

A study on inventorship in inventions involving AI activity

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Executive summary

This study addresses the present as well as potential impact of artificial intelligence (AI) technology on the patent regime, in relation to the concept of inventorship. In this respect, it examines the patent regime of the EPC as administered by the EPO, while also canvassing the legal position in the following eight jurisdictions: United States, China, Japan, Republic of Korea, United Kingdom, Germany, France and Switzerland (hereinafter "the relevant jurisdictions").

The study assesses the issues below, reaching conclusions and making recommendations as follows.

(a) Inventor of an invention involving AI activity

(i) How should the inventor or inventors of an invention involving AI activity be determined?

It was clearly established that none of the relevant jurisdictions allows for AI systems to be considered as inventor under their patent law regimes. Although there are variations in the terminology and even in the actual tests employed by the relevant jurisdiction in determining who is an inventor, the objective of these is overall uniform: to identify the person that was responsible, wholly or partially, for what may be described as the intelligent and creative conception of the invention. Such notion of intelligent and creative conception refers to a contribution to the invention-making process that goes beyond the financial, administrative or mechanical on the one hand, while not being abstract on the other hand. It needs to be of a creative nature but does not necessarily have to be inventive in the non-obvious sense.

(ii) How are the rights – in particular the moral rights – of the inventor impacted by the definition of the inventor?

It has been shown that while a moral right of attribution performs important functions in relation to human inventors, it may be meaningless if applied to AI systems and is not supported by any clear rationale in this regard. Therefore, identification of AI systems as inventors in a similar fashion to attribution done in relation to human inventors does not appear to be warranted by public policy considerations.

(iii) If inventor status is not limited to natural persons, how can the inventor's substantive right to the invention (Article 60(1) EPC) and moral rights, in particular the right to be acknowledged and mentioned, be safeguarded in the patent granting process?

As regards the inventor's moral rights, as mentioned above it has been established that the broadening of the definition of inventor so as to include AI systems may be unwarranted and is likely to result in unnecessary deviation from the basic rationale underpinning the patent regime. Considering the entitlement to the invention, it was similarly concluded that it is meaningless to speak of inventor's rights in this context, when the inventor at issue is an AI system, since an entitlement enquiry refers to concepts such as ownership and employment. Neither concept can be applied successfully to AI systems under our broad legal framework, inter alia, since AI systems cannot own property nor can they be a party to employment relationship.

(iv) If inventor status is not limited to natural persons, how is this to be indicated in the designation of inventor and which function in the chain of creation of the invention is to be indicated as inventor?

Hypothesising that a change to our legal framework is to take place, within which changes to the patent regime will be introduced where AI systems will be considered as inventors, the study concludes that any indication of such inventorship may be done by reference to a legal personhood status and an accompanying system of registration that would be established for that purpose. Since the act of conception was found to be lacking in identifying AI inventors, another approach was proposed, which is based on the de facto contribution of the AI system, benchmarked against a human actor. Hence, the focus would be solely on the output of the AI system, and not on the process by which it arrived at this outcome. Should such output be considered as sufficient to imbue a human with an inventor status if it was produced by a human, it should equally be considered as sufficient to render an AI system as inventor.

(b) Ownership of an invention involving AI activity

(i) To whom does the right to a European patent belong in the case of inventions involving AI activity?

This point was addressed by its division into two sub-scenarios: (1) where AI may be considered as inventors; (2) where the present status quo is kept and only natural persons may be considered as inventors. Alternative (1) relates to a hypothetical scenario that would most likely be part of a broader overhaul of the legal system and for which any discussion on the implications for the patent regime may be premature. In such a case ownership may rest with a newly created legal status for AI systems. Considering alternative (2), this study determines that an approach that is both theoretically sound as well as practically workable should focus on the respective contributions of the various persons in the chain of creation, in relation to and in connection with the AI system(s) that played a role in the invention-making process.

(ii) How should the applicable law concerning inventorship and ownership of the invention be defined?

It has been established that the applicable law on both inventorship and ownership in all of the relevant jurisdictions appears to be the national law. However, in the case where national law calls upon certain factors to be established, such as whether an employment relationship exists or whether a valid contract is in place, such factors may be determined by reference to rules of other legal systems as the case may be, according to conflict of law rules in the given relevant jurisdiction.

(iii) How should the concept of inventor and applicant in relation to inventions involving AI activity be applied in the European patent granting process?

It has been submitted that, as mentioned above, the concept of the inventor in inventions involving AI activity should continue to carry the same meaning as it does in relation to more traditional inventions: a person who made an intelligent or creative contribution to the conception phase of an invention.

(c) Practical aspects of applications concerning inventions involving AI activity in the patent granting process under the EPC

(i) What are the legal consequences of indicating AI as inventor or co-inventor in a European patent application?

Following an analysis of the EPC framework, it was concluded that, should a patent application be filed designating an AI system as inventor, it is likely to be found deficient under Article 81 and Rule 19 EPC and, if not remedied, may be refused under Article 90 EPC.

(d) Is the current legal framework, in particular the EPC, suitable for addressing the inventorship and ownership of inventions involving AI activity?

It has been established that the current legal framework, including the EPC, is suitable for addressing the inventorship and ownership of inventions involving AI activity both at present and in the foreseeable future.

Introduction

With the science underpinning AI technology progressing in leaps and bounds in the last decade, and with AI systems becoming ever more sophisticated while involving a healthy dose of unpredictability, the impact of AI systems on various branches of the legal system is drawing an increasing amount of attention.

The concept of inventorship is key to the patent system, including the EPC. Thus, for example under the EPC, the right to a European patent belongs primarily to the inventor (Article 60(1) EPC). The inventor has both the substantive right to the invention (Article 60(1) EPC) and moral rights, in particular the right to be acknowledged and mentioned. These rights are safeguarded by Article 62 EPC (right to be mentioned), Article 81 EPC and Rule 19(1) EPC (obligatory designation of inventor, including indication of the origin of the right to the invention, if the applicant is not the inventor), Rule 19(3) EPC (communication to the inventor that he has been designated), Rule 20 EPC (publication of the mention of the inventor and a possibility of a waiver) and Rule 21 EPC (rectification of the designation of inventor).

Currently, under the EPC as well as under the vast majority of legal systems worldwide, only natural persons are considered to be inventors. However, as AI systems are becoming prominent in the invention-making processes in various areas of industry, it gives rise to the question of what is the desirable ambit of the inventorship concept. In other words, should the patent regime allow for AI systems to be considered as inventors and what may be the consequences of answering this question either affirmatively or in the negative? It is this question which is the focal point of this study.

1. Setting the scene

For a subject that is so widely researched, discussed and debated, it is somewhat surprising that no uniform definition currently exists to describe what is meant by artificial intelligence (AI). It may be defined in brief as a branch of computer science that studies the properties of intelligence by synthesising intelligence.¹ What is being referred to as AI relies on performing mathematical methods or algorithms by way of a computer implementation. These methods or algorithms are typically capable of learning from data and process data in a manner that demonstrates "intelligence".² Although advances in AI depend on progress and growth in hardware resources, they are at least as equally dependent on advancement in the field of software. Subfields of artificial intelligence include searching and planning, reasoning and knowledge representation, robotics, natural language processing and machine learning.³ It is the latter that is the most referred subfield of AI, to the extent that the two terms are sometimes used interchangeably. Machine learning (ML) may be distinguished from more traditional computer science in that "Rather than explicitly programming a computer to perform a particular task, an ML system uses a learning algorithm through which some internal state of the system is configured in response to input data. The internal state represents what the machine has "learned" from patterns in the input data, without there being any need for the algorithm to include any explicit coding based on what the input data "means", or for the programmer to explicitly define (or even to know) what patterns the machine should look for in the data."⁴ The field of AI also encompasses what was referred to by the EU Parliament as "smart robots", which possess, inter alia, the following characteristics:⁵

- the capacity to acquire autonomy through sensors and/or by exchanging data with their environment (inter-connectivity) and the analysis of this data;
- the capacity to learn through experience and interaction;
- the form of the robot's physical support;
- the capacity to adapt their behaviour and actions to the environment.

Different scholars make various claims regarding the level of autonomy and intelligence of such systems and their ability to replace humans in this respect. It is therefore first necessary to refute some myths in this context and distinguish between science and science fiction. While it is undeniable that the science and technology behind AI systems has made significant progress in the last few years, we are not yet even close to reaching the level of human intelligence by artificial

¹ P. Stone, R. Brooks, E. Brynjolfsson, R. Calo, O. Etzioni, G. Hager, J. Hirschberg, S. Kalyanakrishnan, E. Kamar, S. Kraus, K. Leyton-Brown, D. Parkes, W. Press, A. Saxenian, J. Shah, M. Tambe, and A. Teller. "Artificial Intelligence and Life in 2030." One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016 Study Panel, Stanford University, Stanford, CA, September 2016., p. 13, available at https://ai100.stanford.edu/sites/g/files/sbiybj9861/f/ai100report10032016fnl_singles.pdf

² Ibid.

³ M. MCLAUGHLIN, "Computer generated inventions" (January 7, 2018), at p.8. Available at SSRN: <https://ssrn.com/abstract=3097822> or <http://dx.doi.org/10.2139/ssrn.3097822>.

⁴ M. Summerfield, *The Impact of System Learning on Patent Law, Part 1: Can A Computer Invent* <https://blog.patentology.com.au/2018/01/the-impact-of-machine-learning-on.html>.

⁵ Recommendation to the EU Commission on Civil Law Rules on Robotics (2015/2103(INL)).

means. As to when such level is expected to be reached, a recent survey of leading industry AI experts suggests that about 90% of them hold the view that we should be able to reach such a level by 2075.⁶ Thus, the majority expert view on this matter is that it may take about half a century for the level of human intelligence to be emulated by artificial means. It therefore makes little sense for the patent regime to "gear up" at present for such speculative development. Consequently, it would be desirable to assess the suitability of the patent regime for coping with highly sophisticated AI systems, albeit not ones that may effectively render human intelligence redundant.

An AI system may be used in such a manner that a possible outcome may lead to an invention within the meaning of the patent regime. Where such invention is the subject of a patent application, it may give rise to a number of key questions relating to the capacity of the patent regime to accommodate inventions involving AI activity. In particular, where an invention resulted from a process involving AI activity, who should be identified as "inventor" and should such definition include an AI system? Should the latter be answered affirmatively, where should ownership be vested in such a case?

While this study is confined to the realms of patent law, some of the questions examined have potential implications that go far beyond that of patent law or even intellectual property law in general. Thus, identifying AI systems as inventors may not only require accepting inventorship beyond natural persons under patent law, but also recognising computers as legal persons. This would represent a far-reaching reassessment of ourselves as humans and of society's relationship with technology. It is noteworthy that while the EU Parliament appears to consider such reassessment at least as a plausible future development,⁷ the Commission itself appears to be of the view that such reassessment is currently not warranted by either technical or legal considerations⁸. In addition, the EU Parliament's call for the Commission to consider the establishment of electronic personhood status met a robust critique from EU artificial intelligence and robotics experts, industry leaders and law, medical and ethics experts, stressing that the EU Parliament position was based on a superficial understanding of both the relevant technical and legal landscapes.⁹ Finally, it should be borne in mind that, at present, most jurisdictions appear to limit the identification of an inventor in a patent application to natural persons. Such limitation is a result of either explicit legal language or an implicit legal state of affairs. Regarding the latter, most jurisdictions stipulate that inventors are the first owners of the invention unless the invention at hand was made in the course of employment. Both ownership and employment are legal concepts that require legal personhood, but are essentially meaningless in the case of an AI system, as the latter could neither own property nor be employed in the legal sense of the term. Hence, as things currently stand, most jurisdictions appear to require the identification of a human actor as the inventor. In addition, as we shall see, since the act of invention requires the deployment of human faculties, even entities with legal personality such as corporations may not be considered as inventors.

⁶ V. Müller and N. Bostrom, "Future progress in artificial intelligence: A Survey of Expert Opinion, in V. Müller" (ed.), *Fundamental Issues of Artificial Intelligence* (Synthese Library; Berlin: Springer 2016), at <https://nickbostrom.com/papers/survey.pdf>.

⁷ See EU Parliament recommendation to the EU Commission on Civil Law Rules on Robotics (2015/2103(INL) at 59(f).

⁸ In its outline of the EU future strategy, the Commission simply ignores the invitation to consider the aforementioned reassessment and does not mention "electronic personhood"; see Artificial intelligence: Commission outlines a European approach to boost investment and set ethical guidelines, at http://europa.eu/rapid/press-release_IP-18-3362_en.htm.

⁹ Point 2, *Open Letter To The European Commission Artificial Intelligence And Robotics - Artificial Intelligence and Robotics Experts* – <https://g8fip1kpjlyr33r3krz5b97d1-wpengine.netdna-ssl.com/wp-content/uploads/2018/04/RoboticsOpenLetter.pdf>.

The next part examines the capacity of the present patent regime to accommodate inventions that involve AI activity, and whether there is a need to reconsider the patent system with a view to broaden the category of inventors so as to include AI systems. In assessing the aforementioned issues, we will first examine in brief the criteria used to determine inventorship in the following jurisdictions: United States, China, Japan, Republic of Korea, United Kingdom, Germany, France and Switzerland (hereinafter "the relevant jurisdictions").

1(a) AI as inventor under current regimes

In each of the relevant jurisdictions inventorship serves as a starting point for establishing ownership. Hence, in all of the relevant jurisdictions the inventor would be the first owner of a patent, unless the invention was made in the course of employment and additional conditions were met.¹⁰ In such a case, it may be the employer who is the first owner in some of the relevant jurisdictions, while in others the employer may be the automatic transferee of the right to the patent at issue.

Hence, the default rule is that the inventor is the first owner unless an employment relationship can be established. It is submitted that both concepts – ownership and employment – are meaningless in the context of AI systems. Hence, designating an AI system as inventor may require a patent office or a court to find thereafter that the AI system is the owner of the invention in question, unless it is an employee. Since under the present general legal framework AI systems are capable neither of legally owning property, nor of being employed within the legal sense of the term, a patent application designating AI as an inventor is likely to be rejected as defective.¹¹

In light of the reasoning above, it is necessary to evaluate whether the current regimes could provide a satisfactory designation of inventors in situations where an invention involves AI activity. Namely, would identifying as an inventor a human actor that took part in an invention process involving AI activity suffice in order to meet the designation of inventor requirement under the patent law regime? In order to address this question, it is first necessary to briefly canvass the legal position regarding the concept of "inventorship" in all of the relevant jurisdictions.

1(a)(i) United States

In the United States (US), 35 U.S.C., Section 115 requires that the correct inventor(s) be named in a patent application, while Section 116 sets out guidelines for joint inventorship. No statute or legal instrument in the US defines the concept of inventorship. However, extensive interpretation of the term can be found in the jurisprudence of US courts. For example, the court in *Fiers v. Revel* explained: "The threshold question in determining inventorship is who conceived the invention.

¹⁰ It is noteworthy that in Germany, Japan, Korea and a number of Nordic countries the inventor may also be considered as the first owner in instances that involve inventions made in the course of employment; see below at 2(b)(ii).

¹¹ See a more detailed discussion on this point below, under point 2(c)(i).

Unless a person contributes to the conception of the invention, he is not an inventor [...]. Insofar as defining an inventor is concerned, reduction to practice, per se, is irrelevant.¹² One who merely proposes an idea as to a result that is to be achieved without the means for achieving the said result is not to be considered as an inventor or co-inventor.¹³ Conception of an invention in this context is not just a mere abstract idea of how to solve a problem, but the means by which such problem is to be solved, and their interaction with one another should also be realised.¹⁴

It is noteworthy in the present context that one may conceive an invention and thus be considered as inventor even while adopting "[...] ideas and materials derived from many sources¹⁵ [such as] a suggestion from an employee, or hired consultant [...] so long as he maintains intellectual domination of the work of making the invention down to the successful testing, selecting or rejecting as he goes [...] even if such suggestion [or material] proves to be the key that unlocks his problem."¹⁶

The invention for the purpose of determining who is the inventor is defined by reference to the language of the claims. An inventor or co-inventor is one who makes a contribution to at least one of the claims. Thus, according to Section 2137.01 of the Manual of Patent Examining Procedure: "the designation of authorship or inventorship does not raise a presumption of inventorship with respect to the subject matter disclosed in the article or with respect to the subject matter disclosed but not claimed in the patent [...]".¹⁷ In the same vein, the same part of the manual states that "Each joint inventor must generally contribute to the conception of the invention. A co-inventor need not make a contribution to every claim of a patent. A contribution to one claim is enough." Hence, it is clear that conception of the invention for the purpose of identifying the inventor is assessed by reference to the language of the claims and the subject-matter effectively claimed therein.

Applying the aforementioned to inventions involving AI activity, it appears that the position in the United States may be described as follows. An inventor is the person who conceives the invention. Where more than one person is involved in the conception stage, there may be joint inventors. The invention itself is defined by reference to the subject-matter actually claimed in the application. As stated at the opening passage of this section, at present only natural persons can be identified as inventors.

What would be the case where there is substantial AI activity in the process leading to the invention? Would it still be possible to identify a human actor as an inventor in a manner that is compatible with the definition of the latter under US law? It appears that the answer is affirmative. As the passage above indicates, it is about "intellectual domination" over the work leading the invention down to the successful testing, selecting or rejecting items and materials that may be produced by, inter alia, an AI system. This is the case even where such materials prove to be the key to solving the problem that the invention seeks to address.

¹² *Fiers v. Revel*, 984 F.2d 1164, 1168, 25 USPQ2d 1601, 1604-05 (Fed. Cir. 1993).

¹³ *Ex parte Smernoff*, 215 USPQ 545, 547 (Bd. App. 1982).

¹⁴ For example, see *Mergenthaler v. Scudder*, 1897 C.D. 724, 81 O.G. 1417 (D.C. Cir. 1897).

¹⁵ There is nothing to suggest that such sources or materials could not be the result of AI activity.

¹⁶ *Morse v. Porter*, 155 USPQ 280, 283 (Bd. Pat. Inter. 1965).

¹⁷ *Manual of Patent Examining Procedure (MPEP)*, Ninth Edition, Revision 08.2017, Last Revised January 2018, available at: <https://www.uspto.gov/web/offices/pac/mpep/s2137.html>

Hence, both at present as well as in the foreseeable future invention processes are likely to require "intellectual domination" by human actors, even if the "inventive" and "non-obvious" part was produced by an AI system. Therefore, it appears that the present patent law framework in the United States may continue to function effectively in relation to inventions involving AI activity. In the event that AI technology develops to such an extent that it would no longer be possible to identify human conception at all, and inventions could be produced in full without such human contribution, it may be necessary to consider tweaking the current regime.

1(a)(ii) China

According to Rule 13 of the Implementing Regulations of the Chinese Patent Law¹⁸ an "inventor" is any person who makes creative contributions to the substantive features of an invention. Hence, in order to flesh out who the inventor might be in a given scenario, it is necessary to define what "substantive features" and "creative contributions" mean in the present context.

The jurisprudence of the Chinese courts suggests that contributing to the invention by organisational activity, providing essential facilities or any other auxiliary activity does not amount to contributing towards the "substantive features" of the invention. It appears that "substantive features" in this context may have the same meaning as in the definition of "inventiveness" stipulated in Article 22(3) of the Chinese Patent Law where inventiveness is defined as follows: "Inventiveness means that, as compared with the prior art, the invention has prominent substantive features and represents a notable progress, and that the utility model has substantive features and represents progress." Namely, it is the features that render the invention "non-obvious" as compared with the prior art. For example, in one instance it was held that such substantive features may comprise substantive differences in the sense of technical differences between the invention at hand and the known achievements, similar to the meaning in the definition of "inventiveness" stipulated in Article 22, Paragraph 3 of the Chinese Patent Law¹⁹

As regards the term "creative contributions", it appears that it is not defined under the Chinese Patent Law the Implementing Regulations of the Patent Law or the Guidelines for Patent Examination. Hence, it is not expressly stipulated whether "creative" in the present context has a similar meaning to the "creative/inventive" terminology in the definition of "inventiveness" stipulated in Article 22, Paragraph 3 of the Chinese Patent Law However, some case law appears to suggest that "creative contributions" refers to innovative intellectual work carried out in relation to the aforementioned substantive features.²⁰ Indeed, since Rule 13 refers to "creative contributions"

¹⁸ Implementing Regulations of the Patent Law of the People's Republic of China, (Promulgated by Decree No. 306 of the State Council of the People's Republic of China on June 15, 2001, amended for the first time in accordance with the Decision of the State Council on Amending the Implementing Regulation of the Patent Law of the People's Republic of China on December 28, 2002, amended for the second time in accordance with the Decision of the State Council on Amending the Implementing Regulation of the Patent Law of the People's Republic of China on January 9, 2010, and effective as of February 1, 2010), see <https://www.wipo.int/edocs/lexdocs/laws/en/cn/cn078en.pdf>

¹⁹ Shanghai No. 1 Intermediate People's Court (2011) Hu-Yizhong-Minwu(zhi) -Chu-Zi No.1; a similar approach was applied in Guangzhou Intermediate People's Court (2012) Sui Zhong Fa Zhi Min Chu Zi-No.10.

²⁰ Ibid.

made to the "substantive features", and since the latter, as discussed above, has been interpreted as the features that distinguish the invention from the prior art and render it non-obvious, it is likely that creative contributions to such features comprise intellectual rather than mechanical, financial or administrative contributions to the conception of such distinguishing features. Such creative contributions to the substantive features "are generally considered as the act of proposing the original idea of the originally claimed invention."²¹ In conclusion, it is suggested that under Chinese law it is intellectual contribution to the parts of the invention that distinguish it from the prior art and therefore render it patentable, which amounts to "creative contributions" within the meaning of Rule 13 of the Implementing Regulations of the Chinese Patent Act. In this context it is the conception of the original idea that may guide the invention-making process, which may amount to the requisite contribution.

Since both "creative contributions" and "substantive features" are assessed in relation to that which renders the claimed invention patentable in comparison to the prior art, it is likely that the "invention" in the present context means the invention "as claimed", hence as defined in the claims themselves. As mentioned above, the requisite contribution to the invention-making process may comprise the act of proposing the original idea that led to and guided the invention-making process. This being so, it is unlikely that at present or indeed in the foreseeable future claimed inventions will not involve a human actor that made such intellectual contribution to that which distinguishes the invention from the prior art. While it is potentially possible that AI systems will produce material that is crucial for rendering an invention inventive, it is still likely to be the case that human contribution and human conception of the idea that underpins the invention would enable the identification of a human inventor under Chinese patent law. After all, Chinese law would grant a patent for an invention, the inventive part of which resulted from sheer luck rather than a flash of genius, due to human involvement in the process. Applying the same rationale to the AI scenario, and substituting AI output for "sheer luck", identification of a human inventor should not prove challenging.

1(a)(iii) Japan

Japanese patent law does not contain a definition of "inventorship".²² Such definition is provided for by the jurisprudence of Japanese courts. For example, in one decision of the Tokyo District Court it was held that "[...] the idea in question that has not gone through the aforementioned experiment is a mere research theme [...], and it cannot become the invention in question."²³ This served as the basis for the court's decision to reject the plaintiff's claim of inventorship. An AIPPI report elaborates on the Japanese position on inventorship in the following manner. If person A conceives the means to solving a problem, they are highly likely to be considered as the inventor. If person A only presents the problem, they may still be considered as the inventor (or co-inventor) if the problem itself is a feature of the invention. If Person B conceived the means for solving the problem even if person A gave directions to person B, person B can be considered the inventor.

²¹ AIPPI China Report on Inventorship of Multinational Applications, 07-06-2015, Part II, Section 8 at <http://aippi.org/wp-content/uploads/committees/244/GR244china.pdf>.

²² Act on the Partial Revision of the Patent Act and Other Acts (Act No. 55 of July 10, 2015); Patent Act (Act No. 121 of April 13, 1959, as amended up to Act No. 55 of July 10, 2015).

²³ Decision of 31 Jan 2006, Hanrei Jihou No. 1929 at 92, in AIPPI Japan Report on Inventorship of Multinational Applications, Section 1(a) at <https://aippi.org/wp-content/uploads/committees/244/GR244japan.pdf>.

However, if person B only confirmed that the problem is solved, they may often not be considered to be an inventor.²⁴ The following passage from a District Court of Tokyo ruling may serve to illustrate the type of activity that may or may not suffice in order to establish inventorship. Rejecting the plaintiff's claim for inventorship, the courts stated that the plaintiff "committed nothing more than general or comprehensive administrative actions, and there are no circumstances based on which the plaintiff should be considered to have given specific directions and have actually participated in the aforementioned creative act beyond said administrative action [...]."²⁵ Hence, it is clear that what is needed are acts of a creative nature bringing about the claimed invention. Mere administrative activities, even if of utmost importance, will not suffice for that purpose. The acts in question need to be of a "creative" nature, assessed on a claim-by-claim basis.²⁶

Putting the above in the context of AI systems, again it is clear that a scenario that involves an invention without a human actor being identified as an inventor is not likely to arise in the foreseeable future. Whether an AI system could meet the requirement necessary to establish co-inventorship is a different question, but applying a similar rationale to that which is discussed above in relation to China, it appears that a human actor that is making a creative contribution to the invention is likely to be identified as an inventor under the present and short- to mid-term future technological state of affairs. In such a case it is necessary to evaluate whether there is anything to be gained from broadening the definition of inventor so as to include AI systems to serve as co-inventors. As discussed below, it is submitted that such a change is not warranted.

1(a)(iv) Republic of Korea

As in the case of Japan, Korean law does not contain a definition of "inventorship".²⁷ Such definition is provided for by the jurisprudence of Korean courts. Korean case law defines an inventor as a "person who has substantially engaged in the creative process of an invention".²⁸ "Invention" in this context is understood by Korean courts as the invention as claimed in the patent application. It appears that it is sufficient for a person to have contributed to a "creative" feature of an element that is included in a claim, in order to be considered as an inventor. Hence, inventorship in this sense is established on a claim by claim basis.

As is the case in relation to the jurisdictions discussed above, it is highly unlikely that either the present or the foreseeable technological state of affairs might give rise to an invention where no human inventor could be identified under Korean patent law. A person who had a substantial involvement in the creative process of the making of the claimed invention and made a contribution to that aspect of the said process could always be identified. While it may be the case that such person may use an AI system in a manner that "but for" such use, or "but for" the output that the AI system produces, no invention would have been created, it changes little under the present analysis.

²⁴ AIPPI Japan Report on Inventorship of Multinational Applications, 07-06-2015, Part I, Section 1(b) at <https://aippi.org/wp-content/uploads/committees/244/GR244japan.pdf>.

²⁵ Tokyo District Court decision dated 27 Feb 2007, Hanrei Times No. 1270, at 367, in AIPPI Japan Report on Inventorship of Multinational Applications, Section 1(a) at <https://aippi.org/wp-content/uploads/committees/244/GR244japan.pdf>.

²⁶ Supra, at footnote 24.

²⁷ Korean Patent Act (Act No. 950 of December 31, 1961, as amended up to Act No. 14112 of March 29, 2016)

²⁸ AIPPI Republic of Korea Report on Inventorship of Multinational Applications, 18-05-2015, Part I, Section 1(a) at https://aippi.org/wp-content/uploads/committees/244/GR244rep_of_korea.pdf

Indeed, the only question that may remain open under these circumstances is whether an AI system should be designated as a joint inventor. As mentioned, it is argued below that no sound rationale exists for broadening the present definition of inventorship so as to include AI systems, whether as sole or joint inventors.

1(a)(v) United Kingdom

Section 7(3) of the UK Patent Act 1977 defines the inventor as "the actual deviser of the invention". This definition gives rise to the question of what an "invention" means in this context. Does it mean the invention as claimed in the claims? The Court of Appeal's view on this point is clear: "Does "invention" there mean what is claimed or does the context otherwise require? We think it must have some more general meaning than what is in the claims. The most obvious reason for that is that s.8 applies to situations where there are no claims at all—indeed even prior to a patent application. And applications themselves are not required to have claims. The question of entitlement can therefore arise before any claims exist—and in principle must remain the same whatever claims later emerge. Moreover, as the Deputy Judge observed, it is often the practice of patent agents to put in first drafts of claims, which are wider than they expect to end up with so as to draw a wide search. As for the final claims in the patent as granted, their form and content will depend upon a number of individual factors—what has turned up in the prior art forcing reduction in scope, what subsidiary claims the patent agent has formulated based on the description and what monopoly is actually thought to be valuable (there is no point in claiming wider). Accordingly we think one is driven to the conclusion that s.8 is referring essentially to information in the specification rather than the form of the claims. It would be handy if one could go by the claims, but one cannot. S.8 calls for identification of information and their rights in it. Who contributed what and what rights if any they had in it lies at the heart of the inquiry, not what monopolies were actually claimed."²⁹

Thus, it appears that a claim-by-claim approach was rejected, and the rationale for a more liberal reading of the term "invention", so as to refer to the information as provided for in the specification, was preferred. This is often referred to as the information disclosed in the "heart of the invention", or its "inventive concept". Thus, in an earlier decision the Court of Appeal held that it is the inventive concept that needs to be identified,³⁰ and this has been followed and further developed in later cases. If this is so, it remains to be seen what is meant by a "deviser" of the inventive concept in this context. It was the House of Lords in a subsequent case that clarified that it was not enough that someone may have contributed to the claims, as this contribution may have related to "non-patentable integers derived from prior art".³¹ Hence, a deviser of an invention appears to mean someone who made a contribution to the inventive concept of the invention, the latter not necessarily restricted to the invention as claimed in the claims but rather the invention as described more broadly in the specification. It appears that such contribution must be to an aspect of the invention that is not disclosed in the prior art and possibly renders the invention patentable.

²⁹ *Markem Corporation v Zipher Ltd* [2005] EWCA (Civ) 267, [2005] R.P.C. 31, at para 100-101.

³⁰ *Henry Brothers (Magherafelt) Ltd v Ministry of Defence*, 1999, R.P.C. 442.

³¹ *Yeda Research and Development Co Ltd v Rhône-Poulenc Rorer International Holdings Inc* (HL) [2007] UKHL 43, [2008] R.P.C. 1, at para 20.

It is noteworthy that the devisers of the invention are those that made a contribution that goes beyond the merely financial, abstract or administrative. It appears to be a contribution of an intellectual nature that goes beyond the provision of a mere abstract idea. Sometimes it may be the person who had the original idea, with the actual embodiment of the idea being merely routine. Under such circumstances, the person having the original idea may be considered as the sole inventor, while the person responsible for the actual embodiment may not be considered as a joint inventor. Alternatively, there are instances where reducing the idea to practice is anything but a routine activity and it is not in fact clear whether reduction to practice is feasible. In such circumstances, the person responsible for reduction to practice may also be considered as an inventor.³²

In light of the above, it appears that "devising" an invention must relate to a human actor, since at present as well as in the foreseeable future it is not likely that an AI system will "devise" the inventive concept of an invention. Again, AI activity may be instrumental if not decisive to the patentability of an invention and the success of the latter in solving a technical problem, but nevertheless it is suggested that AI is not likely to be considered as a deviser of the invention, but rather as a crucial tool in arriving at the invention, albeit a sophisticated one with an element of unpredictability. It is submitted that devising, like conception, requires a thought process that is absent in the case of AI systems. The person contributing to the inventive concept of the invention as discussed above, while deploying the AI system in order to do so, may be the sole inventor.

1(a)(vi) Germany

Although Sections 6 – 8, 37 and 63 of the German Patent Law refer to the concept of "inventorship", they do not provide a clear definition for it or give any precise indication of the kind of activity that qualifies as an "invention".³³ In order to be considered as inventor, a person must meet two conditions, as set out by German case law: (1) they must make a contribution that is substantial to the problem that is to be solved by the invention; such contribution must be creative but not necessarily inventive;³⁴ and (2) the said contribution must be "intellectual", in that it must originate from said person rather than being a result of direction by others. This effectively means that there must be a contribution to the teaching of the patent that is significant to the overall success of the invention. This contribution must be creative, although not necessarily inventive. Hence, the provision of tools or facilities although crucial to the invention-making process is not likely to be considered as creative. In other words, an input towards one of the features of the invention, which originates from the alleged inventor (autonomous) and is creative in the sense of resulting from an intellectual effort, may suffice. What is or is not creative is determined on a case-by-case basis. The invention in this context does not necessarily mean the language of the claims, but a somewhat broader concept that could draw from the description or dependent claims.

³² Judge C. Birss. T Austem, S. Baran, et al, *Terrell on the Law of Patents*, Sweet & Maxwell, 18th Ed, at 4-14.

³³ See AIPPI Report on Inventorship of Multinational Applications – Germany (10-05-2015), at <https://aippi.org/wp-content/uploads/committees/244/GR244germany.pdf>.

³⁴ See *BGH decision X ZR 103/11 of 18 June 2013*, at 8.

In light of the above, it appears that the present technological state of affairs as well as foreseeable developments in the field of AI do not anticipate inventions that involve AI activity where no human actor may be identified as an inventor. Under German patent law what is required is for a human actor to make a substantial contribution to the solution of the problem being solved by the invention (which is not necessarily limited to the language of the claims), which is not administrative or financial but does not have to be inventive. For reasons discussed above in relation to other relevant jurisdictions, such human contribution is highly likely to be identified at present as well as in the short- to mid-term future notwithstanding the involvement of AI activity in the invention-making process.

1(a)(vii) France

Although the French Intellectual Property code refers to "*l'inventeur*" (the inventor) on numerous occasions, it does not provide a definition of inventorship.³⁵ Such definition may be discerned from French case law. For example, the Paris Court of Appeal held that in order to be considered as inventor, a natural person must actively participate in making the invention.³⁶ French case law and legal commentary indicate that an inventor is a person who played an active role in the formalisation, technical development and finalisation of the invention.³⁷ Furthermore, such person must establish their contribution to the inventive step of the patented product or process. It is noteworthy that this should be distinguished from the patentability criterion of inventive step. Hence, the courts will examine the person's contribution to the conception of the invention and to its reduction to practice, and determine whether such contribution goes beyond mere execution.³⁸ Where this is the case, such person may be considered as an inventor. On the other hand, contributions such as management and co-ordination of research works, or even the setting out of the results to be achieved, will not usually suffice for establishing inventorship.

French case law indicates that the invention is to be understood by reference to the claims,³⁹ the inventive concepts described in the patent, or the drawings and diagrams where relevant.⁴⁰ Hence, it is not entirely clear whether or not the enquiry is limited to the claims. In light of the above, it is suggested that it may not be so limited.

Drawing on the discussion above, it is highly unlikely that an invention involving AI activity will not involve a human actor that meets the criteria of inventorship under French law. We have seen that under French law an inventor is a person who is actively involved in the conception of the invention, whose involvement in these stages could be described as intellectual or creative and goes beyond mere execution. As will be discussed below in more detail and in relation to all of the relevant jurisdictions, it is submitted that, by definition, every invention has a conception phase and that conception is at present, as well as in the foreseeable future, limited to human faculties,

³⁵ Article L611–6 of the Intellectual Property Code (IPC).

³⁶ *Mr Stanislas v Pol Scarpe Sportive and Nottingham Holding B.V.*, Cour d'appel de Paris, 18 June 2004.

³⁷ See AIPPI Report on Inventorship of Multinational Applications – France (29-05-2015), Part I, Section 1(a) at <https://aippi.org/wp-content/uploads/committees/244/GR244france.pdf>.

³⁸ *Thibierge v Arjo Wiggins Co.*, Tribunal de grande instance de Paris, 16 October 2001.

³⁹ *Musthane v Eaux du Nord SA*, Tribunal de grande instance de Paris, 29 March 2012.

⁴⁰ An AIPPI report indicates that there is no uniform view on this point under French jurisprudence; see *Supra* at footnote 37.

notwithstanding the involvement of a sophisticated AI system featuring an unpredictability element. This being so, it follows that every invention may have been conceived by at least one human actor; it is this actor who is likely to be the inventor under French law.

1(a)(viii) Switzerland

While Swiss patent legislation does not provide an explicit definition of "inventorship",⁴¹ Swiss case law states that what is necessary is a conception of the idea at such a level that it may be reduced to practice by a skilled person.⁴²

It appears that the concept of "invention" in the present context is not merely limited to the language of the claims, but may encompass a broader space that may include other aspects of the patent application.⁴³

Similar to the position in France and other relevant jurisdictions, as the focus in Switzerland is on the person involved in the conception of the idea that underpins a given patent, and since conception is at present as well as in the foreseeable future a strictly human function, a human actor may be identified as an inventor under Swiss law, irrespective of any AI activity involved in the invention-making process. The requirement of conception makes it highly unlikely that at any point in the foreseeable future an AI system could meet the requirements of inventorship, while it is very likely that humans will continue to do so notwithstanding the involvement of AI systems.

1(b) Summary: inventorship rules in the relevant jurisdictions

Creative or intelligent conception of the invention, or contribution thereto, is a feature that runs either explicitly or implicitly throughout the definition of inventorship in all of the relevant jurisdictions.⁴⁴ While some jurisdictions require such conception to be made in relation to the actual language of the claims, others define "invention" in a broader sense as to include additional material in the patent application. Nevertheless, we have seen that whether or not one defines "invention" in a broad sense, the nature of the actual contribution to the conception phase of the said invention should be creative or "intelligent" in its essence. Namely, in all of the relevant jurisdictions what is needed is engagement in the conception phase that goes beyond the provision of abstract ideas on the one hand, and mere execution of those provided by others on the other hand, while at the same time having such engagement made on an intelligent and creative level rather than financial, material or mere administrative level.

⁴¹ Federal Act of June 25, 1954 on Patents for Inventions.

⁴² See AIPPI Report on Inventorship of Multinational Applications – Switzerland (18-05-2015), Part I, Section 1(a), at <https://aippi.org/wp-content/uploads/committees/244/GR244switzerland.pdf>.

⁴³ Ibid, describing the concept of invention under Swiss jurisprudence at Section 1(b).

⁴⁴ Under certain circumstances reduction to practice may also suffice to constitute inventorship in certain jurisdictions (e.g. France).

It is noteworthy that although the EPO does not decide on issues pertaining to inventorship, it has been using a similar rationale to the above in distinguishing between technical and non-technical considerations for the purpose of inventive step assessment. Thus, decisions of the EPO boards of appeal make it clear that a similar analytical approach is being used by the boards when applying *Comvik*⁴⁵ and distinguishing between technical and non-technical considerations, which may or may not contribute to inventive step.⁴⁶ Hence, it is clear that a business person may only instruct a programmer on the objective to be achieved but not on the technical considerations that may or should be taken into account when attempting to realise such objective. Therefore, instructions by such business person or financial administrator may not be considered as contributing to the solution of the technical problem that the invention addresses, regardless of whether or not they are in fact obvious. It is suggested that this analytical approach is similar in principle to the rationale that is applied in the case of inventorship. A person that gives abstract, business or administrative instructions or directions is not contributing to the intelligent or creative conception of the invention within the meaning of the latter under patent law, no matter how crucial such directions are to the invention at hand.

When assessing the nature of contribution to the conception stage it must be borne in mind that the fact that the real inventive "spark", the decisive element that makes an invention work and differentiates it from that which has gone before, must not necessarily originate from the inventive effort of the inventor. All of the relevant jurisdictions grant patents for inventions where such element(s), inter alia, resulted from sheer luck as opposed to traditional inventive activity. The same rationale should apply to inventions involving AI activity, where the aforementioned decisive element results from AI activity rather than human genius.

As discussed above, the legal position in all of the relevant jurisdictions makes it possible for human actors to be considered as inventors, irrespective of any involvement of AI activity in the invention process. We have also seen that at present it would be impossible for AI systems to be considered as inventors under inventorship rules in all of the relevant jurisdictions, inter alia, due to the link between inventorship and ownership, which sometime requires the establishment of an employment relationship. Since both ownership and employment are legal concepts that are at present meaningless in the context of AI systems, inventorship is limited to human actors. In addition, it should be noted that all of the relevant jurisdictions provide, either explicitly or implicitly, that an inventor may make a contribution to the invention's conception. The Oxford English Dictionary defines conception, inter alia, as forming or devising an idea or plan in the mind.⁴⁷ Hence, it is not the result or outcome itself that matters (e.g. the resulting idea or a plan), but the actual process that takes place in a human's mind leading to the said outcome. In the same vein, a corporation cannot conceive anything itself, notwithstanding its legal personality, but rather the people that work for it. It is therefore submitted that in order to be considered as an inventor under the present definition one must be able to employ human faculties rather than merely produce a certain output.

⁴⁵ T 641/00 (OJ EPO 2003, 352).

⁴⁶ For example, see board of appeal decisions such as T 1658/15, T 1954/08 and T 1025/08.

⁴⁷ See Oxford English Dictionary, at (2), <https://en.oxforddictionaries.com/definition/conceive>.

After establishing that under the present legal position AI systems could not be considered as inventors, one may query whether this position should be reconsidered and whether in light of the great advancements in technology and science underpinning the field of AI it is high time for AI systems to be recognised as inventors under the patent regime.

In order to address this query, it is necessary to unpack the reasons for which the patent regime deems it important to identify the inventors responsible for inventions in relation to every patent application. Is it merely in order to serve as a starting point for an entitlement enquiry, or does it serve interests more akin to moral rights under copyright law? Once the rationale behind the requirement to identify the inventor is uncovered, it may be applied to scenarios involving AI activity with a view to assessing whether such rationale still holds in the case of non-human actors or AI systems.

2. Inventors of inventions involving AI activity

2(a) Inventorship

2(a)(i) How should the inventor of an invention involving AI activity be determined?

It is trite law that irrespective of the jurisdiction in question, an invention may be the result of long, laborious effort, a brief but intense spark of genius or the sheer luck of stumbling upon the heart of the invention or inventive concept by pure chance. Hence, even when it is a result of the latter, such an invention still has an inventor, and may be considered patentable. Thus, it is not necessary for the invention to result from a particular type of inventive effort of the inventor. The inventor could therefore be defined, *inter alia*, as the person who recognises the importance and utility of the invention, whichever way it came about. Whether encountering the inventive concept of the invention by pure luck and realising its utility and significance or whether by doing so after examining the output of an AI system, the relevant person may be considered as the inventor and their involvement may be described as intellectual or creative conception.⁴⁸ It is submitted that the fact that the key to the invention was the output produced by an AI system should not make a difference to the analysis above. Obviously, such a scenario may give rise to questions pertaining to inventive step, such as whether a person skilled in the art would have sought the assistance of an AI system under such circumstances and whether having access to its output the usefulness and significance of such output would have been obvious to the skilled person. If the answer to such questions is affirmative, the invention may not be considered as involving an inventive step. However, the question of obviousness is distinct from the enquiry as to the identity of the inventor under such circumstances.

⁴⁸ See detailed analysis of this concept above, under 1(b), and the analysis by M. Summerfield, *The Impact of System Learning on Patent Law, Part 2: System-Assisted Inventing* https://blog.patentology.com.au/2018/01/the-impact-of-system-learning-on_21.html.

Another related question in this context is whether it makes sense to consider a human actor, whose identity may be inconsequential to the invention process, who may simply use a machine learning technique developed by another, as an inventor? It is submitted that under such circumstances, the inventor may be the person who geared up the AI system towards producing the inventive output, including features such as the choice of the algorithm employed, selection of parameters and design and choice of input data.

Some scholars may hold the view that a computer scientist who designs a machine learning system should not be considered as the inventor in relation to such system's output and that it should rather be the system itself. Such view has been justified in the past by reference to a computer scientist who creates an AI system aimed at autonomously developing useful information. When such AI system generates a patentable outcome not envisaged by the computer scientist, there is little justification for considering the computer scientist as an inventor over the outcome generated by the AI system.⁴⁹ The main issue with the above argument is that such machine learning systems do not appear to exist at present, nor are they likely to exist in the short- to mid-term future.⁵⁰ Rather, AI systems perform in areas envisaged by their designers, even if the actual output is unexpected within the meaning of the patent law regime. It follows that where a designer of a system designed it and equipped it in manner suitable to provide solutions to a certain class of problems, such a designer may be considered as (co-)inventor, while the actual user of the system does nothing more than put the system into use, in a manner in which it was intended to be used, and as a result gains access to a solution produced by such a system⁵¹. However, while analysing the rules on inventorship in the relevant jurisdictions, we have seen that conception of the actual invention is required in order for a person to be considered as inventor. Can it therefore be said that a person designing a machine learning system with the invention's goal in mind conceived the claimed invention or at least had a part in its conception? Where this is the case and the person designed the system at issue with a view to providing a solution to a certain problem, such person may be considered to be an inventor under the present inventorship rules in all of the relevant jurisdictions.

2(a)(ii) How are the rights – in particular the moral rights – of the inventor impacted by the definition of the inventor?

We have seen above that both patent law legislation and judicial attitudes restrict the classification of inventorship to human actors in all of the relevant jurisdictions. It is necessary to examine, however, if there is any merit in revisiting such restriction with a view of opening up the inventorship definition to AI systems. Any such change in the definition of the inventor, if one is indeed warranted, may have an impact both on the right of ownership and the moral right of

⁴⁹ See R. Abbott, I Think, Therefore I Invent: Creative Computers and the Future of Patent Law, 57 B.C.L Rev., 1079-1126 (2016), at 1095.

⁵⁰ See for example Mark Summerfield's convincing analysis on this point, supra at footnote 48. Dr Summerfield has both patent law background as well as background in electrical engineering and is the author of Patentology, a blog providing news and opinion on patents, technology and innovation.

⁵¹ It is questionable whether the resulting invention would meet the inventive step requirement under such circumstances. Where it does, it follows that putting the AI system to use, as intended, may not have been obvious. Where that is the case, the user of the system may be considered as the inventor.

attribution. While entitlement is discussed below under Part 2(b), the remainder of the discussion under the present heading relates to the attribution right as distinct from any entitlement enquiry.

The impact that the attribution right has on inventors and the rationale behind it, both in the patent application and the grant documentation, has been examined thoroughly by numerous scholars⁵². For example, Jeanne C. Fromer discusses in detail the role of what she terms as "expressive" incentives in patent law.⁵³ The attribution right under patent law serves successfully two main objectives, both related to personhood interests.⁵⁴ First, the attribution right makes it easy to inform the public about the inventor's involvement in the invention-making process, enabling the public to give them kudos. Such strong reputational recognition may result in a financial reward to the inventor, as it may increase their professional and employment opportunities and as a result in higher financial rewards. Hence, attribution right in this context may provide a pecuniary incentive to invent. Yet attribution may also serve as a purely expressive incentive rather than a pecuniary one, "[B]y bolstering a creator's reputation, attribution expresses the creator's central value to his or her work."⁵⁵ Thus, attribution rewards the inventor with a reputational gain, which is highly important to an inventor in relation to their invention. Such gain is wholly distinct from any pecuniary interest. In addition, it establishes a link between an inventor and their invention, and in doing so "it concretizes the personhood interest creators have in viewing their creations as strong components of their self-concept".⁵⁶ It appears that modern corporate practices do not diminish the inventor's perception as to a link between themselves and the invention, but may actually bolster it. Since in many cases entitlement to the invention will eventually not be vested in the inventor due to the operation of employment laws, contractual arrangements, etc, the attribution right nevertheless retains this link. Thus, it appears that the attribution right in the case of patent law serves two desirable objectives, both positively impacting the inventor's incentives to innovate and invent.

In light of the above, it is indeed not surprising that as evidenced by the "travaux préparatoires" for the EPC 1973, the strongest support for the right of attribution of inventors under the EPC came from the International Federation of Inventors' Associations (IFIA). Similarly, evidence collated for the European Patent Value Project clearly indicates that pecuniary rewards as well as other rewards created by employers such as career advances or other benefits are considered less important than "personal" rewards such as satisfaction or reputation and prestige.⁵⁷ The latter two emerged as very important for a large proportion of inventors.

None of the aforementioned objectives holds in the case of AI systems. An AI system is not out there to better itself financially; neither does it have a personal link with the invention in the making of which it was involved. This being so, is there any other justification for broadening the scope of the attribution right under patent law so as to encompass AI systems?

⁵² See, for example, H. Sauermann & W. M. Cohen, *What Makes Them Tick? Employee Motives and Firm Innovation*, 56 *Mgmt. Sci.* 2134, 2134 (2010); J. P. Walsh & S. Nagaoka, *Who Invents?: Evidence from the Japan-U.S. Inventor Survey 22* (Research Inst. of Econ., Trade & Indus., Working Paper No. 09-E-034, 2009), J. C. Fromer, *Expressive Incentives In Intellectual Property*, *Virginia Law Review*, Vol. 98, No. 8 (December 2012), pp. 1745-1824, F. Lissoni, F. Montobbio, L. Zirulia, *Inventorship and authorship as attribution rights: An enquiry into the economics of scientific credit*, *Journal of Economic Behavior & Organization*, Volume 95, November 2013, Pages 49-69.

⁵³ J. C. Fromer, *Expressive Incentives In Intellectual Property*, *Virginia Law Review*, Vol. 98, No. 8 (December 2012), pp. 1745-1824.

⁵⁴ *Id.*, at 1790.

⁵⁵ *Id.*

⁵⁶ *Id.*

⁵⁷ A. Gambardella, P. Giuri, M. Mariani, et al., *The Value Of European Patents – A Survey Of European Inventors – Final Report Of The PatVal EU Project*, at http://ec.europa.eu/invest-in-research/pdf/download_en/patval_mainreportandannexes.pdf, at 35.

While proponents of broadening the concept of inventorship in order to include AI systems acknowledge that reputational incentives are irrelevant in the context of AI systems, they nevertheless maintain that recognising AI systems as inventors would incentivise the development of such systems, which is consistent with the objective behind the intellectual property clause of the US Constitution.⁵⁸

The author of this study does not find this argument convincing in the present context for the following reasons. First, we have seen that even without recognition of computers as inventors, patents for inventions with substantial AI involvement are still likely to be granted as long as human inventors can be identified, which is the case in the present and likely to be so in the foreseeable future. It is true that once an AI system is deployed, the claimed invention might not be patentable where the availability of such AI system may render it obvious to the person skilled in the art, but this is not necessarily an objectionable outcome. Inventions involving AI activity that are not obvious to the person skilled in the art should continue to be patentable. This study also maintains that concerns for adequate levels of incentives for developing AI systems are at present not supported by empirical data or a credible economic model. It is thus unclear why the prospect of a patent over the AI system itself, trade secrets law, contractual arrangements and more are inadequate in supporting investment in developing AI systems that may be used in invention-making processes. Finally, attributing inventions to an AI system that assisted in its creation in order to support investment in the development of such AI system is an argument that could be used in relation to other crucial means that are used in the invention process. For example, why not require the mentioning of a newly created, highly innovative microscope that, without which, the invention would not have been made?⁵⁹

2(a)(iii) If inventor status is not limited to natural persons, how can the inventor's moral and substantive rights be safeguarded in the patent granting process?

The inventor's rights encompass the right pertaining to entitlement and the right of attribution. Entitlement and ownership are discussed under Part 2(b)(i) below.

As regards the right of attribution, it is currently safeguarded by the right to be mentioned, the obligatory designation of inventor, the need to establish a causal link between the inventor and the applicant, and the process for rectification of the designation of inventor. As argued throughout this study, it is submitted that the broadening of the definition of inventor so as to include AI systems is not required and is likely to result in unnecessary deviation from the basic rationale underpinning the patent regime.

However, if such definition will be broadened as to include AI systems, a number of consequences are likely to follow. First, as we have seen, such revised inventor's definition will be meaningless in relation to the right of attribution of AI systems and hence it is submitted that the inventor's interest need not be "safeguarded" in this context.

⁵⁸ For example, supra footnote 49, at 1104.

⁵⁹ While having the said microscope at hand, as long as it is not part of the state of the art, means that what would otherwise amount to routine activity would nevertheless lead to a patentable invention.

When considering the rights safeguarded under Article 60 EPC, and in particular Article 60(1), for reasons discussed above, it is similarly submitted that it is meaningless to speak of inventor's rights in this context, when the inventor at issue is an AI system. Article 60(1) EPC is concerned with safeguarding the proprietary interest of the inventor, with the exception of inventions made in the course of employment, in which case the right to the patent will be determined in accordance with the relevant national law. As mentioned above, both ownership and employment are legal concepts that are meaningless when applied to AI systems under our broader legal framework. Hence, identifying AI systems as inventors would put the successful application of Article 60(1) EPC into question. This is so since legally it may not only require accepting inventorship beyond natural persons, but also recognising computers as legal persons. This would represent a radical reassessment of the manner in which we humans see ourselves, our position in society and society's relationship with technology. The author of this study is inclined to side with the view expressed in the AI Experts' Open Letter to the EU Commission on AI Robotics,⁶⁰ according to which the need to establish legal personhood for AI systems is unwarranted and stems from a superficial understanding of the technological and legal landscape in which AI systems operate. However, the latter view goes beyond the patent law focus of this study and deserves a detailed legal, sociological and philosophical discussion of its own. Unless and until the aforementioned reassessment takes place, there can be no AI inventor "interest" to safeguard, since AI does not have legal personhood status and is incapable of owning property and benefitting from "rights". The same reasoning applies to the proviso of Article 60(1) EPC that deals with employment situations. Hence, under the present legal framework AI systems cannot be employed within the legal sense of the term and no employment relationship may exist between a natural or legal person and an AI system for the same reasons discussed above. In the same vein, the inventor's interests and rights safeguarded by the need to establish a causal link, the communication to the inventor that he has been designated and the process for correcting a faulty or incomplete designation of inventor cannot be served and, in fact, do not exist in the case of AI inventors. As long as AI systems have no legal personhood status, they may not "own" rights; being incapable of owning rights means one cannot have any interests in safeguarding, guaranteeing or preserving such rights. As mentioned, the question of whether or not creating an electronic personhood status for AI systems is warranted calls upon considerations that go well beyond the remit of the patent law regime and merits a wider discussion that goes beyond the scope of this study.

It is noteworthy that beside the aforementioned recommendations of the EU Parliament, where the possibility of establishing electronic personhood status is contemplated, there are a number of other initiatives that may be considered in this context, including the extent to which, if at all, they impact the analysis above:⁶¹(1) an AI "boy" granted official residency in Tokyo, Japan,⁶²

⁶⁰ Supra, at footnote 9.

⁶¹ It is beyond doubt that with the advent of AI technology, we are likely to witness more initiatives taken at national level in relation to the legal status of AI systems. It is yet to be seen if any such initiative comes to fruition and, if so, what the nature of the legal arrangements concerned will be.

⁶² *Tokyo: Artificial Intelligence 'Boy' Shibuya Mirai Becomes World's First Ai Bot To Be Granted Residency*, at <https://www.newsweek.com/tokyo-residency-artificial-intelligence-boy-shibuya-mirai-702382>.

(2) Sophia, the first robot to be granted citizenship,⁶³ and (3) Estonia's initiative concerning legal personhood for AI systems.⁶⁴

It is suggested that initiatives (1) and (2) appear to be little more than public relation exercises, calculated to bring attention to the activities of the granting body in a particular context. Thus, Shibuya Mirai,⁶⁵ a chatbot programmed to be a seven-year-old boy, was granted residency by Shibuya, a Tokyo ward, in June 2017. It appears that the decision to grant official residency to a chatbot was "part of a project aimed at making the local government more familiar and accessible to locals. The chatty seven-year-old is designed to listen to the opinions of Shibuya residents."⁶⁶ In the present context, it does not appear that Shibuya Mirai enjoys a legal status that enables him to have both rights and obligations in a similar fashion to humans or corporations. The same probably applies to Sophia, a female-looking robot, who became a full citizen of the Kingdom of Saudi Arabia on 25 October 2017. Saudi Arabia's decision to grant citizenship to Sophia followed an announcement relating to the Kingdom's commitment of US\$500 billion to build a futuristic new city powered by robotics and renewable energy.⁶⁷ What Saudi Arabia did not do, however, was to elaborate on what it means for Sophia to be a citizen and what rights she holds, if any. The Kingdom also did not elaborate on whether it intends to create a distinct legal status for AI systems or smart robots such as Sophia.

In contrast, Estonia's legislative initiative appears to be a different thing altogether, as it is a genuine attempt to address a number of thorny issues concerning autonomous systems. As this initiative is still at the drawing board phase, at present it is impossible to know with certainty which path the Estonian government will chose to adopt when it comes to legal status for AI systems. It appears that one alternative under consideration relates to "robot-agent", which would be somewhere between having a separate legal personality and an object that is someone else's property, but little else is currently known.⁶⁸ Hence, details in relation to such an option, or any other arrangement that is currently in contemplation, are not available. It may be useful, however, to consider Estonia's main motivation for its initiative. Although private driverless cars are not yet permitted, driverless parcel-delivery robots have been authorised to operate on the streets of Tallinn, Estonia's capital, since June 2017, and a driverless bus authorised to operate on a small route in the centre of the city. As mentioned, although at present various approaches are being considered regarding the legal status of AI systems, it appears that the main concern is that of liability in cases of accidents or malfunctions.⁶⁹ Hence, the adviser for digital innovation at the strategy unit of the Government Office of Estonia has stated in this context: "The main aim of this regulation is to define liability for Artificial Intelligence [malfunctions] in an user-friendly way, so that

⁶³ *Everything You Need To Know About Sophia, The World's First Robot Citizen* at <https://www.forbes.com/sites/zarastone/2017/11/07/everything-you-need-to-know-about-sophia-the-worlds-first-robot-citizen/#e0edf8046fa1>.

⁶⁴ *Estonia Plans To Give Robots Legal Recognition*, *The Independent* (10-10-2017), at <https://www.independent.co.uk/news/business/news/estonia-robots-artificial-intelligence-ai-legal-recognition-law-disputes-government-plan-a7992071.html>;

From AI To Russia, Here's How Estonia's President Is Planning For The Future, *WIRED* (04-05-2018) <https://www.wired.com/story/from-ai-to-russia-heres-how-estonias-president-is-planning-for-the-future/>.

⁶⁵ "Miri" means "future" in Japanese.

⁶⁶ *Supra*, at footnote 62.

⁶⁷ *An AI Professor Explains: Three Concerns About Granting Citizenship To Robot Sophia*, *The Conversation* (30-10-2017) at <https://theconversation.com/an-ai-professor-explains-three-concerns-about-granting-citizenship-to-robot-sophia-86479>.

⁶⁸ *Supra* at footnote 65.

⁶⁹ <https://e-estonia.com/artificial-intelligence-is-the-next-step-for-e-governance-state-adviser-reveals/>.

citizens on the street would actually understand in case of incident, or some other kind of accident for example, who exactly is liable in every particular case."⁷⁰ This being so, it is not clear whether any legislation passed by the Estonian government will go as far as enable AI systems to enjoy the full scale of rights and obligations as is the case with corporations, not to mention natural persons.⁷¹ It is noteworthy in this context that the law firm that prepared the legal report for the Estonian ministry on this issue was of the view that, at present, granting a legal status to AI systems which encompasses legal rights and responsibilities "goes against Europe's humanist history of law".⁷²

The aforementioned initiatives are not likely to alter the conclusion that, at present, the application of the EPC rules on attribution and entitlement in relation to AI inventors is at best problematic and at worst meaningless. As regards the right of attribution, as we have seen that, even if each of the above initiatives culminates in fully-fledged legal personhood, there is still no credible justification to grant such "person" a right of attribution, as it would not appear to serve any desirable purpose. Considering the EPC rules on entitlement, it should be first borne in mind that the above-mentioned initiatives (1) and (2) appear to be little more than public relation focused initiatives, where the scope of any rights granted to the AI in question, if any rights are to be granted at all, is opaque. In the unlikely event that Sophia's citizenship under Saudi law will turn out to mean that she enjoys the full scale of rights and obligations as humans do, and should the relevant changes be made to the EPC so that inventor status will encompass AI, both ownership and employment relationship could in theory become feasible. It is noteworthy that identification of AI and having internationally recognised registration systems for such AI are only some of the hurdles that will have to be cleared before such scenario could become realistic. Until then, an AI system that owns property and may either be an employee or employer will remain within the realms of science fiction.

Estonian legislative initiatives aimed at changing the legal status of AI systems are also quite opaque at present. We only know that the government is set on examining the paths for making changes in this area and that they are evaluating different alternatives in this context. It is less clear at present what the exact nature of these alternatives is and whether they will go further than addressing the most pressing need in this field, as seen by the Estonian government: legal liability in relation to autonomous systems. Similar to the hypothetical scenario discussed above in relation to Sophia, where the definition of inventorship encompasses AI, should Estonian legislation establish a new legal personhood status for AI systems which will enable AI to own property and enter into legal obligations including employment relationship, EPC rules regarding entitlement could in theory apply to AI, bearing in mind the aforementioned difficulties relating to identification and registration systems. It should be emphasised, however, that at present and until such initiative comes to full fruition with all details available for inspection, any detailed discussion of the implications of such initiatives for the patent regime may be premature.

⁷⁰ Ibid, an interview with Marten Kaevats, adviser for digital innovation at the strategy unit of the Government Office of Estonia.

⁷¹ Thus, such legislation may seek to address the pressing issue of liability and no more, avoiding the thorny issues surrounding a fully-fledged legal personhood.

⁷² *Skype's Homeland Grapples With Dilemma of Robot as Legal Person*, Bloomberg (10-10-2017), at <https://www.bloomberg.com/news/articles/2017-10-10/skype-s-homeland-grapples-with-dilemma-of-robot-as-legal-person>.

2(a)(iv) If inventor status is not limited to natural persons, how is this to be indicated in the designation of inventor and which function in the chain of creation of the invention is to be indicated as inventor?

The above heading essentially queries what the position would be should patent law be overhauled and facilitate the possibility of having AI identified as inventors, as part of a larger change to our legal framework: how is this to be indicated in the designation of inventor and which function in the chain of creation of the invention is to be indicated as inventor?

If the abovementioned changes to our legal framework were to take place, within which changes to the patent regime would be introduced under which AI systems may be considered as inventors, any indication of such inventorship might be done by reference to their electronic personhood status and using a system of registration that would be established for that purpose in a manner not dissimilar to that relating to the legal personality of corporations.⁷³

It is suggested that under such circumstances the relevant function in the chain of creation can no longer be the mental act of creative or intelligent conception as required today, either explicitly or implicitly, in all of the relevant jurisdictions. This is simply because AI systems do not conceive, and have no consciousness or intentions, but rather perform functions as intended to by their designers, notwithstanding any randomness and unpredictability involved. It has been suggested that, rather than focus on AI systems' incapacity to "think", it might be more helpful to look at their output and contribution – an approach which has been referred to as the "functionalist" approach.⁷⁴ According to this approach the focus would be solely on the output of the AI system at hand, and not on the process by which it arrived at this outcome.⁷⁵ Should such output be considered as sufficient to confer on a human an inventor status if a human produced it, it should equally be considered as sufficient to render an AI system as inventor.⁷⁶ It is suggested that within the context of a patent framework that considers AI systems as inventors, such functionalist approach may be a sensible option for determining the place of the inventor in the chain of creation and its identity.⁷⁷ For example, in the case of the US we have seen that the key for inventorship is conception. Conception of an invention in this context is not just a mere abstract idea of how to solve a problem, but the means by which such problem is to be solved and their interaction with one another should also be realised.⁷⁸ Applying the functionalist approach in this context, one may conclude that an AI system that generates a solution including the means to bring about such solution may be considered as an inventor, since this would be the conclusion if such output had been produced by a human rather than by an AI system. Similarly, we have seen that under Chinese patent law an inventor is a person that makes creative contributions to the parts of the invention that distinguish it from the prior art and therefore render it patentable. Applying the functionalist approach, and therefore construing the term creative liberally, it would be AI system output that makes a creative rather than *rudimentary* or organisational contribution to features of

⁷³ On this point see EU Parliament recommendations at footnote 9, para 2.

⁷⁴ See Professor Abbott's discussion on this approach, referring to it as the "functionalist" approach, supra footnote 49 at 1109.

⁷⁵ Thus ignoring the fact that such process does not resemble a human conception process.

⁷⁶ Inventive step inquiry may also prove challenging in this context as it is not clear whether and how it should be benchmarked against the skilled person where the inventor is an AI system; this however, is a separate question that merits a distinct consideration.

⁷⁷ It should be noted that the author of this study maintains that the need for revisiting the present definition of inventorship under the patent regime is unwarranted at present.

⁷⁸ For example, see *Mergenthaler v. Scudder*, 1897 C.D. 724, 81 O.G. 1417 (D.C. Cir. 1897).

the invention that render it patentable in comparison to the prior art. The creative nature of such contribution will be evaluated against a human benchmark; thus, the court may enquire whether such contribution, if made by a human actor, would be considered to be "creative". As the courts are accustomed to make such assessments under the present regime, they should be able to reach a decision in appropriate cases without particular difficulties. In the same manner this approach may be applied to all inventorship tests in the relevant jurisdictions. Under this approach a court would simply ask itself: if performed by a human actor rather than a system, would it be sufficient in order to consider the relevant person as inventor? Where the answer is affirmative, inventorship should be recognised in relation to the AI system that produced the output that has been so assessed.

2(b) Ownership of an invention involving AI activity

2(b)(i) To whom does the right to a European patent belong in the case of inventions involving AI activity?

The above question may be divided into two sub-scenarios: (1) where AI may be considered as inventors, and (2) where the present status quo is kept and only natural persons may be considered as inventors.

As discussed above, scenario (1) can only be envisaged as part of a larger revision of the legal system, where AI systems may be granted a legal status. Under such circumstances the legal right to a European patent is likely to belong to this newly created legal fiction: the electronic person.

After all, this would be one of the main reasons for creating such legal fiction: to enable AI systems to have rights and obligations in a similar fashion to corporations. The nature of such arrangements and the extent to which natural persons located "behind the electronic veil" could be considered as beneficiaries of such rights depends on the nature of the electronic personhood system, which is yet to be established, if at all.

Scenario (2) concerns a different situation, where only natural persons may be considered as inventors. This being so, the question under this heading implicitly queries whether notwithstanding the present status quo in relation to the definition of inventorship, is the right to a European patent impacted by the fact that the invention at hand involved AI activity? It is submitted that this query should be answered in the negative.

Where an invention is created with the involvement or assistance of an AI system, there are essentially two ownership alternatives, excluding the AI system itself: (1) the owner of the AI system; (2) the user/designer of the AI system. Scholarly views on where ownership should lie under such circumstances vary. For example, Ryan Abbott is of the view that ownership should be vested in the owner of the AI system itself, an option discussed above, while Mark Summerfield argues that under the appropriate circumstances it may be the system's designer⁷⁹. Peter Blok's view is closer to Summerfield's in that he maintains that the only one who could be said to be involved in inventive activity pertaining to the invention at issue is the AI system user, hence the

⁷⁹ Supra, at footnote 48.

party who puts the AI tool to use in order to produce the claimed invention, irrespective of the fact that the "heavy lifting" has been done by the AI system itself. Professor Blok asserts that "The inventor is the natural person that, using the computer as a tool, has found the product or process that solves a particular technical problem."⁸⁰ Thus, since under the present as well as the foreseeable technological state of affairs AI systems do not go through the full cycle of the inventive process without human intervention, since such human intervention will usually be required in activities such as identifying the problem, "translating" it to a format that can be processed by the AI system, training the AI and selecting the relevant output by realising the significance and usefulness of the various outputs. Professor Blok groups all such activities under the term "user" of the AI system and concludes that it is the user who should be considered as the inventor.

This may be contrasted with the view expressed by Shlomit Yanisky-Ravid and Xiaoqiong (Jackie) Liu, whose detailed analysis refers to what they call the Multiplayer Model, which according to them characterises the complex process through which inventions involving AI activities are created, which includes numerous actors, both overlapping and independent, encompassing software programmers, data and feedback suppliers, trainers, system owners and operators, employers, the public and the government.⁸¹ They maintain that, inter alia, due to the complexity of the various actors' structure involved in the invention-making process and their respective roles, traditional patent law, which focuses on identifying a single inventor, is ill equipped to deal with such multi-layered landscape. They therefore conclude that such inventions may be rewarded outside the patent system by alternative means.

It is submitted that an approach that is both theoretically sound as well as practically workable should focus on the respective contributions of the various persons in the chain of creation. For example, illustrating the complexity of a creation chain in an AI-based scenario, Yanisky-Ravid and Liu refer, inter alia, to actors such as data suppliers, system owners and system operators.⁸² However, it is submitted that, on its face, none of these actors is likely to be making a contribution that goes beyond the financial, organisational, administrative or mechanical.⁸³ Such contribution is not considered as sufficient to constitute inventorship under patent law and there is no reason to consider such contributions as valid candidates to inventorship only because the inventive process at issue involves AI activity. Two more types of actors are considered by Yanisky-Ravid and Liu: the programmer and the trainer. Both are more likely to be considered as (co-)inventors under adequate circumstances due to the nature of their potential contributions. The case of the programmer is somewhat the weaker of the two since he/she may be considered as a (co-)inventor if programming took place with the goal of the invention in mind. However, where a sophisticated machine learning platform has been created by the programmer, which may have various uses depending on its training and the manner in which it is being "tooled", it is submitted that such

⁸⁰ P. Blok, *The Inventor's New Tool: Artificial Intelligence – How Does It Fit In The European Patent System?*, E.I.P.R. 2017, 39(2), at p. 4.

⁸¹ S. Yanisky-Ravid, and X. Liu *When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law*, at Part II p. 20 (March 1, 2017). *Cardozo Law Review*, Forthcoming. Available at SSRN: <https://ssrn.com/abstract=2931828> or <http://dx.doi.org/10.2139/ssrn.2931828>

⁸² They also refer to, inter alia, the public and the government as potential default options in case no human inventor can be identified.

⁸³ In some instances the operator may be the one selecting the relevant output by realising the significance and usefulness of the various outputs and implementing it; this could possibly suffice for it to be considered as (co-) inventor in suitable circumstances.

programmer may be entitled to any patent granted in relation to the AI system itself, but not in relation to inventions in the creation of which such system has been involved.

It is the data trainer that may have a more solid claim for inventorship under the appropriate circumstances, as he/she may select the data sets, check the system's output and make necessary corrections where necessary, with a view to producing the most optimal output, all with the invention's objective in mind. Thus, the trainer's activity will often be aimed at the claimed invention, being of an intellectual and creative nature, but not financial, abstract or administrative. Such contribution could often be sufficient to establish (co-)inventorship. However, as could be seen from the discussion above, it is nigh impossible to establish a rule of thumb that determines in advance which of the relevant actors may be regarded as inventor. Such analysis should continue to be carried out on a case-by-case basis, applying the rationale above.

2(b)(ii) How should the applicable law concerning inventorship and ownership of the invention be defined?

As a basic rule, all of the relevant jurisdictions apply their national laws when determining inventorship, without any regard to the citizenship or place of residency of the inventor, or where the invention was made.⁸⁴ Article 61 EPC states that disputes as to entitlement must be resolved by the national courts. Since entitlement follows inventorship, it follows that any dispute regarding inventorship may also be resolved by the national courts, by applying their national laws on inventorship. It is submitted that there is no apparent reason to reconsider this arrangement due to involvement of AI activity in the claimed invention.

When it comes to ownership, the basic rule in most of the relevant jurisdictions is that ownership follows inventorship, except in the case of inventions made in the course of employment.⁸⁵ Thus, where inventorship has been established on the basis of the applicable law, which as we have seen is the national law, it provides the starting point for an entitlement enquiry. In the case of the majority of the relevant jurisdictions, this default rule does not apply in the case of employee inventions that were made in the course of employment, where employees could be expected to invent or to contribute to the inventive process due to the nature of their employment. Such expectation could either be discerned from the contract of employment or the nature of the job itself. The rules governing such determinations vary from one jurisdiction to another and are essentially based on national employment laws and the law of obligations. Where an invention is made in the course of employment and meets the relevant criteria under national law, in most of the relevant jurisdictions, with the exception of Germany⁸⁶, Japan⁸⁷ and the Republic of Korea⁸⁸, it belongs to the employer.

⁸⁴ See AIPPI Summary Report on Inventorship of Multinational Inventions at <http://aippi.org/wp-content/uploads/2015/10/SR244English.pdf>.

⁸⁵ With the exception of Germany, Japan and the Republic of Korea; please see below.

⁸⁶ Under the German Act on Employee Inventions (1957, as amended) ownership of such invention initially belongs to the employee, but is then automatically transferred to the employer by operation of law (unless the latter releases the invention back to the employee within a certain period of time). It is noteworthy that employees' initial right to their invention, notwithstanding any employment relationship, could also be found under the patent law regime of Nordic countries, such as the Norwegian Employees Invention Act 2015, the Danish Consolidate Act on Employees Inventions (2012), the Finish Act on the Right in Employee Inventions (1967, as amended in 2006) and the Swedish Act on the Right to Inventions by Employees (1949). In these Nordic countries, the right to an

While ownership in all of the relevant jurisdictions is determined on the basis of national law, when it is based on the showing of inventorship, the situation may be somewhat more complicated when employment law or contract law are involved. In essence, the right to a patent in the case of a patent applied for in a given relevant jurisdiction will be governed by the law of that jurisdiction. However, some of the factors on which the operation of that national law may depend pertain to questions concerning employment law or the law of obligations. Such determinations may refer to laws of other jurisdictions, such as the proper law of the contract or employment law, where employment took place in a jurisdiction other than the jurisdiction where the patent application was made. However, things may become even more complicated in the case of multinational inventions involving a number of inventors living or making the invention in different places and who are not within a contractual framework. Under such circumstances it may be more difficult to determine the relevant factors that inform the national law on inventorship and ownership. In conclusion, the applicable law on both inventorship and ownership in all of the relevant jurisdictions appears to be the national law. However, in the case where national law calls upon certain factors to be established, such as whether an employment relationship exists or whether a valid contract is in place, such factors may be determined by reference to other legal systems as the case may be, according to conflict of law rules in the given relevant jurisdiction.

The arrangement under Article 60(1) EPC in relation to the applicable law in the case of employees' inventions appears both fair, sensible and workable within the framework of European patents, which comprise a bundle of national rights.

2(b)(iii) How should the concept of inventor and applicant in relation to inventions involving AI activity be applied in the European patent granting process?

As discussed under 2(c)(i) below, at present AI cannot be designated as inventor under the EPC. Doing so would likely result in refusal of the application in question. It is obvious that as long as AI systems do not have a legal personality that enables them to hold rights, be bound by obligations and own property, it is difficult to envisage them serving as applicants in the European patent granting process.

As Part 2(a)(i) above explains, the concept of inventor in inventions involving AI activity should continue to carry the same meaning as it does in relation to more traditional inventions: a person who made an intellectual or creative contribution to the conception phase of an invention. We have seen that such contribution does not have to include inventive or genius inputs by the inventor, but may also comprise recognition of the usefulness and significance of material produced by an AI system, in a similar manner to an inventor that stumbles upon an inventive ground-breaking feature by sheer luck, recognises its importance and utility and bases his/her invention on it.

employee's invention is initially vested in the employee, and may be transferred to the employer by operation of law or as a result of an agreement between the parties.

⁸⁷ Under Article 35 of the Japanese Patent Act 1959 (2016 Amendment) ownership of such invention belongs to the employee, with the employer having a non-exclusive royalty free licence to the patent, unless an employment regulation or a contractual agreement specify in advance that it is to be vested in the employer.

⁸⁸ Under the Korean Invention Promotion Act 1994 (2017 Amendment) ownership is vested in the employer only if such employer has in place a pre-designated assignment regulation.

In conclusion, the concept of inventor should apply in relation to inventions involving AI activity in a similar fashion to its application in relation to traditional inventions. The same applies, *mutatis mutandis*, to the concept of applicant under Article 60(3) EPC.

2(c) Practical aspects of applications concerning inventions involving AI activity in the patent granting process under the EPC

2(c)(i) What are the legal consequences of indicating AI as inventor or co-inventor in a European patent application?

As discussed in length above, it is clear that at present all of the relevant jurisdictions limit the definition of inventor to natural persons. Although the EPC does not contain a definition of the term "inventor", it is submitted that it is unambiguously implicit that AI systems cannot be identified as inventors, as discussed above. To recap, identification of AI systems as inventors is not reconcilable with the overall legal framework of the EPC, and in particular the rights enumerated under Article 60 EPC. As mentioned, inventorship is the starting point of an entitlement/ownership enquiry, with the inventor being a first owner unless the invention was made in the course of employment. However, since AI systems do not have a separate legal personality, and are not expected to have one in the foreseeable future, such systems are incapable of owning property. In the same vein, AI systems cannot be part of employment relationships in the legal sense of the term; they cannot be considered as employees unless and until they have legal personality. To conclude, considering AI systems as inventors and applying the provisions of Article 60 to such "inventors" as would be the case under the EPC is unworkable. In addition, it has been established that the moral right to be mentioned as an inventor, which serves a number of key interests in the case of human inventors, would serve no desirable purpose whatsoever if applied to AI systems. Thus, not only does the present legal position not allow for AI systems to be considered as inventors, it is submitted that at present there are no convincing reasons to consider a change in this respect.

In light of the above, should a patent application be filed designating an AI system as an inventor, it would be likely to be found deficient under Article 81 and Rule 19 EPC and, if not remedied, would be refused under Article 90 EPC.

2(d) Is the current legal framework, in particular the EPC, suitable for addressing the inventorship and ownership of inventions involving AI activity?

As has been demonstrated throughout this study, the current legal framework, including the EPC, is suitable for addressing inventorship and ownership of inventions involving AI activity both at present and in the near future.

The suitability of the current regime for addressing inventorship of inventions involving AI activity

Throughout the different parts of this study, it has been established that, first, the patent regime at present does not allow for the definition of inventorship to encompass AI systems and, second, that at present there is no convincing reason to reconsider the breadth of the said definition of inventorship. We have seen that the rationales and justifications for the moral right of attribution for inventors are simply not applicable to AI systems, and that no additional convincing rationale for such attribution right for AI systems could be identified.

Hence, the present legal regime, with its strict definition of inventorship limited to humans, is suitable for the legal and technological landscape both at present and in the near future. Furthermore, it is submitted that even if the science underpinning AI technology progresses to such an extent that the process of invention would be so removed from human involvement that no human actor could be considered as inventor, identifying AI systems as inventors may remain unwarranted.

The suitability of the current regime for addressing ownership of inventions involving AI activity

The discussion above, in particular in relation to point 1(b)(ii), clearly establishes that at present there are no particular difficulties associated with ownership enquiries relating to inventions involving AI activities. However, that is not to say that patent ownership enquiries, particularly in the case of multinational inventions, may not give rise to some thorny questions which are to be resolved on a case-by-case basis by reference to conflict of law rules of a given relevant jurisdiction.

This situation is, however, less problematic within the EPC framework, which essentially "delegates" the resolution of such questions to the discretion of the national courts of the EPC countries. This could sometimes lead to undesirable situations where the courts of one country may decide entitlement in one way, while the courts of another may reach a different conclusion, resulting in conflicting decisions relating to entitlement. However, this is not a contingency that is unique to a scenario involving inventions assisted by AI systems, nor is its likelihood amplified by the involvement of AI in the invention-making process. And while harmonisation in this respect would have been desirable, this is the case irrespective of any AI involvement.

Concluding comments

It has been demonstrated that currently none of the relevant jurisdictions allows for AI systems to be considered as inventor under their patent law regimes and, furthermore, that the present legal landscape is not equipped to facilitate a definition of inventorship that includes AI systems. The latter is due to the fact that inventorship at present serves as a starting point to an entitlement enquiry. We have seen that in this context that the concepts of ownership and employment, that play a key role in such enquiry, are both meaningless in relation to AI systems under the present legal arrangements. As the discussion under Part 2(a)(iii) demonstrates, this conclusion continues to hold notwithstanding a number of recent initiatives concerning the legal status of AI systems.

Although there are variations in the terminology and even in the actual tests employed by the relevant jurisdictions in determining who is an inventor, it appears that the objective of these is uniform: to identify the person that was responsible, wholly or partially, for what may be described as the intelligent and creative conception of the invention. In this context the term intelligence should carry its day-to-day meaning as in conscious self-aware and volitional, hence excluding AI systems at present as well as in the foreseeable future,⁸⁹ while focusing on a contribution to the invention-making process that goes beyond the financial, administrative or mechanical on the one hand, while not being abstract on the other hand. Thus, it needs to be of a creative nature, but does not have to be inventive in the non-obvious sense. The latter is clearly the case, as all of the relevant jurisdictions grant patents where the inventor comes by the core of the inventive concept, the very thing that solves the problem at hand and distinguishes the invention from the state of the art, by dumb luck rather than real inventive effort. In such a case, it is the inventor that realises both the significance and utility of the material that came to their knowledge by sheer luck, which may be sufficient to confer on them an inventor status. This is so even if the said material, which did not originate from the inventor, was the key to solving the problem that the invention addresses.

Applying the same rationale to inventions involving AI activity, it has been demonstrated that the person who realises the significance and utility of the output produced by an AI system may be considered as an inventor.⁹⁰ When it comes to a human actor that uses an AI system, whose identity may be inconsequential to the invention process, who simply uses a machine learning technique developed by another, the inventor may be the person who "tooled" the AI system in a particular way in order to generate the inventive output. Hence, under such circumstances the person that carries out the intelligent or creative conception of the invention may be the one who geared up the AI system towards producing the inventive output, taking decisions in relation to issues such as the choice of the algorithm employed, the selection of parameters and the design and choice of input data, even if the specific output was somewhat unpredictable.⁹¹ It would indeed be desirable for all of the relevant jurisdictions to view inventorship in relation to inventions that involve AI activity in a similar manner, establishing as clear as possible a uniform position on this

⁸⁹ Unless and until AI systems that manifest such characteristics emerge.

⁹⁰ Leaving aside for the present purpose questions pertaining to inventive step.

⁹¹ For an analysis of these points see discussion under 1(b), 2(a)(i) and 2(b)(i).

issue.⁹² As mentioned, once inventorship is established, it serves as a starting point and, in most cases, default option, for an entitlement enquiry.

The concept of inventor should apply in relation to inventions involving AI activity in a similar fashion to its application in relation to traditional inventions. The same applies, *mutatis mutandis*, to the concept of applicant under Article 60(3) EPC. Although the EPC does not contain a definition of the term "inventor", it has been shown that it is unambiguously implicit that AI systems cannot be identified as inventors. Therefore, considering AI systems as inventors and applying the provisions of Article 60 to such "inventors", as would be the case under the EPC, is unworkable. Should a patent application be filed designating an AI system as an inventor, it would be likely to be found deficient under Article 81 and Rule 19 EPC and, if not remedied, refused under Article 90 EPC.⁹³

As regards the right of attribution, or the "moral right" of the inventor in relation to inventions involving AI activities, it has been demonstrated that while such right of attribution performs important functions in relation to human inventors, it is meaningless if applied to AI systems and is not supported by any clear rationale in this regard.⁹⁴ Hence, identification of AI systems as inventors in a similar fashion to attribution done in relation to human inventors is not supported by convincing public policy considerations.

The discussion in Part 2(d) establishes that the current legal framework, in particular the EPC, is overall suitable for addressing the inventorship and ownership of inventions involving AI activity at the present and foreseeable future levels of technological development.

⁹² As has been demonstrated under Part 1 of this study, at present all of the relevant jurisdictions use similar mechanisms to identify inventors, even if the terminology and actual tests differ.

⁹³ See discussion under 2(c)(i).

⁹⁴ See discussion under 2(a)(ii).