Patenting AI: Rethinking Eligible Subject-Matters and the Novelty Requirement in an IoT world.

Constituting a disruptive technology, Artificial Intelligence ('AI') is impacting all industries. However, there are rising concerns that the patent system may not be fit for the future of innovation that is increasingly AI-related and intangible. Indeed, the execution of AI-related inventions requires some kind of computer implementation, thereby potentially reviving patentability issues related to computer-implemented inventions. Whilst patent offices around the world have found ways to adapt their patent systems to grant protection to software, difficulties remain in relation to algorithm-based inventions though they form a significant part of today's innovation. Currently, algorithms themselves do not qualify as patentable inventions. Even if algorithms overcome this first hurdle, concerns arise in relation to the application of patentability requirements such as novelty where national differences remain. This research evaluates the adequacy of the novelty requirement in relation to AI-inventions where many of the underlying concepts and technologies are not novel. The ultimate aim is to evaluate the adequacy of the patent system by looking at inventions that utilize AI, with a particular focus on the excluded subject matters and the novelty requirement. To this end, the research adopts a comparative analysis of these concepts in Europe (EPC countries), Japan and the United States.

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I. Introduction

The patentability of artificial intelligence (AI) revives the broader debate around the patentability of computer programs which are now recognized as patent-eligible inventions across Europe, the United States of America ('US'), and Japan after a dense history of legal developments.[1] With the promise of the Internet of Things ('IoT') - characterized by the interoperability of parts of a smart device or between smart devices using the Internet and embedded in everyday objects – it is crucial to clarify what patent protection is available for AI algorithms and programs.[2]

The current patent systems have mostly focused on protecting the physical structures and the configuration of physical systems. As the future of innovation is increasingly intangible, one of the main problems concerns the economics of algorithmic innovation. Constituting a giant network of connected devices, objects and people through the interplay of sensors, IoT relies on powerful and complex algorithms to collect and analyze data from different devices, and to then share the resulting information with applications built to address specific needs in real time.[3] All IoT projects will include an AI component.[4] Indeed, if IoT devices and

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[1] Some argue that the confusion is linked to the fact that early debates supposedly focusing on whether software should be patentable, actually related to the preliminary question of defining software. B. Sherman, 'Intangible Machines: Patent Protection for Software in the United States' (2019) 57(1) *History of Science*, 18-37.

[2] Also supported by WIPO Technology Trends 2019, *Artificial Intelligence* (2019), 143 available at https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf; Committee to Review Intellectual Property regarding New Data-related Assets, Intellectual Property Strategy Headquarters' Verification, Evaluation and Planning Committee, *Report -Toward Building the Intellectual Property System, the Foundation for Strengthening Industrial Competitiveness, by Promoting the Use of Data and Artificial Intelligence (AI)-*, (March 2017) ('Data-Related Assets Report'), 40.

[3] Committee to Discuss a Next-generation Intellectual Property System, Verification, Evaluation and Planning Committee, Intellectual Property Strategy Headquarters, *Report of the Committee to Discuss a Next-generation Intellectual Property System—Toward the Construction of a Next-generation Intellectual Property System Adapted to the Rise of Digital Networks*, (April 2016), 4.

[4] And whilst this discussion is attracting more and more academic attention in Japan, authorities tend to focus on the implication of AI for creative endeavors rather than the effect for the patent system. Data-Related Assets Report, supra n. 2; Secretariat of Intellectual Property Strategy Headquarters, *Treatment of works created by AI (for discussion))*, (January 2016); Committee to Discuss a Next-generation Intellectual Property System, Verification, Evaluation and Planning Committee, Intellectual Property

components generate vast amounts of data, the analysis element can be substantially enhanced through AI. Where traditional data analysis techniques were not designed with the vast amount of real-time data in mind, AI can mitigate this problem through the interplay of machine learning algorithms. By simulating human behavior, AI creates actionable insights based on identified patterns from the connected devices without, in some cases, the need for any human intervention. Additionally, AI can help solve some of the interoperability issues between devices where operational technology systems have not been designed to allow devices to communicate with each other, or through the interplay of a central platform.

IoT providers are increasingly updating their equipment to accommodate the use of AI,[5] rendering the debate on the proper level of protection for algorithmic inventions unavoidable.[6] Currently, algorithms are excluded from the scope of patent protection because these are not considered to be 'inventions' for being too abstract of non-technical.[7] Proponents for broadening the patent system to cover algorithms within its scope tend to argue that allowing algorithms to be patented would encourage innovation in the AI industry, enable the realization of the promises of the IoT, contribute to consumer welfare, and benefit society as a whole through the increase of trade and economic wealth. Opponents, on the other hand, argue that patenting algorithms would lead to the granting of monopolies over abstract ideas, stifle innovation, and lead to the exclusion of some players, which

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Strategy Headquarters, *Toward the Construction of a Next-generation Intellectual Property System Adapted to the Rise of Digital Networks*, (April 2016), 4-7; Similarly, in Europe, E. Fraser, 'Computers as inventors – legal and policy implications of artificial intelligence on patent law' (2016) 13(3) *SCRIPTed*, 307.

[5] E.g. Microsoft's launch of Azure IoT Edge and Amazon's Greengrass.

[6] USPTO, 'Request for Comments on Intellectual Property Protection for Artificial Intelligence Innovation' (October 30, 2019) 84(210) *Federal Register* 58141-58142 [Docket No. PTO–C–2019–0038; Submission by Switzerland to the EPO on the legal aspects of patenting inventions involving artificial intelligence (AI) as summarized by Heli Pihlajamaa before the Committee on Patent Law on February 20th, 2019 and available at http://documents.epo.org/projects/babylon/eponet.nsf/0/3918F57B010A3540C125841900280653/$File/AI_inventorship_summary_of_answers_en.pdf

[7] The US members of congress consider a draft bill to eliminate the judicially created exclusions from patent-eligibility; see Chris Coons, Sens. Coons and Tillis and Reps. Collins, Johnson, and Stivers release draft bill text to reform Section 101 of the Patent Act (May 22nd, 2019) available at https://www.coons.senate.gov/news/press-releases/sens-coons-and-tillis-and-reps-collins-johnson-and-stivers-release-draft-bill-text-to-reform-section-101-of-the-patent-act.

goes against the ethos the interoperability of devices and therefore, the potential of IoT.

Another important issue relates to the different understanding of patentability criteria in national patent offices around the world – for example, an invention might well be considered patentable in Japan or in Europe, but rejected in the US. Ultimately, this leads to competition problems between nations. For example, one nation being more generous in granting patents for AI inventions may result in the rise of litigations between jurisdictions or intensify legal problems between patent regimes. Hence, this research project evaluates the adequacy of the novelty requirement.[8] Properly assessing and defining prior art will be essential in preventing non value-added subject-matters from being patentable and preserve the equilibrium of the patent system.

This research report adopts a comparative approach looking at the practices of three of the five biggest patent offices in the world, namely the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japanese Patent Office (JPO). It will first analyze the justifications underlying the patent system (Section II) before turning to defining algorithmic innovation for the purpose of AI and IoT (Section III). This section outlines the features of the development of algorithms to highlight the characteristics of modern algorithmic inventions, providing the essential premise for the evaluation of the current patent systems. When addressing the issue of opening the patent system to algorithms, the social need to grant such protection (section IV) and the scope of patent protection for this technological field must be established. Consequently, Section V deals with the first hurdle for patenting algorithms. Reviewing legislation and cases, this section examines the excluded patentable subject-matters and emphasizes the difficulties in constructing algorithms as inventions. Section VI then considers the need to harmonize the novelty requirement further. Finally, Section VII concludes and makes a series of modest recommendations.

II. Purpose of the patent system

Gradually, numerous rationales and justifications have been given to support patent systems.[9] This research report does not provide an extensive examination of these, but focuses on the most common justifications and conceptualizations in order to

[8] Infra section VI.

[9] A. Ramalho, 'Patentability of AI-Generated Inventions – Is a Reform of the Patent System Needed?' (March 2018) *Institute of Intellectual Property, Foundation for Intellectual Property of Japan* 5; L. Bently, B. Sherman, D. Ganjee & P. Johnson, *Intellectual Property Law* (OUP, 5th ed., 2018) 397; R. Merges, *Justifying Intellectual Property* (Harvard University Press, 2011) Part I.

pave the way towards the discussion on whether or not patent regimes should cover algorithms. In its most basic form, patent protection attempts to regulate leading edge scientific progress. However, one of the most obvious difficulties for any patent system is to ensure that legislation can keep pace with the advances of technology.

Evaluating the different conceptualizations for the existence of patent systems,[10] some have advanced natural law arguments emphasizing the need for an inventor to own property rights over the products resulting from their mental labor as articulated by John Locke.[11] Also rooted in natural rights, some relied on the personality theory propounded by Georg Hegel. [12] Under this theory, inventors ought to be granted protection as inventions reflect an idea of an individual and consequently, a manifestation of his personality. However, these natural law arguments have found limited support as these would not justify any limited duration of patent protection, instead favoring perpetual protection.[13]

Others have argued that justice necessitates rewarding inventors through the issuance of patents, in other words, the reward theory or utilitarianism.[14] Here, protection is justified in name of fairness and provides a proportional reward for the usefulness of the invention to society. However, this theory has been criticized for the difficulties in determining what patent protection aims to reward. Is it the labor exercised by its inventor? Or the first to come up with the technical idea? Both seem unsatisfactory. Similarly, this theory does not justify the monopoly given to patentees. Rewards can take varied forms which do not have an adverse impact on the functioning of the market.[15]

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[10] W. Lim, 'Towards Developing a Natural Law Jurisprudence in the U.S. Patent System' (2003) 19 *Santa Clara Computer & High Tech LJ*, 561.

[11] J. Locke, *Second Treatise on Civil Government, in Two Treatises of Government* (Peter Laslett ed., CUP, 1988) ch V; Lim, supra n. 10; A. R. Sommer, 'Trouble on the Commons: A Lockean Justification for Patent Law Harmonization' (2005) 87 J *Pat & Trademark Off Soc'y* 141; D. Guellec & B. van Pottelsberghe de la Potterie, *The economics of the European patent system: IP policy for innovation and competition* (OUP, 2007); Bently and al, supra n. 9, 397.

[12] J. Hughes, 'The Philosophy of Intellectual Property' (1988) 77 *GEO. L.J.*, 329.

[13] This justification can be found in the French Patent Law of 1791.

[14] P. J. Heald, 'A Transaction Costs Theory of Patent Law' (2005) 66 *OHIO ST. L.J.*, 473; 'Ex Ante Versus Ex Post Justifications for Intellectual Property' (2004) 71 *U. CHI. L. REV.*, 129.

[15] E.C. Hettinger, 'Justifying Intellectual Property' (1989) 18 *Philosophy and Public Affairs*, 31-52.

A more popular justification is the incentive theory.[16] Primarily rooted in economic considerations, it is independent from whether justice requires inventors to be rewarded for their endeavors.[17] It purports that the possibility of getting a monopoly is attractive enough to encourage innovation and is the most appropriate form of return for the intellectual labor deployed. Likewise, the disclosure requirement provides an incentive for others to invent around an invention and in turn, receive protection.[18] Yet again, this theory is not without flaws. It relies on the premise that patents are the most effective way in which these incentives can be provided. Furthermore, this theory can be criticized as patents can act as a double-edged sword that may either encourage innovation or block its progress.[19] It also presumes that the value of the invention outweighs the increased costs to consumers and that consumers will be in a position to pay these higher costs.[20]

The public interest rationale appears to be the most popular today and thus, the patent system is 'public-serving'.[21] Protection is justified because of the societal benefits resulting from the granting of patents over time.[22] The only way to justify the harm endured by consumers is if the public receives some corresponding benefit. This means that the place of the inventor is secondary in this conceptualization of patent protection. The exclusive rights granted through the patent mediate the trade-off between incentive and access - not only in terms of duration, but also in other aspects of the scope of protection. Whilst 'access' was initially conceived as to the

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[16] E. Derclaye, 'Patent law's role in the protection of the environment – re-assessing patent law and its justifications in the 21st century' (2009) 40(3) *IIC*, 253-255.

[17] E.g. in the US the language of the constitutional basis for intellectual property protection where the constitution grants power to congress under article 1, Section 8, Clause 8 and stresses the purpose of progress of science as the foundation for the US patent system. For more, see A. D. Minsk, 'Patentability of Algorithms: A Review and Critical Analysis of the Current Doctrine' (1992) 8 *Santa Clara High Tech. L.J*, 285-288.

[18] US: §112 35 US Code; JP: article 36 JPA; Europe: article 83 EPC.

[19] European Commission, *Study on evaluating the knowledge economy: what are patents actually worth? The valuation of patents for today's economy and society* (final report, 23 July 2006) 10.

[20] Which is not the case for many developing countries. C. Finck and C.A. Primo Braga, 'How stronger protection of intellectual property rights affects international trade flows' in C. Finck and K.E. Maskus (ed.), *Intellectual Property and Development: lessons from recent economic research* A co-publication of the World Bank and Oxford University Press, 2005).

[21] R. Tushnet, 'Intellectual Property as a Public Interest Mechanism' in R. Dreyfuss & J. Pila (eds.), *The Oxford Handbook of Intellectual Property Law* (OUP, 2018) 100.

[22] See *Asahi Kasei Kogyo* [1991] RPC 485, 523 (HL); *Graceway Pharmaceuticals LLC v Perrigo Co* (2010) 722 F. Supp 2d 566, 580 (District Court (District of New Jersey)).

public's access to improvements and inventions, it morphed into referring to the invention's disclosure which occurs when a patent application is published, thereby facilitating the dissemination of knowledge and information.[23] Prior to having a patent system, individuals would protect their invention through trade secrets to maintain their competitive advantage. By having a balanced patent system, granting patents acts as incentive for individuals and organizations to disclose knowledge that would otherwise be concealed. The nature of the information is equally valuable.[24] For example, the European Patent Convention ('EPC') requires that the invention be disclosed in a manner that is sufficiently clear so that it can readily be put into practice.[25]

Regardless from its justification, there is no denying that the patent system acts as a regulatory tool with a strong economic nature aimed at encouraging technological innovation as well as the transfer and dissemination of technology in society. This represents a challenge for regulators as they need to strike a balance between providing adequate protection to foster innovation whilst preventing the expansion of patents.[26]

Patent law protects inventions, but very few patent laws define what an invention actually is. This is the case in Europe where the term 'invention' is defined negatively through a list of excluded subject-matters.[27] Even here, the list is excluded 'as such' - meaning that there are ways in which inventions involving these excluded subject-matters can be protected.[28] Contrastingly, the Japanese Patent Act does provide some broad definition where an invention is defined as 'a highly advanced creation of technical ideas utilizing the laws of nature'.[29]

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[23] Bently and al, supra n. 9, 397.

[24] WIPO International Bureau, *"Enlarged" concept of novelty- initial study concerning novelty and the prior art effect of certain applications under draft article 8(2) of the SPLT* (2004) 4 available at https://www.wipo.int/export/sites/www/scp/en/novelty/documents/5prov.pdf

[25] Supra n. 18.

[26] Ramalho, supra n. 9, 8.

[27] Article 52(2) EPC; Guidelines for Examination in the European Patent Office, Part G-II, para 1. Similarly, in the US, there is no statutory definition which led scholars to devise workable definitions. H. E. Potts, 'The definition of invention in patent law' (1944) 7(3) *The Modern Law Review,* 113-123.

[28] Infra section V-1.

[29] Article 2 JPA.

Underlying these excluded subject-matters lies the fear of granting a monopoly to an unworthy invention or of impeding on downstream innovation.[30] The categories of excluded subject-matters make an attempt at ensuring that only 'worthy' objects are granted a limited monopoly.[31] Exclusions such as the one relating to computer programs were mainly motivated by political and economic reasons.[32] Surprisingly, in Europe, there is little guidance to be found in the *travaux préparatoires* to understand the justifications underlying these categories of exclusions.[33] The EPO Guidelines (Part G, Chap. II, 1) merely indicate that some subject-matters are excluded because these are deemed as too abstract (e.g. scientific theories or mathematical methods) and/or non-technical (e.g. presentations of information). Algorithms would generally fall within one of these categories. In the seminal *Vicom* case,[34] an invention involving a mathematical method applied to data resulting in an enhanced digital image on a computer was held to be purely intangible and intellectual, and as such could not be patentable. However, a device that deploys this method can be protected if it encompasses a technical character. Similarly, in the US, where computer programs were protected as early as 1964 by copyright, the judiciary initially excluded computer programs and algorithms from the scope of patent law as these constitute a subset of the abstract ideas' exclusion of 35 USC §101.[35]

Beyond the concern of wanting only to protect worthy inventions, patentability requirements were also introduced having in mind granting property rights for physical embodiments of ideas in parallel with useful and industrial applications of

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[30] The preemption rationale is especially relevant in the US. See *Gottschalk v Benson* (1972) 409 US 63, 175 USPQ 673 (*Benson*), 72; *Mayo collaborative Services v Prometheus Laboratories* (2012) 566 US 66 (*Mayo*), 91. However, there are other justifications possible. For a summary, see Congressional Research Services, *Patent-eligible Subject Matter Reform in the 116th Congress* (September 17th, 2019) 25-26 available at https://fas.org/sgp/crs/misc/R45918.pdf

[31] C. D. Thomas, 'Secret prior art-get your priorities straight' (1996) 9(1) *Harvard Journal of Law & Technology* 148

[32] R. Hilty and C. Geiger, 'Patenting Software? A Judicial and socio-economic analysis' (2005) 36(6) *IIC*, 620. See also in *Mayo*, supra n. 30, at 71 where the court says that the exclusions are justified as this result in 'basic tools of scientific and technological works'.

[33] J. Pila, 'Art. 52(2) of the Convention on the Grant of European Patents: what did the framers intend? A study of the travaux préparatoires' (2005) 36 *IIC* 755; E.D. Vendose, 'In the footsteps of the framers of the European Patent Convention: examining the travaux préparatoires' (2009) 31(7) *EIPR*, 353.

[34] T208/84, *Vicom/computer-related invention* (17 July 1986) ECLI:EP:BA:1986:T020884.19860715.

[35] The US Supreme Court held in *Benson* that mathematical algorithms were not patentable subject-matter. *Benson*, supra 30, 71-72. See infra section V-3.

the time.[36] The novelty requirement constitutes the first barrier to patentability and prevents the protection of the re-invention of the wheel. Guaranteeing that matters that have fallen into the public domain are not once again brought under the control of private entities and preventing double-patenting,[37] novelty protects individuals who have been using a product or process publicly from being prevented from doing so because a patent has been granted over two or more substantially similar inventions.[38] Truly, the novelty requirement establishes boundaries between what belongs to society and what can be privately owned. Because of this particular role, the concept of 'novelty' differs from its ordinary meaning. Under patent law, an invention must be new in the sense that it does not form part of the prior art which is defined broadly.[39] The question that patent examiners seek to answer is whether the same invention has been made available to the public before the filing or priority date and explains why it is not accepted to combine different pieces of prior art for the assessment of novelty.

Let's take a common example of the self-driving car. Companies are not as interested in protecting the self-driving car in itself. They would prefer to protect underlying inventions such the field-of-view object recognition performed by the sensors of the car replicating the human ability to discern objects in a particular environment. More generic concepts such as deep learning or machine learning algorithms involving data collection and analysis capabilities that are crucial to the training of the AI solution. If we allow the protection of such invention, it may well be that later applications fall foul of protection under the application of the novelty requirement. Therefore, to evaluate its adequateness, it is important to answer the policy question of if a patent has been granted over such invention, to what extent should the granted patent prevent the issuance of subsequent patents covering identical (or at least similar subject-matters)? This links to how we conceive two inventions being similar, and, if the subsequent invention is in some way dissimilar but obvious from the earlier patented invention, whether it could be barred from being patented in turn. Ultimately, a strong conception of the novelty requirement contributes to the social goal pursued by the patent paradigm as small improvements on information already found in the public domain will be insufficient to receive a 20-year monopoly.[40]

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[36] *Diamond v Chakrabarty* (1980) 447 US 303, 308 (*Chakrabarty*).

[37] WIPO International Bureau, supra n. 24, 7.

[38] Ibid, 4.

[39] Infra section VI.

[40] Novelty combined with inventive step or non-obviousness, only renders patentable inventions which make a significant improvement on prior art. This position is nevertheless not shared by Scotchmer &

In sum, the patent system provides a mechanism to foster innovation. A social contract takes place between the state and the patentee with obligations on both sides. The state grants a limited monopoly to the inventor in exchange for the disclosure of the invention. At the core of this system is the desire to strike a balance between the interests of society and those of the patentee. There is consequently a crucial need to ensure an appropriate procedure to prevent patents of little worth from being granted easily, as these could also be used against competitors as a threat. Furthermore, this makes the process of examining a patent application even more important. As such, it should be more than a box-ticking exercise and include the assessment of multiple policy considerations, designed to reflect policy objectives sought by the patent system itself.

III. Definition of AI for the purpose of IoT

The first difficulty relates to defining AI.[41] AI is a dynamic concept referring to the development of computer systems able to perform human-like tasks such as speech recognition, visual perception, problem-solving, and decision-making. In light of the variety of types of AI and the absence of a consensus over its definition,[42] it is best to think of AI as a spectrum,[43] ranging from technology using human reasoning cognitive functions as a model to perform specific tasks (weak or narrow AI) to an AI program which is capable of human reasoning and perform intellectual tasks (strong or broad AI).[44] A 'weak AI' generally consists of a

Green who argue that a weaker novelty requirement helps the social goal of disclosure. S. Scotchmer and J. Green, 'Novelty and disclosure in patent law', (1990) 21(1) *The RAND Journal of Economics*, 132. Surprisingly, this was shared by one of interviewees, this scholar would even go as far as arguing that with a strong inventive step requirement, the novelty requirement is not necessary.

[41] Japanese Institute of Intellectual Property, Foundation for Intellectual Property, *Research Report on How Creations Made with the Use of AI and Data for 3D Printing Should Be Protected under Industrial Property Law* (February 2017) 5-7; A. Hiruta, 'Treatment of Inventions Created with the Use of AI' (2017) 1 *IP Journal*, 6; Ministry of Internal Affairs and Communications, *2016 White Paper - Present and Future of Artificial Intelligence (AI)* (2016) 233.

[42] Recently, the USPTO invited submissions as to what AI inventions mean. According to the Association for the Protection of Intellectual Property (AIPPI), AI invention can refer to a wide range of activities including the problem to be addressed, the structure of the database on which the AI trains and learn, the training of the algorithm on the data, the algorithms themselves, the results of the AI invention, the parameters adopted and possibly even more. AIPPI written comments submission before the USPTO, Department of Commerce, [Docket No. PTO–C–2019–0029] (Nov 12, 2019), 2.

[43] Fraser, supra n. 4, 307; R. Abbott, 'I Think, Therefore I Invent: Creative Computers and the Future of Patent Law' (2016) 57(4) *B.C.L. Rev.*, 1093.

[44] A common example is AlphaGo.

computer system focusing on a single task and works on pre-programmed algorithms designed by humans (rule-based systems). A strong AI is even harder to define in the sense that it is hard to understand how the computer system reacts to particular information and what triggers a particular decision or solution to a problem as it is said to mimic human intuition (learned-based system).[45] It nevertheless mainly relies on clustering and association to process data. It is this type of AI which may rely on machine learning[46] or deep learning[47].

The way in which they attempt to solve a problem and who does the actual learning differs. It can either be the human behind the system or the system itself. Take the common example of a system trying to differentiate cats from dogs. A machine learning algorithm requires human intervention to structure the training data into two categories: (1) images of dogs and (2) images of cats. The system studies and learns from this structured data to subsequently be able to differentiate images of cats and dogs.[48] Deep learning networks do not need to have pre-labelled data to learn the differences between images of cats and dogs. Instead, the neural network will send the input data through various layers of a network, using numerous algorithms, and each of these layers will hierarchically define the features of the different images through the use of parameters (weighing coefficients representing the connection strength between neurons).[49] There is no need for human intervention to produce an output.[50] Human intervention will nevertheless be necessary to design the layout and structure of the neural network as well as how neurons are connected, what will trigger these, the parameters, and the training

[45] This is often referred to as the 'black box'.

[46] In short, a subset of AI involving the creation of algorithms which can transform itself without human intervention to produce a specific output. The data fed into the AI program needs to be structured.

[47] Meaning a subcategory of machine learning where the system creates algorithms in the same way as for machine learning but it distinguishes itself by the numerous layers of algorithms used. Each layer provides a different reaction and interpretation to the data fed thereto. This is what is commonly referred to as 'artificial neural network' and does not necessarily require structured data to operate.

[48] Given the need for structured data, these algorithms are not suitable to solve complex problems relying on huge datasets.

[49] In reality, deep learning would not be used for such a simple task. However, this example serves as an illustration to understand the differences between both types of AI.

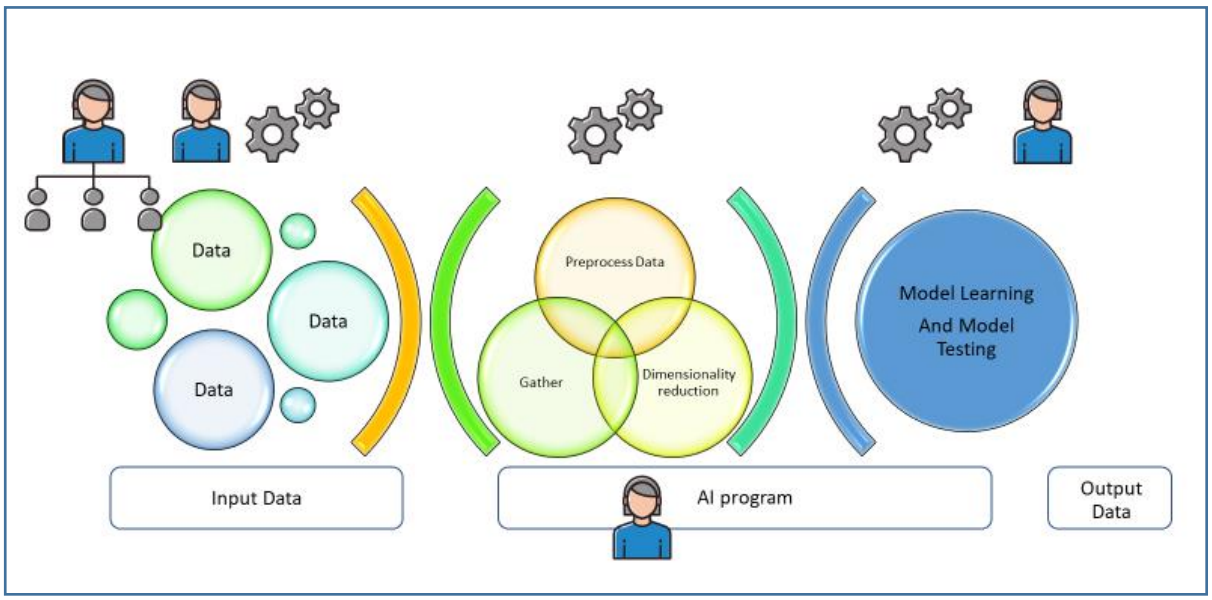
[50] However, it will generally require much more data than a machine learning algorithm to be able to identify concepts, differences and similarities. Data-Related Assets Report, supra n. 2, 23.

methods. Human intervention is also relevant to correct errors if the output is not the desired one.[51]

To perform a task, AI relies on algorithms. Whether these algorithms are already known and form part of the prior art, there are also learned models built only by the human conducting the learning. Although in rule-based systems, the human writes the entire algorithm to be implemented by the machine, learning systems involve adaptive algorithms. These do not solely rely on massive amounts of data but they also involve significant amount of computational resources and time. To put it simply, learned models require a large amount of investment. Additionally, AI programs refer to an intangible and invisible activity, removed from the end-product which has traditionally been the focus of patent law.

[51] L. Vertinsky & T. M. Rice, 'Thinking about thinking machines: implications of machine inventors for patent law' (2002) 8(2) *B. U. J. Sci. & Tech. L.*, 586.

Figure 1. Overall process of strong AI program development



(source: the author)

Figure 1 represents an illustration of the overall process of strong AI program development. The learning process starts with the aggregation of data, which may be derived from a variety of sources such as user input, sensors affixed on objects, or monitoring of user behavior. Because this vast amount of data is likely to include errors, a pre-processing phase is necessary to remove errors and biases and to avoid data skews as the overall goal is for the AI program to identify patterns and features in a given dataset. However, there may be multiple features in one dataset, and it may be extremely costly to define and quantify each feature. Here, the algorithm is able to reduce the waste by focusing on certain features in the pre-processed phase (i.e. dimensionality reduction). This reduces waste of computational capacity but simultaneously reduces the amount of insights and information that may be derived from a particular dataset. The next phase relates to the AI program's attempt to fit the dataset into predetermined models. Generally, several sets are involved.[52] There is the training set which the algorithm attempts to fit within one of the predetermined models by applying parameters to it, then there is the validation set which is used to evaluate error rates of each model for data outside the dataset and finally, there is the test set, which is used to generate a report on the accuracy of the selected model.

[52] For more, see A. Ng, *Advice for applying machine learning: Model Selection and Train/Validation/Test Sets*, https://www.coursera.org/learn/machine-learning/lecture/QGKbr/model-selection-and-train-validation-test-sets.

AI programs do not initiate the invention process.[53] And whilst the AI of today is better conceived as a tool used by humans[54] mainly limited to performing specific tasks,[55] some have noted that a lot of innovation remains in this area and that in a few decades, AI could very well exceed human capabilities.[56] At this stage, it is hard to predict the future of the technology in the long- or even mid-term.[57] What is nevertheless certain is that computer technology continues to progress rapidly and is likely to transcend every industry known today (e.g. manufacturing, financial, medical, politics and content industries).[58]

Another characteristic of AI is that once an efficient algorithmic solution has been found, it can be applied to a series of different complex problems in related or unrelated fields. Furthermore, these programs enable new forms of experimentation by simulating complex systems, ultimately enabling costs and time saving.[59] If most algorithms are known, where does the innovation lie in machine learning?[60] Today's AI computational models rely heavily on huge amounts of data. The algorithms of

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[53] A recent empirical study into the role of the human in the future of the innovative process demonstrates that respondents believed that, when dealing with AI, humans would mostly carry out the step of identifying the problem to be solved rather that selecting the ways in which the problem could be solved or assessing the feasibility of the resulting solution. Hiruta, supra n. 41, 7; Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 26; confirmed in AIPPI, supra n. 42, 4; Vertinsky and Rice, 'Thinking about thinking machines: implications of machine inventors for patent law' (2002) 8(2) *B. U. J. Sci. & Tech. L.*, 586.

[54] Ministry of Internal Affairs and Communications, supra n. 41, 233.

[55] Today's AI can do more than achieving pre-defined tasks and some include the ability to autonomously create, test and make decisions as to a solution to implement.

[56] C. Reedy, *Kurzweil claims that the singularity will happen by 2045* (October 5th, 2017) available at https://futurism.com/kurzweil-claims-that-the-singularity-will-happen-by-2045; Abbott, supra n. 43, 1093.

[57] Dr Thaler argues that he has now invented an algorithm which will become the successor of deep learning, paving the way to sentient AI. Dr S. Thaler, *Imagination Engines Inc. announces a new patent that is arguably the successor to deep learning and the future of artificial general intelligence* (Sept 22nd, 2019) available at https://www.linkedin.com/pulse/imagination-engines-inc-announces-new-patent-arguably-thaler-1e/.

[58] Vertinsky and Rice, supra n. 53, 576.

[59] Ibid, 579-580.

[60] See also WIPO Standing Committee on the Law of Patents, *Background Document on Patents and Emerging Technologies* (Geneva, June 24th-27th, 2019), 11 available at https://www.wipo.int/edocs/mdocs/scp/en/scp_30/scp_30_5.pdf.

tomorrow would operate on small datasets,[61] include more efficient deep learning models, new hardware, and be capable of unsupervised learning.[62] Moreover, innovation lies in the reasoning capabilities of AI algorithms.

The realization of the promises linked to the IoT depends on the adaptive learning capabilities of daily devices and appliances. As IoT technology pursues the goal of detecting, collecting, and analyzing data obtained from sensors affixed on devices and everyday appliances via the Internet, IoT has the capability of dramatically changing manufacturing efficiency. The relationship between AI and IoT is not hard to grasp. As IoT naturally involves big data, the realization of its promises would be limited if we had to rely on human intelligence only. Therefore, AI programs are now seen as crucial to use this big data in a meaningful way.[63] Similarly, as seen above, the performance of machine learning systems largely depends on vast amounts of high-quality data.

IV. Rationale for protecting AI algorithms under patent law

Computer science (and the development of complex AI programs for a wide range of different purposes) is presumably the field presently involving the most intensive human innovative endeavors.[64] One might therefore wonder why the patent paradigm struggles to adapt itself to this form of innovation. The problem is not new. For example, software protection appears to have always caused difficulties for intellectual property law experts.[65] Today, the patent system remains a difficult regime that is not easily intelligible and lacks clear definitions of what constitutes a protectable subject-matter under patent law. This results in the need for elaborate reasonings that, at times, can come near to an elegant juggling of words and concepts. In an attempt to simplify this system and to strengthen its legitimacy in

[61] It is said that in image recognition, there is a need for a dataset of about 15 million images to enable the AI program to identify an object. This constitutes an inherent limitation to the use of neural networks as in some domains there is not sufficient data to begin with.

[62] Whilst progress has been made in relation to unsupervised learning, it often requires human correction. See the example of training an AI program to differentiate dogs from wolves which contained numerous errors. Upon rewriting of the algorithms so that the system would explain its decision-making process, it was demonstrated that the AI program was classifying the images as dogs or wolves based on the presence of snow in the image. P. Haas, *The real reason to be afraid of artificial intelligence* (December 15th, 2017) TEDx Talk available at https://www.youtube.com/watch?v=TRzBk_KuIaM.

[63] M. Sakai, 'Intellectual Property Rights for Business Model by AI/IoT Technology-Claims and Description for Patent Right Protection' (2018) 71(11) *Patent* (Separate Volume No. 20), 228.

[64] On the ways in which AI is likely to change the invention process, see Hiruta, supra n. 41, 7.

[65] Infra section IV-1.

light of today's innovation, this section presents an overview of the arguments supporting and opposing the protection of algorithms under patent law.

1. Arguments supporting the protection of AI algorithms under patent law.

Firstly, **copyright does not offer an adequate form of protection**. Already regarding software, experts have struggled to identify the appropriate form of protection. As Hilty and Geiger note,[66] it is hard to understand why a mathematical formula would be on par with other creative works such as a novel. Nevertheless, today, computer programs tend to be protected as creative expressions under copyright law. Protecting algorithms through copyright is even more problematic as these come closer to ideas than expressions of ideas which fall outside the scope of copyright. Regardless, it is doubtful that algorithms warrant protection for the life of the author plus 50[67] or 70 years.[68] In such a fast-paced technological field, it seems counterintuitive to grant a long term of protection for low creative expressions. Furthermore, copyright mostly protects against literal infringement of the text of the program as it requires *copying* for infringement to be found, resulting in a rather narrow scope of protection for computer scientists.[69] Nevertheless, additional relief may be found in the fact that not only literal copying is protected. Indeed, as courts would do with other creative works such as a novel, the first step is to establish which elements have been copied. Then, courts extract elements copied that are not copyright protected and finally, courts compare the parts reproduced to establish if *originality* has been copied. This explains how parts of codes introduced simply for efficiency purposes would still contribute to the findings of infringement.[70] And yet, algorithmic efficiency represents a big area for innovation presently. Such innovation would probably be best protected under patent law.[71] Here, US courts have paved the way. In *McRo Inc. v. Bandai Namco Games Inc.*,[72] the court provided some clarification on the subject-matters for patent law by holding that patent claims that 'focus on a specific means or method that improves the relevant technology' were not too abstract and may be patentable.[73] Overall, what innovators in the field are trying to protect is not the

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[66] Hilty and Geiger, supra n. 32, 617.

[67] This is the case in Japan, see article 51 of the Japanese Copyright Act.

[68] This is the case in most European countries and in the US. See USC Title 17, Chapter 3.

[69] H. R. Jin, 'Think big! The need for patent rights in the era of big data and machine learning' (2018) 7(2) *NYU Journal of Intellectual Property and Entertainment Law*, 85-86.

[70] D. Koo, 'Patent and copyright protection of computer programs' (2002) 2 *IPQ*, 196-198.

[71] Jin, supra n. 69.

[72] (2016) 837 F.3d 1299, 1314-15 (Fed. Cir.) (*McRo*).

[73] See infra section V-3.

expression of an idea but the ideas or concepts themselves,[74] making patent law more suitable and provides better protection against competitors who develop similar solutions independently.[75]

Secondly, **trade secrets are equally ineffective**. If through the obtention of patent protection, the contents of a patent application become part of the public domain, trade secrets require the invention to be kept secret. This form of protection is attractive as it does not include meeting the patentability requirements established under patent law. Contrastingly, patent protection offers a way to encourage innovation and contributes to the growth of the public domain information in relation to a particular field of technology.[76] Indeed, if an inventor knows that a patent could be granted over an invention, she is less likely to rely on trade secret law despite the fact that protection may last longer than under patent law, provided that no third party has independently obtained the secret.[77] However, trade secrecy may not be the most optimal way to deal with AI algorithmic inventions or even the best strategy as generally, the inventive process of AI programs involves numerous inventors from possibly different companies. Therefore, companies are likely to be interested in creating cross-industry alliances to share knowledge and information.[78] Patent protection could also enhance cross-industry collaboration with a goal to facilitate innovation even though contract law could be used to share information protected as trade secrets. Where innovation is mainly characterized as being incremental and cumulative, this argument gains importance. Indeed, with the current speed in which technology advances in this field, there is a real risk that another company ends up disclosing the details of the subject-matter rapidly if kept as trade secret.

Thirdly, **the current legislative framework is misleading**. It would be a misconception to believe that patent law does not reward inventors of software or algorithms.[79] Patent attorneys generally advise avoiding language such as ‘AI

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[74] S. Utku & A. Strowel, 'Developments regarding the patentability of computer implemented inventions within the EU and the US: Part 1 - introduction and the legal problem of patenting computer-implemented inventions' (2017) 39(8) *EIPR*, 490; Koo, supra n. 70, 189; D. J.M. Attridge, 'Challenging claims! Patenting computer programs in Europe and the USA' (2001) 1 *IPQ*, 24.

[75] Ibid.

[76] Utku and Strowel, supra n. 74, 490; Fraser, supra n. 4, 322.

[77] Jin, supra n. 69, 87.

[78] I.e. data sharing alliances.

[79] Attridge, supra n. 74, 27-28. Also corroborated by the data from the JPO which demonstrates that we are currently in a third AI boom of patent applications with patent applications over core AI accounting

program', 'mathematical algorithm' or 'algorithm' to describe the invention so as not to fall within the exclusions of patentable subject-matters.[80] The language used also varies greatly from a jurisdiction to another. For example, Europe excludes computer programs from patentability unless they bear a technical effect or contribution, whilst Japan has especially enshrined the possibility for patenting 'computer programs, *etc*.' (emphasis added). If it is not that hard to get a patent for an algorithmic invention by being skilled with words, it is perhaps time to adapt practices in order to reflect that reality. Equally, there is no denying that if inventors understand that they are more likely to be protected by applying in certain countries (like Japan), they will more likely set up a business there or market the invention in the jurisdictions where the law is on their side. The opposite also holds true. It may also be more difficult for inventors operating in countries where protection is doubtful to attract the necessary investment for innovative technologies, as investors may fear a slower return on investment. Furthermore, the current system fosters a high degree of invalidity procedures.[81] Faced with the uncertainties as to what is actually being protected, smaller players in the field who lack the financial backing to defend their inventions may suffer negative effects. Equally, investors may be less attracted to supporting start-ups for fear of invalidity procedures linked to the subject-matter eligibility morass currently prevailing.

Fourthly, opening patent eligibility to AI algorithms **encourages innovation and enhances social benefits**. The primary objective of patent law is to encourage innovation and ensure that the public derives the benefits of these inventions. So, when talking about AI algorithms, where is the innovation? After all, algorithms are not new and merely amount to a set of instructions. Whilst the use of AI has assisted innovators in developing inventions for several decades,[82] the recent developments in machine learning and exponential growth in computational powers is becoming one of the biggest drivers of innovation transcending all fields like robotics, healthcare, electronics, manufacturing, finance, genetics, pharmaceuticals, etc.[83] Consequently, enabling the protection of AI algorithms as patentable would be consistent with the justifications and purposes of the patent

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for almost a third of these patent applications. JPO, *Recent Trends in AI-Related Inventions* (July 2019) available at https://www.jpo.go.jp/e/system/patent/gaiyo/ai/ai_shutsugan_chosa.html.

[80] Confirmed by interview with Japanese patent attorneys.

[81] Jin, supra n. 69, 104.

[82] G. Con Díaz, *Software rights* (Yale University Press 2019) 13-34.

[83] Jin, supra n. 69, 98-99; Fraser, supra n. 4, 315; N. Nosengo, *Can Artificial Intelligence Create the Next Wonder Material?* (2016) available at http://www.nature.com/news/can-artificial-intelligence-create-the-next-wonder-material-1.19850 ; Abbott, supra n. 43.

system. Such protection would encourage further human ingenuity in the field as it recognizes the upstream creative activity deployed.[84] Although humans will still innovate in this area without patent protection for AI algorithms, it may well be at a slower pace given the efficiency or logistical problems that may exist. Simultaneously, extending patent protection to algorithms concurs with the public interest rationale of a patent system.[85] After all, as patents have an impact on competition and lead to an increase in prices for consumers, there needs to be a very good reason to do so. However, arguably the absence of patent protection for AI algorithms could lead to less commercialization of useful inventions. As Abbott explains,[86] in some industries like pharmaceuticals and nanotechnologies, the majority of cost incurs after the innovative process, when the product needs to go through clinical trials and the acquisition of regulatory approval for marketing. Therefore, recognizing the innovative endeavors in the process could enhance commercialization of products which, bar the financial support, may never reach the public or enable innovators to focus on the core technological advancements necessary.[87]

Fifthly, there is a **risk of market failure** and recognizing the eligibility of algorithms could **maintain competition** in the field. Characterized by rapid incremental innovation which leads to strong competition in the market, large companies as well as a large number of smaller companies resulting from the fall in costs of computational powers are competing in the market. As the market matures, entry barriers are nevertheless emerging.[88] Arguably the granting of patents over AI algorithms would ensure that not only investors keep on investing

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[84] Demonstrating that algorithms are the result of human creation and not discoverable artefacts, P. M. Nichols, 'Bribing the Machine: Protecting the Integrity of Algorithms as the Revolution Begins' (2019) 56(4) *American Business Law Journal*, 780-786.

[85] Jin, supra n. 69, 104; Fraser, supra n. 4, 328.

[86] Abbott, supra n. 43, 1104.

[87] P. Belleflamme, 'Patents and Incentives to Innovate: Some Theoretical and Empirical Economic Evidence' (2006) 13 *Ethical Perspectives*, 278; A. Hu and I. Png 'Patent Rights and Economic Growth: Evidence from Cross-Country Panels of Manufacturing Industries' (2013) 65 *Oxford Economic Papers*, 675.

[88] C. Watney, 'Reducing Entry Barriers in the Development and Application of AI' (October 2018) *R Street Policy Study NO. 153*, 1-9; However, others argue that barriers to entry are lowering but the barriers to exit increase. Successful innovators become victim of the 'innovators dilemma', see M. Baxter, *The Golden Age of Startups: Technology is Lowering Barriers to Entry, But Increasing Barriers to Exit* (July 12th, 2019) available at https://www.information-age.com/golden-age-of-startups-technology-lowering-barriers-to-entry-increasing-barriers-to-exit-123483996/

in start-ups, but also that undertakings would have a better idea as to the worth of the invention, and would make it easier for their commercialization, transfer or licensing.[89] The costs of discovering or developing a new AI algorithm are generally high. Given the numerous risks taken and the ease with which these inventions may be copied, smaller players may be driven away from making advancements leading to less inventive activity in the field and eventually resulting in potential market failure if no adequate protection is provided.[90] Furthermore, the current differences existing in subject-matters eligibility create extra costs for patentees which is likely to stifle competition and prejudice consumers. IoT, for example, uses the Internet network to share information between devices. Computer software and AI programs equally rely on the Internet which knows no geographical borders. Hence, there is a greater impact resulting from a lack of harmonization on competition as patentees will seek to establish their business (or at least market their invention) in countries where protection is certain.

Sixthly, rendering AI algorithms eligible would contribute to the **realization of the sufficiency of disclosure requirement**. If anything, the current situation fosters secrecy over dissemination.[91] Currently, the practice shows that inventors will still seek to patent their inventions without disclosing the extent of the reliance on complex and powerful algorithms knowing that the disclosure may annihilate their chance at protection. Not only would inventors be incentivized to disclose more abstract problems descriptions and be stimulated to innovate, but the application of the disclosure requirement enshrined in patent law would reduce duplicative efforts from other parties trying to reverse engineer a particular AI program. Other companies can immediately build upon the patented invention. At present, it is hard to understand how the person skilled in the art is able to test the 'enabling disclosure' of a patent application in this field. By having patent applicants disclose more abstract concepts (which still need to be sufficient to teach the person skilled in the art to make and use the invention even if this means relying on a computer as a tool for innovation), there is a better alignment with the justifications for the existence of a patent system.

Seventhly, it would promote **higher quality patents**. There is presently a burden created for patent attorneys (who are left to find creative solutions to protect a particular invention) and courts in infringement procedures. By recognizing algorithms as eligible, fewer patents may be granted (as many of the algorithms

[89] Although Posner counterargued in relation to software patents that software may not be necessary to enhance competition. Posner as cited in Abbott, supra n. 43, 1106.

[90] Fraser, supra n. 4, 315, 321-322; 325; 327; Koo, supra n. 70, 196-198.

[91] Although this statement is less relevant for the US as explained is section VI-3.

relied upon are known) but higher quality patents would be promoted because only the truly deserving innovative algorithms would pass the patentability threshold and consequently, there would be a decrease in post-grant challenges.[92] It is argued that there would not be a flooding of patent offices with applications over abstract or non-technical ideas as patent applicants know that such applications would not pass the patentability requirements. Whilst this statement requires empirical analysis to support it, it is foreseeable that companies are less likely to file patent application over small improvements in this technological field.[93]

Finally, there would be a **recognition of the value of AI algorithms**. The primary value in AI algorithms is not its graphic representation but its *behavior*.[94] Therefore, AI algorithms with identical behavior and yet, a different graphical representation result in market substitutes. Additionally, it is time for patent law to adapt and recognize AI inventions removed from any hardware. AI algorithms behave just like machines that also produce a useful behavior.[95] An AI algorithm is the process of developing and assembling functional elements such as large datasets. These are large and complex - arguably, comparable to the most complex mechanical devices known today.[96] In the future, there will be an increasing need to expand the scope of patent protection beyond the mere conception of protecting end-products implementing the AI as most inventions do not attempt to create self-driving cars but are targeting its building blocks which are vital to training the AI program.[97]

2. Arguments opposing the extension of patent law to algorithms

Firstly, there is **no evidence that further incentives are necessary**.[98] The field being vibrant and competitive, there is no apparent reason for intervention and most

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[92] Scotchmer and Green, supra n. 40, p. 132.

[93] This is ultimately a policy question.

[94] Attridge, supra n. 74, 24.

[95] Koo, supra n. 70, 189

[96] Algorithms are not just math: A. K. Acharya, 'Abstraction in Software Patents (and How to Fix It)' (2019) 18(4) *John Marshall Review of Intellectual Property Law*, 376; Hiruta, supra n. 41, 9; Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 28; C. Dorman, 'One if by land, two if by sea: The federal circuit's oversimplification of computer-implemented mathematical algorithms' (2018) 2 *University of Illinois Journal of Law, Technology & Policy*, 287; Abbott, supra n. 43, 1106.

[97] S. Gokhale, 'Pendulum swinging back in AI direction?' (December 2018, January 2019) *IPM*, 47.

[98] Jin, supra n. 69, 83.

analysts advocate for the maintenance of the *status quo*.[99] Considering the recent study undertaken by the Japanese Institute of Intellectual Property,[100] their interview survey indicated that companies engaging in this field desire protection for learned models for mainly two reasons: (1) protecting a return on investment, blocking entry to the field and combatting imitation; and, (2) to recognize the value of AI.[101] Nevertheless, the authors report that the majority of the respondents weighed against extending protection to cover AI algorithms based mainly on the following arguments: (1) trade secrets offer an adequate form of protection; (2) there is no direct correlation between patent protection over AI algorithms and the development of the field; (3) there are practical difficulties in protecting AI algorithms with the necessary data; and (4) as the learned model cannot be separated from the program, it already corresponds to 'programs, etc.' under Japanese patent law.[102] From the current studies, it is difficult to draw any meaningful conclusion in one way or another.[103] Some even recently argued that, if anything, the exponential growth experienced in the field and the surge of AI patents demonstrate that patent law has well adapted and no further changes are necessary.[104] However, there is recognition that existing patent law differences among jurisdictions are likely to have an impact on the availability of patent protection for AI algorithms which can be costly for businesses and increase legal uncertainty.[105]

Secondly, recognizing the eligibility of algorithms could lead to a **rise in patent thickets and impact competition**. Due to the incremental, inexpensive, quickly superseded algorithmic innovation,[106] patent protection for algorithms could lead to a risk that the field will abound with patents where the costs of examining these

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[99] See recent study undertaken by the Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 32.

[100] Ibid, 28-30.

[101] Ibid, 28. Also, see for example the rise in patent applications numbers in the US for class 706 (dealing with AI data processing systems) as reported in F. A. DeCosta & A. G. Carrano, 'Intellectual Property Protection for Artificial Intelligence' (August 30th, 2017) *Westlaw Journal Intellectual Property*, 1.

[102] Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 29.

[103] Interestingly, a similar debate occurred in relation to computer software at the time. Hilty and Geiger, supra n. 32, 630-632.

[104] AIPPI, supra n. 42, 3; Data-Related Assets Report, supra n. 2, 23-40. However, this may be due to skillful claim drafting rather than a reflection of the adequacy of the patent system.

[105] AIPPI supra n. 42.

[106] P. Blok, 'The inventor's new tool: artificial intelligence – how does it fit in the European patent system?' (2017) 39(2) *EIPR*, p. 73; Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 32; Attridge, supra n. 74, 28-29.

patents and transaction costs increase. This could deter companies from developing new products and processes and stifle innovation.[107] Smaller participants are also likely to be deterred from innovating in the field to the benefit of big corporates.[108] Even if smaller companies have enough financial backing to innovate (and apply for patent protection themselves), they still need to have sufficient funds to defend their patent against infringers if needed. Major corporations are in a better position to even launch vexatious infringement proceedings in order to eliminate the competition or settle out of court.[109] As Attridge argued in relation to software patents already, even if this situation is not providing the necessary conditions to a competitive market, this criticism could be extended to the patent system in general.[110] Whilst the impediment of follow-up innovation is a serious concern to be cognizant of, it must be emphasized that a monopoly would only be granted if the patentability requirements (i.e. novelty, inventive step and industrial application) are met. These well-established criteria of patent law will limit the distribution of temporary monopolies as they do currently in other fields of innovation.[111] Moreover, if patent systems have accommodated AI programs without legislative considerations, these technologies are arguably likely to have a longer-term impact on the patent paradigm as their use increases. As Vaver puts it,[112] the inventive process is dynamic by nature. If it operates in light of established principles of patent law that are amended overtime to accommodate the unforeseeable, the overall 'trend has been towards wider protection'[113].

Thirdly, there could be **practical difficulties for patent offices** linked to the expansion of protection to cover algorithms. This holds true given the nature of the knowledge required to undertake the examination of patent applications and is

[107] Fraser, supra n. 4, 322-325.

[108] Koo, supra n. 70, 209-210.

[109] Hilty and Geiger, supra n. 32, 637-638.

[110] Attridge, supra n. 74, 29. Also recently re-emphasized in Abbott, supra n. 43, 1105.

[111] Equally, until recently, the system prevailing in the US has been characterized of being more liberal in its patentability of computer programs than in Europe. However, it can hardly be said that this led to a stronger software-based economy in Europe. See A. Strowel and S. Utku, *The trends and current practices in the area of patentability of computer-implemented inventions within the EU and the US* (2016) final Report for the European Commission, 6.

[112] D. Vaver, 'Invention in Patent Law: A Review and a Modest Proposal' (2003) 11 *International Journal of Law and Information Technology*, 286-307.

[113] Ibid, 302.

particularly valid for assessing the satisfaction of the inventive step requirement.[114] There are concerns that if a Patent Office is faced with new and unfamiliar technology, it could lead to the granting of a patent to those who were first in applying for patent protection.[115] This changes the nature of the test which should be whether a person with similar expertise would have reached the same technical solution or not.[116] One of the practical difficulties patent offices would face is the identification of prior art. Patent offices' resources are already strained and this could be exacerbated if AI algorithms are eligible for patent protection given the incremental nature of innovation in this field. Even in the situation where patent offices have trained patent examiners and the appropriate instruments to understand and examine AI algorithmic innovation, it may lead to delays or the issuance of lower quality patents.[117] If these patents go unchallenged, there may be negative consequences for the field. However, not only is this argument not unique to AI algorithms but it could be extended to any expansion of patent law which has been hasty and not integrated in the most optimal way. The current situation also includes practical difficulties but these are generally present post-grant, burdening courts in infringement procedures where judges increasingly struggle to evaluate whether infringement has taken place or if the patent should have been granted in the first place given the technological expertise required.

Lastly, there are **difficulties in identifying the object of protection**.[118] Whilst the nature of innovation challenges the idea that AI programs do not deserve protection,[119] it is apparent that there are a wide range of different understandings as to what should be protected. As such, depending on the people consulted, definitions vary.[120] Even when narrowing the object of protection to learned models only, different interpretations exist. In other words, are we referring to the AI program and its parameters or the parameters alone? In respect to the protection of parameters alone, interview findings did not lead to a need to further protect these systems under industrial property law.[121] In order for the patent system to be

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[114] On AI and inventive step, see I. Nakayama, 'AI and Inventive Step – Proposal of Issues' (2019) 72(12) *Patent*, 179-199; Ramalho, supra n. 9.

[115] Hilty and Geiger, supra n. 32, 636-637.

[116] Which has happened in the past in relation to biotechnology and software protection. See Attridge, supra n. 74, 28-29.

[117] Hilty and Geiger, supra n. 32, 636-637.

[118] This was also an argument made in relation to software patents. Utku and Strowel, supra n. 74, 493.

[119] Infra section III.

[120] Ibid.

[121] Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 29.

efficient, there is no denying that any expansion should be duly examined and result from serious reflection, without which such a paradigm might lead to a breaking point. It also leads to broader questions, such as what should patent law seek to protect in the first place.[122] Should it be the process of reaching a specific technical solution or its embodiment in a particular application? Afterall, one AI system might have multiple applications in numerous different fields, many of which may not have been discovered at the time of the application for patent protection.

3. Interim Conclusion

The question as to whether AI algorithms should be eligible for patent protection remains unsolved. Undoubtedly, protection of AI algorithms should only be authorized if patenting these innovations fall within the purposes of the patent system. This section has shown that there are a number of advantages and disadvantages of opening up patent protection to algorithms.

One of the most contentious points would be to recognize AI algorithms as machines. Whilst we should operate with caution to prevent the rise of unworthy patents, there is an increasing need for the patent system to adapt to the nature of innovation known today.[123] Ultimately, AI innovation remains a desirable outcome. Despite the current lack of economic evidence that an expansion of patent protection is warranted for AI algorithms, there are strong arguments that demonstrate that the protection of AI algorithms is in line with the justifications and purpose of the patent system.

V. The first hurdle: subject-matter eligibility

History taught us that software protection has been cumbersome under patent law. In the US, a shift occurred with the landmark case of *Diamond v Diehr*,[124] where the Supreme Court recognized the possibility to grant patent protection over a computer-controlled process producing tangible outputs in the real world (i.e. molding uncured synthetic rubber into cured precision products) and thereby, departed from the former position that all computer programs should be unpatentable because of the exclusion of mathematical formula in *Benson*.[125] Since *Diehr*, lower courts have attributed more attention to 35 USC §101 to determine

[122] Vertinsky and Rice, supra n. 53, 587.

[123] E.g. the discussions of a panel at the 2017 World Economic Forum. World Economic Forum, *World Economic Forum Annual Meeting 2017 System Initiatives Programme* (2017) available at www3.weforum.org/docs/Media/AM17/AM17_System_Initiatives.pdf.

[124] *Diamond v. Diehr*, (1981) 450 U.S. 175 (*Diehr*).

[125] Supra, n. 30.

whether the invention constitutes a process or a machine before turning to the assessment of the well-established patentability requirements of novelty and inventive step. Upon meeting these requirements, the invention may be patentable.[126]

A similar trend can be found in Europe since the leading *Vicom* case,[127] where the EPO Boards of Appeal held that a mathematical method to digitally process two-dimensional data representing stored images was a patentable subject-matter despite the language of article 52(2) and (3) EPC indicating that computer programs 'as such' are not patentable. To reconcile the decision with the provisions, the Boards of Appeal created the 'technical effect' doctrine whereby computer-related inventions need to achieve a 'further' technical effect than the physical modification of the computer hardware resulting from the execution of the computer program instructions. Since *Vicom*, some have underlined the absurdity of maintaining the exclusion of computer programs from eligible patent subject-matters in the EPC. This possibility was entertained during the conference for the revision of the EPC in November 2000 but was eventually dropped.[128]

Japan has made that further step. If initially patent protection was excluded for computer-related inventions, following a change initiated in the nineties, computer-related inventions are patentable provided that these result in 'a highly advanced creation of technical ideas utilizing a law of nature'.[129] Nevertheless, despite the legislation embracing the protection of computer-related inventions, uncertainties remain in cases that blend computer programs with mathematical or business methods, as occurs with many algorithms.[130] Whilst the above improvements are

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[126] A similar path can be found in relation to the grant of patents for methods of doing business. With the decision in *State Street Bank & Trust v. Signature Financial Group,* The US Court of Appeal for the federal circuit recognized that: 'a practical application of a mathematical algorithm, formula or calculation' should be patentable if 'it produces a useful, concrete and tangible result'. (1998) 149 F.3d 1368, at 1374.

[127] Supra n. 34.

[128] E. Hausman, M. Cohn and S. Presenti, 'Will Israel follow the USA, Japan and the EPO and allow patent protection for software stored on a storage medium?' (2002) 33(1) *IIC*, 20.

[129] Article 2(1) JPA. Reviewing early case law in this area, see M. Dragoni, Software Patent-eligibility and patentability: a comparison between Japan, Europe and the United States' (2018) 43(1) *AIPPI Journal*, 28-50.

[130] *JPO Guidelines for Examination*, (2012) 11 and ff. available at http://www.jpo.go.jp/tetuzuki_e/t_tokkyo_e/Guidelines/7_1.pdf

welcomed, problems remain when it comes to patenting AI algorithms removed from any hardware element.[131]

1. Europe

Discoveries, scientific theories, mathematical methods, artistic creations, performing mental acts and programs for computers are not patentable 'as such' because these do not result in an invention for the purpose of the patent system. Underlying the EPC, inventions must include technical features and be concrete.[132]

An AI algorithm essentially consists of a mathematical method or a collection of algorithms can be described as mathematical models.[133] Depending on its application, an algorithm, for example, may also be considered as a scheme, a set of rules or method for performing mental acts, playing games or doing business.[134] Bar the 'as such' doctrine, AI would not be patentable in Europe.[135] To patent AI algorithms in Europe, there is a need to bring the invention into a technical setting without which the invention would be considered too abstract to be patented.[136]

Until recently, patent applicants faced great uncertainty as to the patentability of AI algorithms given the lack of guidance and meaningful case law in this area.[137] With the *2019 Guidelines for Examination in the European Patent Office* (EPGL),[138] the EPO provides non-legally binding guidance on the examination of AI-related inventions. Unsurprisingly, these guidelines provide that AI inventions are to be treated as other inventions involving mathematical methods.[139] Machine learning and learned models rely on computational models and algorithms that are of an

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[131] See US: In *Re Alappat* (1994) 33 F.3d 1526 (Fed. Cir.)*; In Re Beauregard* (1995) 53 F.3d 1583 (Fed. Cir.); Europe: T1173/97 (1998) ECLI:EP:BA:1998:T117397.19980701; T935/97 (1999) ECLI:EP:BA:1999:T093597.19990204;

[132] Rule 43(1) EPC.

[133] Excluded under article 52(2)(a) EPC.

[134] Excluded under article 52(2)(c) EPC.

[135] See Reasons 8 of T1510/10 where the use of machine learning (which could be expanded to AI) will not be sufficient in itself to be patentable in relation to a method and arrangement for the ranking of live web applications. (2013) ECLI:EP:BA:2013:T1510.20131204.

[136] T22/85, *IBM/Document abstracting and retrieving* (1988) ECLI:EP:BA:1988:T002285.19881005.

[137] Some guidance could be extracted from how the EPO assess software-related inventions. See EPGL, Part G, Chap. II, in particular 3.6 and 3.7.

[138] Available at https://www.epo.org/law-practice/legal-texts/guidelines.html.

[139] For an overview of the EPO's approach to assessing whether a software fits the definition of invention under article 52 EPC, see EPGL, Part G, Chap. II, in particular 3.6 and 3.7.2.

'abstract mathematical nature'.[140] Therefore, to overcome the ineligibility as an invention, the invention needs to include a further technical effect going beyond the normal physical interaction between a software and the hardware when the computer program is executed by the machine.[141] It is consequently counterproductive to argue that all computer programming activities include *de facto* a technical character as these consist of methods that ought to be carried out by a machine or network system.[142] This being said, if the subject-matter includes a technical character, it will result into an invention.

This construction implies that it is not the AI algorithm that is being patented, but it is the technical device using AI which is the subject of protection. Here, it is irrelevant whether the technical means is actually already part of the prior art such as the inclusion of a computer, computer network or other medium. Appraised as a whole, the invention will be understood as eligible for patentability.

Under the EPO's reasoning, there is a presumption that machine learning algorithms or neural networks are non-technical if removed from their technical field of application.[143] This non-technicality might not be overcome by merely specifying that parameters are of technical nature as it may be excluded on the basis that it falls under the category of performing mental acts instead of on the basis of the mathematical method exclusion. According to the EPGL,[144] the presumption of non-technicality can be overcome for AI inventions if the claim relates to a 'technical application' of a mathematical method or if the claim concerns a 'technical implementation' of a mathematical method.

(1) Technical application

The first way for the AI algorithm to escape ineligibility is if the AI algorithm's functionality is limited to a *specific* technical purpose.[145] Some AI relevant

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[140] EPGL, Part G, Chap. II, 3.3.1.

[141] T1173/97, supra n. 131 and confirmed in G3/08 (2010) ECLI:EP:BA:2010:G000308.20100512.

[142] Ibid.

[143] This is in line with the EPO case law. See for example T1194/97 whereby a computer-implemented data structure was held as having technical character. Adopting a reasoning *a contrario*, merely describing data collection on a logical level does not amount to a technical character. T1194/97, data structure product/Philips (2000) ECLI:EP:BA:2000:T1194/97.20000315.

[144] EPGL, Part G, Chap. II, 3.3.

[145] In accordance with T1227/05, *Circuit simulation I/Infineon Technologies* (2006) ECLI:EP:BA:2006:T122705.20061213 and T1358/09, *Classification/BDGB Enterprise Software* (2014) ECLI:EP:BA:2014:T135809.20141121 in relation to computer programs but which can provide guidance for AI protection too. G1/19, a referral case in relation to computer-implemented simulation methods is

examples are provided such as ‘controlling a specific technical system or process, e.g. an X-ray apparatus or a steel cooling process’; ‘digital audio, image or video enhancement or analysis, e.g. de-noising, detecting persons in a digital image, estimating the quality of a transmitted digital audio signal’; ‘separation of sources in speech signals; speech recognition, e.g. mapping a speech input to a text output’; and, ‘providing a medical diagnosis by an automated system processing physiological measurements’. [146] Furthermore, the mere possibility that a mathematical method may serve a technical purpose will not be sufficient. Care must be taken so that the claims are drafted in such a way that these are essentially limited to the technical purpose. The technical purpose of a mathematical method will hinge upon the direct technical relevance of the results provided by this mathematical method.

Given the emphasis on a ‘specific technical purpose’, it is envisaged that an invention that generates realistic-sounding audio in a text-to-speech system could be eligible for protection. However, a more general claim for generating arbitrary data sequences is unlikely to fit this category.

(2) Technical implementation

In contrast with having a technical output, this category relates to the *design* of the mathematical method. To put it simply, if the design of the mathematical method is ‘motivated by technical considerations of the internal functioning of a computer’[147], this should render the invention eligible for protection. Here, if the mathematical method does not go beyond a generic technical implementation, then it will not contribute to the technical character of the invention. The EPGL also specify that if an algorithm merely provides a more efficient mathematical method than what is already known in the prior art, this will be insufficient.

(3) Teachings from the EPO

Eligibility has not been totally excluded for AI algorithms under the EPC. Despite the language of the exclusions provided under article 52(2) and (3) EPC, algorithms can be considered as inventions if the algorithm is not claimed *as such* but represents a step in the functioning invention considered as a whole. The new guidelines are clear insofar as AI and machine learning inventions should be treated as computer-related inventions under the EPC. Consequently, the exclusion of

currently pending before the Enlarged Board of Appeal. The current Amicus Curiae briefs (available on the EPO’s website) seem to favor an application of T1227/05 to these inventions.

[146] Supra n. 144.

[147] Ibid, T1358/09, supra n. 145.

mathematical methods will only be applicable if the claims relate to abstract mathematical methods. The only way to save the program (or in our case an AI algorithm) from being excluded is to demonstrate that the programming of AI contributes to an overall further technical character.[148] An example can be found in T1227/05,[149] where a software relied on mathematical formula for simulating the noise of an electronic circuit. Facilitating the design of electronic circuits by requiring less test production, the mathematical idea achieved a technical effect and was eligible. Hence, provided that the computer supports the human in achieving a technical effect, the invention has something technical that can be eligible. Expanding the teaching of this case to an AI context, an AI algorithm can be eligible for patentability if it produces a technical result even where the AI replaces the human in the innovative process.

Furthermore, where an AI or machine learning system serves a technical purpose, the steps of generating the training dataset, and the training process of the AI or machine learning system, [150] may also contribute to the technical character of the invention if those steps support achieving the technical purpose.[151] This is significant as it opens the door to patent protection for methodologies for training AI or AI algorithms. It has also the potential to enable the eligibility of methods for the creation of training datasets. To be eligible, patent applicants must convincingly explain how the method for creating the training dataset constitutes a stable and repeatable technical effect.[152] This probably includes having to determine specific features in the claims which enable the training method to produce a technical effect. Therefore, despite this broadening of subject-matter, in practice it may well be difficult for applicants to obtain a patent over subject-matters such as the training process of an algorithm or the method to generate training datasets.

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[148] This criterion has been widely criticized as also recognized in the European Commission Report 2008. European Commission, *Study on the effects of allowing patent claims for computer-implemented inventions, final Report and Recommendations* (June 2008), 8.

[149] Supra n. 145.

[150] EPGL Part G, Chap. II-5, 3.6.3.

[151] T1175/09 (2012) ECLI:EP:BA:2012:T117509.20120206. However, there may be clarity issues in which case, close attention should be paid to T2026/15, *Training method/PUCHER* (2018) ECLI:EP:BA:2018:T202615.2018417.

[152] Some see this as the introduction of the concept of 'plausibility' traditionally known in relation to pharmaceuticals and biotech fields in the AI field. Sam Jones, 'Patentability of AI and machine learning at the EPO' (Dec 21st, 2018) *Kluwer Patent Blog* available at http://patentblog.kluweriplaw.com/2018/12/21/patentability-of-ai-and-machine-learning-at-the-epo/

Going back to the traditional example of the self-driving car, a novel algorithm may analyze inputs from various sensors of the car to determine the quality of the surface of the road (e.g. dry, wet, ice) and adapt the driving accordingly, not only to improve the overall performance of the car, but also to minimize possible car accidents. This AI invention bears a technical character as it relies on a technical device (i.e. the car). However, taken in isolation, the algorithm itself is treated as non-technical despite the fact that it contributes to the overall technicality of the self-driving car.

A contrario, a patent claim that depicts a novel learning model to match offers to the demands of users by comparing information contained in offers, demands and the information collected from users' preferences would lead to a different result. There is no denying that in isolation, this AI algorithm is technical and implemented by a computer. Yet, because of its application, this invention clearly relates to a business model that cannot be patented because its contribution to the prior art is not of a technical nature.

Overall, it is positive to see that the EPO has taken steps towards recognizing the eligibility of some contributions made by machine learning and algorithms for patentability. This being said, it has already been noted that the judiciary has been dealing with the technical merit doctrine in an arbitrary fashion in relation to computer programs.[153] Similar issues are likely to arise with the eligibility AI algorithms and traces of such risks can already be found today. For example, despite the fact that the EPGL explicitly refer to examples such as the classification of images, videos, audio or speech signals based on low levels features as being technical applications which are patentable, the administrative position of the EPO is to reject the findings of technical character when dealing with the classification of text documents based on their textual content.[154] Therefore, if there is a political decision to enable the patentability of AI, the current situation (with untested new EPGL) could lead to a rather restrictive eligibility of AI.

2. Japan

The Japanese Patent Act 1959 (JPA) defines an 'invention' in article 2(1) as 'the highly advanced creation of technical ideas utilizing the laws of nature'.[155] The insertion of 'highly advanced' merely refers to the distinction between utility models and inventions. However, 'technical ideas' is interpreted in an objective manner, meaning that the invention is not the result of hazard but can be

[153] Hilty and Geiger, supra n. 32, 626.

[154] T1358/09, supra n. 145.

[155] This provision should be read in parallel with article 29(1) JPA.

repeated.[156] Furthermore, the 'laws of nature' suggests acts resulting from pure mental activities should be excluded.[157] In contrast with the other jurisdictions scrutinized, article 2(3)(i) adds that a computer program is to be understood as a product for the purpose of the JPA.[158] To complete the picture, article 2(4) defines computer programs as 'a computer program (a set of instructions given to an electronic computer which are combined in order to produce a specific result, hereinafter the same shall apply in this paragraph) and any other information that is to be processed by an electronic computer equivalent to a computer program'.

Similar to Europe and the US, there is a list of ineligible subject-matters.[159] However, this list is not statutory and can be found in the *Examination Guidelines for Patent and Utility Model in Japan* (JPGL) Part III, chap. 1, 2.1. For example, subject-matters that do not utilize the laws of nature, that are not regarded as technical ideas (i.e. presentation of information and mere aesthetic creations), that result in discoveries and those contrary to the laws of nature will not result in an invention.

According to the JPO's practice, the examination of eligibility involves a two-step approach.[160] First, the examiner establishes whether the subject-matter triggers a 'creation of technical idea utilizing a law of nature'[161] separate from the use of a computer program to achieve the solution. After all, under the JPA, a computer program is patentable as it is understood as inducing a machine to execute a method thereby creating a 'technical idea utilizing a law of nature'.[162] The invention must be considered as a whole.[163] Therefore, only a component of an invention may be

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[156] Unlike in Europe where this concept enables the distinction between ideas and their applications.

[157] In practice, these are not assessed in isolation. see Dragoni, supra n. 129, 40.

[158] But the Institute of Intellectual Property purports that if the invention consists of a learning method than it has to be protected as a method to produce a product. The product being the resulting learned model. The eligibility of the learned model for patent protection hinges upon whether a learned model results in a product and corresponds to a 'program' in the sense of the Act. Japanese Institute of Intellectual Property, Foundation for Intellectual Property, supra n. 41, 31. However, doubts as to this approach are expressed in Sakai, supra n. 63, 240-241.

[159] JPGL, Part III, chap. 1, 2.1; Examination Handbook for Patent and Utility Model in Japan (Examination Handbook) Annex B, Chap. 1.

[160] Examination Guidelines on Computer Software-related Inventions, 20.

[161] In accordance with JPGL, Part III, Ch. 1.

[162] However, the subject-matter will not result in a patentable invention if it falls under JPGL, Part III, chap. 1, 2.1.

[163] Tokyo High court Judgment, December 25th, 1956, Gyōshū, vol.7 no 12, 3157 and especially, Intellectual Property High Court, First division, June 24th, 2008, 2007 (Gyo-Ke) 10369.

utilizing the laws of nature and still be eligible. If the patent examiner cannot determine whether the invention utilizes the laws of nature, the examiner moves onto the second step, which involves determining whether the subject-matter is eligible for protection from the standpoint of software. Concretely, this means that the examiner will check whether the information processed by the software is in reality relying upon the use of hardware and *how* the software interacts with the hardware.[164]

Given the absence of statutory language excluding software from patentability, Japan is in better position to tackle the protection of AI inventions. Already in 2004, the Tokyo High Court explicitly notes that algorithms can be eligible for patentability as long as natural laws are utilized, meaning that the claims must explain the relationship between the algorithm and the physical parts of the invention, and this relationship must result from a concrete interaction.[165] Here, simply stating that the mathematical formula must be executed by a computer will be insufficient. What is important is to explain the specific interaction between the hardware and the software.[166] In a recent document from the JPO providing examples pertinent to IoT technology, the JPO confirms that inventions equivalent to a computer program can be eligible for protection. Therefore, data structure that constitutes information that needs to be processed by computers can be patentable.[167] It is not essential for the information to directly instruct a computer and it is sufficient that the invention shares similar properties to a computer program.[168]

3. US

The US patent system rests on the idea that '[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the

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[164] Which applicants are encouraged to provide in the claims.

[165] Tokyo High Court, December 21st, 2004, 2004 (Gyo-Ke) 188, Hanji 1891, 139. However, if the invention consists of a mathematical method to resolve merely a mathematical problem, then it will not be eligible. Intellectual Property High Court, February 29th 2008, Hanji, No. 2012, p. 97, 2007 (Gyo-Ke) 10239.

[166] Ibid.

[167] See case 2-13: data structure of dialogue scenarios in voice interactive systems found in the JPO's case examples pertinent to AI-Related technology available at https://www.jpo.go.jp/e/system/laws/rule/guideline/patent/handbook_shinsa/document/index/app_z_ai-jirei_e.pdf which can be contrasted to the revised examination handbook appendix B chapter 1, 2.1.2.

[168] Also confirmed in document Examination Guidelines on Computer Software-related Inventions, 1-2.

conditions and requirements of this title'[169]. Prior to this statutory provision, the judiciary had already established that laws of nature, abstract ideas and natural phenomena could not be patented.[170] Against this backdrop, the USPTO and courts determine what are the eligible subject-matters for patent protection.[171] This led courts to note that the very nature of a computer program results into patenting an abstract idea and therefore, was initially not allowed.[172] Similarly, courts have expanded the categories of ineligible subject-matters to mathematical algorithms and business methods for similar reasons.[173]

The inability to patent mathematical formula was noted in *Benson*[174] in relation to a converter capable of transforming decimal numbers into binary numbers. Here, the Supreme Court defined an algorithm as 'a procedure for solving a given type of mathematical problem'[175]. In so doing, the Court conflated algorithms with ways to convert one form of numerical representation to another which could be done through mental process with the help of tables – holding that the application of a mathematical formula derives from its connection to a computer. If the algorithm is claimed independently from any hardware, it shall be ineligible. If one allowed the patentability of computer programs this would be tantamount to patenting the underlying algorithm which the Court considered as resulting in the patenting of an abstract idea.[176] This led to a series of discussions before the courts as to whether the subject-matter resulted merely from a purely mental activity which is not

[169] 35 USC §101.

[170] *Chakrabarty*, supra n. 36; repeated in *Mayo*, supra n. 30 and *Alice Corp Pty Ltd v CLS Bank International* ((2014) 134 S. Ct. 2347) (*Alice*) cases more recently.

[171] See also 2019 *Revised Patent Subject-Matter Eligibility Guidance* which includes that judicial exclusions cover: abstract ideas such as mathematical concepts, mental process, certain methods of organizing human activity as well as laws of nature and natural phenomena; Congressional Research Services, supra n. 30.

[172] Utku and Strowel, supra n. 74, 489-510; This section is not exhaustive. For a complete and more detailed analysis, see Con Díaz, supra n. 82, 139-160.

[173] *State Street Bank and Trust Co v signature Financial Group* (supra n. 126) If it produces a tangible and practical utility, it may be eligible for patentability.

[174] Supra, n. 30.

[175] Ibid. This definition is criticized for being overly inclusive (as not all algorithms solve mathematical problems) and rather unhelpful (because there is no definition as to what a mathematical problem consists of) simultaneously. Minsk, supra n. 17, 258.

[176] Supra, n. 30, at 71.

patentable or if there is something more, in which case, this provides clues for patent eligibility. [177]

Let's take the example of the *Christensen* decision in relation to a method for determining subsurface porosity through a particular mathematical formula. [178] Although the Court tried to limit the teachings of the *Benson* decision by restricting the decision to its facts, i.e. to claims directed to a machine whilst rendering programs ineligible, it was still constrained by its decision, and eventually, rejected the eligibility of the claims. Later cases nevertheless adopted a closer reading of *Benson* and rendered both machine and process claims ineligible. From the *Flook* decision, [179] the Court rejected the eligibility of a method for updating alarm limits during catalytic conversion of hydrocarbon through the use of a computer program because the only novel element subsisted in the mathematical formula.

Starting with *Diehr*,[180] the Supreme Court recognized the possibility to patent a law of nature or mathematical formula provided that they have a concrete application. [181] It thereby limited the exclusion of computer programs from patentability to those patent applications which, as a whole, described a mathematical formula *in abstracto*.

AI programs are assessed as other computer-implemented inventions under US law. If some argue that there is no current urge to change patent eligibility to accommodate AI inventions, in the nineties, there were nevertheless uncertainties as to how some AI innovation might be protected. [182] For example, if the AI invention merely consisted of mathematical methods or algorithms without having any accompanying specific applications, these may be ineligible as constituting an abstract idea only. [183]

Some thirty years later, the Supreme Court addressed the scope of the law of nature exception in *Mayo*.[184] Dealing with a method to give treatment to a patient by measuring metabolites in human blood to then calibrate the appropriate drug

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[177] Minsk criticizes the reasoning of the Court in Benson for going way beyond what was needed to decide the case and therefore has detrimental effects on the development of innovation. Minsk, supra n. 17, 258; L. R. Turkevich, 'An end to the "Mathematical Algorithm" Confusion' (1995) 17(2) *EIPR*, 91-98.

[178] *Application of Christensen* (1973) 478 F.2d 1392 (C.C.P.A.).

[179] *Parker v Flook* (1978) 437 U.S. 584 (Flook).

[180] Supra n. 124.

[181] Vertinsky and Rice, supra n. 53, 592.

[182] AIPPI, supra n. 42, 6.

[183] See *AT&T v Excel Communications* (1999) Inc. 172 F.3d 1352 (Fed. Cir.).

[184] *Mayo*, supra n. 30.

dosage, the Court denied patent eligibility because the claims represented 'little more than an instruction to doctors to apply the applicable laws when treating their patients'[185] and thereby lacked any inventive concept.

Against this backdrop, the 2014 Supreme Court decision in *Alice v CLS Bank*[186] has changed the rules of patent eligibility in the US.[187] The facts relate to the patenting of a platform used to drive financial transactions to mitigate settlement risk. As held, the first step is to determine whether the claim is seeking patentability of an ineligible subject-matter such as an abstract idea, laws of nature or natural phenomena. If not, the invention is deemed patentable. In the affirmative, the second step seeks to determine whether the subject-matter nevertheless includes an 'inventive concept', transforming an ineligible subject-matter into an eligible concept which occurs if the claims result in something 'significantly more' than a patent on an ineligible concept in practice.[188] Hence, a claim reciting an algorithm which can be implemented by a normal computer will often be ineligible.

Whilst the *Alice* and *Mayo* frameworks have cast doubt on the eligibility of business methods and software patents, subsequent decisions from the Federal Circuit have tried to soften the impact of *Alice*.[189] The *Enfish* case can be considered as it relates to data structure (a self-referential database allowing for faster search and more effective storage in this case). Here, because the court was satisfied that the claims went beyond the attempt of patenting an abstract idea to patent a specific way of improving the performance of computers in dealing with self-referential databases, it was found eligible for patentability. To determine whether a patent application tries to patent an abstract idea, the court held that previous court decisions in relation to the patenting of an abstract ideas must be consulted. Subsequently, the subject-matter needs to be assessed as a whole to determine whether the claims attempt to patent an ineligible subject-matter. Hence, the Federal Circuit in *Enfish* recognizes that the patenting of algorithms is not inherently abstract and that some improvements made in computational-related technology notwithstanding hardware

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[185] *Mayo*, supra n. 30, at 79.

[186] Supra n. 170.

[187] Constituting a drastic change in a system which has been relatively stable for some 250 years.

[188] This is based on the test developed in *Alice/Mayo*.

[189] This decision has been widely criticized. E.g. M. Dhenne, 'The AIPPI and the computer-implemented inventions' (2019) 41(10) *EIPR*, 621-627; Jin, supra n. 69, 78-110; D. O. Taylor, 'Confusing Patent Eligibility' (2016) 84 *Tenn. L. Rev.*, 158; Hon. P.R. Michel, 'The supreme Court Saps Patent Certainty' (2014) 82 *Geo. Wash. L. Rev.*, 1758.

impact can be non-abstract.[190] Such cases give an impression that the Federal Circuit's interpretation took a liberal position towards subject-eligibility.[191]

More recently in *Thales Visionix, Inc. v United States*,[192] a US Court of Appeal found eligible the technique for positioning sensors in a particular configuration and using the raw data from these to more efficiently and accurately calculate the position and orientation of an object on a moving platform. Given the draftsmanship of claims that focused more on the novel configuration of the sensors than on the new mathematical equations used to make the calculations, the concept was held as eligible for patentability.

Despite the optimism shared by these decisions,[193] other cases with implications for AI patents might be less favorable. In *Digitech Image Technologies v Electronic Imaging*,[194] the facts relate to 'the generation and use of an "improved device profile" that describes spatial and color properties of a device within a digital image processing system'[195]. According to the description of the problem, all prior devices include some form of distortion in spatial and color properties. Whilst the case does not deal with AI inventions, it does contain statements such as '[t]he method in the '415 patent claims an abstract idea because it describes a process of organizing information through mathematical correlations and is not tied to a specific structure or machine',[196] which are problematic for the protection of AI inventions. Similarly, in *Electric Power group, LLC v Alstom SA*[197], the court dealt with the reception of real-time data originating from occurrences in a wide geographical area and automatically analyzing these occurrences on an interconnected electric power grid. Given the intangibility of the claims, the Federal Circuit found that the claims centered around data collection, gathering, analyzes and displaying results which constitute 'a combination of those abstract ideas'. There was no inventive technology, resulting in an ineligible subject-matter. The court distinguished the facts from those in the *Enfish* case, as in the latter, the claim focused on a specific improvement in how computers could carry out some of the basic functions of

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[190] Also confirmed in *McRo*, supra n. 72.

[191] Utku and Strowel, supra n. 74, 505.

[192] (2017) 850 F.3d 1343 (Fed. Cir.).

[193] To be contrasted with others such as *RecogniCorp, LLC v. Nintendo Co.*, (2017) 855 F.3d 1322, 1324, 1327-28 (Fed. Cir.) which held that a claim dealing with the encoding and decoding of image data was not eligible because of lack of inventive concept and constituted a mere abstract idea.

[194] (2014) 758 F.3d 1344 (Fed. Cir).

[195] Ibid.

[196] Ibid, at 1350.

[197] (2016) 830 F.3d 1350, 1353-54 (Fed. Cir.).

storage and retrieval of data retrieval of data whereas *Alstom* saw no attempts to improve hardware, which prevented the claims to be eligible for patentability. This is an extremely broad decision which had an impact on the patentability of software-related inventions but it must be noted that it does not related to AI applications.

Nevertheless, the USPTO recognizes the patentability of AI through class 706 of MPEPand has established dedicated teams to review the prior art directed toward AI algorithms.[198] Turning to learned models, Gokhale argues that the current state of the law in the US does not render patentable learned models consisting of an AI program and its parameters.[199] The learned model will not be eligible for protection unless it is recorded in a 'recording medium'.[200] The difficulty is that currently a key aspect of machine learning relates to the noise associated with any dataset and the suitability of a particular algorithm in relation to a specific model. This is removed from the recording medium and yet, innovation in this area such as ways to facilitate the training process would be deemed as innovative by experts in the field. A risk is that these AI algorithms include more generic mathematical methods (which are directed to an abstract idea) and that by rendering these eligible, a subtraction of information in the public domain is condoned. Doubts can also be derived from the *Alstom* decision, as with a certain level of abstraction many of these models can be boiled down to 'collection, gathering, analyzing data and displaying results' which are ineligible. The difference with *Alstom* nevertheless lies in the processing phase which relates to a human created framework involving algorithms which may evolve overtime. This is arguably substantially more than simply collecting, analyzing and displaying results or equating a mental process.

Despite the uncertainties, some guidance can be found in the *2019 Revised Patent Subject-Matter Eligibility Guidance* (USPTO Guidance). Recognizing the difficulties in applying the *Alice/Mayo* test in a consistent manner, the USPTO decided to revise its procedure on eligibility. According to the new rules, a two-step test is applied. Firstly, an assessment of the claim must determine whether it involves a judicial subject-matter exclusion. Here, the USPTO Guidance clarifies the meaning of 'abstract ideas'. Instead of requiring examiners to compare claims to judicial precedents, the USPTO Guidance offers a summary of the case law and established three categories of abstract ideas: mathematical concepts, certain methods of organizing human activity and mental processes.[201] Notwithstanding exceptional circumstances, subject-matters that do not fall under these headings

[198] DeCosta and Carrano, supra n. 101.

[199] Gokhale, supra n. 97, 47-48.

[200] DeCosta and Carrano, supra n. 101.

[201] USPTO Guidance at 52.

should not be treated as an abstract idea.[202] Guidance is also provided in relation to the meaning of a patent claim 'directed to' an ineligible category. The patent examiner must determine if the subject-matter exclusion is integrated into a 'practical application of the exception'[203]. If it is not embedded into an application, then the second step is triggered. Here, further analysis will be necessary as per the *Alice/Mayo* test to establish whether the elements of the subject-matter provide an inventive concept. Provided that the answer is positive, the claim will be eligible for patentability. Early comments of these changes have been mixed. Some commentators welcome the new USPTO Guidance for providing more clarity and lowering the threshold for triggering ineligibility under section 101 but others criticize these changes for being inconsistent with the recent jurisprudence from the Supreme Court.[204]

In relation to the eligibility of AI programs, the USPTO Guidance provides some insights in example 39.[205] The case scenario relates to a neural network trained to classify images based upon the presence of a human face or not for the purposes of facial detection in images. Because the claims rely on hardware and are not written in a way to claim a mathematical method, business method or a mental process, the USPTO notes that the claim is eligible for protection.

4. Comparison

One of the inherent difficulties with patenting AI algorithms derives from the fact that most attempt to replicate human ingenuity and therefore, are more susceptible to be found ineligible for patentability. This comparative exercise teaches us that all three jurisdictions assess AI inventions just as computer programs. This being said, differences remain from the standpoint of the statutory framework and practices.

It is noteworthy that Japan is the only jurisdiction defining invention positively. Contrastingly, Europe and the US only define invention negatively, either through statutory provisions or precedents. Focusing on the Japanese definition of invention, it is unique insofar as this is the only jurisdiction requiring both the involvement of a 'technical idea' and the utilization of the laws of nature. We also find the concept of technical idea in Europe and the US, though this is a relatively recent concept (especially in the latter case). Despite the explicit reference to the

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[202] Ibid at 53.

[203] Ibid at 54.

[204] Congressional Research Services, supra n. 30, 32.

[205] Available at https://www.uspto.gov/sites/default/files/documents/101_examples_37to42_20190107.pdf

laws of nature, this is not alien to the other jurisdictions under scrutiny and appears to be a way for rejecting the eligibility of abstract ideas under the JPA.[206]

As confirmed by the interviews conducted in Japan with patent attorneys, academics and officials from the JPO, the eligibility of AI algorithms is easy to satisfy in practice provided that care has been given to claim drafting. The claims in patent applications must explain the involvement of hardware, especially, how the software or AI algorithm interacts with the hardware. It appears especially easy in Japan to connect the invention to the use of the laws of nature and thus, qualify as an invention, as opposed to the practice in other jurisdictions. For example, in Europe, the over-focus on the technical features (and the further technical character) requires a higher level of examination and generally raises the bar of eligibility for computer-implemented inventions. Likewise, in the US, the test has become substantially harder to pass since the *Alice-Mayo-Alstom* decisions, leaving the applicants in doubt as to the outcome of their patent applications. These decisions appear to bring the US closer to its European counterpart by requiring an element of tangibility close to what is currently applied under the EPC and the technical merit doctrine. Though, the European technical merit doctrine has been widely criticized (and still is), at least there now exists a body of case law to help patent applicants as to its meaning.

Beyond that, relying on hardware and tangibility of the invention might lead to problems in the future regarding the eligibility of subject-matters. Since the 50's, computer programs have progressively dematerialized and do not rely on machines (i.e. hardware) to perform a technical function. If draftsmanship currently enables the satisfaction of this requirement, it may not be reflecting the true nature of the invention and is likely to create problems in the future, limiting the eligibility of AI innovation. The same is true regarding algorithms. If the initial justification for their exclusion from patentability was that these merely consist of mathematical formula waiting to be discovered in nature or equal to an abstract idea, this is not the case today. AI algorithms result from human ingenuity with some elements autonomously adjusted by the algorithm itself (in the case of a strong AI which calibrates parameters on its own without human intervention). The best way forward may be to remove the blanket exclusion of eligibility of algorithms, or reduce it to algorithms that can be done by hand and consider this on a case-by-case basis by determining whether the subject-matter presents technicality (understood more broadly as currently conceived in Europe to cover social and economic utility of

[206] Dragoni, supra n. 129, 101.

the invention).[207] Furthermore, patentability requirements will ensure that only valuable algorithms receive protection.

We can see the difficulties in patenting AI innovation in how the different jurisdictions would protect neural networks. Some guidance can be extrapolated from one of the case studies provided in a recent co-authored report by the EPO and JPO.[208] The invention consists of a trained model to instruct a computer to attribute quantified values for the reputations of accommodation based on text data of the reputation of said accommodations. To function, the trained model operates by relying on two neural networks, which causes the computer to perform calculations based on the frequency of certain keywords obtained from text data about the reputation of establishments. Taking into consideration the prior art, a claim for the invention described here above leads to different outcomes in Europe and in Japan. For the EPO, a trained neural network causing a computer to perform calculations is of an abstract nature without any specific instructions that needs to be carried out by a computer.[209] Therefore, such subject-matter falls outside the scope of 52(2) and (3) EPC (and following *Alice*, this is would also be the outcome reached in the US). Additionally, the EPO is not convinced that such subject-matter would include a further technical matter going beyond the normal interaction between the program and the computer on which it is run, especially as the problem solved appears to be of commercial nature (ranking accommodations' reputations). The situation may be different if the claim covered a technical problem instead of a commercial one and, depending on the disclosure and draftsmanship of the claims, the subject-matter may be eligible for patentability. If the claim focuses more on the structure and function of the neural networks as well as its ranking process, which contributes to the overall technical process, than the invention may be covered by art. 52(2) and (3) EPC.

Contrastingly, Japan more easily considers a trained model as an invention. This can be explained by the fact that the claim, as described, not only effectively outlines a program despite referring to 'model', but this model relies on software and hardware to function. Consequently, the subject-matter results in the creation of a technical idea utilizing a law of nature and results into an invention as per the JPA.[210] It must be noted that it is necessary to explain the relationship between

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[207] This would ensure a greater respect with the fact that inventions must be patentable in all fields of technology as prescribed by art. 21.7(1) TRIPS.

[208] EPO and JPO, *Comparative Study on Computer-Implemented Inventions/Software-related Inventions: Report* (2018) 50.

[209] Ibid, 55.

[210] Data-Related Assets Report, supra n. 2, 33.

software and hardware to be eligible for protection.[211] This liberal view even enables business-related inventions to be patented in Japan (in the financial sector). This is not possible in other jurisdictions.

Furthermore, the way in which eligibility is assessed varies in different countries. In Europe and US there is a certain complexity linked to the dissection of technical and non-technical features. If non-technical features are ignored in the assessment of eligibility in Europe and the US, this is not the case in Japan where the invention is assessed as a whole. Given the nature of the information society and the rise of intangible innovation, the Japanese solution seems to be favorable to AI innovation where technical and non-technical aspects are integrated and generally inseparable.

There are nevertheless limitations to this AI friendly approach adopted in Japan. A learned model embedding a technical idea and utilizing the laws of nature will only be eligible if it is understood as an AI program and its parameters (the weighting coefficients discussed in section 3 of this report). However, if the inventor is attempting to get a patent over the parameters alone,[212] this is akin to trying to patent data, which falls outside the scope of computer programs (and is protected by specific legislation since last year). As recognized by the Japanese Committee to Review Intellectual Property Regarding Data-Related Assets, if these models are eligible for protection, it is necessary to hold discussion on the application of patentability requirements to this technological innovation and determine the scope of protection to be granted.[213]

Doubts as to the types of learned models that are eligible for patentability have emerged. For example, Sakai explains that despite the optimism of the JPO, areas of uncertainties remain. By announcing that learned models can be patentable as they are akin to programs, there is a risk that patent attorneys use ‘learned models’ as terminology to ensure eligibility when in reality, the invention relates to algorithms. Whilst the difference might not be straightforward, Sakai provides us with an illustration by considering a US patent application in relation to the independent learning by the layers of a neural network on their own (i.e. batch normalization). This is an essential step in deep learning where a trained algorithm needs to adapt to perform in a new setting. A common example leads us back to an algorithm trained to recognize cats in images, but where the original network was only fed with images of white cats. If suddenly we apply the AI model to images of colored cats, the model will not perform well. By using batch normalization, there is an improvement of the performance of the neural network by adding parameters

[211] Sakai, supra n. 63, 237.

[212] Which seems to be a possibility in the US.

[213] Supra n. 210.

that adjust and scale each layer. In this case, there are doubts as to whether we are dealing with an 'invention of a process to produce a product'.[214] Beyond appearances, the subject-matter might actually be datasets - bringing the need to better understand the learned model as a program and a learned model that might refer to datasets. Moreover, there are some criticisms of applying well-established patent paradigm concepts to this very type of innovation. Let's not forget that the Japanese Supreme Court has held that product-by-process claims in fields such as biotechnology or chemistry refer to 'products that can exist in the natural world under the rules of a principle of nature (regardless of whether it has actually existed in the natural world)'[215] which explains how such claims utilize the laws of nature.[216] However, in theory there is potentially no limitation to the structure of a learned model (AI program and its parameters), bringing into question how some subject-matters might be utilizing the laws of nature and fit the definition of 'invention' under the JPA. Based on the case studies from the JPA (link to the reputation of accommodations example), it is only when the claims and descriptions explain the relationship between the software and hardware that the learned model will qualify as an invention. However, patent examiners must be vigilant as some applicants might be using 'learned models' to actually get a patent over algorithms or parameters that should be considered to be data or data structure.

Difficulties are also present in the US. In addition to the confusion following the *Alice-Mayo-Alstom* decisions, there may be disclosure implications rendering the eligibility of learning models close to impossible. It is expected that patent attorneys will need to ensure the disclosure of the starting design, layout and structure of the neural network prior to any training being done accompanied with the training data and protocols. Whilst these difficulties may be overcome if the invention relies on commercially available AI programs, (in which case, patent attorneys can simply make a reference to these), it seems to be counterintuitive to render eligible AI algorithms based on already available programs instead of rewarding patentees for coming up with new AI algorithms. Yet, Jin argues that this narrowly defined patent right is to be welcomed as it should encourage industry collaboration and promote innovation through data reuse.[217]

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[214] Sakai, supra n. 63, 242.

[215] Ibid, 244.

[216] Supreme Court (Case No.: 2012 (Ju) 1204 on June 5, 2015); Supreme Court (Case No.: 2012 (Ju) 2658) on June 5, 2015.

[217] Jin, supra n. 69, 110.

VI. The second hurdle: challenges in applying the novelty requirement

When attempting to patent AI, the two first hurdles will relate to eligibility and issues of prior art under the novelty requirement. Although this is not to say that there is no impact on the inventive step requirement, this issue has already attracted a lot of attention whilst discussions around novelty are only nascent. Generally speaking, an invention will be considered new if it does not form part of the prior art. Consequently, the invention should not have been made available to the public in some form.[218] As explained in section 2, the underlying goal is to avoid that products and processes already in the public domain suddenly become privately owned again. It also ensures that two limited monopolies are not granted over the same invention. This explains why it is not possible to combine pieces of the prior art for the purpose of novelty. What patent examiners will ascertain is whether the subject-matter makes a technical contribution to the prior art sufficiently different from what was already known up to the filing or priority date. However, the above relies on the premise that the entire prior art is known at a specific moment in time, which in reality, is hard to establish in this field.

If the novelty requirement has not created many problems by the past, there are possible difficulties lying ahead for the patentability of AI algorithms. Firstly, the satisfaction of the novelty requirement for AI algorithms is contingent upon the technical contribution made to the prior art. As mentioned in the preceding section, algorithms can be excluded from protection for being abstract ideas or non-technical. Provided that this hurdle is overcome, novelty generally cannot derive from non-technical elements such as a more efficient mathematical method. The contribution must be of a technical nature. The problem is that taken in isolation, the features of an invention might be non-technical but when considered as a whole, these non-technical features may well contribute to the overall technical nature of the invention.

A classic example can be found in noise reduction algorithms in images. The algorithm used to analyze a signal for noise reduction may be non-technical. However, it contributes to the overall technical character of the invention by allowing the reduction of noise in a particular image. The same can be said about an algorithm capable of turning text content into speech. This is because the input and output quantity differ, exemplifying the presence of a technical contribution. Secondly, the novelty of AI algorithms inherently depends on the inventive process

[218] There are differences in terms of the form amongst different countries. WIPO International Bureau, supra n. 24, 4.

itself as novelty may be lacking if the algorithm used is already commercially available. The satisfaction of novelty for AI algorithms also require versatility in its reported results (outputs) or datasets. Therefore, the more randomness and versatility is present in the algorithm, the more likely it will generate novel inventions.[219] Yet, the harder it is to satisfy the sufficiency of disclosure requirement.

1. Europe

According to article 54 (1) and (2) EPC, '[a]n invention shall be considered to be new if it does not form part of the state of the art. The state of the art shall be held to comprise everything made available to the public by means of a written or oral description, by use, or in any other way, before the date of filing of the European patent application.' This is a very broad definition, as anything made available in any language and anywhere in the world will form part of the prior art.[220] Novelty will be defeated where the skilled person in the art has sufficient information using the common general knowledge in the field at the priority date to perform the subject of the disclosure.[221] This is referred to as an 'enabling disclosure', meaning that not only all the information belonging to the subject-matter must be found in the prior art, but there should be also a disclosure of the process of how to replicate the subject-matter of the application.

Unsurprisingly, the initial step is to define what forms part of the state of the art. We already commented on the width of this concept. Bar the exclusion of information obtained in breach of a confidentiality agreement; specific rules apply to the examination of patent applications not yet published by the EPO at the time of filing. Indeed, as prescribed by article 54(3) EPC, secret prior art originating from the patent applicant and third parties must be included in the prior art.[222] This ensures that there is no double-patenting of the same subject-matter and patents are

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[219] Vertinsky and Rice, supra n. 53, 494; Fraser, supra n. 4, 319.

[220] EPGL Part G, Chap. IV, 1.

[221] EPGL Part G, Chap. IV, 2; EPGL Part G, Chap. VI, 3; EPGL Part G, Chap. VII, 3.1; T26/85, *Thickness of magnetic layers* (1988) ECLI:EP:BA:1988:T002685.19880920; T206/83, *Herbicides* (1986) ECLI:EP:BA:1986:T020683:19860326; T491/99, *Caisse octogonale/OTOR* (2000) ECLI:EP:BA:2000:T049199.20001024.

[222] This is only for the purpose of determining novelty and not inventive step. EPGL Part G, Chap. IV, 4. For a more detailed report on this, see Tegernsee Experts Group, *Treatment of conflicting applications* (Munich, Sept. 24th, 2012).

not granted over minor improvements or differences in relation to a similar subject-matter.[223]

But this concept is also broad due to the fact that the prior art is not limited to what has been explicitly disclosed in the past, and includes also implicit disclosures as interpreted by the person skilled in the art.[224] Once the relevant prior art has been identified and its content absorbed, the next step consists of comparing the claimed invention to the prior art as defined to determine whether novelty is present. This will be the case if the claimed invention departs from the prior art as defined by the applicant. However, if the subject-matter is clearly and directly inferable from the prior art, then novelty will be destroyed.[225] Here, a presumption is made that the person skilled in the art would consider these inferred elements as being disclosed.

If defined as algorithms and parameters, AI programs can include features that can be considered as automatically present if the teaching of the prior art is exercised. Not only can the patent examiner derive parameters from the prior art but if a specific disclosure of these parameters is made, this has the consequence of destroying novelty of a future generic feature in the claim.[226] In other words, the specific disclosure of parameters will destroy the novelty in a range including the same value. However, the opposite does not hold true and a generic disclosure will not destroy the novelty in specific claims.[227]

To sum up, the EPO adopts a strict approach to novelty. In a recent report co-authored by the EPO and the JPO, an example of how novelty should be examined in relation to AI inventions is analyzed.[228] The subject-matter relates to a 'robot apparatus' comprised of two claims. The first claim relates to the 'communication, via transmission section and a reception section, with a server'. The server, the

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[223] Extreme care is therefore advisable. See dramatic consequences in T1496/11, *Self-verifying security documents* (2012) ECLI:EP:BA:2012:T149611.20120912.

[224] T677/91 *Mass selective ejection/FINNIGAN* (1992) ECLI:EP:BA:1992:T067791.19921103; T465/92 Aluminum alloys (1994) ECLI:EP:BA:1994:T046592.19941014.

[225] T465/92, *supra* n. 223; T511/92 (1993) ECLI:EP:BA:1993:T051192.19930527; T6/80 (1981) ECLI:EP:BA:1981:T000680.19810513; T71/93 (1993) ECLI:EP:BA:1993:T007193.19930601.

[226] This is derived from established case law from the Boards of Appeal. See T651/91 (1993) ECLI:EP:BA:1993:T065191.19930218; T6/04 NMR imaging with simulation of the pulse sequence (2006) ECLI:EP:BA:2006:T000604.20060721; T1174/05 *Displacement member/VADERSTAD* (2008) ECLI:EP:BA:2008:T117405.20080124; and, T776/07 (2009) ECLI:EP:BA:2009:T077607.20090402. See also EPGL Part G, Chap. VI, 5.

[227] T1786/09 (2010) ECLI:EP:BA:2010:T178609.20101123 and T651/91, supra n. 225.

[228] EPO and JPO, supra n. 208, case B-1 p.59.

network and the production facility do not appear to be included in the claimed subject-matter. Although the EPO found the claim to depart from the prior art 'on the basis of information received via a network from a production facility of the said object', novelty was not satisfied as the claim could cover other unclaimed devices, other than the robot apparatus. Helpfully, the EPO explains that should the network or production facility been part of the claimed subject-matter, then the claim would have been directed to a robot and consequently, been held as novel given the absence of disclosure of such routing of information in the prior art. The second claim is similar to the first, but it includes that the 'response information contains the attribute information and the unique identification information of each of the said object specified by the said server'. Here, the EPO found no difficulty in holding the subject-matter as novel given that 'the response information is attribute information and a unique identification of the object'.

2. Japan

In Japan, statutory law puts an emphasis on distributed publications or inventions made publicly available online or through other electronic communications in Japan or elsewhere (article 29(1)(iii) JPA).[229] However, this also includes invention 'publicly worked'[230] (i.e. inventions performed in front of an audience somewhere in the world) and inventions 'publicly known'[231], meaning that the contents of an invention are known by the unspecified individuals who are not bound by an obligation of secrecy (e.g. through the observation of a manufacturing process, during a lecture or presentation).[232]

Interestingly, prior art and the effect of earlier patent applications are regulated separately in Japan. Article 29-2 JPA (in conjunction with article 39) covers the situation where two or more applications are in conflict. Here, article 29-2 provides that against third parties, information disclosed in earlier patent applications not yet published might destroy novelty in the latter application. However, if the earlier patent application originates from the same inventor as the later application and that the information contained in the earlier patent application is disclosed but not claimed, then the later application may be successful provided that the patentability requirements are satisfied.[233]

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[229] JPGL Part III, 2-3, 3.1.2.

[230] Article 29(1)(i) JPA.

[231] Article 29(1)(ii) JPA.

[232] JPGL Part III, 2-3, 3.1.3, 3.1.4.

[233] JPGL Part III, 2-3.

Once the prior art has been identified, the patent examiner proceeds to the examination of novelty. Taking into consideration the common general knowledge (including well-known art in the specific field of the subject-matter, also known as 'enlarged novelty'),[234] the patent examiner wearing the hat of the person skilled in the art will look for differences between the closest prior art and the subject-matter of the patent application as a whole in front of him. Unsurprisingly, if differences exist, then novelty subsists, whereas if both are identical, then novelty is deemed lacking.[235] Similarly as to what we have seen under the EPC, the novelty in specific features claimed is not destroyed by the prior disclosure of generic concepts.[236] Conversely, if the prior art includes specific features, then the more generic concepts will be deemed known and cannot be claimed as novel anymore.[237]

Going back to the example of the robot apparatus, the JPO confirms that their examination of novelty would lead to a similar outcome as reached by the EPO insofar as the first claim would lack novelty whilst the second claim would be considered as novel.[238] Explaining its decision regarding the first claim, the JPO identifies the subject-matter as being a sub-combination between a robot apparatus and a server.[239] Many IoT-related technologies include sub-combination, as these inventions generally include multiple devices, sensors and servers that all connected through a server and for which it is generally difficult to claim the system as a whole,[240] emphasizing the importance of this example. The JPO refused to find novelty in the claim because 'on the basis of information received via a network from a production facility of the said object' only depicts the source from which the server obtains information without specifying how this program performs a function of the robot apparatus. We see here, resurfacing the importance of disclosing the relationship between hardware and software. On the other hand, the second claim satisfied novelty as it is much more detailed and depicts how the robot apparatus has a control section storing a program – which, itself, controls the functioning of the robot apparatus following the information received, departing from the disclosed prior art.

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[234] JPGL Part III, 2-3, 3.1.2.

[235] JPGL Part III, 2; JPGL Part III, 3.1.

[236] JPGL Part III, 3.2.

[237] Ibid.

[238] EPO and JPO, supra n. 208, 67-68.

[239] JPGL Part III, 2-4, 4.

[240] This is because, increasingly part of this system exists outside Japan, making it more intricate to exercise rights. S. Yamamoto, 'Enhancement of Cases Related to IoT-Related Technology, etc.-Outline of Cases and Commentary of Relevant Examination Standards' (2017) 285 *Tokugikon*, 36.

3. US

As for the two jurisdictions above, an invention must be 'new', meaning that it must not have been disclosed more than a year before filing and it must not have already been patented by somebody else.[241] Furthermore, a specific claim will anticipate a more generic claim but the converse would not hold true just like in Japan and Europe.[242] However, unlike the other jurisdictions under scrutiny, there have been certain changes in the recent years as to what should be included as part of the prior art. If previously, disclosures through public use or selling were limited to the US territory, the America Invents Act 2011 broadened this to the rest of the world.

But these are not the only noteworthy changes, this same legislation also changed the rules in relation to self-collision. Prior to the America Invents Act 2011, section 102 (e) prescribed that a person shall be entitled to a patent unless: 'the invention was described in — (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent,…' (emphasis added). This means that the US do not include prior patent applications by the same inventor but yet to be published as part of the prior art. Currently, the law still protects inventors, but the provisions have slightly changed. Section 102(a)(2) now reads as a person shall be entitled to a patent unless: 'the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.' (emphasis added).

One of the particularities of the US system is that unlike Europe and Japan, the concept of secret prior art will be taken into consideration for both novelty and inventive step where the applicants differ. Where applicants are the same, secret prior art will not be novelty destroying, but it will be taken into account if the matter as a whole would be obvious to the person skilled in the art.

The very nature of certain AI algorithms may render the satisfaction of the disclosure requirement challenging. Let's focus on rule-based systems before turning to learned-based systems. Rule-based systems imply that a researcher or a

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[241] 35 USC §102. The US moved from a first-to-invent to a first-to-file system in 2011, aligning the US with the two other jurisdictions under scrutiny. Leahy-Smith America Invents Act, Pub. L. No. 112-29 (H.R. 124 125 (Sept. 16, 2011)).

[242] US Manual of Patent Examining Procedure, section 2131.

team of researchers have pre-determined rules specific to a particular type of application. However, when it comes to the patenting of this invention, they may want to draft claims directed to a broader scope of the application developed that is actually not supported by the rules, thereby failing to meet the disclosure obligations.[243] These difficulties are further exaggerated when contemplating the patentability of learning models. The performance of the AI program inherently depends on its network topology[244] which combines training datasets, algorithms, number of layers, number and types of neurons, the parameters etc. Eventually, the scope of the patent in the US will be determined by what has been disclosed which teaches the person skilled in the art for him to put into practice. But this begs the question as to how much should the applicant disclose to support broader claims based on the resulting application? There is a risk in disclosing one way or just a few ways of achieving the application. Whether in a rule-based or learning-based system, there is a certain degree of randomness as well a great number of ways to achieve the application by changing the rules applied to the system or by changing the arrangements in the architecture of the system.

Some have argued that §112(f) 35 USC could be of use as it allows functional claiming.[245] This could be very interesting as we mentioned that AI inventors are interested in patenting specific functions like 'means to determine presence of objects in an environment'. As confirmed by case law, the Federal Circuit held that an inventor does not have to disclose the entire structure for performing the functions claimed.[246] However, this provision has its limitations in relation to computer-related inventions as it might not prevent the inventor from having to detail the specifics of a network. In *EON Corp. IP Holdings LLC v AT&T Mobility LLC*,[247] the Court of Appeal of the Federal Circuit held that unless the functional claiming refers to the most basic functions of a computer (e.g. storing, processing

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[243] §112(a) 35 USC requiring: 'a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.'(emphasis added). For other jurisdictions see supra n. 18.

[244] For examples, see https://towardsdatascience.com/the-mostly-complete-chart-of-neural-networks-explained-3fb6f2367464

[245] DeCosta and Carrano, supra n. 101.

[246] *In re Katz Interactive Call Processing Patent Litigation* (2011) 639 F.3d 1303, 1316 (Fed. Cir.) (*Katz*). This decision enabled inventors to avoid disclosing the most basic functions of a computer in every patent application.

[247] No. 14-1392 (Fed. Cir. 2015) (*Eon*).

data) then the inventor must disclose the information, this includes the disclosure of algorithms necessary to implement the function.[248] *In casu*, the proceedings dealt with the failure to disclose at least one algorithm for providing structure for various computer-implemented means-plus-function form claims. Therefore, unless the functions are common to all general-purpose computers (like receiving, processing or storing information),[249] patent applicants are required to disclose the underlying structure of a specific function.[250]

4. Comparison

As the list of protectable subject-matters grows, there is a greater emphasis on patentability requirements such as novelty and inventive step to ensure the legitimacy of the patent system. Whilst the novelty requirement has not created much trouble by the past, some remaining disparities could lead to greater situations in which an invention receives protection in one jurisdiction and not another. Difficulties certainly exist in identifying the relevant prior art, understanding it and updating it in relation to AI and IoT inventions.[251] Furthermore, concerns increase in relation to the satisfaction of the sufficiency disclosure requirement given the difficulties in describing how AI algorithms works.

The existing differences in the assessment of the novelty requirement provide evidence of deeply-rooted and conflicting policy objectives. The most noticeable difference refers to how different jurisdictions determine the prior art for the purpose of conflicting patent applications. Given that patent applications are not published on the same day as they are filed, but up to eighteen months later, there is a window within which several patent applications covering the same subject-matter might be filed, and in which case, there is a risk of double patenting or patent thickets (if the subject-matter is similar but not identical). So, to what degree can the earlier patent application yet to be published be novelty destroying? This

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[248] Thereby reverting back to its former case law. See *WMS Gaming, Inc. v. Int'l Game Tech*. (1999) 184 F.3d 1339, 1348–49 (Fed. Cir.). Also cited in *Eon* at 7. *Katz* thereby represents an exception to a well-established body of cases requiring disclosure.

[249] And even here, the court warned that for a narrower construction of the plain meaning of these functions, applicants are required to make disclosure of the structure. *Eon,* supra n. 246, at 11.

[250] As previously held in *Ergo Licensing LLC v Carefusion 303 Inc.* (2012) 673 F.3d 1361 (Fed. Cir.), 1365. Holding otherwise would render the claim indefinite in nature.

[251] A basic illustration of this relates to how the invention is defined as being new in an AI world as well as previous inventions in the field. As explained in section 2, AI programs might involve similar decision-making in different technical applications. Here, the algorithms or training datasets may be similar, which creates an overlap between the process and the results and therefore, may be novelty-defeating.

section attempted to provide an answer to this question by differentiating between when the applicant of the earlier patent application was a third party and the situation in which both applicants are identical or partially the same (self-collision).

The way Japan and the US do not treat self-collision issues with caution demonstrates that this patent system encourages the proliferation of patents over similar inventions with minor variants. Whilst this drawback may be mitigated by the fact that Japanese patent examiners are able to replace obvious variants when determining novelty (the claimed invention therefore does not have to be explicitly disclosed in the prior art, implicit disclosure suffices) or that this has an impact on the assessment of inventive step like in the US, this can be contrasted with the Europe where the patent culture deters patent applicants from applying for protection for smaller contributions, thereby preferring to reward the first inventor.[252] This may provide a further explanation why the Japanese patent system is more IoT and AI innovation friendly. In a technical field characterized by the multiplicity of inventors involved in the inventive process, there is a certain convenience in allowing multiple inventions claimed in relation to a similar subject-matter by the same inventors given that large teams of inventors may be working together and consequently, there is a greater chance that patent applications are being submitted in short period of time.

The issue of conflicting patent applications is not new.[253] Already in 1988, the AIPPI adopted a resolution for the exclusion of self-collision in situations where the applicants in both applications are partially the same.[254] Nevertheless, some thirty years later, divergences remain that lead to a situation in which some patents may be granted in some jurisdictions (e.g. Japan or US) and not others (e.g. Europe). At the AIPPI Congress 2018,[255] one of the study questions tackled the issue of conflicting patent applications. It is noticeable that the majority of the respondents were in favor of harmonization in this area.[256] There was an

[252] There are differences in terms of the form amongst different countries. WIPO International Bureau, supra n. 24, 9.

[253] Ibid.

[254] Resolution Q89C. This was followed by 2 other resolutions (Resolution Q126 in 1995 and Resolution Q167 in 2002). The topic was once again at the center of a study question for the AIPPI congress 2018, demonstrating its topicality.

[255] S. Matheson, J. Osha, A-M. Verschuur, Y. Inui, A. Laakonen and R. Nack, *2018 Study Question: conflicting patent applications* (2018) available at https://aippi.org/wp-content/uploads/2018/01/Conflicting-patent-applications-Study-Guidelines-29Jan2018.pdf.

[256] 85% of the 44 respondents.

overwhelming support for ensuring that secret prior art is novelty-destroying where the applicants are different.[257] Regarding secret prior art against the same inventor, a majority believed that it should equally be used for the purpose of novelty without any anti-self-collision time period.[258]

Although the issue of conflicting patent applications relates to the breadth of the prior art playing an essential part of the patent system, there are also differences in terms of how novelty is assessed in the three jurisdictions. Firstly, there are differences in what should be compared against the prior art. Here, it is noteworthy that Europe and Japan apply a whole-contents approach whilst the US measures each claim-based approach.[259] Secondly, despite novelty being a strict requirement, Japan applies a concept of enlarged novelty by which the threshold is heightened for patent applications as novelty will be determined not based on what has traditionally been referred to as 'photographic novelty' (i.e. are there any differences between the invention in the patent application as compared with the prior art) but based on everything that the person skilled in the art understands as being included when reading the prior art. Even stricter, the person skilled in the art will deny novelty where there is a difference between the prior art and the whole contents of the patent application that only amounts to a well-known equivalent. This can have important consequences in relation to generic/specific patent applications. If, as in the US or Europe, the patentability of a generic does not preclude the patentability of a more specific subject-matter, patent applicants will have to demonstrate that the specific is not simply a substitute or equivalent in Japan. In other words, the patent applicant must demonstrate that the specific later invention would not be derived within the prior 'enlarged' disclosure part of the prior art.

Aside from the concern as to whether the person skilled in the art should be re-defined for the purpose of AI-inventions,[260] the extent to which inventors must disclose their inventions is still unclear. Patent law requires clarity and sufficiency of claims to teach the person skilled in the art and demonstrate that the invention is repeatable. The main problem with AI programs is that these are usually opaque

[257] 95% of the 44 respondents.

[258] 75% of the 44 respondents.

[259] The claim-based approach is likely to create complexities in the future given the intricacies of AI and IoT technology. Claims inherently involve new elements which intermingle with the already known and patent examiners will find it more difficult to draft claims in a way which focuses on the new elements only.

[260] Topic which has attracted attraction in the last years and which is predominantly relevant for inventive step but not without impacts for the assessment of novelty.

with relatively little information as to how a particular system reaches a specific decision or result. Whilst decisions like *EON* in the US lead to the requirement of the algorithm's disclosure, what is the state of play in relation to network topology? Some industry players seem to believe that there is no need to provide detail as to the network structure.[261] Legal experts in Europe advocate however the need define the features of the neural network in great depth but perhaps the source codes do not have to be disclosed to meet the enablement requirement.[262]

This has consequences not only for the granting of patents (creating difficulties for patent examiners to assess novelty), but will be crucial in post-grant procedures. Indeed, if it is not possible to understand how an AI program reaches a specific result, it will be difficult for the plaintiff to assert that an infringement using the same method occurred. There is a risk that in the absence of mature ways of categorizing existing knowledge essential to identify the prior art, more dependence will be set on the inventor's disclosures of prior art. Yet, it must be noted that the inventor has only the obligation to disclose the prior art that *he is aware of* in a field where machines are increasingly replacing human ingenuity is likely to decline and therefore, potentially has drastic consequences for the proper identification of prior art.

VII. Conclusion and recommendations

The is no denying that the information society characterizing the 4th Industrial Revolution has serious implications for the innovative process. Current innovation relates to how information is handled and processed to which algorithms are key as they treat huge amounts of data in a matter of minutes where it would take months, if not years, for humans to carry out the same tasks. If some argue that the patent system does not need to be overhauled to handle AI inventions,[263] there remain serious concerns that the patent paradigm may not be able to adapt given its current emphasis on the replacement of manual labor by machines when it is actually moving onto the replacement of the intellectual activity itself. A re-evaluation of the justifications for the existence of a patent system as well as the appropriate balance to be struck between the interests of right-holders and society is necessary.

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[261] Spinella-Mamo (IP counsel at self-driving car startup ZOOX) speaking at an artificial panel in September 2018 at the AIPPI Congress.

[262] Jones Day, *Patenting Artificial Intelligence and Machine Learning Innovations in Europe* (Oct, 2018).

[263] See speech held by Heli Pihlajamaa (EPO Director Patent Law) at an artificial panel in September 2018 at the AIPPI Congress.

Despite the subject-matter exclusions implying that algorithms and neural networks are not eligible for protection; this research project demonstrates that all three jurisdictions found ways to render some types of algorithms and neural networks eligible. In fact, all three are very active in the international forum to find ways to better seize the opportunities bestowed by AI and IoT-related technologies by incorporating AI innovation in computer-implemented inventions and ensuring that they remain competitive. Yet, stretching computer-generating inventions to encapsulate the intangible nature of the future of innovation could bring patent law to breaking point, policy-makers to think about the ways in which it can respond to the needs of technological developments where machines are replacing human ingenuity. Furthermore, the extent to which patent protection is available remains different in the jurisdictions studied whilst the international and cross-border nature of innovation in AI and IoT fields begs for further harmonization in the domain.

One of the questions resurfacing today relates to the eligibility of algorithms for patent protection and one of the most common arguments is that these are open source and protected by copyright so they do not need further protection. If AI and IoT-related technologies have so far attracted the interest of all size companies because many of the most common algorithms are available as open-source (developed from OSS), small- and mid-scale companies remain at a disadvantage compared to large-scale companies who are better positioned to invest simultaneously in other activities that are susceptible of patentability. [264] Additionally, these smaller companies are in a more vulnerable position in order to secure and retain investment from third parties, resulting from the doubts surrounding patentability or the apprehension of invalidity through post-grant procedures.

Despite the availability of patent eligibility, it is hard to conceive how the trend of having open source algorithms would change. To the contrary, OSS is extremely popular and will continue to grow. These algorithms are part of the prior art and should not come under private control. Allowing the eligibility of complex algorithms should contribute to this as patent applicants will be compelled to clearly establish the parts already known or available from the parts for which they intend to get patent rights. This should also contribute to reducing the risks of patent thickets as not every little improvement of the technology will be patentable, as well as providing adequate incentives to address key technological challenges of

[264] E.g. Google making its algorithms open-source whilst simultaneously investing in activities such as batch normalization (essential for improving the speed, performance, and stability of artificial neural networks) to obtain patent rights over these inventions.

machine learning. Whilst there is a genuine enthusiasm in enabling the patentability of AI-related inventions within the current patent system, there is a growing need to determine the appropriate scope of protection for these inventions. For example, considering a neural network as a product may result in too little protection, whilst considering it as a process may lead to too broad protection resulting in the increase of market prices for consumers above efficient levels and rise of patent thickets.

Against the current backdrop, patent offices bear an important role in advising inventors on what is eligible for patentability and how to draft successful claims (especially in light of the paucity of cases). But equally, patent offices must develop strategies to cope with the growing number of applications relating to AI and IoT technologies which has an impact on the quality of patentability assessment, identification of prior art and evaluation of the appropriate breadth of the monopoly granted through patents.

Without a reliable and robust way to categorize and describe inventions, it is hard to identify the appropriate prior art. One of the current difficulties relates to the current practice whereby patent attorneys have developed skillful draftsmanship techniques to avoid unpatentability.[265] Many patents involving algorithms or AI programs avoid the reliance of concepts such as 'algorithms' and 'programs' or 'AI programs' altogether.[266] In the absence of standardization of appropriate search procedures and methods of classification of the prior art, patent examiners and inventors are left to their own devices with little incentive to scrutinize the prior art in a meaningful way. Furthermore, patent offices during the examination process are more reliant on the prior art as identified by the applicant, which might reduce over time and eventually render the novelty requirement meaningless.

Although the three jurisdictions under scrutiny apply the novelty requirement, divergences remain in its application. There is a strong possibility that these differences provide advantages to inventors in some jurisdictions where the system is more inventor-friendly (i.e. Japan and US). Nevertheless, frustration can be felt by inventors securing protection in these countries while being unable to obtain protection in other jurisdictions (like Europe) over the same subject-matters.

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[265] H. Kohno, 'Tips for identifying AI/IoT inventions and acquiring patents for them' (2018) *Research Institute of Economy, Trade and Industry*, 67.

[266] As confirmed by two patent attorneys in Tokyo. See also, O. Baldus, 'A Practical Guide on How to Patent Artificial Intelligence Inventions and Computer Programs within the German and European Patent System: Much Ado about Little' (2019) 41(12) *EIPR*, 753.

Held as public-serving, patent law should serve the public interest by ensuring that information and knowledge are disseminated in society. The current practices enable the patentability of AI without upholding the disclosure requirement. For example, in Europe or Japan, there is no need to disclose the algorithms relied upon or the actual role of the AI in the inventive process. In the US, even if algorithms should be disclosed, there is a current understanding that network topology are not subject to the same disclosure requirement. It is therefore time to address this issue. The EPO has already paved the way and has welcomed views on how sufficiency of disclosure should be assessed in relation to AI inventions. In order to avoid black box patenting, there is a need for the three jurisdictions to establish whether sufficient disclosure is satisfied on the ability for a computer to reproduce the claimed results.

Recommendations:

1 – **Limit the ineligibility of algorithms from patentability**: there is a need to ensure that the patent system adapts to new technologies and especially, the evolution of the nature of the innovative process and guarantees that the patent justifications and rationale are met. It is therefore time to recognize that algorithms today are much more than mathematical formulas. These result from human ingenuity and provide complex solutions to technical problems.[267] If a change in legislation can be difficult to achieve in practice, **a better way would be a change in interpretation of this excluded subject-matter**. Only Europe has a statutory exclusion for mathematical formula. It could be envisaged that this exclusion limits itself to **simple algorithmic problems which can be achieved easily by the human mind**. Once there is an invention in a field of technology then this one should be patentable regardless of any further requirements linked to technicality. This would also contribute to having a patent system that is more easily accessible in the eyes of inventors which ultimately would lead to easier claims to assess.

2 – Countries should harmonize their approach to novelty: jurisdictions should reflect on whether a whole-contents approach or a claims-based approach is desirable in light of the current innovation trends. Here, a **whole-contents approach should be preferred**. Furthermore, **self-collision should apply to both**

[267] A discussion well underway in the US where four options have been outlined following the confusion of the *Alice/Mayo* test. These are: 1) No changes and let the courts refine the test on a case-by-case basis; 2) Introducing a statutory list of exclusions like in the EPC; 3) Adopt a lower eligibility standard such as that the invention must result from human ingenuity, have a real life existence or contribute to technological arts; finally, 4) Remove subject-matter exclusions altogether and focus on patentability requirements. See Congressional Research Services, supra n. 30, 26-30.

secret prior art originating from the applicant and third parties to ensure that only valuable subject-matters are patented and avoid double-patenting issues.

4 – Both Europe and the US should **drop the technical character** doctrine: in both jurisdictions, this doctrine has led to a series of complexities and uncertainties. Not only is there evidence that this doctrine is hard for courts to apply in particular cases, but it can lead to bizarre and often hard to justify outcomes. Here, focusing on the inventive concept as done in Japan contributes to the legitimacy of the patent system in the future.

5 – Further discussions on the rationale of the **disclosure requirement** should take place. Whilst the idea behind the sufficiency of disclosure is to enable the person skilled in the art to learn how to replicate the invention as described in the patent application, there is no denying that as a source of knowledge, patent applications are rarely relied upon. Therefore, the social goal of contributing to the dissemination of knowledge and information is not realized. Perhaps the jurisdictions under scrutiny should consider moving away from a system where applicants are merely required to provide information how to make and use the invention to focus on ensuring that information related to the reasons as to **why or how the invention works are specified.**[268] Equally, there is a need to ensure that the rules and processes included in a system are explained.

6 – **Patent Offices must carry on their work on the dissemination of case studies in the area of AI and IoT-related technologies**: there is no denying that these are extremely useful for prospective applicants, patent examiners and add transparency in the application process. As such, patent offices should carry on monitoring the evolution of intangible innovation and should provide additional examples as to the patentability of algorithms, neural networks, training processes, parameters, etc. Here, it would be particularly helpful to know how much should be disclosed to meet the novelty threshold e.g. should the topology of the network be disclosed? Should the algorithms be provided? Or the parameters used? This requires careful examination as this could have dramatic consequences on the patentability of future inventions.

The patent system has survived three industrial revolutions without changing drastically and has the ability to survive a fourth, but there are still elements that can be improved. Whilst the current position amongst patent offices seems to be to approach the patentability of AI inventions on a case-by-case basis, current

[268] As already suggested by S. B. Seymore, 'Patenting the Unexplained' (2019) 96(4) *Wash ULO*, 707-752.

divergences in regime are likely to be of more central importance in the future. The current situation leads to the downplaying of the AI element in patent applications thereby minimizing the actual disclosure. This does not seem in line with the goals of patent law. Although the recommendations above might sound radical, eventually these changes are required to guarantee the societal benefits deriving from AI and IoT technologies. Without this, patent attorneys, patent examiners and eventually courts will be asked to make decisions on a case-by-case basis without fully taking into consideration the broader policy implications of these decisions.

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