate a series of information mechanisms present in memory, predisposing and facilitating the subject in the cognitive processing of the next stimulus. Priming makes use of the heuristics of recognition, whereby each piece of information is stored in a mental schema formed temporally on successions and linked to information flows received with respect to the first piece of information acquired. During the priming effect, each subsequent stimulus increases the accessibility of information in memory. According to neuropsychology, priming consists of the activation of groups of neurons surrounded by weak connections between them, so that when these neurons are activated by the perception of an object already seen, the signal immediately spreads and becomes prioritised over the others coming in. This activates a memory in the implicit memory that influences the response, and which represents the incoming information; thus, a series of images related to the object in question is activated in our minds. By repeatedly exposing people unconsciously to a stimulus, i.e., by means of "subliminal perception" a greater positive attitude towards the stimulus to which they are exposed is obtained and the greater their new exposure to the stimulus will be, like a kind of "stimulus hunger". Finally, in order to increase accessibility to information through priming, the purpose must manifest itself as immediately available, otherwise priming alone fails to dictate that people do things they do not want to do. It is amply demonstrated by neuropsychological studies that one cannot induce aims and goals in subjects if these are not already present in their imagination.

61. The theory of nudges people towards behaviour that is positive for their well-being, without using coercive methods but leaving them free to choose: the decision-making processes and behaviour of groups and individu-

prohibiting the choice of other options and, in any case, without significantly changing their value and economic incentives within the scope of individual choices. Judicial *opting out* entails the acceptance of consolidated and tested mental schemes formed by the processes of *priming* and *nudging*: such tools find a secular collocation in "collections", "compendia", "maxims", "pandettes", "codes", but, above all, these are formed as legal documents, understood as private extra-procedural writings certain in terms of paternity and provenance or acts of various kinds at the disposal of the judge that form his opinion and mature his decision.

This Skinnerian stimulus-response-reinforcement cycle[62], rather than the habit loop (signal-routine-gratification)[63] responds better to the formulation and realisation of a protocol of algorithms to produce clones of the monocratic judge.

This protocol is formulated from the theories of language and communication unanimously recognised by the Italian and international scientific community[64]. What is represented is not the replacement machine of the judgement-maker, but rather its clone, that is, the exact judgement-maker multiplied. The robotic machine would not be just any judge, but that very same judge to whom the case would be assigned and who would therefore assume its legal mentality, preparation and human, eventual and always undesirable ideological entrainment.

The first problem to be addressed in preparing a protocol is given by the analysis of anthropic communication in a theoretical sense, the study of its entropic evolution, even to the realisation of an error-free syntropic judgement model. Finally, starting from the judgements of the judge by means of a reduced statistical model, broken down by the legal institutions dealt with by the judge, design the customised judgement-type.

Upon entering into the entropic calculation of the sentence text, it becomes evident that the calculation of the entropy of a linguistic text, whether

als can be influenced through "indirect" suggestions and reinforcements with an effectiveness equal to or greater than that which can be obtained through the imposition of rules, laws or direct instructions: the desire to feel accepted, to be part of a homogeneous group that shares ways of thinking, values and behaviour is a natural need for human beings. Social pressure is, therefore, a very effective weapon that can drive people to conformism, discrimination and the adoption of bad habits, but also to virtuous behaviour, cooperation and activism. Communicating or, even better, showing how many people have made the same choice or implemented the same behaviour increases the likelihood that others will "follow suit". human beings naturally manifest an aversion to change and a tendency to inertia. For this reason, the use of "default options", i.e., default settings, is very effective in guiding an individual's choices. Offering the individual a recommended or directly pre-set option is tantamount to lowering the cognitive load required to make the decision; consequently, in the absence of a strong personal motivation, most people will tend to accept it passively.

62. Learning in a three-term contingency (discriminating stimulus, behavioural response and reinforcing stimulus) occurs following the issuance of a single response, in a manner that can be described as discrete or all or nothing. Teaching technologies, from a perspective consistent with B. F. Skinner and Murray Sidman, therefore, do not require the person to go through an error phase in order to learn something. Errors can be avoided, and with them a number of side effects of punishment, if the teaching technology is designed on the basis of shaping both behavioural responses and discriminating stimuli (response shaping and stimulus shaping) according to the paradigm known as errorless learning).

63. The habit loop has always been used in behavioural psychology in operant conditioning, where a learned behaviour is maintained by the responses it receives. The habit loop consists of three phases: the signal: the consequence of a particular condition (environmental, emotional, …) that requires a gratification, and prompts the brain to perform the routine to obtain it; the routine: the action that occurs following the occurrence of the signal. A routine can be physical (action performed), mental (thought) or emotional (change in mood); the gratification: the reward obtained from the performance of the routine. It is the element that reinforces the unfolding of the ritual of habit.

64. Cf. writings by: Gopen-Smout, De Mauro, Cortellazzo-Viale, Sabatini, Mortara-Garavelli, Rovere, Ondelli-Romanini, Pellegrino, Zaccaria, Timpanaro, Guastini, Belvedere, Dell'Anna, Viezzi, Ainis, Romano, Reinach, Austin, Cohen-Perrault, Habermas-Honnet-Joas, De Fazio, Masini, Simone, Voghera, Abutalebi-Green, Shannon, Manfrino, Minnaja-Paccagnella and many others.

it be a newspaper article, a novel, a poem, or an article of law, is at least a quarter of a century old[65]. An entropic calculation was made at the end of the 1990s based on grapheme frequency tables drawn up for some European languages[66]. This led to the development of an entropic theory of communications, which employs mathematical-statistical source models endowed with the Markovian[67] property to test the intelligibility of a message. These models can be simulated by means of a computer[68].

The limitation of this approach appears to be associated with the evolution of language over time[69], which could potentially result in a reduction in entropy. It is evident that, as was the case previously, the entropy calculated at the grapheme level varies in accordance with the lexical components of the text under consideration. However, this variation, which is relatively limited, tends to diminish with an increase in the length of the selected text. Conversely, if entropy is calculated at the level of phonemes, it varies considerably according to the chosen phoneme transcription.

Additionally, entropy is a quantitative measure of the degree of disorder within a system. It can be conceptualised as a metric that represents the proximity of a system to a state of equilibrium: "This is evidenced by the observation that all entropic phenomena, whether physical or linguistic, tend to evolve towards a state of uniformity. In other words, they proceed from a differentiated state towards a more homogeneous and simple state. As time passes, the system becomes increasingly homogeneous and uniform, which is to say that the entropy of the system itself increases"[70].

The entropic communicative world is inherently a representation of assertions based on incomplete information. It is the result of the "…interaction of individuals, and as such, it is inherently unpredictable. This unpredictability results in a high entropy, which can be defined as one of the possible states of "consistent"[71]. The *de facto* unpredictability of individual human behaviour, as a result of the self-referentiality of homo socialis[72] and the variants of the logic underlying our free will, gives rise to unpredictability in legal computation. This can be attributed to the chaotic nature of information in law, which can be defined as the entropy of legal information"[73].

If a legal practitioner offers only one answer to each procedural legal question, and therefore only one measurement, to complementary questions that exclude each other, answers and measurements are offered that elide each other. This results in entropic causality in law being nothing but the result of the limitedness of the information received and produced. Evolution occurs through the "when" and "where" the legal information contained in the norms is activated, as their sufficient condition, and the *Quis, Quid, Ubi, Quibus auxiliis, Cur, Quomodo, Quando* as their necessary and sufficient condition.

A legal programme of "quality" must be "symmetrical", i.e., ordered at its origin. Over time, that which is homogeneous will become chaotic, with a decay that can be slowed down, counteracted, but never eliminated. The need for recodification intervenes for this purpose as decisional reprogramming. As stated by Prigogine and Stengers, "The speed of entropisation can be slowed down but never stopped, and high entropy states are much more numerous and therefore more possible than low entropy states: this is true for any type of organisation of information"[74].

The implementation of potential slowdown systems necessitates the continuous input of both

65. Shannon 1951, pp. 50-64; Barnard 1955, p. 49.
66. Manfrino 1960, pp. 4-29.
67. Battaglia 2007, pp. 51-69.
68. Debiasi–Valli 1968, pp. 293-314; Minnaja–Paccagnella 1977.
69. Afendras–Tzannes–Trépanier 1973.
70. Gintis–Helbing 2013.
71. Lloyd 2006.
72. Gintis–Helbing 2013.
73. Sabetta 2008.
74. *Ibidem.*

human and computer resources, resulting in an entropic reduction. This is achieved by enhancing the information calculation capacity in accordance with Moore's law, while maintaining a constant valuation of available resources. This can be described as the "transfer of entropy from one system to another" or, alternatively, a reduction in the chaoticity of the system on which the legal programme is to operate. The exchange between rules (the legal programme) and energy (the judicial resources) results in information becoming entropy, which is invisible and therefore unusable.

It can be argued that legal information is an inherent and defining aspect of reality, preceding the actuality of the situation. However, the legal information element, or "bit", is defined as a binary alternative between two extremes. This presents a complexity that is only later evaluated as an evolution of information, or its temporally successive elaboration.

One cannot perceive a legal event or any event in and of itself; rather, one apprehends it through consciousness, becoming part of it, attracted by it, and processing it. In other words, one is indistinguishable from the legal event by becoming a normative source in and of itself. Consequently, the entropy of the information content of the individual norm becomes irreversible once its meaning has been altered, as the measurement of information alters the information in contact with the system itself. At this juncture, it is imperative to conceptualise the legal structure as a causal structure, wherein the interpretation of the norm gives rise to the structure of the legal organisation. However, this, in turn, influences the interpretation and the legal reality in a manner analogous to any reality in terms of information processing.

It follows that in order to achieve the desired organisational result, such as a "just" sentence, there are various paths, i.e., various possible recombinations of norms. This is due to the fact that the "… length of information increases the probability of its decoherence…"[75]. Therefore, the shortest reasoning resorted to is that which is probabilistically more exact and given by the *novacula occami*, i.e., the "principle of economy" or "…The principle of parsimony, which indicates that "…among several hypotheses for the resolution of a problem, the simplest one should be chosen with equal results, is a methodological principle"[76]. It is also reflected in the Latin brocardo: "Frustra fit per plura quod potest fieri per pauciora", which translates to "Entia non sunt multiplicanda praeter necessitatem". Finally, the Latin phrase "Pluralitas non est ponenda sine necessitate" demonstrates regularity, structure and order. As a result, the human function is increasingly limited to the mere formulation of material facts, rather than legal facts. This is particularly evident in the decision-making process regarding the interpretation and processing of large amounts of information, in accordance with the aforementioned Moore's law. Consequently, the scope for decisive action is reduced to the simplified codification of events and sentences, in line with Occam's razor.

At the end, the use of mathematical-statistical model-sources with the Markovian property, which can be simulated through a computer, to gauge the comprehensibility of an oriented communicative message in legal communication has limitations. The evolution of language over time may result in a reduction of entropy usually found in court documents representing legal facts. If entropy is calculated at the level of phonemes, it varies considerably depending on the phoneme transcription chosen. Thus, if one wishes to frame it in a study for a simulator, a verbal source synthesising the human voice can be considered a Markovian analogue process of the written verbal source alone[77].

The entropy[78] of an information source provides insight into the minimum number of "av-

75. Carroll 2006.

76. *Ibidem*.

77. Various Authors 1975, p. 296; Various Authors 1974.

78. From the definition of thermodynamic entropy, it can be deduced that there is a relationship between information and thermodynamic entropy. In-depth studies in the field of information theory were initiated in 1948 by Claude Shannon, who enunciated the "uniqueness theorem of entropy" in information theory as follows: A set of alphanumeric characters, A, is defined as {A(1), A(2), A(3), … A(n)}. The probability of observing the symbol A(i) is defined as p(i). The entropy, H, is then defined as H(p(0), p(1), …, p(n)). As can be observed, the entro-

erage" bits required to store a message from the source and the predictability of messages emitted by the source[79]. It has been demonstrated that a sequence of messages emitted by a source can be compressed, without information loss, down to a minimum number of bits per message equal to the entropy of the source. The sequential arrangement of alphabetical letters, such as aaaaaaaaa, exhibits a lower level of entropy than a word like "sentence," which in turn displays a lower level of entropy than a completely random string, such as frhsnr04ns-29450gmd. In general, entropy can be defined as the randomness inherent in a given string of characters. It is closely related to the minimum number of bits required to represent that string without error.

Thus, in information theory, Shannon's formula[80] for calculating information entropy is described by the equation[81]:

$$H(X) = -\sum p(x)\log_2 p(x) \qquad [1]$$

$x \in X$

with: H(X) entropy;

p(x) probability,

:= is the symbol for "equal by definition", used for the definition of a concept by equality with other known concepts.

Where the entropy H(X) of a message source represents the "average" information contained in each emitted message, which is the greater the less likely it was originally (assumed). As a consequence of this, a message that is taken for granted and shows a high probability of being emitted by the source actually contains little information, whereas an unexpected and unlikely message contains a large amount of information.

As a consequence of this, given an alphabet of N symbols, the entropy of the legal universe $\log_n$ (N) in t symbols are used with the same frequency, and one can define legal "alphabet efficiency" transmitting information about the typical fact, becomes maximum if or when all sy as the ratio between its entropy and the maximum possible entropy found for an alphabet of N symbols:

$$H\left(X\right) := -\sum p\left(x\right)\log_2 p\left(x\right)/\log_2 N \qquad [2]$$

$x \in X$

Thus, in order to compress files without losing information, it is necessary to use an efficient alphabet. Furthermore, an examination of a compressed file with a text or hexadecimal editor reveals the significant randomness of the bytes present, which provides an opportunity to enhance the efficiency of the encoding process. Using, then, the Huffman encoding[82] and the arithmetic encoding[83], they must estimate the probability with which the symbols of the previous encoding occur in order to improve it. Information is measured in bits, which

py H reaches its maximum value when p(i) is equal to 1/r (where r is the total number of states). This allows for the definition of entropy to be accurately defined and represents the only possible definition. This is in accordance with the principles set forth by Claude Shannon in his seminal work, A Mathematical Theory of Communication.

79. It must fulfil three conditions: if A(k) has probability p(k)=0 of occurrence, then H(p(0), p(1)… p(k-1),0) = H(p(0), p(1)… p(k-1)); and given independent systems A and B there is subadditivity H(A,B)< H(A)+H(B).

80. In contrast to Shannon's approach, which considered the amount of information exclusively in probabilistic terms, whereby a discrete information source is represented as a stochastic process generating characters from a finite alphabet at each temporal instant, Shannon did not deal with semantic content.

81. Shannon 1948, pp. 379-423 and pp. 623-656; Shannon showed how a "random source of information cannot be represented with a number of bits=0.69315 nat [Ed: unit of measurement introduced by Shannon] lower than its entropy, i.e., its average self-information" This result was already implicit in John von Neumann's statistical definition of entropy, who, apostrophised on the subject by Shannon, did not consider it worthy of attention.

82. Huffman coding uses a specific method to choose the representation of each symbol, such as a code without prefixes, i.e., in which no binary string of any symbol is prefixed to the binary string of any other symbol, expressing the most frequent character in the shortest possible way.

83. Arithmetic coding is a compression technique without the loss of information. In computer science, data is represented as a fixed set of bits, for example, characters are often represented with eight bits. Since some symbols with arithmetic coding assume to appear more frequently than others, it assigns variable length codes to the symbols in order to minimise the total number of bits to be transmitted.

are defined as the uncertainty of an event occurring with probability ½. Alternatively, bits can be considered as the information that is obtainable by knowing the outcome of that event. As previously stated, entropy is employed to quantify the information embedded in a message. It was established that the entropy H(X) of a discrete random variable X with probability distribution p(x) represents the degree of uncertainty, or information, associated with the value of X.

Another measure of fundamental importance in information theory is the mutual information between two random variables X and Y, jointly defined as:

$$M(\mathrm{X},\mathrm{Y}) = \sum p(\mathrm{x},\mathrm{y}) \log_2 \frac{p(\mathrm{x},\mathrm{y})}{\mathrm{p}(\mathrm{x})\mathrm{p}(\mathrm{y})} \qquad [3]$$

where p(x,y) represents the joint probability distribution of X and Y, while p(x) and p(y) are the marginal probability distributions of the two variables, respectively. Mutual information informs us how much Y's knowledge reduces X's uncertainty; thus, it quantifies the "mutual" information, i.e., that shared by X and Y. In fact, we can also write:

$$M(\mathrm{X},\mathrm{Y}) = H(X) - H(\mathrm{X}|\mathrm{Y}) \qquad [4]$$

where H(X|Y) *is the* conditional entropy of X given Y, i.e:

$$H\left(\mathrm{X}|\mathrm{Y}\right) = -\sum\sum p\left(\mathrm{x},\mathrm{y}\right) \log_2 p\left(\mathrm{x}|\mathrm{y}\right) \qquad [5]$$

Mutual information can be regarded as a special case of the relative entropy D(p//q), defined:

$$M\left(\mathrm{X},\mathrm{Y}\right) = \sum p\left(\mathrm{x},\mathrm{y}\right) \log_2 p(\mathrm{x},\mathrm{y})/\mathrm{p}(\mathrm{x})\mathrm{p}(\mathrm{y}) \qquad [6]$$

where q(x) is an arbitrary probability distribution on X; In fact, it results:

$$I(\mathrm{X},\mathrm{Y}) = D(p(\mathrm{x},\mathrm{y})//p(x)p(y)) \qquad [7]$$

The relative entropy I(X,Y) is interpreted as the "distance" D (even if it is actually not) between the distributions p(x) and q(x), and while it is always non-negative (and is equal to o if and only if p = q), it is not symmetrical and does not respect the triangular inequality[84].

It has been shown in several studies[85] that an indicator of semantic relevance is given by the unevenness of the "occurrence"[86] profile of a word in a text: in fact, the presence of a word only in certain areas or domains of a (sentence) text means that it is linked to and represents a particular context or section.

Using Montemurro and Zanette's M-Z algorithm[87], based on this assumption, we aim to quantify the information contribution that each word adds to those contexts in which it appears: this index is represented by the difference between Shannon's mutual information assessed on the text (i.e., between the words of the sentence text and the contexts into which it is subdivided) and on a randomised version of the same, obtained by randomly mixing[88] all its words; in other words, it measures how far each of the words deviates from having a homogeneous occurrence profile.

Let us now subdivide the (sentence) text into contiguous sections of equal length: experimentally[89] we know that there exists a particular length that maximises the value of the index (and therefore also maximises the information), and that this maximum (global or absolute) is represented as unique (or extremal); this length varies according to the genre of writing (and, in the extended case, of the linguistic form used in the text) and is typically quantified around a thousand words.

We now derive the explicit writing of the information index.

84. In mathematics, the triangular inequality states that, in a triangle, the sum of the lengths of two sides is greater than the length of the third, in Ferrarese 2017, p. 41.

85. Montemurro 2014, pp. 5-16.

86. In corpus linguistics, occurrences are defined as the absolute frequency of a term in a given text, the presence of a word within the text of a paragraph, document, or book. The term is derived from the English word "occurrence".

87. Montemurro 2014; Montemurro 2010, pp. 135-153; Montemurro 2009, pp. 165-169.

88. For example, by means of the text randomiser compiler by Miniwebtool.com.

89. Montemurro 2009.

Consider a text consisting of N words, using a vocabulary of *K* different words, and a partition *P* of the text divided into intervals $A_1, \ldots, A_P$ of equal length (length is measured in number of words).

Let ω now be a word that appears n times in the text and n_j times in the interval A_j; we then define the conditional probability of encountering the word ω in the interval A_j, as:

$$\rho(\omega \Big| A_j) = \frac{n_j}{S} \qquad [8]$$

Then, the probability of finding the word ω throughout the text is:

$$\frac{n}{N} = p(\omega) = \sum_{j=1}^{P} p(\omega \Big| A_j) p(A_j) \quad \text{where } p(A_j) = \frac{1}{P}, \forall j \qquad [9]$$

We can now use Bayes' rule[90] and calculate the probability $p(A_j|\omega)$; we obtain:

$$p(A_j \Big| \omega) = \frac{p(\omega|A_j)p(A_j)}{p(\omega)} = \frac{n_j}{n} \qquad [10]$$

This indicates the probability of its occurrence within the *j-th* interval, given that it is present in the word *ω*.

Use these quantities to calculate the Shannon mutual information between text sections and word distribution, as follows:

$$M(\mathrm{P}, \Omega) = \sum_{A_j}^{\omega} p(A_j,\omega) \log_2 \frac{p(A_j,\omega)}{p(A_j)p(\omega)} \qquad [11]$$

One must now subtract, from this quantity, the mutual information obtained in a generic randomised text as a measure of the informational contribution of words understood as the tendency of words to distribute themselves unevenly throughout the text.

Let, then: $< \tilde{M} (A_j, \Omega) >$ the mutual "average information" between all possible permutations[91] of the text; the information index is defined as:

$$\Delta\mathrm{I}(\mathrm{P},\Omega) := M(\mathrm{P}, \Omega) - < \tilde{M}(\mathrm{P}, \Omega) > \qquad [12]$$

We observe that if we denote by $\tilde{p}(A_j|\omega)$, $\tilde{p}(\omega)$ and $\tilde{p}(A_j)$ the probabilities calculated on the randomised text and note that $\tilde{p}(A_j) = p(A_j)$ and $\tilde{p}(\omega) = p(\omega)$, the measure [12] can be written in terms of a difference of entropies calculated on the sentence text and its randomised version, respectively:

$$\Delta\mathrm{I}(\mathrm{P},\Omega) := M(\mathrm{P}, \Omega) - < \tilde{M}(\mathrm{P}, \Omega) > = \qquad [13]$$

$$= H(P) - H(\mathrm{P}|\Omega) - (< \tilde{H}(P) > - < \tilde{H}(\mathrm{P}|\Omega) >) = < \tilde{H}(\mathrm{P}|\Omega) > - H(\mathrm{P}|\Omega) = [14]$$

$$= \sum_{\omega=1}^{K} p(\omega) \sum_{j=1}^{\mathrm{P}} [p(A_j|\omega) \log_2 p(A_j|\omega) - < \tilde{p}(A_j|\omega) \log_2 \tilde{p}(A_j|\omega) >] \qquad [15]$$

$$= \sum_{\omega=1}^{K} p(\omega) \sum_{j=1}^{P} [p(A_j|\omega) \log_2 p(A_j|\omega) - < \tilde{p}(A_j|\omega) \log_2 \tilde{p}(A_j|\omega) > \qquad [16]$$

We derive the explicit writing of $< \tilde{H}(P|\omega) >$ on a randomised text divided into P parts of equal length, with ω word occurring n times in the text and n_j times in the interval A_j, obtaining:

$$= \sum_{\omega=1}^{K} p(\omega\ ) \left[< \tilde{H}(\mathrm{P}|\omega) > \mathrm{nbsp;} - H(\mathrm{P}|\omega) \right] \tilde{H}(\mathrm{P}|\omega) = -\sum_{j=1}^{P} \frac{n_j}{n} \log_2 \frac{n_j}{n} \qquad [17]$$

So, the average entropy over all possible random realisations of the text is:

$$< \tilde{H}(P|\omega) > = - \sum_{\substack{m_1+\ldots+m_P=n, \\ m_j \leq \frac{N}{P} \forall j}} \left[p(m_1, \ldots, m_P) \sum_{j=1}^{P} \frac{m_j}{n} \log_2 \frac{m_j}{n} \right] \qquad [18]$$

where $p(m_1, \ldots, m_P)$ is the probability of finding mj occurrences of *ω* in part *j*. Breaking down the expression [18] with respect to each of the P terms of the second sum, we obtain:

$$= -P \sum_{m_1=1}^{min\{n,\frac{N}{P}\}} \sum_{m_2+\ldots+m_P=n-m_1} p(m_1, \ldots, m_n) \frac{m_1}{n} \log_2 \frac{m_1}{n} = = -P \sum_{m_1=1}^{min\{n,\frac{N}{P}\}} p(m_1) \frac{m_1}{n} \log_2 \frac{m_1}{n} \qquad [19]$$

90. Bayes' rule links the inequalities of event A1 to event A2, before and after their conditioning to event B1. The relationship is expressed in terms of the Bayes factor, Λ. Bayes' rule is derived from and is closely related to Bayes' theorem.

91. In mathematics, a permutation is defined as an exchange of the order of a sequence of elements, which may be any, with the objective of finding the number of all permutations (i.e., all sequences with order) that can be formed given a certain number, n, of elements.

$$-\sum_{\substack{m_1+\ldots+m_P=n,\\ m_j\leq\frac{N}{P}\forall j}}\left[p(m_1,\ldots,m_P)\frac{m_1}{n}\log_2\frac{m_1}{n}\right]-\ldots-\sum_{\substack{m_1+\ldots+m_P=n,\\ m_j\leq\frac{N}{P}\forall j}}\left[p(m_1,\ldots,m_P)\frac{m_P}{n}\log_2\frac{m_P}{n}\right]= \quad [20]$$

To sum up, we can write the average entropy using the following formula:

$$<\tilde{H}(P|\omega)>=-P\sum_{m=1}^{min\{n,N/P\}}p(m)\frac{m}{n}\log_2\frac{m}{n} \quad [21]$$

where *p(m)* is the probability of finding the word ω exactly m times in one of the intervals A_j, or:

$$p(m)=\frac{\binom{n}{m}\binom{N-n}{N/P-m}}{\binom{N}{N/P}} \quad [22]$$

In order to test an M-Z algorithm in an entropic environment, we extract the words with the highest information content (*keywords*) from our judgment texts broken down by legal institutions, comparing these results with those obtained on a lemmatised version[92] of our corpus of judgments: To lemmatise our judgment texts we make use of a probabilistic-heuristic grammar annotator that makes use of decision trees, such as Lexicool[93], available GNU-GPL on the web[94].

92. To lemmatise a text means to replace each word, token, with its lemma, i.e., its non-flexed form.

93. Lexicool is a software available under the GPL licence that makes it possible to analyse a text and obtain grammatical analysis (tagging) and lemmatisation of individual words. "There are two advantages to lemmatisation and tagging of text: the first, due to lemmatisation, is the optimisation of the databases used. In these databases, only those lemmas will be present to which the forms in the text will be traced. Verbs will be present in the database conjugated in the infinitive and not in all the possible forms in which they can be conjugated; nouns will be present in the singular; adjectives and adverbs in English would theoretically not need to be lemmatised since they are indeclinable. This entails a considerable streamlining of the database and thus less memory space occupied by it, and a not inconsiderable increase in the speed of the software process and consequently of the analysis. The second advantage (deriving from tagging) consists in the fact that the software implemented will only be able to search the database on words belonging to certain grammatical categories, thus considerably reducing the number of queries to be made and consequently increasing the performance of the software. One might, for example, want to analyse only nouns or only adverbs. Tagging also makes it possible to divide the headwords in the database into different tables according to grammatical category and to search for each term in the analysed text in the appropriate table". Lexicool is 'the most complete and efficient research tool possible for linguists and especially for translators and interpreters. The site is managed by an international team of linguists and programmers based in France and headed by Sebastian Abbo, the site's founder. The team's main work consists of searching and classifying bilingual and/or multilingual dictionaries/glossaries in free access on the Internet. Each resource found is evaluated as objectively as possible according to presentation, user-friendliness, general usefulness and size (number of entries, number of languages). On this appreciation depends on the position of the dictionary/glossary in the search results. Currently, the directory has more than 8000 links and new resources been added every day. https://www.lexicool.com/text_analyzer.asp?IL=2.

94. In order to calibrate the model under study, we have considered a 'large corpus' composed of 34 texts of judgments of different monocratic rites (ordinary civil, labour, justice of the peace, civil appeal to justice of the peace, criminal) in their version in Italian only. This corpus has been indicated with the generic symbol Γ. It is, therefore, a non-parametric corpus of modest dimensions, yet one that enables the illustration of intriguing properties and the proposal of potential avenues for further reflection on the analysis methodology that can be adopted. In order to test the M-Z algorithm in an entropic environment, the words with the highest information content (keywords) are extracted from the sentence texts, with the results being compared with those obtained on a lemmatised version of the corpus. The process of lemmatisation involves replacing each word, token with its lemma, that is to say, with its non-flexed form. In order to lemmatise the sentence texts, a probabilistic-heuristic grammar annotator was employed which utilises decision trees, such as Lexicool, this tool is also primarily an annotator for parts of speech. Lexicool was employed for each original corpus text, designated as Γi, as well as for a lemmatised version of it, indicated as Λi. It was observed that the cardinality of the vocabulary in the texts with corpora Γ i and Λ i exhibited minimal change. The explanation can be found in the existence of blocked phraseologies in the sentential sphere. The literal 'applicable fact-law' method entails a linguistic standard of exposition for the adjudicator, both in the explanation and, even more so, in the writing of the motivation. The process of lemmatising a text has two principal benefits. Firstly, since lemmas encompass

We will observe that the cardinality[95] of the vocabulary in texts with corpora Γ i and Λ i hardly changes at all.

The current explanation can be attributed to the presence of obstructed legal phraseologies in the sentence, namely. The adjudicating operator must employ a linguistic standard of exposition when applying the literal applicable fact-law method. This standard should be used in the drafting of the motivation, which is a bound literal technique, rather than in the explanation of the sentence, which is free technique. Article 12 of the Italian "Preleggi" [trad. Pre-Laws] mandates that the law must not be given any meaning other than what is expressed by the proper meaning of the words and the intention of the legislature.

If a dispute cannot be decided by a precise provision, regard shall be had to the provisions regulating similar cases or similar matters; if the case still remains doubtful, it shall be decided according to the general principles of the legal system of the state. As is well known, a part of speech depends not only on the word itself, but also on the context: thus, simply associating each word with

entire classes of inflections, the redundancies inherent to the legal vocabulary are effectively eliminated. Secondly, it reduces the sparsity of data that is always present in the study of texts in sectorial natural languages, such as legal. The words are ordered in a decreasing sense with respect to frequency, which decreases with the trend of a cardinality of exponent ~ -1 (seen Zipf's law). Finally, the process of lemmatisation results in a reduction in the cardinality of the vocabulary, which in turn leads to an increase in the average word frequency. This is achieved without any loss of comprehensibility. The lemmatised text could generally rely on the informative contributions of a smaller number of words, but the total quantity of information conveyed is the same as that obtained from the original text. This indicates that the information conveyed by the lemmas is redistributed over their inflected forms. During the experimental investigation of merit sentences, it was observed that the keyword extraction process applied to sentence texts may yield results that are influenced by the presence of pronouns, prepositions, and verbs. As nouns are the category that gathers together all the semantic content of a sentential text, establishing its subjects and objects and limiting its legal themes, the extraction was carried out with the cleaning of spurious lemmatised terms. The Lexicool textual machine was employed as a part-of-speech analyser to facilitate the sentential pre-analysis procedure, which was then applied to the M-Z algorithm in an entropic environment for the purpose of assessing a causal impact. In this context, the sentential POS-tagger, which is pre-trained by Lexicool, was utilised to produce tagged output given an input corpus.

95. "In set theory, cardinality, or the number or power of a finite set, refers to the number of its elements: it is indicated by the symbols A, #(A) or card(A). The definition provides an abstract definition and a generalization of the concept of natural number that is also valid for infinite sets. The definition follows the following steps: • Two sets A and B are said to be 'equicardinal' or equipotent or even 'equinumerous' if a one-to-one correspondence can be established between their elements, that is, if each element of A can be associated with one and only one element of B, and vice versa. • It is noted that equicardinality is an equivalence relation (that in reality it only enjoys the properties that characterize equivalence relations) but in axiomatic set theory it is not an equivalence relation, due to the fact that the set of all sets equipotent to an assigned set A is not a set, but a proper class. Therefore, two sets are said to have the same cardinality or the same power if they are equicardinal". Halmos 1974.

its morphosyntactic category of highest probability is an inefficient way of POS-tagging[96-97].

To this extent, Markovian selection[98] appears efficient in literary contexts, but not with the constraint of the language of law, which establishes fixed forms for associating fact and law through a literal-judicial interpretation given by the law itself[99].

Legal sectorial linguistics systems exhibit "intermittent" behaviour, i.e., they alternate long periods of lexical inactivity with phases of hyperkinesis: for instance, in legal texts it is possible to discern a differentiated intermittency for $P(\tau)$ partitions (i.e., $P(\tau)$ distribution signals) in the occurrence profiles of law-specific terms. Thus, the rhythm of the legal term follows the fixity and mobility of the occurrence profiles.

If, in general, a binary string is constructed to visualise this phenomenon, whose *i-th* element is presented as equal to 1 if the event under consideration occurs at time i and 0 otherwise, and in such a case, through a Poisson process, the pattern is presented as random and the probability of an event is independent of time; thus, the return time between two consecutive events, τ, follows an exponential distribution.

Consequently, the rhythm of the legal term is contingent upon the simultaneous presence of both fixity and mobility in the occurrence profiles.

If, in general, we wish to visualise this phenomenon, we may construct a binary string, wherein the *i-th* element is equal to 1 if the event in question occurs at time i and 0 otherwise. In this case, through a Poisson process, the pattern is presented as random. Consequently, the probability of an event is independent of time. Therefore, the return time between two consecutive events, τ, follows an exponential distribution. The term "burstiness" or "intermittency" is employed when the pattern in question is not random.

It is well known that part of the language depends not only on the word itself but also on the

96. *PoS tagging* (part-of-speech tagging) assigns a tag (a tag is defined as a keyword or term associated with information, which identifies and describes the object, making it possible to reclassify and search for information based on keywords) to each word in a *document/corpus*. The choice of *tagset* to be used depends on the language/application being used. The input is a string of words and a *tagset* to be used and the output is the association of the 'best' *tag* with each word. Several *tags* can be seen compatible with a word (ambiguity case), the task of a PoS tagger is to resolve ambiguities by choosing the most appropriate tag according to the context of the word. One of the main problems of a probabilistic method is that it cannot deal effectively with the problem of sparsity of data; in the case of language, due to Zipf's law, this problem is well present, and so if one has a corpus of limited size, the POS-tagger will not work well. One of the methods that can circumvent this problem is the Tree-tagger; it makes use of a corpus annotated by parts of speech to construct a decision tree, which allows for good estimates of transition probabilities. So, we want to determine the probability that a word has p.o.s. $\tau \in$ T, with T being the set of parts of speech; then we consider the set of trigrams $[\tau,\tau\text{-}1,\tau\text{-}2]$, where $\tau\text{-}1,\tau\text{-}2 \in$ T are the possible P.O.S. preceding τ, and we construct the decision tree by proceeding recursively through tests. For example, one test is to ask whether or not it is true that τ-1 is a lemma; we then set $\{\tau\text{-}1 = NN\}$ as the first node of the tree and divide the set of trigrams into those that verify the test, and those that do not (similarly, the tree is also divided into two subtrees). We then proceed recursively with further tests τ-1 and τ-2.

97. Schmid 1994.

98. Manning–Schütze 1999. Lecture notes by F. Tamburini (University of Bologna) on word-space models; Hidden Markov models (HMMs) are used in numerous applications in natural language processing, such as automatic speech recognition, POS-tagging and other pattern recognition. Essentially, these are Markov chains that are allowed to emit a 'symbol' each time a state is reached. Formally, let $V = \{v1, \ldots, vn\}$ be a set of symbols and S a finite or countable set of Markov chain states with transition matrix A and initial distribution Π. Then an HMM is a triple $\Lambda = (A,B,\Pi)$ where $(B)i,j$ is the probability of generating the symbol vj when the state si is reached, i.e., $(B)i,j = (P(y(t) = vj \,|x(t) = si \in S)$, with $y(t) \in V$ being the symbol generated at time t and $x(t) \in S$ being the hidden state at time t.

99. Article 65 of the Judicial Ordinance, in indicating the powers of the Court of Cassation, states that it 'ensures the exact observance and uniform interpretation of the law, the unity of the national objective law, and respect for the limits of the various jurisdictions'; id est: the supreme body appointed to interpret the law must ensure uniformity and unity of the national objective law, confirming that the law is objective, i.e., it must be certain in order to allow for its control'; cf. Betti 1948, p. 13.

context: therefore, simply associating each word with its most likely morphosyntactic category is an inefficient way of doing POS tagging. At this point, apart from the Markovian selection , , , , which is efficient in literary contexts, but not with the constraint of the language of law, which establishes fixed forms to associate fact and law through a literal-judicial interpretation given by the law itself, in order to tag correctly, we explicitly formulate the so-called "supervised learning" rules for tagging, unanimously accepted by the scientific community, such as:

- manually annotate a sample of data (training corpus);
- let the program extract generalisations from the annotated data;
- use a program that has been "trained" on annotated data to annotate new data.

Obviously, taggers will work best when used to tag corpora similar to the training corpus, i.e., taggers calibrated only for judgments on the merits will give maximum efficiency when used for judgments in general, rather than when also used to tag legal literature in general.

In keeping with this, the *burstiness* or intermittency variable is introduced, on the other hand, only when, and to the extent that, the pattern being represented is not random.

Therefore, an effective indicator is calculated that can measure this trend by means of a mathematical lemma:

Lemma 1. Let σ be$_\tau$ *and* μ be$_\tau$, respectively,

- the standard deviation and the mean of $P(\tau)$;
- then the coefficient of variation, defined as $\frac{\sigma_\tau}{\mu_\tau}$;
- means the deviation (departure) from a Poissonian signal.

Indeed, it takes on a value of +1 for a Poissonian signal tending to $+\infty$ and for signals of distribution $P(\tau)$ with infinite variance and finite mean. We prefer, however, an indicator that collects values within a finite interval, and, therefore, we define the *burstiness* index as:

$$B = \frac{\frac{\sigma_\tau}{\mu_\tau} - 1}{\frac{\sigma_\tau}{\mu_\tau} + 1} \qquad [23]$$

The B-index takes values in the limited open range (-1,1), and the signals with the greatest *burstiness*, i.e., intermittence, are those that are closest to the +1 value.

Since words in a text can assume intermittent behaviour, it has been experimentally observed that such words tend to be those of greater semantic relevance. So, we use the index B precisely to calculate the *burstiness* of a word ω in a text string $w_1, \ldots, w_n$; to do so, we transform the text string into a binary string by replacing w_i with 0 if $w_i \neq \omega$, and with 1 if $w_i = \omega$.

If, in this way, we compute $B(\omega)$ for each $\omega \in V$, as the vocabulary of the text string, occurring more than 1 time (=Freq.(ω) ≥1, in the text), we finally obtain a distribution of values for B in the limited open interval (-1,1), whose words with the highest value of B will be our *keywords* [Tab. 1].

Continuing with the evolution of our algorithms, *clustering* consists of grouping a set of word-data according to an established distance between them: in the context of the study of legal language, it is necessary to form clusters (groups) of tokens that share meanings or linguistic functions, or that are together by strict linguistic construction. In fact, the token-words of a text can be represented by vectors in an n-dimensional space called *word space*, and can, therefore, be compared and clustered according to their appropriate reciprocal distance, which will be calculated shortly [Fig. 1].

A *word space* is a model in which words are represented as vectors in an n-dimensional space[100], which we want to represent as a locus of (legal) word meanings; we construct *word spaces* consistently with the so-called "distributional semantics", which states: "Words with similar distributional properties have similar meanings"[101].

100. This theory proposes the paradigm according to which words are distributed in a space in which they are at a distance from each other proportional to their degree of similarity, so that according to the distributional hypothesis "two words are the more semantically similar, the more they tend to appear in the same linguistic context".

101. Eichinger 2017, pp. 1489-1492.

Correspondence between information and frequency of words, in sentence no. 65/2017 of 12 January 2017 of the Court of Verona, section 3, civil jurisdiction							
3-word combination	Frequencies	3-word combination	Frequencies	3-word combination	Frequencies	3-word combination	Frequencies
delle buste paga	12	adempimenti in materia	3	dipendenti un trattamento	3	12 del 1979	2
in materia di	6	ai suoi dipendenti	3	iscritti agli albi	3	1 comma 1	2
materia di lavoro	6	calcolo e stampa	3	nel caso di	3	1 della l	2
buste paga in	5	caso di specie	3	passata in giudicato	3	23-ott-07	2
attività di consulenza	4	circostanza non contestata	3	per sua natura	3	25 i 0013649	2
centri di elaborazione	4	consulente del lavoro	3	redazione delle buste	3	adempimenti di cui	2
compilazione delle buste	4	consulenti del lavoro	3	riservasse ai suoi	3	agli albi di	2
datore di lavoro	4	della legge n	3	soggetti iscritti agli	3	ai minimi retributivi	2
di elaborazione dati	4	di attività di	3	suoi dipendenti un	3	ai propri dipendenti	2
tanto dal ccnl	4	di cui al	3	tra le parti	3	albi di cui	2
un trattamento economico	4	di cui all'art	3	0013649 del 23	2	alla normativa vigente	2
16-gen-15	3	di lavoro previdenza	3	103 del 16	2	all'entrata in vigore	2
Average	Standard deviation	Sum of frequencies	B			al primo comma	2
3,16	2,494	158	-0,118			al risarcimento del	2

Tab. 1 — *Example of correspondence between information and word frequency (it)*

According to Manning[102], semantic similarity between two words is a function of the degree of similarity of their "linguistic environment", i.e., the degree to which the so-called "distributional hypotheses" co-occur – in similar contexts.

On this position Kilgariff argued: "Where word senses have a role to play in a scientific vocabulary, they are to be construed as abstractions over clusters of word usages"[103]. A distributional model realised by means of a "word-by-word" (*WxW*) *occurrence* matrix, in which the occurrences of each word are counted in a limited closed interval [-a, a], contains this type of relationship (an example of a paradigmatic relationship turns out to be that

102. Manning–Schütze 1999.

103. Kilgarriff 1997, pp. 91-113.

DyLan TextTools v2.1.9 guest | esci | guida | italiano | english

Testo da analizzare | Suddivisione in frasi | Suddivisione in token | Parti del discorso | Annotazione | Analisi globale della leggibilità | Proiezione della leggibilità sul testo

SID	TID	token	lemma	POS	F-POS	tratti morfo-sintattici	ID testa	tipo di dipendenza
1.	1.	-	-	F	FC	_	18	punc
	2.	I.	I.	S	SP	_	4	mod
	3.	D.	D.	S	SP	_	4	mod
	4.	s.n.c.	s.n.c.	S	S	num=n|gen=n	18	subj
	5.	di	di	E	E	_	4	comp
	6.	S.	S.	S	SP	_	7	mod
	7.	F.	F.	S	SP	_	5	prep
	8.	e	e	C	CC	_	7	con
	9.	G.	G.	S	SP	_	7	conj
	10.	,	,	F	FF	_	11	punc
	11.	per	per	E	E	_	9	comp
	12.	conto	conto	S	S	num=s|gen=m	11	prep
	13.	di	di	E	E	_	12	comp
	14.	C.	C.	S	SP	_	15	mod
	15.	P.	P.	S	SP	_	13	prep
	16.	,	,	F	FF	_	11	punc
	17.	si	si	P	PC	num=n|per=3|gen=n	18	clit
	18.	occupava	occupare	V	V	num=s|per=3|mod=i|ten=i	0	ROOT
	19.	di	di	E	E	_	18	arg
	20.	redigere	redigere	V	V	mod=f	19	prep
	21.	le	il	R	RD	num=p|gen=f	22	det
	22.	buste	busta	S	S	num=p|gen=f	20	obj
	23.	paga	paga	S	S	num=s|gen=f	22	mod

Fig. 1 — *Tokenisation in the decision n. 65/2017 of 12 January 2017 of the Court of Verona, section 3 civil jurisdiction. By Dylan analysis v.2.1.9. Simplification SID 1-23. Randomized vers.*

between the words "judge" and "justice"). On the other hand, a distributional pattern obtained by means of a "word-by-document" (WxD) matrix, i.e., one in which – given a corpus of documents – one counts the occurrences of each word in each document, contains this type of relationship (an example is the relationship linking "judgment" to "order"). We establish, for the occurrence patterns of the extractable keywords, the metrics to be applied to the clustering algorithms, in order to identify the presence and intensity of the relationships existing between these words.

The (main) metric for calculating *word spaces* in linguistics is that determined by the "cosine distance" represented as follows:

$$d(x,y) = 1 - \frac{|xy|}{xy} = 1 - \cos\theta_{x,y} \quad [24]$$

Whenever we do clustering, therefore, we always adopt this distance. Furthermore, we only experiment on legal syntagmatic relations, using only WxD-type matrices.

One of the earliest approaches to the representation of word meaning in the NLP, which is still given as being little used due to the exact (and time-consuming in terms of usable computer processes) calculation of occurrences rather than the statistical approach based on the probability

of finding occurrences in the corpus, or through statistical averages, is the use of the co-occurrence matrix between words in the corpus, based on a window of ±*m* adjacent words: the "Word embeddings with Co-occurrences and SVD"[104], is the method that exactly expresses the occurrences in a matrix function according to distance-cosine and is legally acceptable as it responds with deterministic and not inferential probabilistic exactness, to Article 12 of the Preleggi. This symmetrical matrix, in essence, counts how many times a given word appears in the window of another within the corpus[105]. The concept behind this construction is that words with similar meanings should have similar usage within the corpus, with similarity reflected in the corresponding row x column of the matrix. We assume a corpus consisting of 3 simple sentences with a window of ±1 words, without taking punctuation into account, and we also include the <BEGIN> and <END> markers of the sentences in the count as follows:

<START> I purchased <END>
<BEGIN> I am the owner <END>
<START> I want to sell <END>

Iterating over all the words in the corpus, we obtain a co-occurrence matrix by counting the words that appear in the respective window [Tab. 2].

We immediately realise that the management of such a matrix, on a real corpus relying on a dictionary of at least 50k-100k words, becomes extremely large and difficult to manage. Moreover, we are faced with an extremely sparse matrix, since relatively "few" words will appear in the window of a given word, leaving us with a matrix composed largely of zeros. In order to make this model practically usable, it is therefore necessary to reduce the dimensionality of the vectors associated with each word, trying to lose as little information as possible. To this end, we use the singular value decomposition (SVD), which allows us in its reduced form to decompose a matrix in the form $A=UDV^T$, where:

104. Another approach used in the field of Natural Language Processing derived from the 2013 paper 'Efficient Estimation of Word Representations in Vector Space' (Mikolov, Corrado, Chen, Dean) is the Word2vec which are trainable models for distributed word representation: by proposing a system that can be trained iteratively on a corpus of documents, capable of learning the meaning of words through word embeddings of a fixed size, one should overcome the problems of dictionary extension. Compared to the co-occurrence matrix, it overcomes the concept of the preliminary calculation of co-occurrences via a $|V|\times|V|$ matrix and its subsequent reworking via SVD, which is cumbersome on extended datasets and dictionaries that may well exceed 100k-1M terms. *Word2vec* models are known as: CBOW (*Continuos Bag Of Words*) model that works on the averages of *word embeddings*; the *Skip-Gram* model that works on similarity and probability distribution of the generated context; the *Negative Sampling* model, consists of an approximation by sampling a set of *word embeddings* extracted according to the frequency Pn (w) of the relevant words in the corpus; the Hierarchical softmax model, involves replacing the entire output layer, including the U matrix, with a binary tree whose leaves are the words of the dictionary and each node of the graph (not a leaf) is associated to a word embedding that the model will learn. A fundamental property of the *Hierarchical softmax* is that each node is guaranteed to normalise the probability.

105. Vagueness is a characteristic feature of the lexicon of natural languages and of the legal lexicon, so special attention is paid to semantic nuances, both in a hermeneutic and in a pragmatic key. The corpus studied distinguishes, in particular in the argumentative part of the sentences, for example, between intent and gros "negligence", where "the subjective element of intent is present when the subject has voluntarily taken advantage of himself" and "gross negligence is present when the subject has acted with obvious carelessness, recklessness and incompetence", with serious disobedience to the law, or even when the behaviour is carried out with "an indisputable disregard of elementary obligation". On the other hand, the vagueness of the language of the law is due to the use of abstract terms that represent concepts of social value and imply evaluations of different "moral situations". Examples are: "diligence", "omission", "good faith", "good morals", all of which require clarification and contextualisation: 'It is thus possible to identify the violation of the canons of loyalty and protection inherent in the principle of good faith, which governs the execution of contractual relationships, including those of employment, pursuant to art. 1375 of the Civil Code, as well as the breach of the duty of care established by Art. 1176 of the Civil Code'.

	<START>	Me	I have	They are	I want	Purchased	Owner	Sell	<END>
<START>	0	3	0	0	0	0	0	0	0
Me	3	0	1	1	1	0	0	0	0
I have	0	1	0	0	0	1	0	0	0
They are	0	1	0	0	0	0	1	0	0
I want	0	1	0	0	0	0	0	1	0
Purchased	0	0	1	0	0	0	0	0	1
Owner	0	0	0	1	0	0	0	0	1
Sell	0	0	0	0	1	0	0	0	1
<END>	0	0	0	0	0	1	1	1	0

Tab. 2 — *Co-occurrence matrix e.g.*

– $A \in R^{n \times d}$ is the starting matrix of rank r,
– $D \in R^{r \times r}$ is a diagonal matrix, on which the singular values of A are placed, arranged on the diagonal in descending order $\sigma 1 \geq \sigma 2 \geq \ldots \geq \sigma r$;
– $U \in R^{n \times r}$ is an orthogonal matrix ($UU^T=I$), whose columns form an orthonormal basis for the space generated by the columns of A;
– $V \in R^{d \times r}$ is an orthogonal matrix ($VV^T=I$), whose columns form an orthonormal basis for the space generated by the rows of A.

At this point we can choose a new reduced dimension k<r for our vectors and consider the submatrix $U1_{:n,1:k}$ of dimension n×k as our new word *embedding* – thus truncating the dimensions *r* in the various matrices of the decomposition to *k*. In this way it can be shown that the new *embedding* captures, however, a relevant part of the variance of the embedding. $\frac{\sum_{i=1}^{k} \sigma_i}{\sum_{j=1}^{r} \sigma_i}$ relevant part of the variance *of the* original *embedding*.

In this way we are able to go from vectors (*word embeddings*) of tens of thousands of components, to vectors of a hundred or so components, retaining much of the encoded information and allowing us to work with manageable vectors to perform comparisons, similarities and other linear operations normally performed on word *embeddings*. Although this model apparently has limitations due to the high dimensionality of the starting matrix and its sparsity, which can be partially resolved through SVD, it has the advantage of maintaining efficiency and reliability in the presence of a codified and rigid language such as the legal language of judgement.

However, SVD decomposition requires quadratic time, but, above all, one must consider the problem of adding new words in the *corpus*, which entails modifying the entire co-occurrence matrix. Furthermore, there is an issue of imbalance between the frequencies of common and uncommon words, which often requires corrections and/or the elimination of the most common words that carry little meaning (e.g.: articles, conjunctions, etc.). Indeed, for our purposes, the representation of the pattern through *keywords* alone excludes "spurious" syntactic elements.

A final discussion deserves the choice of the judgement sample to construct the algorithmic protocol capable of generating judgements autonomously, as a virtual machine, a clone of the real judge and its direct emanation.

If the *keywords* taken from the judge's databases of previous judgments are loaded as input data, broken down by institute and case, and processed according to the illustrated protocol, the output is a written judgement including the operative part, exactly clones of what the judge could have produced, due to his cycle of mental habit and within the framework of the laws and codes. The advantage is obvious: the multiplication of the "human" judge into a judging "humanoid" machine, subject to the same laws as the "human", as an expression of its own will, since it can be tutored in due final control.

Obviously, the greater the size of the statistical universe under consideration, the more reliable the decision-making outcome and the lower the probability of error. However, it should be noted that the *MZ* algorithm of entropy reduction, which is applied to the text's syntropy at the outset, is the only truly statistical element that exists. Nonetheless, this does not invalidate the tagging of the keywords, which are the only elements required for the final processing.

Analyzing the entire set of judgments provides the only way to obtain an output free from statistical errors. This can always be achieved through the use of probabilistic sampling, which maintains a constant fit at Chi-square=0, with events-sentence distributed poissonically.

It is important to always explain technical abbreviations when first used. The probability distribution may be approximated with a Gaussian distribution when the number of events is sufficiently large (with mean square deviation equal to the square root of the mean number of events-sentence) or by utilizing maximum likelihood, reasoned-choice or other non-probabilistic methodologies.

6. *Keywords* as lemmas for robotic sentences

Generally speaking, lemmatising a text has two classes of benefits: firstly, since lemmas bring together whole classes of inflections, redundancies in the legal vocabulary used are eliminated. Secondly, it reduces the sparsity of data that is always present in the study of texts in sectorial natural languages, such as the legal language, and since the words are ordered in a decreasing sense with respect to frequency, the latter decreases with the trend of a well seen cardinality of exponent ~-1[106]. Lastly, lemmatising reduces the cardinality of the vocabulary and consequently increases the average frequency of words, without subtracting comprehensibility from its content. The lemmatised text could generally count on the informative contributions of a smaller number of words, but the sum of these quantities is the same as that obtained from the original text: thus, the information of the lemmas is redistributed over its inflected forms.

On the other hand, in keyword extraction performed on sentential texts, one can obtain a result compromised by the presence of pronouns, prepositions and verbs. As nouns gather all semantic content of a sentence, establishing subjects and objects, as well as rhythm and legal themes, extraction using the Lexicool textual machine as a part-of-speech analyzer is required. To arrive at a sentential pre-analysis, the M-Z algorithm must be applied in an entropic environment to assess causal impact. Spurious lemmatized terms are cleaned during extraction.

In this regard, we use the POS-tagger[107] of sentence, "pre-trained" taggers from Lexicool that, given an input corpus, produce tagged output. As is well known, a part of speech is not only dependent on the word itself, but also on the context: thus, simply associating each word with its most likely morphosyntactic category is an inefficient way of POS-tagging. Thus, apart from the Markovian selection[108], which is efficient in literary contexts, but not with the constraint of the language of law that establishes fixed forms to associate fact and law through a literal-judicial interpretation[109] given by

106. Montemurro–Zanette 2005.

107. PoS tagging (part-of-speech tagging) assigns a tag (a tag is defined as a keyword or term associated with information, which identifies and describes the object, making it possible to re-classify and search for information based on keywords) to each word in a document/corpus. The choice of tagset to be used depends on the language/application being used. The input is a string of words and a tagset to be used and the output is the association of the 'best' tag with each word. Several tags can be seen compatible with a word (ambiguity case), the task of a PoS tagger is to resolve ambiguities by choosing the most appropriate tag according to the context of the word.

108. Manning–Schütze 1999; Lecture notes by F. Tamburini (University of Bologna) on word-space models; Hidden Markov models (HMMs) are used in numerous applications in natural language processing, such as automatic speech recognition, POS-tagging and other pattern recognition. They are basically Markov chains that are allowed to emit a 'symbol' each time a state is reached. Formally.

109. According to a philosophical essay by Professor Luigi Vallauri Lombardi, who is Professor of Philosophy of Law at the University of Florence, there are no less than '144 different ways of interpreting a legal norm'. In general,

the law itself, in order to tag correctly, we explicitly formulate the so-called "supervised learning" rules unanimously recognised by the scientific community for tagging as:

- handwriting a sample of data (training corpus);
- let the programme extract generalisations from annotated data;
- using a programme "trained" on annotated data to annotate new data.

Obviously, taggers will work best when used to tag similar training corpora, i.e., taggers calibrated only to judgments on the merits will be most efficient for use in judgments in general, rather than when also used to tag law literature in general. Other non-Markovian tagging methods for approaching the study of judgments are: the Tree-taggerPOS tagging[110] the Hierarchical clustering (bottom-up)[111], the Kmeans[112], the EM[113].

For the choice of lemmas by means of a non-probabilistic – but qualitative – analysis, it is very efficient and convenient to engage the linguistic machine of *Opinion mining-Sentiment analysis* "Lexalytics" by Lexalytics, 48 North Pleasant St., Amherst, MA 01002, USA, useful both for defining

under the subjective aspect, interpretation is distinguished into doctrinal, judicial and authentic, while for the preordained rule that can be derived from the normative system, which is that dictated by Article 12, Paragraph I of the Dispositions of the Law in General: 'In applying the law, no other sense can be attributed to it than that made manifest by the proper meaning of the words according to their connection, and by the intention of the legislator'.

110. Schmid 1994; Montemurro–Zanette 2005, pp. 29-40. One of the main problems of a probabilistic method is that it fails to deal effectively with the problem of sparsity of data; in the case of language, due to Zipf's law this problem is well present, and so if you have a corpus of limitate size the POS-tagger will not work well; One of the methods that can circumvent this problem is the Tree-tagger; it makes use of a corpus annotated by parts of speech to construct a decision tree, which allows for good estimates of transition probabilities. So, we want to determine the probability that a word has p.o.s. $\tau \in T$, with T being the set of parts of speech; then we consider the set of trigrams $[\tau,\tau\text{-}1,\tau\text{-}2]$, where $\tau\text{-}1,\tau\text{-}2 \in T$ are the possible P.O.s. preceding τ, and we construct the decision tree by proceeding recursively through tests. For example, one test is to ask whether or not it is true that τ-1 is a lemma; then, we set $\{\tau\text{-}1 = NN\}$ as the first node of the tree and split the set of trigrams into those that verify the test, and those that do not (similarly, the tree is also split into two subtrees). We then proceed recursively with further tests τ-1 and τ-2.

111. Hierarchical algorithms have two main characteristics: they are strong (they form disjointed classes) and they recognise a structure, hierarchical, between the elements within a class. These characteristics are read graphically with a tree dendrogram, which has as its root the cluster formed by all elements and as its leaves the clusters formed by syn-groups of elements. The Bottom-Up Algorithm is an example of clustering. Starting with the individual og-jects (the leaves of the tree), the algorithm identifies the two most similar elements and combines them into a single cluster. This process is iterated until all elements belong to a single cluster.

112. The k-means is a non-hierarchical iterative clustering algorithm, i.e., it is based on the idea of finding, iteratively, an optimal partition of the dataset into a predetermined number of clusters (k). Generally, a random partition is considered as the first iteration. Moreover, k.means is a 'strong' algorithm, i.e., it assigns each vector xi one and only one cluster cl. Precisely: $cl = \{x_i \,|d(x_i, \lambda l) \leq d(x_i, \lambda_j), \forall j, 1 \leq j \leq k\}$, where: d is the distance used 'Euclidean' and $x_1, \ldots x_m$ are the vectors of the dataset, while $\lambda_1, \ldots, \lambda_k$ are the centroids of each cluster, redefined at each new iteration as the average of the vectors belonging to the cluster considered. The complexity is O(n) and convergence of the method occurs when the clusters calculated at the i + 1-ma iteration are the same as those calculated at the i-ma iteration (in this case, convergence at step i): convergence is however not taken for granted, as it may happen that the algorithm oscillates between two solutions; therefore, a check should be added in order to avoid the loop.

113. EM (Expectation-Maximisation) is an iterative, non-hierarchical, weak clustering algorithm: this means that it does not associate each vector with a single cluster of belonging in a deterministic manner but rather provides the probability of the vector to belong to each of the clusters. In theory, this idea is formalised by assuming the existence of unobservable data z_j, the z components of which$_{ji}$ assume value 1 if the j-th data belongs to the i-th cluster.

the entropic space of analysis, and for comparing sentences by expressing, through the parameters returned by the internal processing, a relative score. Lexalytics is useful both for defining the entropic space of analysis and for comparing the sentences by expressing, through the parameters returned by the internal processing, a score relative to the analysis of the unfolding and a score relative to the motivation of the decision; working with algorithms that isolate the extracted entities, *topics*, lexemic combinations, category readability, lexical profile, morpho-syntactic profile, tokens, lemmas, dependencies, parts of speech, sentence division and many other indices.

Pivotal to the sentimental or opinion theory is the scientific conviction of the authors mentioned in paragraph 5, that linguistic lexemes and habits given by priming and nudging influence the written verbal representation of sentences. While the legal practitioner's linguistic skills are utilized for the narrative unfolding in the judgement, their representation of the material fact is done so appropriately to the legal fact as in figures 4, 5, 6, 7.

In order to facilitate a more profound comprehension of the qualitative method by means of a lexical machine, it is first necessary to adopt any civil, criminal or even administrative judgment of the Italian legal system. In the present case, a civil-law judgment is to be adopted. As previously stated, the judge's mood is calculated in the section of the judgment entitled *Course of events*, which is reported by the judge using free-form linguistics [Fig. 2].

The subsequent step involves the calculation of the mood of the part of the judgment entitled *Reasons for the decision* [Fig. 3]. This section of the judgment is formulated in accordance with Article 12 of the Pre-Laws of the Italian legal system, which stipulates as follows: "In applying the law, no other meaning can be attributed to it than that made clear by the proper meaning of the words according to their connection and the intention of the legislature. In instances where a dispute cannot be resolved by a specific provision, consideration shall be given to the provisions governing analogous cases or matters. If the matter remains ambiguous, it shall be resolved in accordance with the general principles of the legal system of the State". Article 65 of the Italian Judicial Order stipulates the powers of the Court of Cassation. It states that the court "ensures the exact observance and uniform interpretation of the law, the unity of the national objective law, and respect for the limits of the various jurisdictions". In other words, the court's primary function is to provide a definitive interpretation of the law, ensuring uniformity and unity of the national objective law. This confirms the objective nature of the law, which must be certain to allow for its control. The result of literal interpretation is thus subject to logical interpretation, and although Art. 12 makes no mention of it, it is imposed by an intellectual requirement of the interpreter – who is a judge – who cannot disregard the general principle from which the law derives and the precise purpose it is intended to achieve. The former is the *ratio legis*; the latter, the *occasio legis*. The former illuminates the interpreter by elucidating the meaning of the rule, while the latter provides an explanation of the legislator's intention and the reasons that led to it. In the light of these elements, the content of the rule becomes clearer. It is noteworthy that the logical interpretation may contradict the literal or grammatical interpretation. In such cases, the interpreter must refrain from preferring the logical interpretation. The Supreme Court has explicitly stated that: "When the literal interpretation of a rule of law is sufficient to express a clear and unambiguous meaning, the interpreter must not resort to logical interpretation, especially if through that interpretation there is a tendency to alter the clearly expressed intention of the law". This principle was articulated by the Supreme Court in its 17 November 1993 ruling (Cass. Sez. Lav.). In accordance with the principle of *non liquet*, which precludes the consideration of alternatives or evasion of responsibility, the judge is obligated to determine the moment of motivation, when the arguments substantiating the interpretative choice made become unavoidable and compelling. Any judge is bound to provide the sole correct response to the question posed by the parties. This response must be given, unambiguous, and deemed appropriate by the judge. The motivation must endeavour to persuade that the judge could not have responded more effectively.

The process is further advanced through the calculation of the so-called 'Entities', that is to say, the keywords that evoke the 'sentiment' regarding the judge in accordance with the priming effect. The computational mood is then calculated from these individual entities [Fig. 4].

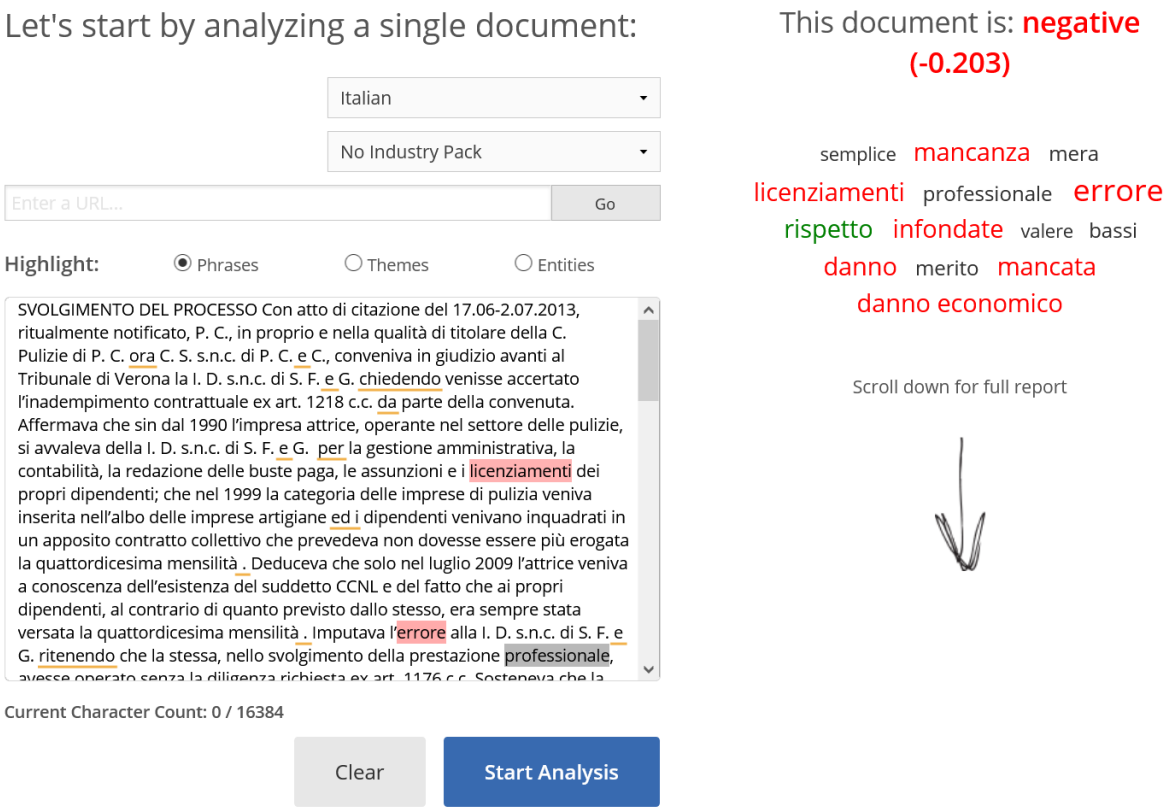

Fig. 2 — *Opinion mining analysis of decision no. 65/2017 of 12.01.2017 of the Court of Verona (Italy), section 3 civil jurisdiction. Course of events. By Lexalytics*

The "Items" associated with these entities are also calculated according to statistical evidence, i.e., with maximum correlation [Fig. 5].

To each item is assigned a sentiment according to its own linguistic dictionary. Each mood is thus weighed individually and, as a whole, is judged for the purpose of an ideological balance, producing expression of the judge's will.

This may include the use of technical terminology and objective language to maintain objectivity and clarity in the delivery of information. It is important to ensure the use of correct spelling and grammar while adhering to conventional academic structure and maintaining a balanced perspective. Additionally, precision is key in language choice to convey exact meaning appropriately.

A physical altercation with a troublesome superior is a relevant circumstance that may not necessarily be recognised as a legal fact, due to the expiration of the offence as a "non-execution of sentence". In the reasoning of the verdict, the judge rationalises their decision regarding the result of the legal fact, namely the intentional legal act, via a process of strict "interpretation".

The judge, who has full knowledge of the laws (*iura novit curia*) within the framework of the legal principle stemming from the bromcardo da *mihi factum, dabo tibi ius*, will act linguistically by means of established "routines" in ordering the judgement, acting on the same available verbal universe acquired over long focused legal studies, apprenticeships and professional updates followed, in the light of the economy of the process to be pursued.

For these reasons, the lemmatic analysis from which to draw capital *keywords* to be analysed and put in relation to each other to construct the structural equation with an explaining solution (the sentence), takes on a connotation more in keeping with reality if it breaks down the limits of the error given by the quantitative forecasting method, using a machine that assigns quality scores according to the perception of the social experience of the judge on the lemmatized term used. It has already been used for three decades to compose market analyses by means of a sociocultural target language.

Thus, when we speak of opinion mining-sentiment analysis in Lexalytics is nothing more than

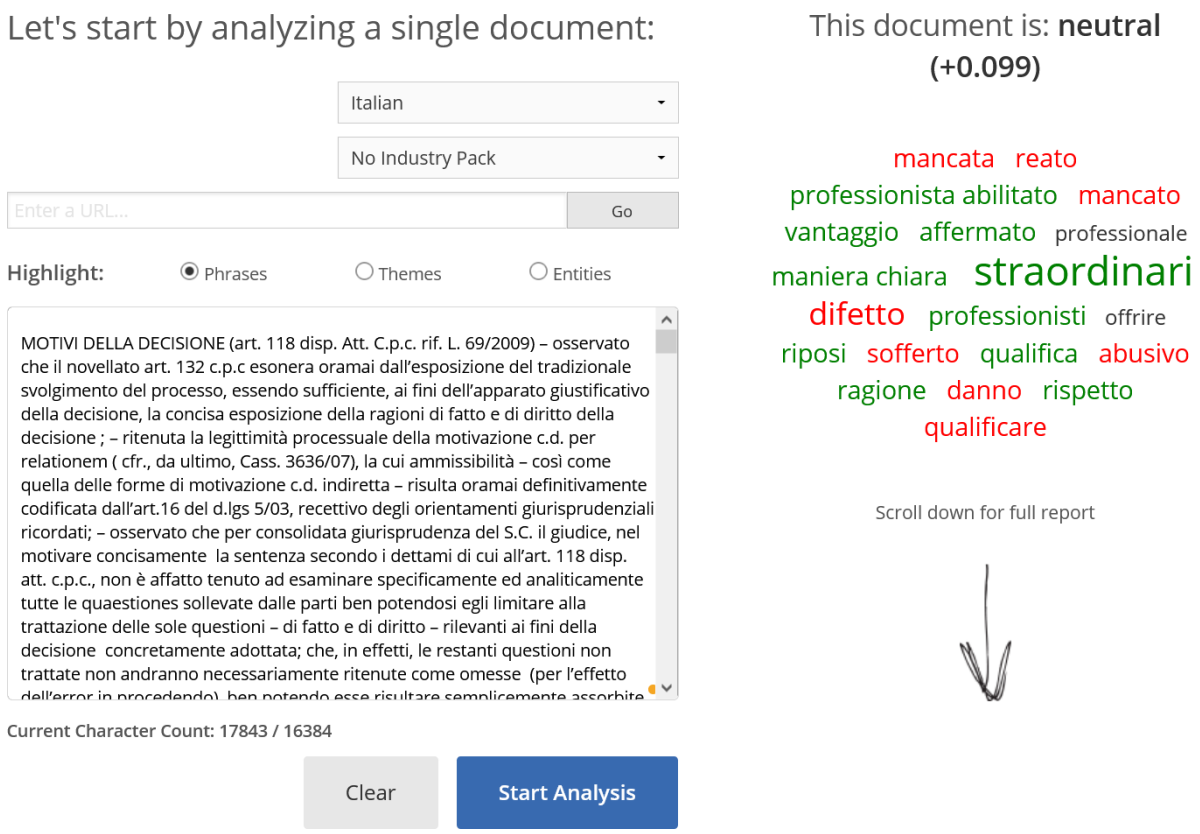

Fig. 3 — *Opinion mining analysis of decision no. 65/2017 of 12.01.2017 of the Court of Verona (Italy), Section 3 Civil Jurisdiction. Reasons for the decision. By Lexalytics*

the process of defining and categorising opinions in a given text as positive, negative or neutral. The three *machine learning* classification algorithms that are mainly used for *opinion mining* are:

– *Support Vector Machines (SVMs)*
– *Naive-Bayes*
– *Decision Trees*

Each has advantages and disadvantages; comparative studies have concluded that the *Naive-Bayes* classifier is the most accurate of the three.

There are also two main algorithms used within a lexicon-based approach:

– *Corpus*
– *Dictionary*

The *Naive-Bayes* classifier, which we prefer, is one of the three self-learning classification algorithms where each individual element is evaluated to determine the probability that the sum of these values leads to a predefined result: to better understand the concept, we can take as an example the offences of theft and embezzlement. If anyone takes possession of a thing, 'stealing' it from the person who owns it, in order to make a profit, he will most likely commit the crime of theft if he does not yet own the thing, embezzlement if he already owns it. Although these characteristics depend on each other or on the existence of the others, all these properties independently contribute to the likelihood of this legal act being sanctioned as theft.

Translating this into the sphere of motivations, we can state that a positive lemma may have a score of +1 while a negative lemma will have a score of -1. It is also possible to assign higher values to certain lemmas that may be more negative in terms of degree. In any case, if the final score of a mention is positive, then the mention is positive and vice versa for negative results. Let us take, as an example, a simple judging device and see how a Lexalytics computer would rank it if we assigned a score to the individual "terms" used, assuming we had already assigned a positive-negative score to a group of terms, such as:"exonerates" (positive/P) – "is not at all" (negative/N) – "relevant" (positive) – "motivate" (positive) – "concretely" (positive), "adopted"

Extracted entities	Associated themes	Evidence	Sentiment
G.	-	7	-3.21
Themes			**Sentiment**
ex art			+2.19
prestazione professionale			+2.19
diligenza richiesta			+2.19
giudizio avanti			-0.59
mera compilazione			-1.14
buste paga			-1.14
specifiche direttive			-1.14
chiedendo il rigetto			-1.49
domande attrici			-1.49
imputava l'errore			-2.45
Verona	+	5	-2.56
S. F.	+	5	-1.20
luglio 2009	+	3	-0.20

Fig. 4 — *Opinion mining analysis of the ruling n. 65/2017 of 12.01.2017 of the Court of Verona, Section 3 civil jurisdiction. Extracted entities. By Lexalytics*

(positive), "limit" (negative), "established" (positive), "jurisprudence" (neutral/NE).

Now let's take a hypothetical post of judgement that notes the mood (motivation/feeling) of the judging driver: "…having observed that (NE) according to the consolidated (P) jurisprudence (NE) of the S.C. the judge (NE), in motivating (P) concisely (P) the judgement (NE) according to (P) the dictates (NE) of art. 118 disp. att. (NE), it is not at all (N) obliged (N) to examine (N) specifically (NE) and analytically (NE) all (P) the quaestiones (P) raised (P) by the parties (NE), being able (P) to limit (N) himself (P) to the treatment (P) only of (N) questions (NE) – of fact (NE) and of law (NE)- relevant to (P) the decision (P) concretely (P) adopted (P)".

Each lexeme appears only once, and if we assign a "1" to each positive and negative value, then we can simply divide the positive and negative words by the amount of words (30) in the entire mention.

- Positive words: 13/30 = +0.43
- Negative words: 5/30 = +0.16
- Neutral words: 12/30 = +0, 40
- Tempest on mood: [P]0.43 – [N]0.16 = + 0.27
- Prevalent content (ideological drag) : P+N-NE = +0.19

Since the total of our mention is positive, we can say that the mood of the above-mentioned is positive. This is a fairly clear-cut case, because we did not encounter polarising words, the *keywords*, which could distort the result if a computer cannot work out which category the word belongs to. In the case illustrated, one can see an ideological drift given the positive translations of the data with respect to the neutral element.

Finally, the use of a lexical *mining* machine offers innumerable advantages over quantitative POS-tagging methods: 1) they assign points and frequencies on lexemes instead of just frequencies; b) they assign frequencies and positions in the corpus; c) they assign values socially deemed as positive and their negative opposite weighted. It is evident that the comparison of positive and negative values and their summation determines a result value that allows a *mood of the judgment* to be weighed, i.e., how much the judgment weighs the *sentiment*

70 themes

more info | api documentation

Extracted themes	Evidence	Sentiment
accertato l'inadempimento contrattuale ex art	7	-3.30
adeguare la gestione delle buste	7	-0.25
apposito contratto	7	-1.09
assegnati i termini	7	-3.17
assegnava i termini	7	-2.18
attività di consulenza	7	+2.27
atto di citazione	7	-1.15
bassi rispetto	7	-5.09
buste paga	7	-12.15
CCNL con mancanza	7	-5.09
chiedendo il rigetto	7	-9.38
chiedevano la concessione dei termini	7	-2.60
comparsa di costituzione	7	-1.70
comparse conclusionali	7	+0.15
confronti di un dipendente	7	-5.09
conseguente inapplicabilità	7	-10.89
contratto per iscritto	7	+1.39
danno economico	7	-5.09
danno ex art	7	-17.10
Deduceva l'inapplicabilità dell'art	7	-2.58
diligenza richiesta	7	+6.42

Fig. 5 — *Opinion mining analysis of the sentence n. 65/2017 of 12.01.2017 of the Court of Verona, Section 3 civil jurisdiction. Themes. By Lexalytics*

of the people who, through their representatives, formed the laws. The judgement thus becomes a thermometer of the social *mood* that also reveals any ideological dragging of the judgement against the legal provision of Article 12 of the Pre-Laws.

7. The *acceptance* of robotic sentences

The debate on robotic decision-making is an extraordinarily important topic that raises fundamental questions about the future of the legal system. This debate starts with the following question: is it possible to imagine a future in which judicial decisions are completely entrusted to robotic systems, based solely on the application of algorithms?

In this discussion, it is important to consider legal calculability and the value of precedent[114]. Legal calculability refers to the ability to precisely and computationally define legal rules and princi-

114. Carleo 2017, p. 193. On the first applications of artificial intelligence systems in the judicial sector, see also: Castelli–Piana 2018, p. 154 ff.; Livni 2017; Carleo 2019, p. 341.

ples that guide legal decisions. Precedent value, on the other hand, concerns the importance of past decisions in shaping law and creating legal precedents.

However, before embracing the idea of a fully automated justice system, we need to consider some fundamental issues. First, there is the ethical dilemma concerning the use of technology in justice. We must ask ourselves whether it is acceptable, in terms of legal education and the fundamental principles of the legal tradition, to entrust meaningful decisions to algorithmic systems. This raises concerns about the loss of humanity and discernment in decision-making, which are essential values for justice[115].

Furthermore, the issue of calculability and predictability of decisions raises questions about the very purpose of judicial decision-making. While the use of technology aims to improve the efficiency and predictability of decisions, we have to question whether this goal is compatible with the intrinsic purpose of justice, which is to assess and resolve disputes fairly and based on the specific facts of each case.

It is fascinating to observe how the idea of using a robot, based on the application of an algorithm, to issue judicial decisions elicits very varied reactions among jurists, oscillating between enthusiastic interest, concern and sometimes dismay. This debate epitomises the conflict between technological innovation and legal tradition, shedding light on essential questions for the future of the legal system[116].

It should be noted that, when assessing the efficiency of an economic system, two of the main indicators considered are the efficiency of the legislative and judicial system, and the duration of legal disputes. These are aspects that the jurist cannot ignore, since, as Riccardo Orestano states, "the jurist can never abstain or alienate himself from life and its knowledge"[117].

Enthusiasm for the idea of robotic decision-making is often fuelled by the promise of greater efficiency and timeliness in the resolution of legal disputes. The possibility of quick and objective answers to legal problems may seem tempting. However, this prospect also raises legitimate concerns about the loss of humanity in decision-making. The role of the judge is not only to apply the law mechanically but also to exercise discernment, sensitivity and understanding of the nuances of situations.

When we discuss the robotic decision, we are really entering a new era, a radical change in the paradigms of justice and law. In this context, IT tools stop being mere aids for communication, managing legal documents or searching for information. They take over the main role in decision-making in complex legal contexts. This concept has given rise to a new terminology: "robogiudians", a definition coined by Max Tegmark, a physicist at MIT[118].

The idea of "robot judges" raises fascinating and revolutionary prospects for the legal field. They could be thought of as highly specialised software capable of handling a wide range of legal cases in parallel, rather than serially as is often the case with human judges. This ability to work simultaneously on all pending cases could lead to a significant reduction in trial time and related costs, making the legal system more accessible and efficient for all[119].

Another aspect to consider is the prospect of "robot judges" with unlimited memory and learn-

115. See on the topic, Various Authors 2019, p. 1656 ff.; Rordorf 2018, p. 4 ff.

116. The relationship between techne and law is developed in the well-known dialogues by Irti–Severino 2000, p. 665, then collected in Irti–Severino 2001; in this regard, see also Severino 2013, p. 87, on the prevalence of technology 'destined to become, from means to ends… and, subordinating every force to itself, it establishes a hierarchy, recognises to every force what is due to them within that hierarchy, thus realising the form of justice to which society is destined to achieve'.

117. Orestano 1987, p. 335.

118. Robogiudists' are artificial intelligence systems designed to meticulously apply the same rigorous legal standards to every legal matter. They act tirelessly without falling victim to human error, such as bias, fatigue or lack of up-to-date legal knowledge. This perspective promises objectivity and consistency in the application of law, eliminating the variability that often characterises human decisions; Tegmark 2018, p. 143.

119. *Ivi*, p. 144.

ing capabilities. Unlike human judges, who may have limitations in understanding complex technical issues, these systems could successfully deal with a wide range of cases, from patent disputes to murders, due to their ability to constantly learn and adapt. This could help ensure greater uniformity and objectivity in legal decisions[120].

A critical aspect emphasised by proponents of robotic decision-making is the predictability of decisions. This recovery of "legal calculability" is considered an important value, as it promotes equal treatment of citizens. The idea is that "robot-icists" apply laws and legal principles consistently, avoiding the subjective variations that can occur in human decisions. This would contribute to a fairer and more predictable legal environment for all.

Interestingly, these ideas are not entirely new. As early as 1969, the jurist Losano hypothesised that cybernetics could be a tool to promote equality by counteracting judicial creativity that can lead to inequalities and the skills of expert lawyers that may not be accessible to all[121].

The perspective of "robogiudists" offers a fascinating vision for the future of the legal system, with the possibility of greater efficiency, uniformity and predictability in decision-making. However, these ideas also raise important ethical, legal and social questions that require careful consideration and reflection as we approach this new era of justice.

8. The physiological limits of the human judge

In the period between the 1920s and the late 1930s, a current of legal thought known as "legal realism" emerged in the United States. This current represented a significant departure from the formal theory of law that had dominated the field until then. Legal realism vigorously opposed formalism, which limited legal reasoning to mere demonstrative logic.

One of the leading proponents of legal realism was Jerome Frank, whose 1930 work made an impressive critique of the formalist conception of jurisprudence. Frank argued that judges' decisions were not the result of rigorous logical reasoning, but rather of "intuitions" through which judges arrived at a final decision. These intuitions often preceded any attempt at justification or explanation. According to Frank, the determining factors in judicial decisions were psychological, moral, political and economic[122].

In this context, the legal norms cited in judgments were regarded as mere formal elements, often used to justify or legitimise decisions made on the basis of other considerations. Legal realism raised important questions about the very nature of legal decision-making and led to a critical review of previously dominant theories in the field of law.

Legal realism highlighted the inherent limits to the decision-making operation of judges, challenging the traditional idea that judgments were the result of a rigorous process of logical application of laws. This movement helped to "desacralise" the role of judges and their decisions, challenging the image of judgments as supreme manifestations of the magistrates' thought and methodological logic.

An aphorism emblematic of the realist perspective is the famous phrase "Justice is what the judge ate for breakfast" paraphrased in the title of an essay that appeared in the 1990s that fuelled this realist perspective and aroused lively interest in the legal debate[123]. This expression satirically condenses the realist view that judicial decisions were often influenced by subjective, personal or even random factors, rather than by a strict and impartial application of the law.

In an interesting study conducted by three researchers at Columbia University in collaboration with Tel Aviv University, the topic of rational decision-making in judges was addressed. The surprising results of this research seemed to confirm critics' concerns about rationality in the decision-making processes of judges[124].

120. *Ibidem*.

121. Losano 1969. Losano's further contributions on the subject are also important. In particular: Losano 1967, pp. 1589-1602; Losano 1966-1967, pp. 307-325; Losano 1971, p. 152 ss.; Losano 1978, pp. xii-xiv.

122. Frank 1930, p. 448.

123. Kozinski 1993, p. 993.

124. Danziger–Levav–Avnaim-Pesso 2011, pp. 6889-6892. For more on the subject, Marzocco 2018, p. 272.

In the study, the researchers closely examined the findings of no less than 1,110 sentences handed down by eight judges of two separate Israeli courts. These courts were responsible for deciding whether or not to grant freedom for good behaviour to prisoners held in the country's four largest prisons. In terms of our legal system, this judiciary would roughly correspond to the Surveillance Court.

The results of the survey revealed a surprising trend: the rate of granting parole requests decreased by 65% when decisions were made at the beginning of each work session or shortly after the morning coffee break or immediately after the lunch break. In other words, favourable sentences seemed to be concentrated at specific times of the judges' working day.

This study analysed the work of judges over a 10-month period. The results raised important questions about the rationality of judicial decisions and the effect of the time of day on their ability to make impartial decisions. In particular, they highlighted how external circumstances, such as fatigue or hunger, could significantly influence judges' decisions, raising important ethical and procedural questions in the judicial system.

In this study, each judge dealt with a significant amount of cases each working day, dealing with a range from 14 to 35. The research examined several variables, including the order in which the cases were presented (i.e., after how many prisoners their case was called), the time of day the cases were dealt with, the ethnic origin and background of the prisoners, as well as the type of offence they were convicted of.

During the course of the day, the judges regularly took two breaks, one for coffee and one for lunch, each with varying times and durations, and had three consecutive work sessions. This allowed the scholars to examine not only the effect of time on the judges' decision-making, but also the impact of the breaks on their decision-making ability.

The results of the survey revealed a surprising pattern: the tendency for prisoners to pass favourable sentences was much more pronounced at the beginning of each work session, but gradually declined as time passed until it became insignificant. However, this trend would reverse and return to its peak after coffee or lunch breaks. What was clear from this study was that factors completely unrelated to the legal issues dealt with significantly influenced the judges' decisions.

A simple interruption of work and the intake of a drink or food was enough to cause judges to treat often entirely similar cases differently. This phenomenon raised important questions about the consistency and impartiality of judicial decisions and underlined the extent to which environment and personal circumstances could influence the judges' decision-making process.

Understanding the results of this study required an analysis that went beyond the field of law, exploring the spheres of the psychobiology of the brain and the physiology of the human body. It was discovered that repetitive work, accompanied by the need to make similar decisions in an almost systematic manner, can gradually exhaust an individual's mental resources, impairing his or her ability to plan, adapt and evaluate actions efficiently. Routine tends to weaken so-called "executive functions" and can lead to conditioning in decision-making involving almost identical situations[125].

Mental fatigue may increase the decision-maker's propensity to simplify problems, prompting him/her to rely primarily on similar past experience. However, it is interesting to note that the ability to tackle problems in a more considered manner is restored, and mental fatigue is overcome, after a short break and an increase in blood glucose levels, which can be achieved through the consumption of drinks or food.

In other words, this study highlights how the judge's physical and psychological condition can influence judicial decisions in surprising ways. Mental fatigue and routine can lead to a more superficial approach to decision-making and a tendency to follow precedents without properly assessing the specific circumstances of each case. However, a break and an adequate supply of glucose can help restore mental clarity and the ability to make more considered decisions. These results highlight the importance of considering not only legal aspects, but also psychological and physiological ones in the context of judicial decision-making.

125. Eagleman 2016, p. 220. For more on the subject, Ekman 1999, p. 508; Ekman–Oster 1979, pp. 527-554; Fiandaca 2013, p. 408; Fuselli 2013, p. 256.

The results of this study highlight the importance of the judge's psychophysical condition even in decisions involving the responsibility of a defendant. The resting condition of the judge can, in fact, have a significant impact on the quality of decisions. A well-rested judge is more likely to make well-considered decisions than one who is tired and exhausted by the daily routine.

The researchers also examined the importance of the length of hearings and how much the time factor can influence the decision-making process. It turned out that the longer a hearing lasts, the greater the risk that a judge's mental fatigue negatively affects his or her propensity to make favourable rulings. This raises interesting questions about time management in judicial hearings and the need to consider the rest requirements of judges during proceedings that may extend over many sessions.

While there is a lack of specific empirical data to assess the effect of breaks, such as lunch breaks, in the context of long and complex hearings, one undeniable fact remains: factors outside the technical and legal issues can significantly influence the decision-making process, even when judges with established professional experience are involved.

9. Will there ever be a *just judge*?

Scholars identify a number of factors within the proceedings that can contribute to judicial errors[126]. Often, the error is attributed to a kind of "deviation" by the judge from the rational path outlined by epistemological rules. These rules aim to establish in concrete terms the relationship between probability and proof, using appropriate inference criteria such as the maxim of experience, statistical law or scientific law with varying degrees of empirical reliability.

However, it should be noted that judicial errors may result from a complex combination of factors, some of which may not be strictly related to epistemological rules. These factors may include emotional influences, mental fatigue, psychophysical conditions of the judge, factors external to the trial itself, or even the interpretation of evidence in complex and evolving contexts.

In addition, it is important to emphasise that miscarriages of justice are not only limited to wrong decisions in terms of the guilt or innocence of the defendant, but may also relate to the size of the sentence or other procedural issues. Therefore, the analysis of miscarriages of justice requires a thorough understanding of all these factors and the complex dynamics that can influence decision-making in the justice system.

The causes of miscarriages of justice can be attributed to a wide range of factors, which often include human behaviour, whether guilty or innocent, but also circumstances due to chance, misleading appearances or even outright fatalities. These factors can be divided into categories that include aspects related to the trial system, but also influences external to the trial itself.

One of the relevant factors is human behaviour. Errors may result from decisions of the protagonists involved in the trial, whether they act in good or bad faith. However, the causes of errors cannot always be attributed to individual responsibility, as there may also be situations where the innocence of a defendant has not been adequately recognised due to misleading or manipulated evidence or testimony.

In addition to causes related to human behaviour, there are factors that fall into the sphere of coincidences or false appearances. In some cases, mere chance can lead to miscarriages of justice, while in others, circumstances can create an illusion of guilt or innocence.

More, there are influences outside the process itself that can contribute to miscarriages of justice. The press, mass media and, more recently, the Internet and social media, can exert a strong influence on public opinion and, consequently, on the judicial process. Often, sensationalist narratives and the tendency to emphasise the emotional aspect of cases can distort the perception of reality.

Sociological research has shown how television, in particular, can exert a powerful suggestive force through images, significantly influencing opinion formation. This phenomenon can lead to a distorted reading of reality, in which the emotional aspect prevails over the rational evaluation of evidence.

Misperceptions or distorted perceptions pose a threat as they influence people's opinions, attitudes and behaviour. Thus, they can lead us to make decisions based on prejudices or misleading perceptions, influencing our attitudes and behaviour. It

126. Troisi 2011, p. 304; on this topic see also Imposimato 2009, p. 442.

is therefore crucial to be aware of these external influences and try to critically evaluate the information presented to us, especially when it comes to legal and judicial matters.

The phenomenon of the spectacularisation of trials has become an obvious reality with wide public resonance[127]. It is enough to think of court cases such as that of Perugia, linked to the murder of Meredith Kercher, which divided public opinion between those who believed in the innocence of the defendants and those who supported their guilt. Similarly, the trial of Annamaria Franzoni, accused of the murder of her little son, or the case of the death of Alberto Stasi's girlfriend, which saw the final conviction of the young defendant. The spectacularisation of trials has become increasingly invasive, often overstepping the boundaries of the legitimate exercise of the right to report news. This phenomenon has had a significant impact on the lives of those involved, creating an overlap of television broadcasts that, in some cases, seem to anticipate or even replace the judicial decision. During these broadcasts, witnesses and experts, often more or less qualified, are interviewed and "alternative truths" are proposed in order to increase the television audience. This approach can have a considerable impact on public opinion and can sometimes undermine the fact-finding process, which should take place in an impartial and rigorous manner within the appropriate court context[128].

Television broadcasts tend to arouse strong emotions in viewers, often influencing public perceptions of court cases. In particular, in trials before a jury of popular judges, there is a risk that these jurors, as television viewers, will be influenced by the emotional stirrings and suggestions in the broadcasts. This can be a problem, since the task of the jury is to reach an impartial decision based solely on the evidence and the law, without being influenced by outside influences. Therefore, it is important to carefully consider the impact of the spectacularisation of trials on public perception and the legal system as a whole.

The use of media in the trial represents a challenge for both the defendant and the justice system, and this issue is considered among the main causes of miscarriages of justice[129]. While in the real trial, the defendant enjoys the presumption of innocence, in the media trial, which is often characterised by a sensationalist narrative, the defendant is forced to defend himself against a potential justicialist drift[130].

Scholars tend to attribute most miscarriages of justice to the incorrectness or even falsity of the evidence presented. False testimony, a distorted perception of the facts by witnesses, or a lack of understanding by the judge of the basic principles of testimony can lead the judge to wrongly convict an innocent individual. In addition, a personal investigation conducted improperly, in violation of court rules or in an unprofessional manner, can lead to miscarriages of justice. Similarly, a confession obtained through coercion by investigators, especially on psychologically vulnerable individuals, may lead to wrongful conviction.

It is important to note that the media attention on a court case can amplify these problems, as it can influence public opinion and put pressure on the justice system to deliver a verdict quickly. Therefore, it is crucial to strike a balance between freedom of the press and the goal of ensuring fair and impartial trials, so that media use of the trial does not become a threat to justice itself.

Scientific evidence, although often regarded as a source of objective evidence, can also deviate from the truth. In such cases, it is experts, acting as expert witnesses or consultants, who can lead the judge to an erroneous conclusion in the case. This phenomenon can be observed in various legal systems, with the US experience providing significant examples.

Federico Stella, in particular, analysed the accusatory paradigm and the antagonistic structure of the criminal trial, noting that this has led experts to adopt a kind of "partisan culture". This culture leads experts not to separate facts from scientific opinions, opinions from conjecture, and questions

127. Amodio 2016, p. 274.

128. Kalb 2005, p. 239.

129. Troisi 2011, p. 304; on this topic see also Imposimato 2009, p. 442.

130. Paulesu 2008, p. 600.

of fact from value choices[131]. This phenomenon is often associated with the concept of pseudoscience or so-called "junk science", and has been widely examined by legal process scholars, especially in the United States"[132].

This may lead the judge to form an erroneous conviction, wrongly assuming that the elements provided by scientific evidence are subject to objective evaluation. In the presence of evidence based on scientific knowledge, the judge may erroneously withdraw from his evaluative function[133].

In fact, the role of the judge should be to carefully examine the margin of error present in any scientific method and the expert should be obliged to clarify the probability of error associated with the scientific model used. In this way, scientific evidence can be prevented from being distorted or misunderstood, ensuring a fair and impartial trial based on reliable scientific knowledge. The issue of judge subjectivism is a crucial aspect of the criminal trial, yet scholars in this field have often not given it the attention it deserves. In the past, questions have been raised about the judge's insufficient caution or experience in evaluating evidence, the difficulties in distinguishing between truthful and untruthful testimony, and the challenges associated with the statements of weak subjects, such as minors[134].

However, it is surprising to note that there has been relatively little reflection on the fact that the conclusive judgement of a trial is often based on intuition rather than strict logic. This statement was made as early as the beginning of the last century by scholars such as Altavilla[135]. To fully understand this dynamic, it is useful to consider the words of Calamandrei, who emphasised that, except in pathological cases, the judge is influenced by reasons not declared even to himself. These are unconscious sympathies or repulsions that intuitively guide him to select a legal solution from among many possible ones, a solution that reflects these hidden feelings[136]. These feelings may be triggered by the emotions aroused in the judge by the human case under discussion, and in this way may unconsciously condition his judgement.

This element of subjectivity is an important challenge to be faced in the legal system, as it underlines how complex it is to achieve a completely impartial decision. Few, like Piero Calamandrei, have written of the verdict, without mincing words, "that the motivation is nothing more than an expedient of formal hypocrisy, made almost, one might say, to give a logical disguise to a will born of quite different motives that may be arbitrariness and injustice"[137].

The idea that the justification of the judgment can serve primarily to validate a hypothesis already formed by the judge represents an intriguing and incisive perspective within the judicial system. This concept suggests that, in reality, the judge's decision-making process may be largely intuitive, with the justification following later to provide a retroactive rational justification.

Moreover, this insight sheds light on the understanding of judicial decision-making. Jerome Frank, one of the leading figures of legal realism, had clearly emphasised that judges are no different from other people and that irrational forces can play a significant role in their decisions. This represents a realistic and humane view of the judicial system, contrasting with the traditional idea of judges as purely rational and objective beings.

This view challenges the image of the judge as a being completely immune to emotional or irrational influences. On the contrary, it suggests that judges, like all individuals, can be influenced by emotional, personal or psychological factors that can significantly shape their decisions. Therefore, recognising this human dimension in judicial decision-making is crucial for a more complete and realistic understanding of the functioning of the legal system.

131. Stella 2001, p. 608.
132. Jasanoff 1995, p. 400.
133. Dominioni 2005, p. 372.
134. Pisapia 1989, pp. 165-178.
135. Golding 2001, p. 187.
136. Calamandrei 1965, p. 618.
137. Calamandrei 1954, p. 157.

Cappelletti's view that the real motivation for a judgment lies in the judge's feelings and emotional sphere emphasises the importance of subjective variables in judicial decision-making[138]. This perspective suggests that free conviction, which forms the basis of judicial evaluation, is intrinsically linked to a discretion that can result in personal intuitions, feelings, emotions and sometimes even ideological beliefs, personal values and subjective worldviews.

In other words, the judge's decision-making process cannot be separated from his or her personal experiences, emotional inclinations and personal convictions. This recognition challenges the idea that law is an exclusively rational and objective discipline, emphasising instead the human and subjective dimension that permeates the legal system.

The various regulatory strategies adopted in the various trial systems to limit the judge's discretion and regulate the use of evidence have often proven their insufficiency in preventing miscarriages of justice. This highlights the complexity of judicial decision-making and the difficulty of completely reducing subjectivity in the evaluation of evidence. Indeed, these challenges reinforce the importance of greater awareness of the human and emotional factors that can influence judicial decisions, as well as the need for constant improvement of methods and protocols to minimise judicial error.

The analysis of psychological phenomena such as instinct, intuition, subjectivity, emotions, feeling and bounded rationality is a fundamental approach to better understand judicial decision-making. While traditional trial-criminal doctrine tends to neglect these aspects, psycho-legal research and cognitive sciences have long recognised their essential role in judicial decision-making. It is important to emphasise that errors in judicial decision-making are not random, but often result from predictable patterns of thought operating under conditions of uncertainty. These errors can be difficult to anticipate and control, as they are ingrained in the common way of reasoning and decision-making.

In other words, the risk of making mistakes is present in any human activity involving the making of a judgement, and this is particularly true in the judicial context, where the consequences of decisions can be significant for the lives of the people involved.

10. Concluding reflections

In this context, it may be necessary to intervene in order to ensure the pseudonymisation or encryption of personal data. This is essential to protect the individuals' right to privacy and control over their personal information. Moreover, it helps to prevent the risk of profiling by judicial institutions.

Pursuant to this, work needs to be carried out on two fronts. The first is to establish a comprehensive and dependable database of judicial rulings. The second imperative is the assurance of adherence to constitutional principles and individual rights when implementing AI systems.

It is not feasible to merely substitute the natural judge with automatic predictive justice systems, regardless of any technological advancements. Citizens retain their fundamental right to access an independent and unbiased judge, established by law, in order to safeguard their rights.

However, the usefulness of AI systems cannot be denied in assisting judges in performing their duties. These systems include state-of-the-art search engines, software for drafting legal documents, automated systems to streamline internal work processes as well as software for easy perusal and filtering of information. They are also useful in handling simple, serial, repetitive, purely documentary cases, among others. AI systems could prove useful in alternative dispute resolution procedures when citizens freely choose them to expedite certain justice processes, particularly those related to administration and civil matters.

It would be unwise to neglect the potential benefits brought by information technology and new AI systems. When used in a carefully controlled manner, they could facilitate the enhancement of both quality and efficiency within our justice system. Moreover, they have the potential to lure greater amounts of industrial capital investment from abroad.

138. Cappelletti 1969, p. 569.

References

E.A. Afendras, N.S. Tzannes, J.G. Trépanier (1973), *Distance, Variation and Change in Phonology: Stochastic Aspects*, in "Folia linguistica", vol. 6, 1973, n. 1-2

E. Agazzi (1980) (ed.), *Modern Logic. A Survey*, Springer, 1980

C.E. Alchourrón, A.A. Martino (1990), *Logic without Truth*, in "Ratio Juris", vol. 3, 1990, n. 1

E. Amodio (2016), *Estetica della giustizia penale*, Giuffrè, 2016

C. Barbaro (2018), *Uso dell'intelligenza artificiale nei sistemi giudiziari: verso la definizione di principi etici condivisi a livello europeo?*, in "Questione giustizia", 2018, n. 4

G.A. Barnard (1955), *Statistical Calculation of Word Entropies for Four-Western Languages*, in "IRE Transactions on Information Theory", vol. 1, 1955, n. 1

F. Battaglia (2007), *Catene di Markov*, in Id., "Metodi di previsione statistica", Springer, 2007

J. Bernstein (1990), *Uomini e macchine intelligenti*, Adelphi, 1990

E. Betti (1948), *Le categorie civilistiche dell'interpretazione*, in "Rivista italiana per le scienze giuridiche", Giuffrè, 1948

R. Bin (2013), *A discrezione del giudice. Ordine e disordine: una prospettiva "quantistica"*, FrancoAngeli, 2013

M.A. Boden (2018), *Artificial Intelligence: A Very Short Introduction*, Oxford University Press, 2018

P. Bourdieu (2005), *The Practical Sense* (tr. it.), Armando, 2005

M. Brady (2013), *Emotional Insight: The Epistemic Role of Emotional Experience*, Oxford University Press, 2013

P. Calamandrei (1965), *Processo e democrazia*, in M. Cappelletti (a cura di), "Opere giuridiche", vol. 1, Morano Editore, 1965

P. Calamandrei (1954), *La crisi della giustizia*, in Aa.Vv., "La crisi del diritto", Cedam, 1954

M. Cappelletti (1969), *Processo e ideologie*, il Mulino, 1969

A. Carleo (2019) (a cura di), *Decisione Robotica*, il Mulino, 2019

A. Carleo (2018) (a cura di), *Il vincolo giudiziale del passato*, il Mulino, 2018

A. Carleo (2017) (a cura di), *Calcolabilità giuridica*, il Mulino, 2017

S.B. Carroll (2006), *Infinite forme bellissime. La nuova scienza dell'Evo-Devo*, Codice Edizioni, 2006

C. Casonato (2019), *Intelligenza artificiale e diritto costituzionale: prime considerazioni*, in "Diritto pubblico comparato ed europeo", 2019, n. 1s

S. Cassese (2022), *Il governo dei giudici*, Laterza, 2022

C. Castelli, D. Piana (2018), *Giustizia predittiva. La qualità della giustizia in due tempi*, in "Questione giustizia", 2018, n. 4

A. Celotto (2019), *I robot possono avere diritti?*, in "BioLaw Journal. Rivista di BioDiritto", 2019, n. 1

A. D'Aloia (2019), *Il diritto verso "il mondo nuovo". Le sfide dell'Intelligenza Artificiale*, in "BioLaw Journal. Rivista di BioDiritto", 2019, n. 1

D. Dalfino (2019), *Stupidità (non solo) artificiale, predittività e processo*, in "Questione giustizia", 3 luglio 2019

S. Danziger, J. Levav, L. Avnaim-Pesso (2011), *Extraneous factors in judicial decision-making*, in "Pnas", vol. 108, 2011, n. 17

D. Davidson (1980), *Mental Events*, in Id., "Essays on Actions and Events", Clarendon press, 1980 (in Italian: *Eventi Mentali*, in "Azioni ed eventi", il Mulino, 1992)

A. de Tocqueville (1840/1968), *La democrazia in America*, II, transl.it., Utet, 1968

G.B. Debiasi, G.A. Valli (1968), *Sorgenti di messaggi per prove di intelligibilità della parola*, in "Atti e memorie dell'Accademia patavina di scienze, lettere ed arti", vol. 80, 1968

L. De Renzis (2019), *Primi passi nel mondo della giustizia «high tech»: la decisione in un corpo a corpo virtuale fra tecnologia e umanità*, in A. Carleo (2019) (a cura di), "Decisione Robotica", il Mulino, 2019

O. Dominioni (2005), *La prova scientifica penale. Strumenti tecnico-scientifici nuovi o controversi e altamente specializzati*, Giuffrè, 2005

D. Eagleman (2016), *The Brain: The Story of You*, Canongate Books Ltd, 2016

T. Eichinger (2018), *The Corpus Replication Task*, in "Proceedings of the 2017 International Conference on Computational Science and Computational Intelligence (CSCI)", IEEE Computer Society, 2018

P. Ekman (1999), *Introduzione*, in C. Darwin, "L'espressione delle emozioni nell'uomo e negli animali", Bollati Boringhieri, 1999

P. Ekman, H. Oster (1979), *Facial Expressions of Emotion*, in "Annual Review of Psychology", vol. 30, 1979

M. Fasan (2019), *Intelligenza artificiale e pluralismo: Uso delle tecniche di profilazione nello spazio pubblico democratico*, in "BioLaw Journal. Rivista di BioDiritto", 2019, n. 1

L. Ferrajoli (2013), *Nove massime di deontologia giudiziaria*, in "Una Città", 2013, n. 208

M. Ferrarese (2017), *Decisional processing on parking behaviour in entropic settings*, in "Archives of Transport", vol. 41, 2017, n. 1

G. Fiandaca (2013), *Sul ruolo delle emozioni e dei sentimenti nella genesi e nella applicazione delle leggi penali*, in O. Di Giovine (a cura di), "Diritto penale e neuroetica", Cedam, 2013

K.A. Findley, M.S. Scott (2006), The multiple dimensions of tunnel vision in criminal cases, in "Wisconsin Law Review", 2006

A. Forza, G. Menegon, R. Rumiati (2017), *Il giudice emotivo. La decisione tra ragione ed emozione*, il Mulino, 2017

J. Frank (1930/2009), *Law and the Modern Mind*, Routledge, 2009

S. Fuselli (2013), *Le emozioni nell'esperienza giuridica: l'impatto delle neuroscienze*, in L. Palazzini, R. Zannotti (a cura di), "Il diritto nelle neuroscienze. Non 'siamo' i nostri cervelli", Giappichelli, 2013

E. Gabrielli, U. Ruffolo (2019), *Artificial intelligence and law*, in "Giurisprudenza italiana", 2019, n.

A. Garapon, J. Lassègue (2018), *Justice Digitale. Revolution graphique et rupture anthropologique*, Presses Universitaires de France - PUF, 2018

H. Gintis, D. Helbing (2013), Homo socialis*: an analytical core for socio-logical theory*, 2013

M.P. Golding (2001), *Legal reasoning*, Encore Edition, 2001

D. Goleman (1995), *Emotional Intelligence: Why it can matter more than IQ*, Bloomsbury, 1995

I. Goodfellow, Y. Bengio, A. Courville (2016), *Deep Learning*, The MIT Press, 2016

G. Gulotta (2014), *Psicologia dell'errore nell'investigazione e nel giudizio*, in L. De Cataldo Neuburger (a cura di), "'L'operazione decisoria'. Da emanazione divina alla prova scientifica. Passando per Rabelais", Cedam, 2014

G. Gulotta (2011), *Compendio di psicologia forense, criminale e investigativa*, Giuffrè, 2011

P. Hadot (2007), *Wittgenstein and the Limits of Language*, Bollati Boringhieri, 2007

P.R. Halmos (1974), *Naive Set Theory*, Springer, 1974

H.L.A. Hart (1961), *Il concetto di diritto*, Einaudi, 1961

G.E. Hughes, M.J. Cresswell (1996), *A New Introduction to Modal Logic*, Routledge, 1996

M. Iaselli (2024), *AI Act. Principi, regole ed applicazioni pratiche del Reg. UE 1689/2024*, Maggioli, 2024

F. Imposimato (2009), *L'errore giudiziario. Aspetti giuridici e casi pratici*, Giuffrè, 2009

N. Irti (2019), *Il tessitore di Goethe (per la decisione robotica)*, in A. Carleo (a cura di), "Decisione robotica", il Mulino, 2019

N. Irti, E. Severino (2001), *Dialogo su diritto e tecnica*, Laterza, 2001

N. Irti, E. Severino (2000), *Le domande del giurista e le risposte del filosofo (un dialogo tra diritto e tecnica)*, in "Contratto e impresa", 2000, n. 2

S. Jasanoff (1995), *La scienza davanti ai giudici*, Giuffrè, 1995

D. Kahneman (2012), *Thinking, Fast and Slow*, Newyord Macmillan, 2012 (tr. it. *Pensieri Lenti e Veloci*, Mondadori)

L. Kalb (2005), *La "ricostruzione orale" del fatto tra "efficienza" ed "efficacia" del processo penale*, Giappichelli, 2005

J. Kaplan (2018), *Intelligenza artificiale. Guida al futuro prossimo*, Luiss University Press 2018

A. Kilgarriff (1997), *I don't believe in word senses*, in "Computers and the Humanities", vol. 31, 1997, n. 2

A. Kozinski (1993), *What I Ate for Breakfast and Other Mysteries of Judicial Decision Making*, in "Loyola of Los Angeles Law Review", vol. 26, 1993, n. 4

L. Lanza (2011), *Emozioni e libero convincimento nella decisione del giudice penale*, in "Criminalia. Annuario di scienze penalistiche", 2011

J. Ledoux (1998), *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*, Simon & Schuster, 1998

E. Livni (2017), *Nei tribunali del New Jersey è un algoritmo che decide chi esce su cauzione*, in "Internazionale.it", 3 marzo 2017

S. Lloyd (2006), *Il programma dell'universo*, Einaudi, 2006

M.G. Losano (1978), *L'informatica nell'Europa Orientale e l'opera di Viktor Knapp*, in V. Knapp, "L'applicabilità della cibernetica al diritto", Einaudi, 1978

M.G. Losano (1971), *Il primo anno del Centro di Giuscibernetica dell'Università di Torino*, in "Rivista internazionale di filosofia del diritto", 1971, n. 1

M.G. Losano (1969), *Giuscibernetica: macchine e modelli cibernetici nel diritto*, Einaudi, 1969

M.G. Losano (1967), *Cibernetica e diritto in Europa*, in "Il ponte", vol. 23, 1967, n. 12

M.G. Losano (1966-1967), *Giuscibernetica*, in R. Treves (a cura di), "Nuovi sviluppi della sociologia del diritto", Edizioni di comunità, 1966-1967

N. Luhmann (1990), *Sistemi sociali. Fondamenti di una teoria generale* (tr. it.), il Mulino, 1990

S.L. Lustig, K. Delucchi, L. Tennakoon et al. (2007), *Burnout and Stress Among United States Immigration Judges*, in "Bender's Immigration Bulletin", 2007, n. 22

R. Manfrino (1960), *L'entropia della lingua italiana ed il suo calcolo*, in "Alta frequenza", vol. xxix, 1960

C. Mangione, S. Bozzi (1993), *Storia della logica. Da Boole ai giorni nostri*, Garzanti, 1993

C. Manning, H. Schütze (1999), *Foundations of statistical natural language processing*, MIT press, 1999

V. Marzocco (2018), *Nella mente del giudice. Il contributo di Jerome Frank al realismo giuridico americano*, Giappichelli, 2018

C. Maslach, W.B. Schaufeli, M.P. Leiter (2001), *Job Burnout*, in "Annual Review of Psychology", vol. 52, 2001

T. Mazzarese (1996), *Forme di razionalità delle decisioni giudiziali*, Giappichelli, 1996

C. Minnaja, L.Paccagnella (1977), *Variazioni dell'entropia linguistica dell'italiano scritto e calcolo di un'entropia fonematica*, in "Rendiconti del Seminario Matematico della Università di Padova", vol. 57, 1977

C.J.A. Mittermaier (1846), *Della differenza fra delitti consumati e tentati, e dei gradi del conato*, in F.A. Mori (a cura di), "Scritti germanici", A. Nanni ed., 1846

M.A. Montemurro (2014), *Quantifying the information in the long-range order of words: Semantic structures and universal linguistic constraints*, in "Cortex", vol. 55, 2014

M.A. Montemurro, D.H. Zanette (2010), *Towards the quantification of the semantic information encoded in written language*, in "Advances in Complex Systems", vol. 13, 2010, n. 2

M.A. Montemurro (2009), *The statistics of meaning: Darwin, Gibbon and Moby Dick*, in "Significance", vol. 6, 2009, n. 4

M.A. Montemurro, D.H. Zanette (2005), *Dynamics of Text Generation with Realistic Zipf's Distribution*, in "Journal of Quantitative Linguistics", vol. 12, 2005, n. 1

J. Nieva-Fenoll (2019), *Intelligenza artificiale e processo*, Giappichelli, 2019

C. Nordio (2022), *Giustizia ultimo atto. Da Tangentopoli al crollo della magistratura*, Guerini e Associati, 2022

R. Orestano (1987), *Introduzione allo studio del diritto romano*, il Mulino, 1987

A.G. Orofino (2002), *La patologia dell'atto amministrativo elettronico: sindacato giurisdizionale e strumenti di tutela*, in "Il Foro Amministrativo C.d.S.", 2002, n. 9

P. Otranto (2018), *Decisione amministrativa e digitalizzazione della p.a.*, in "federalismi.it", 2018, n. 2

P.P. Paulesu (2008), *La presunzione di innocenza, tra realtà processuale e dinamiche extra processuali*, in A. Balsamo, R. Kostoris (a cura di), "Giurisprudenza europea e processo penale italiano", Giappichelli, 2008

G. Pisapia (1989), encyclopedic voice: *Errore giudiziario (riparazione dell')*. Diritto processuale penale, in "Enciclopedia Giuridica", vol. XIII, Ist. della Enciclopedia Italiana G. Treccani, 1989

R. Pound (1908), *Mechanical Jurisprudence*, in "Columbia Law Review", vol. 8, 1908, n. 8

H. Putnam (1987), *Mind, Language and Reality*, Adelphi, 1987

S. Quatrocolo (2019), *Equo processo penale e sfide della società algoritmica*, in "BioLaw Journal. Rivista di BioDiritto", 2019, n. 1

R. Rordorf (2018), *Editoriale*, in "Questione giustizia", 2018, n. 3

A. Ross (1965), *Diritto e giustizia*, Einaudi, 1965

B. Russell (1914), *Our Knowledge of External World*, Allen and Unwin, 1914 (tr. it.: *La conoscenza del mondo esterno*, Longanesi, 1966)

G. Ryle (2009), *The Concept of Mind*, Routledge, 2009

S. Sabetta (2008), *Computazione ed entropia del sistema normativo*, in "complexlab.it", 2008

F. Saitta (2003), *Le patologie dell'atto amministrativo elettronico e il sindacato del giudice amministrativo*, in "Rivista di Diritto Amministrativo Elettronico", luglio 2003

G. Sartor (2005), *Legal Reasoning. A Cognitive Approach to the Law*, Springer, 2005

G. Sartor (2003), *Cognitive automata and the law*, in "The Law of Electronic Agents", Unipubskriftserier, 2003

F. Schauer (2000), *Le regole del gioco. Un'analisi filosofica delle decisioni prese secondo le regole nel diritto e nella vita quotidiana*, il Mulino, 2000

H. Schmid (1994), *Probabilistic Part-of-Speech Tagging Using Decision Trees*, in "Proceedings of International Conference on New Methods in Language Processing", 1994

J.R. Searle (1995), *The Construction of Social Reality*, Free Press, 1995

J.R. Searle (1984), *Intentionality and Its Place in Nature*, in "Dialectica", vol. 38, 1984, n. 2-3

E. Severino (2013), *La potenza dell'errare*, Rizzoli, 2013

S. Shalev-Shwartz, S. Ben-David (2014), *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press, 2014

C.E. Shannon (1951), *Prediction and Entropy of Printed English*, in "The Bell System Technical Journal", vol. xxx, 1951

C.E. Shannon (1948), *A Mathematical Theory of Communication*, in "Bell System Technical Journal", vol. 27, July-October, 1948

A. Simoncini (2019), *L'algoritmo incostituzionale: intelligenza artificiale e il futuro delle libertà*, in "BioLaw Journal. Rivista di BioDiritto", 2019, n. 1

L. Solum (2019), *Artificially Intelligent Law*, in "BioLaw Journal. Rivista di BioDiritto", 2019, n. 1

F. Stella (2001), *Giustizia e modernità. La protezione dell'innocente e la tutela delle vittime*, Giuffrè, 2001

E. Stradella (2019), *La regolazione della Robotica e dell'Intelligenza artificiale: il dibattito, le proposte, le prospettive. Alcuni spunti di riflessione*, in "MediaLaws", 2019, n. 1

P.F. Strawson (1961), *Introduzione alla logica teorica*, Einaudi, 1961

M. Tegmark (2018), *Vita 3.0 Esseri umani nell'era dell'intelligenza artificiale*, Raffaello Cortina Editore, 2018

M. Trifone (2009), *Il linguaggio burocratico*, in Id. (a cura di), "Lingua e identità. Una storia sociale dell'italiano", Carocci, 2009

P. Troisi (2011), *L'errore giudiziario tra garanzie costituzionali e sistema processuale*, Cedam, 2011

R.C. Van Caenegem (1991), *I signori del diritto* (tr. it), Giuffrè, 1991

Various Authors (2019), *Intelligenza Artificiale e diritto*, in "Giurisprudenza italiana", 2019, n. 7

Various Authors (1986), *Linguaggio e giustizia*, Nuove Ricerche, 1986

Various Authors(1975), *Italian speech synthesis from unrestricted text for an automatic answerback system*, in "Proceedings of the 8th International Congress on Acoustics", Chapman and Hall, 1975

Various Authors (1974), *Voice from computers: development prospects and reality of an application*, in "Proceedings of the 3rd Conference on Cybernetics and Biophysics", 1974

L. Viola (2018), *L'intelligenza artificiale nel procedimento e nel processo amministrativo: lo stato dell'arte*, in "federalismi.it", 2018, n. 21

F. Viola, G. Zaccaria (2003), *Le ragioni del diritto*, il Mulino, 2003

G.H. von Wright (1989), *Norma e azione. Un'analisi logica*, il Mulino, 1989

L. Wittgenstein (1967), *Tractatus logico-philosophicus*, Einaudi, 1967