



Universiteit
Leiden
The Netherlands

The regime for international air carrier liability: to what extent has the envisaged uniformity of the 1999 Montreal Convention been achieved?

Grigorieff, C.I.

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Appendix:

Artificial Intelligence as an Aid in the Decision-Making Process

A.1 INTRODUCTION

The purpose of this Appendix is to provide a primary introduction to Artificial Intelligence technologies, with a particular focus on their expected capabilities when it comes to a uniform application of the 1999 Montreal Convention.

From this perspective, this primer will start with a description of what Artificial Intelligence consists of and what its applications could be in the field of Justice (section A.2.). Once the main features of Artificial Intelligence have been examined, this appendix will look at how the principles of interpretation of the 1969 Vienna Convention may be converted into an algorithm (section A.3.).

A.2 ARTIFICIAL INTELLIGENCE AND PREDICTIVE JUSTICE

A.2.1 The Role of the Machine

We have arrived at a stage where humans are able to create machines with computing capabilities far superior to our own, with almost instantaneous results. In order to proceed with a complex calculation, the machine follows a mathematical logic that is essentially translated into algorithms.¹ An algorithm can be compared to a cooking recipe, where the procedure is described step by step in detail, with possible alternatives. For example, in the case of lack of wheat flour, the algorithm might recommend other flours.

1 The online Oxford University Press dictionary gives the following definition: 'A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer', Source: Lexico, <<https://www.lexico.com/en/definition/algorithm>> (accessed 31 October 2019); The European Commission for the Efficiency of Justice in its 2018 'European ethical Charter on the use of Artificial Intelligence in judicial systems and their environment' gave the following definition: 'Finite sequence of formal rules (logical operations and instructions) making it possible to obtain a result from the initial input of information. This sequence may be part of an automated execution process and draw on models designed through machine learning', Source: Council of Europe, <<https://rm.coe.int/ethical-charter-en-for-publication-4-december-2018/16808f699c>> (accessed 31 October 2019). Unidroit and UNCITRAL are working on a common list of definitions relating to Artificial Intelligence. For an in-depth presentation of these mechanisms and their role, see, Adrien van den Branden, *Les robots à l'assaut de la justice – L'intelligence artificielle au service des justiciables* (Bruylant, 2019).

While the process can be translated into a mathematical language, the choice of recipe is still human. These human factors, known as ‘proxies’,² present the risk of possibly forgetting important data or incorporating biases into the coding.

Thanks to the intervention of statisticians, an algorithm can be continually improved by so-called ‘feedback loops’. In other words, they will award bonus points when the solution proposed by the algorithm is ultimately adopted, or to stay with the cooking example, when the dish made according to the recipe only is considered satisfactory without any personal changes. Technology improvement, known as ‘machine learning’,³ means that sometimes the machine no longer requires external intervention from statisticians to assign bonus points. There are different levels of machine learning.

The current most advanced level is known as ‘deep learning’. It allows, for example, for facial recognition and permits instant translations that are not on the basis of simple dictionaries, but from learning of millions of examples and deducing context.⁴ Reference can be made to the concept of

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- 2 The online Oxford University Press dictionary gives, amongst other things, the following definition: ‘A figure that can be used to represent the value of something in a calculation’, Source: Lexico, <<https://www.lexico.com/en/definition/proxy>> (accessed 31 October 2019).
 - 3 The online Oxford University Press dictionary gives the following definition: ‘The use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyse and draw inferences from patterns in data’, Source: Lexico, <https://www.lexico.com/en/definition/machine_learning> (accessed 23 December 2020); The European Commission for the Efficiency of Justice in its 2018 ‘European ethical Charter on the use of Artificial Intelligence in judicial systems and their environment’ gave the following definition: ‘Machine learning makes it possible to construct a mathematical model from data, incorporating a large number of variables that are not known in advance. The parameters are configured gradually during the learning phase, which uses training data sets to find and classify links. The different methods of machine learning are chosen by the designers depending on the nature of the tasks to be completed (grouping). These methods are usually classified into three categories: (human) supervised learning, unsupervised learning and reinforcement learning. These three categories group together different methods including neural networks, deep learning, etc’, Source: Council of Europe, <<https://rm.coe.int/ethical-charter-en-for-publication-4-december-2018/16808f699c>> (accessed 31 October 2019).
 - 4 See, for example, Google, <<https://ai.google/research/pubs/pub45610>> (accessed 31 October 2019).

Artificial Intelligence,⁵ when it becomes difficult for a human to distinguish if a reasoning was elaborated by a human or a machine.⁶ There would be three different stages in its evolution: the weak level, where the machine only reproduces human behaviour; the strong level, where it thinks and acts like a human; and finally the ultimate level of super-intelligence where the machine would be radically more intelligent than humans.⁷ This last stage is still far from being reached. However, these Artificial Intelligence technologies have already found some application in different fields of our everyday life, including in Justice.⁸

Indeed, these technologies allow an instant analysis of a huge amount of data, such as legislation, judicial decisions and literature, and suggest a possible legal solution in light of given factual elements.⁹ This application,

5 The online Oxford University Press dictionary gives the following definition: ‘The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages’, Source: Lexico, <https://www.lexico.com/en/definition/artificial_intelligence> (accessed 31 October 2019); The European Commission for the Efficiency of Justice in its 2018 ‘European ethical Charter on the use of Artificial Intelligence in judicial systems and their environment’ gave the following definition: ‘A set of scientific methods, theories and techniques whose aim is to reproduce, by a machine, the cognitive abilities of human beings. Current developments seek to have machines perform complex tasks previously carried out by humans. However, the term artificial intelligence is criticised by experts who distinguish between “strong” AIs (yet able to contextualise specialised and varied problems in a completely autonomous manner) and “weak” or “moderate” AIs (high performance in their field of training). Some experts argue that “strong” AIs would require significant advances in basic research, and not just simple improvements in the performance of existing systems, to be able to model the world as a whole. [...]’, Source: Council of Europe, <<https://rm.coe.int/ethical-charter-en-for-publication-4-december-2018/16808f699c>> (accessed 31 October 2019).

6 A test was first introduced by Alan Turing in 1950. See, Alan Turing, *Computing Machinery and Intelligence*, *Mind* 433-460 (1950).

7 See, Adrien van den Branden, *Les robots à l’assaut de la justice – L’intelligence artificielle au service des justiciables* 81-82 (Bruylant, 2019).

8 See, European Commission, *Study on the Use of Innovative Technologies in the Justice Field*, final report, Source: Publications Office of the European Union, <<https://op.europa.eu/en/publication-detail/-/publication/4fb8e194-f634-11ea-991b-01aa75ed71a1/language-en>> (accessed 17 September 2020).

9 In 2020, the Council of the European Union acknowledged that: ‘[...] artificial intelligence systems in the justice sector may in the future be capable of performing increasingly complex tasks – within the legal framework of a Member State – such as analysing, structuring and preparing information on the subject matter of cases, automatically transcribing records of oral hearings, offering machine translation, supporting the analysis and evaluation of legal documents and court/tribunal judgements, estimating the chances of success of a lawsuit, automatically anonymising case law and providing information via legal chatbots’, Council of the European Union, Council Conclusions, Access to justice – seizing the opportunity of digitalization, *Official Journal*, 14 October 2020, C-342 I/1, at 35.

known as 'predictive justice',¹⁰ has proven efficiency in cases which did not require human emotion¹¹ such as equity.¹² While legal professionals spend a lot of time consulting books or in search for the right case law in libraries and databases with limited key words, Predictive Justice software uses a semantic field of research. It means that not only keywords are used, but also the contextual environment, occurrence of commentaries, and so forth. The number of research parameters can therefore be largely extended.¹³

Nevertheless, to achieve this mission, the machine needs to have access to a considerable amount of data.¹⁴ The collection of this data in a machine-readable format is complex. While some data is not collectable for free, such as commentaries, the *Travaux Préparatoires* of the 1999 Montreal Convention

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- 10 The European Commission for the Efficiency of Justice in its 2018 'European ethical Charter on the use of Artificial Intelligence in judicial systems and their environment' gave the following definition: 'Predictive justice is the analysis of large amounts of judicial decisions by artificial intelligence technologies in order to make predictions for the outcome of certain types of specialised disputes (for example, redundancy payments or alimentary pensions). The term "predictive" used by legal tech companies comes from the branches of science (principally statistics) that make it possible to predict future results through inductive analysis. Judicial decisions are processed with a view to detecting correlations between input data (criteria set out in legislation, the facts of the case and the reasoning) and output data (formal judgment such as the compensation amount). Correlations deemed to be relevant make it possible to create models which, when used with new input data (new facts or precisions described as a parameter, such as the duration of the contractual relationship), produce according to their developers a prediction of the decision (for example, the compensation range). Some authors have criticised both the form and substance of this approach. They argue that, in general, the mathematical modelling of certain social phenomena is not a task comparable to other more easily quantifiable activities (isolating the really causative factors of a court decision is infinitely more complex than playing the game of Go or recognising an image for example): here, there is a much higher risk of false correlations. In addition, in legal theory, two contradictory decisions can prove to be valid if the legal reasoning is sound. Consequently, making predictions would be a purely informative exercise without any prescriptive claim', Source: Council of Europe, <<https://rm.coe.int/ethical-charter-en-for-publication-4-december-2018/16808f699c>> (accessed 31 October 2019).
 - 11 See, Adrien van den Branden, *Les robots à l'assaut de la justice – L'intelligence artificielle au service des justiciables* 27 (Bruylant, 2019). A further step was taken in 2016 when a research team observed that Artificial Intelligence could predict the outcome of decisions of the European Court of Human Rights with 79 percent accuracy. See, Nikolaos Aletras, e. a., *Predicting Judicial Decisions of the European Court of Human Rights: A Natural Language Processing Perspective*, PeerJ Computer Science (24 October 2016), Source: PeerJ, <<https://peerj.com/articles/cs-93>> (accessed 12 May 2020).
 - 12 There are other Artificial Intelligence based applications used in the Justice environment, such as one that predetermines recidivism risk in criminal proceedings, but these go beyond the scope of this work. Moreover, the concept of 'predictive justice' should not be confused with any sort of mechanism allowing criminals to be arrested prior to offences being committed, a concept popularized in Science Fiction movies and known as 'predicative justice'.
 - 13 Adrien van den Branden, *Les robots à l'assaut de la justice – L'intelligence artificielle au service des justiciables* 84 (Bruylant, 2019).
 - 14 See, Council of the European Union, Council Conclusions, 'Access to justice – seizing the opportunity of digitalization', *Official Journal*, 14 October 2020, C-342 I/1, at 36.

or some judicial decisions; other is known to be open access, that is to say publicly available for free in a full version, and some is even called ‘open data’¹⁵ once it is in ‘open access’ and in a machine-readable format.

In light of the improvement of translation systems, Predictive Justice software will be able to suggest a *proforma* decision after an examination of existing domestic and foreign jurisprudence, legislation, *Travaux Préparatoires*, dictionaries, or any other parameter included in the applicable algorithm. This instantaneous analysis of existing knowledge would not only improve the predictability of a Court decision, as the system would have analysed the way equal facts have been treated in the past, but would also bring further uniformity as the decision suggested would ideally have analysed all available case law and would be the same across all ratifying jurisdictions using and/or feeding the same software.

A.2.2 The Role of Humans

The emerging reliance on Artificial Intelligence designed software in the sphere of Justice will undoubtedly change the role of legacy actors. With a decision in hand prepared by a machine whose legal skills are not disputed, judges would be likely to adhere to it once the litigious factual elements had been proven. The judge may, however, consider the decision suggested by the machine as not in line with his or her personal understanding of the case. In this scenario, they would have to justify in writing – probably more explicitly than what they are currently required to in many jurisdictions – the reasons why they deviated from the suggested decision.

Depending on how the suggested decisions are provided, such a deviation may require that the judges have some coding skills in order to be able to explain the reasons why they believe the algorithm used did not fit in a particular case. Lawyers as well would have to demonstrate, if they are not satisfied with the suggested decision, that the algorithm used did not fit the particulars of the case. This could happen, for instance, if they deemed factual elements to have been incorrectly filled in, or if the weight given to

15 The European Commission for the Efficiency of Justice in its 2018 ‘European ethical Charter on the use of Artificial Intelligence in judicial systems and their environment’ gave the following definition: ‘The term refers to making structured databases available for public download. These data can be inexpensively re-used subject to the terms of a specific licence, which can, in particular, stipulate or prohibit certain purposes of re-use. Open data should not be confused with unitary public information available on websites, where the entire database cannot be downloaded (for example, a database of court decisions). Open data do not replace the mandatory publication of specific administrative or judicial decisions or measures already laid down by certain laws or regulations. Lastly, there is sometimes confusion between data (strictly speaking open data) and their processing methods (machine learning, data science) for different purposes (search engines, assistance in drafting documents, analysis of trends of decisions, predicting court decisions, etc.)’, Source: Council of Europe, <<https://rm.coe.int/ethical-charter-en-for-publication-4-december-2018/16808f699c>> (accessed 31 October 2019).

certain elements in the algorithm were not consistent with the case. With respect to the Conventions, such scenarios could occur, for example, if a lawyer believed that too much credit had been granted to Warsaw Instruments case law while litigating a Montreal case.

In order to be able to dispute the suggested decisions, the algorithm used must obviously be known.¹⁶ As copyright issues may prevent full transparency, such algorithms should be established by States, and more specially by all States that have ratified the 1999 Montreal Convention. This would also have the benefit, in terms of uniformity, of the existence of a unique algorithm shared by all.

A.3 ARTIFICIAL INTELLIGENCE AND INTERPRETATION

A.3.1 Researching a Coherent Algorithm

However, in order to suggest decisions in line, not only with existing international case law, but also with the 1999 Montreal Convention itself, a coherent algorithm translating common interpretation rules should be found.

A.3.2 Translating a Hermeneutical Methodology into an Algorithm

The question is therefore to determine whether the process of interpretation can be translated into an algorithm. In a 2018 study, Professor Luigi Viola took up the challenge.¹⁷ He used as an example the Italian interpretation rules set out in Article 12 of the Preliminary Provisions (*Preleggi*) of the Italian Civil Code, assuming this methodology would be universal, being an expression for the natural need for legal certainty,¹⁸ and similar to the one established by the 1969 Vienna Convention.¹⁹ This Article 12 of the Preliminary Provisions of the Italian Civil Code, giving priority to literal interpretation over any other methodology, provides that:

16 In a case involving Artificial Intelligence in criminal proceedings, the algorithm used to help determine the risk of recidivism was neither communicated to the judge nor the defendant. The possibility of challenging this computer-based decision was hence very limited. The Supreme Court of Wisconsin held, however, that such a risk assessment, based on a computerized tool developed by a private company, could still validly be used, provided it was not determinative. *See, State of Wisconsin v. Eric L. Loomis*, 2016 WI 68, cert. denied. For a commentary of the decision, *see*, Adrien van den Branden, *Les robots à l'assaut de la justice – L'intelligence artificielle au service des justiciables* 5-6 (Bruylant, 2019); Anonymous, *State v. Loomis*, 130 Harvard Law Review 1530-1537 (2017).

17 Luigi Viola, *Interpretation of the Law Through Mathematical Models – Trial*, A.D.R., *Predictive Justice* (Diritto Avanzato, 2018).

18 *Ibid.*, p. 55.

19 *Ibid.*, p.61.

In applying the law, one cannot attribute to it any other meaning other than that made evident by the particular meaning of the words and the connection between them, and by the intention of the lawmaker. If a dispute cannot be decided by a specific provision, reference shall be made to provisions governing similar cases or similar matters. If the doubt persists, the decision shall be made according to the general principles of the legal system of the State.²⁰

The author saw in this provision an algorithm insofar as it provided for a sequenced operation to arrive at an outcome.²¹ He also considered the trial itself to be an algorithm insofar as:

[...] a judicial measure (PG) is determined by a series of operations predetermined by law, arising from the composition of proven facts (FP) and the law as it is interpreted (IP), namely $PG = FP \wedge IP$.²² IP.²³

He further noted that:

In essence, Article 12 highlights the fact that to understand the meaning of a text of law we must start from what is written (IL), together with the reason for which it was written (IR) [...]. Only if what is written, which is the clear starting point, does not produce a sufficiently certain meaning, do we then look for a similar situation in the legal system (AL) that can help us solve a practical case. If we do not find a situation similar to the proposed case anywhere in the legal system, then we apply general principles (AI).²⁴

Would there be any difference between a literal interpretation and a teleological one, a greater weight or at least equal value weight, should be given to literal interpretation. In a mathematical language, this would be translated as: $(IP) = IL \geq IR$.²⁵

The next step, recourse to an interpretation by *analogia legis* (AL), could be translated as follows:

Consequently: the interpretation of a law provision can derive from *analogia legis* if and only if a precise provision cannot be found, namely if $IL = 0$ (IR normally depends on the presence of IL). Thus, interpretation $(IP) = AL \Leftrightarrow IL = 0$; if it is

20 Translation provided at *Ibid.*, p. 44. The original text reads: 'Nell'applicare la legge non si può ad essa attribuire altro senso che quello fatto palese dal significato proprio delle parole secondo la connessione di esse, e dalla intenzione del legislatore. Se una controversia non può essere decisa con una precisa disposizione, si ha riguardo alle disposizioni che regolano casi simili o materie analoghe; se il caso rimane ancora dubbio, si decide secondo i principi generali dell'ordinamento giuridico dello Stato'.

21 Luigi Viola, *Interpretation of the Law Through Mathematical Models – Trial, A.D.R., Predictive Justice* 116 (Diritto Avanzato, 2018).

22 This symbol means 'union'.. See, *Ibid.*, p. 36.

23 *Ibid.*, p. 35-36.

24 *Ibid.*, p. 56.

25 *Ibid.*, p. 73.

used despite being unusable, where a 'precise provision' exists, then $IL \geq IR > AL$ (literal interpretation is greater or equal to teleological interpretation, which, in turn is greater than *analogia legis*, only when $IL > 0$, $IR > 0$, $AL > 0$).²⁶

The same reasoning applies with respect to interpretation by *analogia iuris* (AI).

Professor Luigi Viola considered that Article 12 does not prevent other types of interpretation, such as evolutionary, systematic or constitutional orientated interpretations from being used.²⁷ The value of these could be summarized as follows: $IL \wedge IR \circ^{28} AL \circ AI$.²⁹ Other tools should also be considered such as *ad absurdum*, equitable and through combined provisions interpretations. As these would be considered as a union of a literal and a teleological interpretation, they would be translated as: $IL \wedge IR$.³⁰

Acknowledging that the same type of interpretation may lead to opposite outcomes, he noted that an interpretation, pursuant to each mechanism, may either be positive (+), negative (−) or indirect (being ultimately negative in terms of logical incompatibility).³¹ He suggested therefore that:

If a literal interpretation (+IL) affirms a *quid*, but the latter is neutralised by another literal interpretation (−IL), then no literal interpretation can prevail ($+IL - IL = 0$) over the other because it has, in effect, been neutralised. Consequently, other interpretative instruments must be used, such as *analogia legis* (AL), legitimised by the absence of a precise literal interpretation ($+IL - IL = 0$), and, as an *ultima ratio* (should *analogia legis* 'fail' $-AL \approx^{32} 0$), an interpretation based on general principles (AI).³³

In light of the above, he considered that the content of Article 12 of the Italian law could be summarized as follows:

The interpretation of law (IP) equals (=) the union ($\wedge$) of positive or negative literal interpretations ($IL \pm ILn$) with positive or negative teleological interpretations ($IR \pm IRn$); in the absence of a precise provision of law ($IL = 0$), interpretations by *analogia legis* are added or subtracted ($\Rightarrow (AL \pm ALn)$); in the event that the case is still dubious ($AL \approx 0$), interpretations by *analogia iuris* are added or subtracted ($\Rightarrow (AI \pm AI n)$).³⁴

26 *Ibid.*, p. 79-80.

27 *Ibid.*, p. 89.

28 This symbol means that the composition must be understood as a merger or synthesis of non-homogeneous data. See, *Ibid.*, p. 35.

29 *Ibid.*, p. 93, 95, 98.

30 *Ibid.*, p. 99, 100, 101.

31 *Ibid.*, p. 119.

32 This symbol means 'approximately', see, *Ibid.*, p.125.

33 *Ibid.*, p. 119.

34 *Ibid.*, p. 125.

In short:

$$\begin{aligned} IP &= (IL \pm ILn^{35}) \wedge (IR \pm IRn) \circ [IL = 0 \Rightarrow^{36} (AL \pm ALn)] \circ [AL \approx 0 \Rightarrow (AI \pm AI_n) \text{ or} \\ IP &= \Sigma i(n)''^{37} \end{aligned}$$

The perfect adequacy of such a formula with the requirements of the 1969 Vienna Convention and the specificities of a uniform instrument such as the 1999 Montreal Convention must, of course, be discussed and decided by the ratifying Parties of the 1999 Montreal Convention, and was introduced here only as an example of the possibility of translating interpretation rules into an algorithm. Again, alongside the structure of the formula, ratifying Parties should also agree on the weight to be given to several parameters, as discussed in Chapter 5.

A.4 THE DAWN OF ARTIFICIAL INTELLIGENCE LAW

The potentialities of Artificial Intelligence mechanisms are promising. However, the ability of machines to reason and make decisions impacting human life will require the creation of new liability rules and the adoption of strict measures to safeguard our human rights.³⁸

Interesting legal discussions on all these topics are yet to come, but go beyond the scope of the present study.

35 This symbol means 'a variable denoting the number of possible interpretations of the same type', see, *Ibid.*, p. 125.

36 This symbol means 'if...then', see, *Ibid.*, p. 125.

37 *Ibid.*, p.124-126.

38 See, for example, European Commission, Proposal for a Regulation of the European Parliament and the Council laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union legislative Acts, 21 April 2021, COM (2021) 206 final.

