PATENT SYSTEM AND ARTIFICIAL INTELLIGENCE: TOWARDS A NEW CONCEPT OF INVENTORSHIP?

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Patent System and Artificial Intelligence: Towards a New Concept of Inventorship?

Gabriele Cifrodelli*

Outstanding LLM Dissertations 2021

Abstract

The objective of this work is to answer the question whether an AI can be considered an inventor, as can a human, through a methodological approach which analyses different documents that are mostly secondary sources, but also case-law and legislation. The answer is negative: there is no such thing as a new concept of AI inventorship for now.

In particular, although there have been attempts by some authors - defined as the "classic literature" - to consider AI as creative and thus capable of generating inventions (the so-called "AI-generated" inventions), a more careful "technical" literature states that AI systems operate through a different intelligence than the human one, and this philosophical difference can be practically envisaged not only in the current case-law of the EPO, but also in the way machines operate in our reality. Indeed, the computational problem solving mechanism requires the human contribution, especially in the phases of abstraction/modelling, defining an algorithm and programming. Therefore, even the most sophisticated soft-computing methods, such as ANNs and EAs, cannot be considered autonomous.

However, this work will not completely underestimate the possibility that in the future there could be something such as an AI inventorship. Unfortunately, not only the very important incentive justification but also other classic IP theories (fairness, personality, and culture) would not be compatible with this hypothetical AI inventorship. As a consequence, the current patent system should be reformed through the implementation of a tailoring approach. The problem is that, in order to do so, legislators and judges should be aware of the optimal patent strength of each industry. However, the information about R&D costs, risk of failure, and level of innovation, is very difficult to obtain. Given this impossibility to reform the patent system, other ways through which AI inventorship can be protected will be mentioned.

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Introduction

"The real danger of artificial intelligence is not that computers are smarter than us, but that we think [they] are".[1] This impactful quotation can be considered the summary of this work's argument: AI is not at that Sci-fi level where it would substitute humans in every aspect of life. It is definitely true that the AI-oriented debate has been growing consistently in every scientific field in the last few years,[2] but it is also true that, more than addressing reality and finding solutions to practical problems, most of the time the discussion is theoretical and hypothetical. This means that we are still far from a situation where AI would be considered similar to humans. Transposing this discussion in the field of intellectual property, and specifically patents, the objective of this work is to answer the question whether an AI can be considered an inventor, as can a human. Through a methodological approach which analyses different documents that are mostly secondary sources, but also case-law and legislation, it can be said that, although there have been attempts by some authors, which are part of what in this work will be defined as the "classic" literature, to consider AI as creative and thus capable of generating inventions (the so-called "AI-generated" inventions), a more careful "technical" literature states that for now computers are not smarter than us. Hence, the term "AI-generated" inventions is not appropriate and a better one would be "aided by AI" inventions. However, this work will not completely underestimate and deny the possibility that in the future there could be something such as an AI inventorship, and it will try to find a proper way to deal with this hypothesis before it is too late. Indeed, law must keep pace with society, and, in order to do so, law has to study and predict a phenomenon and find appropriate legal solutions even before the phenomenon itself occurs. Therefore, for now AI cannot be considered as determining a new concept of inventorship under the patent system, but if this possibility is faced in the future, we must be ready, and this paper can offer a direction to follow.

It is important now to clarify in more detail the structure of the work. The first chapter sets the indispensable grounds for the central discussion that will be developed later on. In particular, the first section introduces the concept of inventorship, its importance in the context of patent justification, and the approach through which an inventor can be identified. It will be underlined that the inventive contribution requirement is not well- defined and clear, and consequently, the inventor results in a dynamic and never static concept. The second section explains what an AI is or, more appropriately, what the classic literature thinks an AI is, and refers to some

[1] G. Smith, *The AI Delusion* (OUP 2018) 237.

[2] See e.g. in the field of intellectual property *WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI)* WIPO/IP/AI/2/GE/20/1 (13 December 2019).

inventions that were allegedly made by AI, and were for this reason called "AI-generated" inventions. It introduces the idea, that will be explored in more details in the second chapter, according to which it is probably not entirely correct to state that AI are really the inventors. In the third and final section of this chapter the relationship between AI and humans will be investigated, specifically how different the machine and human intelligences are, and how this difference leads to a conception of AI and its way of operating that is not the one that we see in Sci-Fi movies.

In the second chapter the debate about whether an AI should be considered an inventor is addressed from different perspectives. In particular, in the first section the legal point of view will be taken into account, referring to the EPC and the EPO decision, on the one side, and to the very recent Australian decision, on the other side. It will be underlined that the approach adopted by the EPO, according to which an AI could not be granted a patent, is the most appropriate one, since it is legally connected to the philosophical difference between human and machine intelligences. Instead, the second and third sections will deal with the more technical perspective of AI systems. First, two different ways through which AI is expected to operate are juxtaposed, and it will be explained why only one of them, the so-called computational problem solving, is the one that realistically makes AI functioning and, as a consequence, does not allow it to be an inventor. Eventually, the term "aided by AI" inventions is introduced, which is something totally different from AI-generated inventions, and is a more correct definition to describe the actual contribution by AI to patentable inventions, even despite the so-called black box problem. Finally, it will be clear that for now only humans can be recognised as inventors, and the machines are just the executioners of what the humans themselves conceptualise and create.

The third and final chapter is the most Sci-Fi of the entire work, since it introduces a hypothetical scenario where there is an assumption according to which AI can be considered an inventor. This would happen the moment that computers start to be autonomous and not just automatic, and really contribute in an inventive way to the creation of a certain product or process, without human intervention. This is unlikely to occur in the near future, although eventually it will happen, and human society must be prepared for that, also in terms of new legal rules and their enforcement. Therefore, the main question of the chapter is whether the current patent system is suitable for a hypothetical AI inventorship. In particular, in the first section the incompatibility with the foundations of the patent system will be underlined. The second section investigates the possibility of a reformation of the current patent system, adopting the so-called "tailoring" approach which would allow patents to be granted according to the specific development of a certain invention. The practical difficulties of this system will also be addressed. Therefore, the third and final section will bring to attention three different ways (other than patentability) through which AI inventorship can be protected: first mover strategy, digital tools against counterfeiting, and social recognition of multiplayers in the AI industrial sector.

Chapter 1: Preliminary remarks

1.1. Inventorship in the actual patent protection: the uncertainty of the "inventive contribution" requirement

Inventors have always been at the centre of the patent system. It can even be affirmed that inventors have basically shaped the justification for the patent system itself. Indeed, the first proponents of patent protection stated that inventors must be granted the fruits of their mental labour, in terms of a reward.[3] This conception has been known as fairness theory, and can be traced back to the work of the British Philosopher John Locke,[4] who, although he never talked about intellectual property, surely has been considered the predecessor of the justification for this kind of mental and abstract property. It is definitely true that the public interest rationale, according to which the public should endure the harm caused by the monopoly of a patent only to the extent that the public itself receives some benefit,[5] has always been the most important argument for patent protection (see 3.1). However, as has been just underlined, it is also true that human inventors (and authors in the copyright context) have been the first underlying drive to intellectual property protection.

Now the question that must be answered and that is essential for the further analysis is how the inventor can be identified. The UK jurisdiction can offer an interesting contribution in this regard, since courts have always stated that to qualify as an inventor the person needs to show that she contributed to the so-called "inventive concept".[6] However, determining this inventive contribution is definitely not an easy task, considering that it represents a "relation of discontinuity between the claimed invention and the prior art",[7] and most of the time it is extremely complicated even for the inventor to establish where this line of discontinuity lies.[8] In

[3] F. Machlup and E. Penrose, *The Patent Controversy*, 10 J Ec Hist 1 (1950) 11-17.
[4] See J. Locke, *The Second Treatise of Government* (1689) Chapter 5.
[5] L. Bently et al, *Intellectual Property Law* (2018) 397.
[6] See *GE Healthcare v. Perkin Elmer* [2006] EWHC 214.
[7] *Rhone-Poulenc Rorer International Holdings v. Yeda Research and Development Co.* [2007] UKHL 42 [20].
[8] ibid.

addition, and this is the most relevant aspect for this work, the relationship can easily change over time and from a specific subject to another one.[9] Therefore, the concept of inventorship itself is a dynamic one, constantly evolving, and the only approach to identify the inventive contribution is on a case-by-case basis. For instance, it is generally accepted that the person who, through her invention, has solved a particular problem or answered a certain question, must be considered an inventor.[10] This is the most common definition of an inventive contribution. However, sometimes the threshold has been lower, such as in the case of the improvement of an existing device, or when it was stated that even the generation of an idea or method of research can be considered inventive.[11] As can be noticed, these different assessments of the inventive contribution requirement lead to a different understanding about who an inventor is. Therefore, inventorship results in a dynamic and never static concept, and can potentially evolve, as soon as the inventive contribution is assessed.

The situation is not different in the context of the European Patent Convention. In particular, although the right to be named as the inventor is envisaged,[12] and thus it is required that the inventor is mentioned in the patent application,[13] there are no clarifications about who the inventor is or how she can be identified as such. Moreover, the European Patent Office has never clearly specified this aspect in its case law, until probably the DABUS decisions, which will be analysed in the following chapter (see 2.1). This uncertainty at the European level led to different interpretations of the inventorship requirement by national courts. For instance, Germany provides that the inventor is the human being who made the invention, in the sense that she learned how to solve a particular problem with certain technical means, and disclosed her knowledge in order to implement that invention.[14] It can be observed that the already- mentioned UK approach and this German definition of inventorship are similar when it comes to the resolution of a particular problem to identify the invention. Nonetheless, in the UK approach there is no reference to the element of disclosure, which is instead present in the German case-law. Therefore, the definitions of inventorship can be countless according to the country that is taken into consideration, and this reinforces the fact that inventor is not a clear concept. Consequently, this element must be considered in order to state whether an AI can be

[9] Bently (n. 5) 625.
[10] ibid.
[11] *Staeng's Patent* [1996] RPC 183, 189.
[12] EPC, Art. 62.
[13] EPC, Art. 81.
[14] *Steuervorrichtung*, Decision of 18 May 2010 – X ZR 79/07 (GRUR 2010, 817) [28].

considered an inventor. But first, it must be clear what an AI is or, more appropriately, what the classic literature thinks an AI is.

1.2. AI according to the classic literature: main features and inventions

Notwithstanding the fact that AI systems have increasingly become part of our everyday life, there are no clear definitions about them,[15] but just various explanations as different features of AI are taken into consideration.[16] This is the first substantial difficulty when it comes to dealing with AI. However, in the context of intellectual property, it has usually been stated that AI corresponds to machines which "are capable of performing tasks that, if performed by a human, would be said to require intelligence".[17] In particular, eight features are identified, and they are supposed to be the main stones which build the so-called 3A era of advanced, automated, and autonomous AI systems.[18] The question that will be asked throughout this work (see 2.2) is whether these features correspond to what AI is now. The first feature is the one of creativity: AI systems are allegedly capable of creating new products and processes, and improving the ones that already exist.[19] Secondly, AI can offer unpredictable results, although it is based on algorithms that follow certain precise data.[20] The third feature is the independent autonomous operation that AI can exercise, even if this aspect is deeply influenced by the level of human intervention which is in turn dependent on the specific industry where AI operates.[21] In fourth position, we find the aspect of rational intelligence, meaning that a machine can perceive data and decide which activity to deal with and which one to avoid in order to reach the best possible goal.[22] This feature is related to another one, the fifth, which is the free choice goal oriented, according to which AI systems choose between alternatives to achieve the best outcome.[23] The sixth aspect is the evolution of AI according to the reception of new data, and the seventh feature is related to the ability of AI to collect, access, communicate with data of the outside world on the basis of the ones already gathered.[24] As the eighth and final aspect of AI there is

[15] M.U. Scherer, *Regulating Artificial Intelligent Systems: Risks, Challenges, Competencies, and Strategies*, 29 Harv. J.L. & Tech. 353 (2016) 360.
[16] S. Russell & P. Norvig, *Artificial Intelligence: A Modern Approach* (2013).
[17] Scherer (n. 15) 362.
[18] S. Yanisky-Ravid and X. Liu, *When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law*, 39 Cardozo L. Rev. 2215 (2018) 2224.
[19] ibid.
[20] ibid at 2225.
[21] ibid.
[22] ibid at 2226-2227; Russell & Norvig (n. 16).
[23] ibid at 2228; Scherer (n. 15).
[24] ibid at 2227.

the efficiency and accuracy in processing tons of data, even beyond the capacity of humans to do so.[25]

With these eight features in mind, before assessing them in a more critical way in order to realise that they probably represent an overestimation of what AI systems are at this stage, some examples of what the classic literature calls "AI-generated inventions" should be mentioned. In particular, there are three important cases which try to demonstrate that AI systems (mostly computer) have been creating machines since the twentieth century.[26] The first one that we refer to is the notorious "Creativity Machine", invented by the computer scientist Stephen Thaler. This device is a computational paradigm, which is considered capable of emulating the basic mechanisms that are employed for the construction of an idea.[27] Indeed, this Creativity Machine could generate something similar to what we define an idea, through the use of software concepts defined as artificial neural networks (see 2.2), which are essentially multiple on/off switches that connect themselves without human intervention.[28] Doctor Thaler associated the processes used by the Creativity Machine to the those of the human brain and consciousness.[29] The more relevant aspect is that Doctor Thaler filed two patents related to this AI. The first one was properly the Creativity Machine as the patentable subject matter, and the scientist was rightly recognised as the inventor.[30] The second patent has always Doctor Thaler listed as the inventor, although he himself stated that the Creativity Machine should have been granted the patent.[31] Now a strong doubt rises here: notwithstanding the statement made by the scientist, why did he decide not to mention the AI as the real inventor of the "Neural Network Based Prototyping System and Method" (the second patent)? Perhaps he was not convinced that the Patent Office would have granted the patent to the Creativity Machine, considering that probably at the end this AI was not to be considered as the one with the inventorship.

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[25] ibid; G.F. Luger, *Artificial Intelligence: Structure and Strategies for Complex Problem Solving* (2008).
[26] R. Abbott, *I think, Therefore I Invent: Creative computers and the future of patent law*, 57(4) B.C.L. Rev. 1076 (2016) 1083.
[27] *What Is the Ultimate Idea?,* Imagination Engines Inc., https://perma.cclP877-F33B (last visited July 7, 2021).
[28] Abbott (n. 26) 1084.
[29] S. Thaler, *Creativity Machine@ Paradigm*, Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship 451 (2013).
[30] U.S. Patent No. 5,659,666 (filed Oct. 13, 1994).
[31] U.S. Patent No. 5,852,815 (filed May 15, 1998).

A second type of AI that has allegedly succeeded in making patentable results is the software Genetic Programming (GP).[32] In particular, GP emulates in a digital way the same processes of evolution, i.e. mutation, sexual recombination, and natural selection, in order to achieve a kind of machine intelligence with the lowest level of human intervention.[33] In 2005 the US Patent Office granted a patent to the scientist and pioneer in the GP field, John Koza, for a computational invention created by the GP called "Invention Machine".[34] However, even in this case, as in the one of the Creativity Machine, despite the fact that Koza declared that his Invention Machine has created not only this but many other patentable inventions,[35] in the 2005 patent application there is no mention of the involvement of a computer.[36] Indeed, Koza was legally advised to identify only his team as inventors.[37]

The third and more recent example of AI as possible inventor is the machine called "Watson", which was invented by IBM, and is well known because it beat the former winners of the game show *Jeopardy!*, winning a conspicuous monetary prize.[38] IBM has always defined Watson as an AI capable of computational creativity.[39] In particular, IBM stated that Watson can generate millions of ideas and decide which are the best ones, elaborating on enormous data in order to achieve new and better goals.[40] For instance, after the winning in the *Jeopardy!* game, Watson was used to generate new food recipes on the basis of only the user input, which consists of parameters related to ingredients, dish and style.[41] Therefore, thanks to the user input, Watson could process several food combinations, and then, following a novelty and quality criterion, could come up with the final output.[42] Since food recipes can potentially constitute a patentable subject matter,[43] someone stated that even Watson's recipes could be patented, and the AI would have been recognised as the inventor.[44]

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[32] J.R. Koza, *Human-Competitive Results Produced by Genetic Programming*, 11 Genetic Programming & Evolvable Machines 251 (2010) 265.
[33] J.R. Koza et al., *Evolving Inventions*, Sci. Am. (2003) 52.
[34] J. Keats, *John Koza Has Built an Invention Machine*, Popular Science (2006), http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine (last visited July 8, 2021).
[35] Koza (n. 32).
[36] Keats (n. 34).
[37] Telephone Interview by Abbott with Koza (2016).
[38] J. Best, *IBM Watson*, Techrepublic, https://perma.cc/BQ4V-Q48F (last visited July 8, 2021).
[39] *Computational Creativity*, IBM, https://perma.cc/6FK4-WTL3 (last visited July 8, 2021).
[40] ibid.
[41] *Watson Cooks Up Computational Creativity*, IBM, https://perma.cc/GGV7-NHT4 (last visited July 8, 2021).
[42] ibid.
[43] *Can Recipes Be Patented?,* Inventors Eye (2013), https://perma.cc/EN3V-9DY4 (last visited July 8, 2021).
[44] Abbott (n. 26) 1090.

As can be noticed, in all of these three cases, despite the conviction of the inventors according to which their machines could be capable of generating patentable inventions, in the more practical aspect, none of these AIs was recognised as an inventor by the Patent Office. It is true that at that time the debate was less consistent, and the patent authority was not even asked to decide on the matter, but it also true that probably these machines could not be even considered to be inventors. The philosophical basis of this statement will be elucidated in the next and final section of this chapter.

1.3. The relationship between AI and humans: who is the most "artificial" one

Contrary to what was stated in the previous section, which alluded in a way to the fact that AI can be considered to be as intelligent as humans, it will be now emphasised that the so-called machine intelligence is radically different from the human one.[45] Indeed, the human intelligence is the one that is artificial, instead the AI intelligence is automated.[46] This consideration is perfectly explained by Professor Hildebrandt, who in turn based her work on the thought of the philosophical anthropologist Helmuth Plessner. In particular, the latter identifies three constitutional laws of the human condition: first, our nature is deeply artificial; second, our cognition depends on a mediated immediacy; third, the so called ex-centric positionality of humans creates a utopian point of view.[47] Basically, all of these three laws embody the fundamental principle of our existence, according to which humans can never be at one with themselves.[48] This means that, according to Plessner, we can never access the outer world in an unmediated way, and so we cannot do that with the world we institute, the shared world, or even with the inner world, which is the world that we experience.[49] Therefore, our self is constituted by an ex-centric position. Despite the apparent negative connotation that this term can involve, it is exactly this position of the human, this incongruence of the self with the self, which allows the misunderstandings that are productive and creative.[50] Naturally, at the same time, this incongruence generates an uncertainty that can never be solved.[51] Although this can have negative consequences on ourselves, such as fear or mental pain, it is the aspect that makes us human, in the sense that we have to face the fragility and resilience of

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[45] M. Hildebrandt, *The Artificial Intelligence of European Union Law*, (21)1 German Law Journal 74-79 (2020) 74.
[46] ibid.
[47] H. Plessner & J.M. Bernstein, *Levels of Organic Life and the Human: An Introduction to Philosophical Anthropology* (Millay Hyatt trans., 2019).
[48] Hildebrandt (n. 45) 75.
[49] ibid.
[50] ibid.
[51] ibid.

the institutionalised world, since this is a fundamental part of the human intelligence: being vigilant and adaptive.[52] If this general thought is applied in our field of interest, i.e. patents, it can be understood that, on the one side, the productive and creative misunderstandings from our ex-centric position ultimately lead to the novelty and the inventive contribution which are required in the patentable inventions, and on the other side, the uncertainties, which for instance occur when we interpret the inventive contribution (see 1.1), are something that must be accepted, that are part of being human.

When it comes to AI, Hildebrandt talks about the "agency" of smart technologies.[53] In particular, agency is defined as an ability to perceive the environment around you in terms of actionability, and thus the ability to act in that world.[54] In this way, agencies perceive what the environment can afford them as the actions the agencies themselves can execute.[55] Thanks to this concept of agency, it can be understood that the human and AI agencies are two different ones, because the abilities through which they operate are different.[56] Indeed, machines have an agency that is considered data and code-driven, considering that they can perceive the environment in a form of data, whereas a human's perception is mediated by language and interpretation.[57] Moreover, since the data cannot speak for itself, AI requires codes, such as, in the context of machine learning, when there is a compression of data into a mathematical function, which is defined as the target-function and is responsible for clarifying the data in the light of a specific task that the machine is required to perform.[58] Now, since algorithms, which are mathematical functions serving as hypotheses for the target function, cannot be instructed on future data, it cannot be known whether the target function is sufficiently approximated.[59] Consequently, machine learning uses objective functions in order to identify the best possible approximation of the target function. As can be noticed, all of this not only helps to understand how AI actually works (something that will be analysed in more detail in the next chapter, see 2.2), but, most importantly, this indicates that machine learning does not operate on the basis of meaning (as humans do) but only on mathematics, in the sense that it cannot take a first or second-person

[52] ibid.
[53] M. Hildebrandt, *Smart Technologies and the End(s) of Law: Novel Entanglements of Law and Technology* (2015).
[54] ibid.
[55] ibid; F.J. Varela et al, *The Embodied Mind: Cognitive Science and Human Experience* (1991).
[56] Hildebrandt (n. 45) 76.
[57] ibid.
[58] ibid.
[59] D.H. Wolpert, *Ubiquity Symposium: Evolutionary Computation and the Processes of Life: What the No Free Lunch Theorems Really Mean: How to Improve Search Algorithms*, 2013 Ubiquity 2 (2013).

perspective, since it is based on our ability to take a third-person perspective.[60] Therefore, the fundamental nature of AI is automated (see 2.3), and does not correspond to the artificiality/complexity that Plessner thinks it is characteristic of humans. With all these premises in mind, in the following chapter there will be a focus on the main question of this work: can AI actually be considered to be inventors?

Chapter 2: Computers are not smarter than us (yet)

2.1. Where we are now: the EPO and Australian decisions

Despite all the uncertainties about identifying the inventorship concept at both European and national levels (see 1.1), one aspect can be considered more certain and less dynamic: the inventor has always to be a human being.[61] Indeed, the existence of an individual human inventor is presupposed by the EPC.[62] In particular, other than the above- mentioned right to be named as the inventor (see 1.1), it is stated that the right to an invention and consequently to the grant of the patent shall belong to the inventor or his successor in title.[63] This right includes, on the one hand, the inventor's personal right to have a relationship with its invention, and on the other hand, the more material right to the patent derived precisely from this relationship.[64] In addition, the person entitled to obtain a European patent before the EPO is the applicant.[65] Taking all of this into consideration, as mentioned before, it can be said that a European patent is granted only to a human inventor of a product or process which is the subject of the patent application.[66]

This conception of human inventorship seems to have been confirmed in the notorious DABUS decisions by the EPO.[67] In particular, in two applications filed in Autumn 2018, a machine called DABUS, described as a "type of connectionist artificial intelligence", is named as the inventor. Indeed, the applicant claimed that the invention, as the subject of the applications, had been made by the machine, because the latter identified the novelty of the idea before a person could do so. Moreover, the applicant should have been recognised as the assignee of the patent because he was the owner of the machine and thus its successor in title. By contrast, the EPO

[60] Hildebrandt (n. 45) 77.
[61] E. Stankovà, *Human Inventorship in European Patent Law*, The Cambridge Law Journal 1-28 (2021) 11.
[62] ibid.
[63] EPC, Art. 60 (1).
[64] K.J. Melullis, *Patentfahige Erfindungen* in G. Benkard (ed.), *Europaisches Patentübereinkommen* (2002) 301.
[65] EPC, Art. 60 (3).
[66] Stankovà (n. 61) 10.
[67] EPO decision of 27 January 2020 on EP 18 275 163 and EP 18 275 174.

stated that an AI cannot be considered an inventor since this would be contrary to the EPC, and specifically to Rule 19(1) Implementing Regulations, which provides that the designation of the inventor in the patent application[68] should contain the family name, given names and full address of the inventor itself. Now, the EPO interprets the term name as the one attributed to natural persons, not to things, since a name not only helps to identify people but, most importantly, allows people themselves "to exercise their rights and form part of their personality".[69] Indeed, the EPC does not refer to non-persons, such as AI, and this is deeply confirmed by the travaux préparatoires to the EPC 1973, where there is a constant reference to a natural person.[70] Only the latter has the legal personality as a consequence of being human.[71] In addition, although legal persons are not humans, they have been assigned their legal personality by a legal fiction, which can be made through either legislation or case-law, and in this way companies or other legal entities can be granted rights, such as a patent.[72] Instead, at least for now, no legal fiction has been established for AI. Therefore, an AI system cannot serve as a designated inventor in the EPO patent grant proceedings.[73] Contrary to this well received case-law, a very recent judgement by an Australian federal court firmly stated that an AI system can be considered an inventor.[74] Without entering into details about the interpretation of the Australian Patent Act, one of the main reasons behind this conclusion is that, according to the federal judge, "an inventor is an agent noun; an agent can be a person or a thing that invents".[75]

Now, both arguments by the EPO in the DABUS decision and by the federal judge in the Australian judgement, although legalistic in the sense that the courts decided these cases taking always into account the current provisions of their respective patent laws, could enclose a more philosophical dispute. In particular, the Australian judge asserts that humans and AI are agents in a similar way, and thus they have the same kind of intelligence and creativity. Instead, the EPO asserts that human and machine intelligences are totally different, and only the first one is able to create something. Thus, only humans can be recognised as creators of something. This last argument is more appropriate than the one by the Australian judge, since it is coherent not only with Hildebrandt's conception of the substantial differences between human and AI

[68] EPC, Art. 81.
[69] EPO decision (n. 67) at [22].
[70] See e.g document BR/169 e/72 ett/AV/prk, point 31 ("development of invention by a person").
[71] EPO decision (n. 67) at [27].
[72] ibid.
[73] Stankovà (n. 61) 8.
[74] *Thaler v Commissioner of Patents* [2021] FCA 879.
[75] ibid at [10]

intelligences (see 1.3), but also with the idea according to which one of the fundamental elements of intellectual property subject matter in general (not only for patents) is the "origination in an act of human creation (requiring a certain talent or capacity)".[76] An invention specifically is produced by a process where the human agent (who operates through a different kind of agency than AI, see 1.3) uses their inventive skills to build on, modify or adapt the pre-existing natural world,[77] in order to perhaps try to put an order in the institutionalised world (as Plessner defines the world that we create, see 1.3). It can be strongly said that this is the fundamental reason why AI cannot be equated to natural persons, and why AI is not covered by a legal fiction as a legal person is. In the next section, the more technical reason why AI is not similar to humans (for now) will be specified, juxtaposing two different ways, of which only one is more realistic and thus correct.

2.2. Computational creativity vs. computational problem solving

Someone believes that AI-generated inventions may be deserving patent protection because the creativity in these cases is not a human one, but it is a computational creativity. In particular, the machine itself is responsible for achieving certain discoveries that need the application of great amounts of data, or that make a deviation from the conventional wisdom.[78] This computational creativity is, first of all, strictly linked to the conception used in the space context of the so-called evolvable systems, i.e. AIs which can evolve in terms of shape, function, design, in order that they can become better and more "intelligent", due to a process which basically follows the biological evolution.[79] Indeed, these systems are based on evolutionary algorithms that are starting to design complex engineering structures which can be considered equivalent to what an human expert achieves.[80] Therefore, since these AI systems are evolving, they can be equipped with a particular creativity that potentially leads to some inventive step and novelty not achieved by the human who designed the machine. As a consequence, the most important feature of this computational creativity is the unpredictability of the solution that the AI reaches. Indeed, in the classic literature it has been stated that machines can discover and implement complex rules or patterns that their human inventors never thought about.[81] Thus, since the human expert could not foresee the results that the AI achieved, she cannot be considered the inventor of those results, but the AI is. As can be easily noticed, this narrative is perfectly in

[76] J. Pila, *The Subject Matter of Intellectual Property* (Oxford 2017) 9.
[77] B. Sherman, *What Does It Mean to Invent Nature?* 5 U.C. Irvine Law Review 1193 (2015) 1203.
[78] Abbott (n. 26) 1113.
[79] J.D. Lohn, *Evolvable Systems for Space Application*, NASA (Nov. 24, 2003), https://perma.cc/BWC7-UPJK (last visited July 12, 2021).
[80] ibid.
[81] R. Plotkin, *Genie in the Machine. How computer-automated inventing is revolutionizing law and business* (Stanford Law Books 2009) 80.

line with AI's eight features to which the classic literature refers when it wants to justify the possibility of AI inventorship (see 1.2), and it is precisely from these eight features and the idea of computational creativity that the opposite (and correct) way through which AI operates is introduced.

To start discussing the computational problem- solving, it is important to clarify two concepts or, it is better to say, two subfields of AI, since they are at the centre of the recent debate on patent and AI-generated inventions: Artificial Neural Networks (ANNs) and Evolutionary Algorithms (EAs).[82] These soft-computing approaches, already mentioned in this work (see 1.2), are applied to solve problems that are characterised by high uncertainty and complexity,[83] and from the perspective of the inventorship discussion it must be assessed which kind of computation is performed when these methods based on ANNs and EAs are implemented in a computer.[84] In particular, ANNs correspond to various computational methods which form a type of machine learning, the most "futuristic" one, defined as "the study of methods for programming computers to learn".[85] In processing training data, an algorithm learns how to correlate the inputs to the outputs by establishing a function[86] which, eventually in the course of learning, is constantly defined, refined and executed by the algorithm, according to the specific problem that the machine is designed to solve.[87] Therefore, on the one hand, each artificial neuron solves a small part of the problem, and on the other hand all the neurons in parallel solve the problem as a whole.[88] Now, the reason why this is the first method which stimulates the discussion about AI inventorship is that sometimes it has been stated that, through these ANNs, machines can perform tasks without being clearly programmed for.[89] Consequently, there can be that unpredictability which, as stated before, is one of the eight features of the creative AI, and thus computational creativity. However, if the computational problem-solving aspect is emphasised, it can be understood that there are always instructions responsible for determining how the input-output relation is assessed through computation.[90] Indeed, through the machine

[82] D. Kim, *'AI-Generated Inventions': Time to Get the Record Straight?* 69(5) GRUR International 443–456 (2020) 451.
[83] O. Maimon and L. Rokach, *Introduction to Soft Computing for Knowledge Discovery and Data Mining* in O. Maimon and L. Rokach (eds), *Soft Computing for Knowledge Discovery and Data Mining* (Springer 2008) 1.
[84] Kim (n. 82).
[85] T.G. Dietterich, *Machine Learning* in Lynn Nadel (ed), *Encyclopedia of Cognitive Science* (Wiley Online Library 2006) 1.
[86] Kim (n. 82).
[87] J.P. Mueller, L. Massaron, *Artificial Intelligence for Dummies* (John Wiley & Sons 2018) 137.
[88] ibid.
[89] Kim (n. 82).
[90] ibid.

learning technique, computers are not instructed in the conventional way, but are capable to "ingest and process data by using sophisticated statistical techniques".[91] Therefore, actually machine learning is not related to the real meaning of understanding.[92] By contrast, it is always based on mathematical and statistical methods[93] which at the very end derive from the mind of the human inventor, and not from the AI itself.

The second soft-computing method which is usually brought as an example to demonstrate that AI can be creative is the EAs, which generate and evolve a set of solutions, defined as population,[94] applying reiterative modifications that are typical of the biological life -mutation, recombination, and selection-[95] and then reaching the best scoring solution which complies with this principle of natural evolution.[96] Now, the apparent problem here is that these EAs are part of a category called "stochastic search" algorithms,[97] and this term stochastic usually involves randomness,[98] almost hinting at the fact that these algorithms are out of the control of the human inventor, leading to an unpredictability of the results achieved by the machine. However, actually, this is not the case, since, in order to function properly, stochastic search algorithms must take into account fundamental prerequisites that will be responsible for the execution of the computation.[99] For instance, it is the human inventor who predefines the initialisation function within the EA in order to specify "the search initialisation in the form of a probability distribution over initial search positions and memory states".[100] Therefore, even in this case of soft-computing, there is always the constant intervention by a human being that dictates the instructions on which computation is then executed.[101] This leads to the idea of computational problem- solving, which is something completely different from the computational creativity, and it is the real way through which AI works (for now).

Problem- solving is generally defined as a process that through a series of actions is meant to achieve a certain goal.[102] If this concept is transposed in the computational field, problem-

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[91] T. Taulli, *Artificial Intelligence Basics: A Non-Technical Introduction* (Apress 2019) 66.
[92] Mueller, Massaron (n. 87) 127.
[93] Taulli (n. 91).
[94] H.H. Hoos and T. Stützle, *Stochastic Local Search Algorithms: An Overview* in J. Kacprzyk and W. Pedrycz (eds), *Springer Handbook of Computational Intelligence* (Springer 2015) 1087.
[95] ibid at 1097.
[96] Kim (n. 82) 452.
[97] Hoos and Stützle (n. 94) 1085, 1086.
[98] Kim (n. 82) 452.
[99] ibid.
[100] Hoos and Stützle (n. 94).
[101] Kim (n. 82) 452.
[102] K.J. Gilhooly, *Human and Machine Problem Solving. Toward a Comparative Cognitive Science* in K.J. Gilhooly (ed), *Human and Machine Problem Solving* (Springer 1989) 3.

solving is similar to the process of calculating a mathematical function, specifically transforming x values into y values.[103] To better understand the relationship between human and computer within this computational method, it is important to state its main phases, which are the following: problem formulation, abstraction and modelling, the design of an algorithm (or adjustment of a pre-existing one), programming, data manipulation, execution, interpretation and communication of the results.[104] In particular, the important phases, through which it can be clear how the human inventor is always at the centre of the process (as its creator), are, on the one hand, abstraction and modelling, that consider the moment where an object, system or process are reduced to a set of essential characteristics for a certain modelling purpose,[105] and, on the other hand, designing an algorithm and programming, i.e. a series of steps that the computer works through to produce an output,[106] originally defined by the human scientist. Now, it would be incorrect to state that problem solving would not allow humans to be inventors. By contrast, it is exactly solving a problem the most important (and certain) aspect to assess whether there has been an inventive contribution (see 1.1), and here the human inventor is the one solving the problem, not the computer. Indeed, only the first one is responsible to set and coordinate all the phases mentioned above. Instead, the AI merely executes them, and it is well-known that executing is not an aspect which leads to the identification of the inventor. Therefore, considering all of the above, it can be stated that probably there are not "AI-generated" but only "aided by AI" inventions, and in the next section it will be clarified what exactly it is meant by this term.

2.3. Not "AI-generated" but "aided by AI" inventions

The classic literature refers always to the same examples when it comes to AI-generated inventions (see 1.2), but it never explains precisely what is the computational process behind those machines that are considered inventors.[107] However, since the technical literature is finally taken into account here, it can be noticed that these machines are the products of AI sophisticated techniques such as ANNs and EAs (see 2.2), which have been applied for decades in various fields of science, and yet in this literature it is impossible to find evidence that inventions in general were generated by AI.[108] Instead, it has been always admitted that "[w]hile

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[103] P. Ferragina and F. Luccio, *Computational Thinking. First Algorithms, Then Code* (Springer 2018) 3.
[104] Kim (n. 82) 449, see table.
[105] Government Office for Science, *Computational Modelling: Technological Futures* (2018) 112, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/682579/computational-modelling-blackett-review.pdf (last visited July 14, 2021).
[106] ibid.
[107] Kim (n. 82) 445, 446.
[108] ibid.

AI is not the answer to every challenge, it is a useful tool that if used correctly can help to augment current understanding and drive new discoveries".[109] Therefore, processes to design and apply computational systems are recognised more as computer-aided problem solving, and for this reason, instead of the word "autonomy",[110] this literature refers correctly to automation, meaning that a task can be carried out by a computer without human intervention only during the performance of a function,[111] that has been dictated by the human scientist. By contrast, in order to be autonomous a computer should be self-determined and self-governed,[112] something that for now is not realistically possible. For instance, the design of systems that would be self-organising has been an important aspiration in the field of genetic programming,[113] but it was stated that this scenario is highly unrealistic in the foreseeable future.[114] It can be said that, although they are deeply different (see 1.3), in the end machine intelligence is strictly correlated with human intelligence, in the sense that as soon as humans do not understand the underlying intellectual mechanisms that could allow AI to perform tasks in a more efficient way,[115] and finally bring machines to an higher "evolutionary" level, the machines will remain automatic but not autonomous. Therefore, at least for now in order to perform their tasks they always need the contribution (it could be said: the real inventive contribution) of the human who created the machines. This is why it is more appropriate to talk about "aided by AI" and not "AI-generated" inventions.

This more appropriate definition of inventions raises the issue of the so-called black box models, which are basically functions that are too complicated to comprehend and explain.[116] In particular, since some types of AI (mostly ANNs) are defined as black box models, the relevant question that must be answered is whether perhaps these black box machines can indicate certain decision-making autonomy that would undermine the previous argument according to

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[109] M.A Sellwood and others, *Artificial Intelligence in Drug Discovery*, 10(17) Future Medicinal Chemistry 2025 (2018) 2025.
[110] See Abbott (n. 26) 1083: '[c]omputers have been *autonomously* creating inventions since the twentieth century'.
[111] S. Nof, *Automation: What It Means to Us Around the World* in S. Nof (ed), *Springer Handbook of Automation* (Springer 2009) 14.
[112] Online Etymology Dictionary, *Autonomy*, https://www.etymonline.com/word/autonomy (last visited July 14, 2021).
[113] M. O'Neill and L. Spector, '*Automatic Programming: The open issue?' Genetic Programming and Evolvable Machine* (11 September 2019) 1, https://doi.org/10.1007/s10710-019-09364-2 (last visited July 14, 2021).
[114] ibid at 2.
[115] J. McCarthy, *What is Artificial Intelligence* (Stanford University, 12 November 2007) 4, http://www-formal.stanford.edu/jmc/whatisai.pdf (last visited July 14, 2021).
[116] C. Rudin, *Stop Explaining Black Box Machine Learning Models for High Stakes Decisions and Use Interpretable Models Instead*, 1 Nature Machine Intelligence 206 (2019) 206.

which there is not autonomy but just automation in AI. Indeed, assuming that it is impossible to understand and solve a problem in a black box, the human could not be considered to be the one finding the solution and thus the inventor, but the AI could.[117] Actually, if the definition of this black box issue is carefully analysed, taking into account the technical and reliable literature, it can be noticed that this term implies computational complexity, such as the non-linearity of a model[118] or the impossibility of data-retrieval from a neural network.[119] Indeed, it has been stated that most of the AI computational problem solving systems do not retain records of links among different actions, states and goals, and thus it is not possible to give explanations of their decision-making.[120] Despite this limited understanding of how these data are represented, in the end it can be understood how ANNs are trained,[121] and hence the human being is always in control of the machine, without being bypassed by some autonomous AI that, as already stated, do not exist yet.

Considering all stated above, what is left of the unpredictability as the main feature of the computational creativity (see 2.2)? Basically nothing, since the unpredictability itself is not an indicator of the fact that AI can be considered an inventor. Indeed, problem solving does not mean that a solution should be known even before starting the process to reach it.[122] Instead, problem solving, as defined by the mathematician George Polya, relates "to search[ing] consciously for some action appropriate to attain some clearly conceived but not immediately attainable aim".[123] Therefore, the aim is not always known before engaging in the problem solving itself. Moreover, although sometimes it is difficult to detect how exactly a certain function will be represented in terms of input and output and the computer is the one that defines it, the human can make the same calculations and reach the same outcome (although it may take her years),[124] since it is the human herself who invented that problem-solving mechanism, and not the algorithm that, as sophisticated as it may be, just embodied and executed that mechanism. However, what would happen if all this argument was no longer reliable? In the next and final chapter of this work, a hypothetical AI inventorship will be addressed.

[117] Kim (n. 82) 453.
[118] G. Rebala, A. Ravi and S. Churiwala, *An Introduction to Machine Learning* (Springer 2019) 2.
[119] P. Langley, *Planning Systems and Human Problem Solving*, 7 Advances in Cognitive Systems 13 (2018) 19.
[120] ibid.
[121] Kim (n. 82) 454.
[122] ibid.
[123] G. Polya, *Mathematical Discovery* (Wiley 1992, first published in 1962) 117.
[124] Kim (n. 82) 454.

Chapter 3: What if…? Prospects for a scenario where AI can be an inventor

3.1. AI as inventor: incompatibility with the foundations of the patent system

If this chapter tries to answer the question about the suitability of the current patent system to protect hypothetical AI inventorship, first the theoretical foundations must be considered. In particular, it should be noted that patents represent significant social costs since they establish monopolies.[125] In addition, the patent system can prevent new entries by erecting barriers to subsequent research.[126] For instance, without the implementation of licensing contracts, firms that conduct upstream research can potentially sue developers who would deliberately or inadvertently work on patented information to implement that research.[127] Now, these problematic aspects effectively show that in order to accept and enforce patents the public must have a benefit after the 20-years monopoly (see 1.1). Therefore, the main justification of patents, is to guarantee an incentive for innovation, and, afterwards, the disclosure to the public of the relative results.[128] As a consequence, incentives must be designed to correctly balance between the interests of the patent holders and the benefit for the public at large.[129] On the one hand, if the monopoly conferred by the patent is too broad, the patentee would be the only one allowed to innovate, and this would chill innovation as a whole. On the other hand, if patent rights are too limited, there will not be enough incentives for inventors to bolster innovation.[130] As can be noted, despite some general and not entirely clear indications in the EPC,[131] this balance is not an easy one to assess, and is deeply influenced by the different industries, scientific areas, and inventions that are considered in each situation.[132] For instance, in the software industry there is not a strong reliance on patents as a method to prevent free-riding on inventive activity,[133] since software innovation is not only quite inexpensive, incremental, and characterised by a first

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[125] Abbott (n. 26) 1105.
[126] ibid.
[127] A.K. Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 Nw. U. L. Rev. 77 (1999) 133.
[128] K. Lybecker, *How to Promote Innovation: The Economics of Incentives* (2014), https://www.ipwatchdog.com/2014/07/21/promote-innovation-the-economics-of-incentives/id=50428/ (last visited July 27, 2021).
[129] E. Fraser, *Computers as Inventors - Legal and Policy Implications of Artificial Intelligence on Patent Law*, 13 SCRIPTed 305 (2016) 325.
[130] ibid.
[131] See e.g. Protocol on the Interpretation of Art. 69 EPC, Art 1: "[Art. 69] is to be interpreted as defining a position [...] which combines a fair protection for the patent proprietor with a reasonable degree of legal certainty for third parties".
[132] Abbott (n. 26) 1105.
[133] W. Landes & R.A. Posner, *The economic structure of intellectual property law* (2003) 312.

mover advantage, but also can be protected by other forms of intellectual property (e g copyright).[134]

When it comes to the specific field of hypothetical "AI-generated" inventions, the question that needs to be answered is whether this type of inventions is compatible with the theoretical foundation of the patent system described above. There are several reasons why this compatibility is not attainable from different perspectives. First, it can be stated that software developers would have non-economic incentives to justify the creation of computational computers.[135] For instance, they would implement creative machines to enhance their reputation, or simply to satisfy a scientific curiosity and build up collaboration with other scientists.[136] Therefore, from the perspective of creators, patents would not be needed to incentivise the development of this AI. Secondly, if patents are conferred for AI-generated inventions there could be an impairment of human innovation, since human creativity would be substituted and weakened by autonomous (not automated, for the difference see 2.3) algorithms.[137] This leads in turn to the almost complete elimination of human talent and the easier availability of the inventive process to people who are not so skilled or full of resources.[138] As the last relevant reason why AI inventions are not compatible with this justification of the patent system, although it is clear that innovation increases economic growth, if there is too much innovation, as it would happen in case of the fast development of always new "AI-generated" inventions, there would eventually be a lack of value for those inventions, since the consumers would fail to recognise real and true ground-breaking technologies.[139] As can be observed, both the patent holder and the public at large would be deeply influenced by the patentability of AI-generated inventions, not in the sense of an unbalance between the different interests at stake (something that in the end could be accepted), but because there would be an impairment of all these interests. Therefore, from both perspectives, this incentive justification of the patent system does not seem compatible with creative machines.

[134] ibid; Abbott (n. 26) 1106.
[135] Abbott (n. 26) 1106.
[136] ibid.
[137] ibid; R. Abbott, *Hal the Inventor: Big Data and Its Use by Artificial Intelligence* in C. Sugimoto, H. Ekbia and M. Mattioli (eds), *Big Data Is Not a Monolith* (Cambridge: MIT Press, 2016) 195.
[138] L. Vertinsky and T. Rice, *Thinking About Thinking Machines: Implications Of Machine Inventors For Patent Law*, 8 Boston University Journal of Science & Technology Law 574 (2002) 586.
[139] S.D. Anthony, *Innovation Gone Overboard* Harvard Business Review (2008), https://hbr.org/2008/03/innovation-gone-overboard (last visited July 28, 2021).

Even if other justifications of the patent system (or, this time, of intellectual property in a more general way) are taken into account, AI inventorship does not find a support.[140] In particular, the labour or fairness theory (see 1.1), a non-utilitarian theory thanks to which patents have been granted, and in general intellectual property has been established, can recognise the ownership to someone who has worked for several years on the creation of a particular product or process. By contrast, the same theory would never apply for AI-generated inventions, considering that the computer, which allegedly created that invention, cannot own property, and all computer work would always be the same and appropriate.[141] Similarly, the moral desert theory, which is a specification and evolvement of the fairness theory in the context of mental labour,[142] would not be compatible with AI inventorship, since a computer which is not a person does not properly deserve to be recognized as the proprietor of the fruits of its labour. Following the same line of thought, personality theory, according to which, in the context of patents, innovation is performed to satisfy a human and personal development,[143] would result in contrast with computational computers and their inventions, since machines invent due to the fact that they receive an instruction to invent, and not for some kind of human desire. Moreover, they would not be offended if their inventions undergo some alterations in the way they are made or applied.[144] Lastly, AI inventorship could be a concern under the Social Planning or Culture Theory, which states that patents, as property rights, should achieve "a just and attractive culture".[145] It must be said that also humans can create immoral technologies that would endanger cultural goals, but surely creative machines would be more inclined to do so, since they do not follow any moral principles or values. In conclusion, not only the notorious incentive justification but also other theories that have always constituted the foundation of the patent system and IP in general would not be appropriate to support computational computers and their inventions. Therefore, in the next section, it will be clear how perhaps the patent system would need a reform to accommodate the peculiarities of this type of inventorship.

[140] Abbott (n. 26) 1107.
[141] ibid.
[142] uSee H. Spencer, *The Principles of Ethics* (R. Machan ed. 1978, first published in 1893).
[143] T.G. Palmer, *Are Patents and Copyrights Morally Justified? The Philosophy of Property Rights and Ideal Objects*, 13 HARV. J.L. & PUB. POL'Y 817 (1990) 835-36.
[144] Abbott (n. 26) 1107.
[145] W. Fisher, *Theories of Intellectual Property*, in NEW ESSAYS IN THE LEGAL AND POLITICAL THEORY OF PROPERTY (Stephen Munzer ed., 2001) 172.

3.2. Rethinking the current patent system: the "tailoring" approach

It is clear that the patent reward is questionable, since most of the time it fails to maximise the benefit for society as a whole.[146] Most of the reasons why the patent system has noticeable flaws (see 3.1) are connected to the fact that patent's rights are granted in the same way and with the same length of protection for completely different inventions, without taking into account the R&D costs and other relevant economic factors.[147] Therefore, this system provides an enormous and excessive monopoly for some inventions that would not need it, meanwhile it offers less protection to some inventions that would need more.[148] This situation occurs since, under the current patent laws (in basically every country of the world), the patent authority determines only whether the patent should be granted, and not which type of legal entitlements or length of protection should be attributed to each patent.[149] Indeed, as soon as an invention is new,[150] non-obvious,[151] industrially applicable,[152] and has as its object a patentable subject matter,[153] the patent office is required to grant the patent that will protect that invention, as it would protect any other ones, resulting in a "massive over-inclusiveness problem",[154] which in turn leads firms to depend on patent protection only for a small percentage of all the R&D that they usually implement.[155] In this small percentage AI-generated inventions would not find a place, since there would not be enough incentives for their patentability (see 3.1). Hence, an appropriate reform of the patent system could introduce a "tailoring" approach of patent awards, in the sense that different inventions would require different levels and lengths of patent protection.

Before clarifying what a tailoring approach is and whether it is practical, it has to be said that a government, when implementing such a system, would try to pursue the optimal patent strength, which can be defined as "a function of both the invention's need for protection and the likelihood of a patent on that invention stifling later innovation".[156] In particular, the most important elements that must be considered when it comes to assessing a hypothetical patent protection are the R&D costs, the technological risk which is connected with that particular R&D,

[146] Yanisky-Ravid and Liu (n. 18) 2252.
[147] B.N. Roin, *The Case for Tailoring Patent Awards Based on Time-to-Market*, 61 UCLA L Rev 672 (2014) 677.
[148] ibid.
[149] ibid at 700.
[150] See EPC, Art. 54.
[151] EPC, Art. 56.
[152] EPC, Art. 57.
[153] EPC, Art. 52.
[154] Roin (n. 147) 701.
[155] E. Mansfield et al., *Imitation Costs and Patents: An Empirical Study*, 91 ECON. J. 907 (1981) 915-17.
[156] Roin (n. 147) 698.

and the availability of other means of protection that are not patent-oriented.[157] For instance, assuming that all the other factors are on an equal position, the patent protection should be higher the greater the R&D costs are.[158] In addition to patent protection, the determinants of patent's ability to stifle innovation should be taken into account in the calculation of the optimal patent strength. Indeed, if patent rights are stronger, there is a higher chance of preventing technological improvements, specifically when innovation is mainly cumulative, patent licensing is expensive, and weaker patent rights would be enough to call forth previous inventions.[159] Considering all these factors, by trying to assess the optimal patent strength in the context of AI inventorship, it may be stated that the patent strength in this sector would not be so effective. Indeed, not only, despite conspicuous R&D costs at first, would the development of AI-generated inventions eventually be easier and less expensive because of the speed that a machine would gain in implementing products or processes, but also there would be other effective means of protection apart from patents (see 3.3). Moreover, as soon as this type of AI starts to be applied, everyone would like to be part of this cutting-edge innovation, and this is clearly a cumulative effort. Therefore, strong patent rights here would not properly protect the invention and could stifle innovation, and this is exactly the reason why a tailoring approach would be beneficial.

There are two ways through which a tailor system can be implemented: either through uniform (technology-neutral) patent laws, or technology-specific rules. The main problem with both approaches is the lack of information, on the side of a state or an international organisation, about the optimal patent strength which would be required in order to enact these types of laws. Ideally uniform patent laws would establish the availability, duration and scope of protection of a patent, taking into high consideration the various economic factors that would lead to the optimal patent strength.[160] This neutral system could theoretically achieve economic policy goals without forcing the governments to make "crude-line determinations".[161] However, to legislate in this way, a government would need an observable proxy for the assessment of the optimal patent strength, something that is attainable only by having access to certain features of the inventions (R&D costs, risk of failure, anticipated revenue streams, etc…) that are usually never disclosed by the inventor/firm.[162] Therefore, it would be difficult, if not

[157] P.S. Menell, *A Method for Reforming the Patent System*, 13 MICH. TELECOMM. & TECH. L. REV. 487 (2007) 494.
[158] S. Shavell, *Foundations of Economic Analysis of Law* (2004) 146.
[159] Roin (n. 147) 699.
[160] ibid at 704.
[161] A.K. Rai, *Building a Better Innovation System: Combining Facially Neutral Patent Standards With Therapeutics Regulation*, 45 HOUS. L. REV. 1037 (2008) 1057.
[162] Roin (n. 147) 704.

impossible, for the government to implement the tailoring based on these economic determinants without having deep knowledge of them. Alternatively, there can be the enactment and application of technology-specific laws, but also in this case the state has limited information. Indeed, it does not have enough details about the social costs and benefits of a patent, and thus about (as in the case of technology-neutral laws) the economic analysis to assess the optimal patent strength.[163] In addition, this type of laws would be even more problematic to enact considering that boundaries between technologies are always changeable, as the technological and economic conditions in R&D industries.[164] All these reasons related to the impossibility of implementing a tailoring system would definitely find consistent space in the AI sector since, if AI could actually generate inventions, there would be a constant development and a dynamic R&D that would not be incentivised by patents, but just by the enthusiasm and willingness to succeed in this field (see 3.1). Therefore, the lack of information and the mutability of technology have an impact in this type of industry. Given the difficulties to reform the patent system and the absence of an optimal patent strength, the final section introduces other ways to protect AI inventorship technology.

3.3. What else…? Other ways to protect AI-generated inventions

There are three ways through which AI generated inventions can be protected, without resorting to the instrument of the patent which, as already demonstrated, cannot properly incentivise the implementation of this industrial sector. The first strategy that can be used is the one of first mover, which basically consists of a head start over the competitors and, as a consequence, an opportunity to obtain a more consistent portion of the customers.[165] If the AI technology is considered, more substantial profits are obtained, together with other important advantages that would not be achievable through the classic patent protection.[166] First of all, new technology which is developed by a first mover can allow the latter to gain and maintain leadership in the market.[167] In some industries patents offer only a weak protection (see 3.1 and 3.2), and patent race would be useless.[168] Therefore, first mover would be the real incentive to take control of the market, and this would inevitably create the race to innovation that is needed. Secondly, this strategy would lead the first mover to capture a monopoly like status, meaning that they

[163] ibid at 707.
[164] ibid.
[165] Yanisky-Ravid and Liu (n. 18) 2254.
[166] M.B. Lieberman & D.B. Montgomery, *First-Mover Advantages*, 9 STRATEGIC MGMT. J. 41 (1988) 41.
[167] ibid at 42.
[168] J.B. Taylor & A. Weerapana, *Principles of Microeconomics* (7th ed. 2012) 43-44.

would sell at a higher rate and generate higher profits.[169] It is true that monopolies are not usually beneficial for society at large, but it must not be forgotten that in the end patents also generate monopoly. The difference is that at least through the first mover approach the firm would earn more, and this means more R&D investment, which in turn means more innovation. Third, first movers would control the resources, in the sense that in some industries such as AI inventorship the spaces are limited to the first firms that decided to invest in that sector.[170] This situation can appear as bad as the monopoly, but actually in the end the firms that "earned" a place in the market have to maintain great production and output in order to keep that place and not lose it to someone else. As the fourth advantage of the first mover there is the consumer's loyalty, since, after using certain products or services that would be the first ones in the market, customers would be inclined to trust the first mover. Indeed, the familiarity with a well-known and pioneer brand is always preferred by the public than the search for alternatives.[171] Finally, there is naturally the advantage of blocking competitors in the future, meaning that first movers who control and know the market can hinder the access of subsequent firms.[172] Considering that in the AI sector the invention process can be extremely short, since, as mentioned before, creative machines would be faster to generate new products or processes, probably instead of trying to obtain a patent, the best way to protect and innovate this AI inventorship would be by encouraging the first mover strategy.

Another way to regulate AI inventorship that is not patent-oriented could be the application of digital tools against counterfeiting which would be the main problem if there was no patent law. In particular, AI systems could generate products that infringe patents responsible for protecting data AI systems themselves may find while they work on a particular invention.[173] To avoid this counterfeiting and copying, the implementation of technical tools such as firewalls could be the best solution.[174] Without entering into too much detail, the next-generation firewalls would be a perfect instrument, since they substitute the traditional network security infrastructure in order to establish a tightly integrated system that would offer more visibility and control, safe enablement, simplification, and an alignment between IT and business.[175] In this way firewalls would be more efficient than intellectual property law. An actual example is

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169 ibid at 253.
170 Yanisky-Ravid and Liu (n. 18) 2255.
171 Taylor & Weerapana (n. 168) 46-47.
172 Yanisky-Ravid and Liu (n. 18) 2255.
173 ibid at 2257.
174 ibid.
175 *Next-Generation Firewalls For Dummies®*, Palo Alto Networks Limited Edition (John Wiley & Sons, Inc. 2019) 50-51.

the website eBay, which implements digital tools to prevent infringement of intellectual property rights.[176] Therefore, considering the multiple challenges that in general the digital environment is facing, one of them, protecting data and ensuring the legitimate implementation of AI-generated inventions, can be fulfilled by digital tools.

The final method through which AI inventorship can find an alternative to patentability is strictly linked to the basic incentive which dominates the software industry (see 3.1), i.e. the recognition that the multiplayers, such as programmers, trainers, and operators, deserve for the contribution they offered in the establishment of this AI inventorship industry.[177] It is exactly this social recognition that would incentivise players in this sector to innovate more and more, even without the guarantee of a patent.[178] It is true that in a hypothetical scenario where AI-generated inventions would be possible, only the AI itself would be recognised as an inventor, since it is the one which offers the inventive contribution for that particular product or process (see 1.1). In the meanwhile, it has not to be forgotten that the human players are the only ones who can ignite the start of this industry and are the ones who need to be incentivised in order to boost that industry even more, and machines do not require any motivation to generate inventions. Therefore, even in this hypothetical situation of AI inventorship, the difference between the human and machine intelligences stands (see 1.3): it is still the first one that will allow the second one to exist. The "primal" inventor will always be the human being.

Conclusion

This work answered the question whether AI can be considered an inventor, as can humans, according to the current patent system. The answer is negative: there is no such thing as a new concept of AI inventorship for now. In particular, the inventive contribution requirement is the only patentability aspect that has been addressed since it is the only one able to indicate whether there is an inventor, and this requirement does not find a concretisation when it comes to AI intelligence and creativity. AI systems operate through a different intelligence from the human one, and this philosophical difference can be practically envisaged not only in the current case-law of the EPO through its accurate interpretation of the EPC, but also in the way machines operate in our reality. Indeed, the computational problem-solving mechanism requires human intervention, especially in the phases of abstraction/modelling, defining

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[176] *Reporting Intellectual Property Infringements (VeRO)*, Ebay, https://www.ebay.com (last visited Aug 8, 2021).
[177] Yanisky-Ravid and Liu (n. 18) 2258.
[178] ibid.

an algorithm and programming. Therefore, even the most sophisticated soft-computing methods, such as ANNs and EAs, although they work in an automated way to the point where they are defined as black-box models, cannot be considered autonomous, in the sense that they are not self-governed, and they always need the contribution of the human that created the AI itself. This is the reason why for now there are only "aided by AI" inventions and not "AI-generated" inventions, and the inventorship is attributed to the human being and her inventive contribution. However, if AI could finally operate in a way according to which they are as much inventors as are humans, and thus there were finally "AI-generated" inventions, would the current patent system still be suitable? Unfortunately, not only the very important incentive justification but also other classic IP theories (fairness, personality, and culture) would not be compatible with this AI inventorship. As a consequence, the current patent system should be reformed through the implementation of a tailoring approach, according to which patents must be granted with different levels and lengths of protection on the basis of each invention that is under review before a patent office. The problem is that, in order to apply this approach, legislators and judges should be aware of the optimal patent strength of each industry, but this information is very difficult to obtain, since economic factors, such as R&D costs, risk of failure, and level of innovation, are never disclosed by the firms. Given this impossibility to reform the patent system, there are other ways through which AI inventorship can be protected: the first mover strategy, which has a series of advantages that in turn lead to more controlled but effective innovation, the digital tools against counterfeiting, especially next-generation firewalls, and the social recognition of the multiplayers in the AI industry, something that would constitute a better incentive than patent protection. Only in this hypothetical situation, although an impulse by the "primal" inventor - the human being - is always needed, a new concept of inventorship can be discerned, not only since something different from human - AI - may be an inventor, but also because there could be a shift from the classic patentability to other systems of protection of the human and machine intelligences and creativities. This may potentially lead, in the long run, to a reconsideration of IP in general, in terms of real utility of this field of law in our life. Time (and research) will tell.

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