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CAN THE 'INVENTED' BECOME THE 'INVENTOR'? REVISITING INVENTORSHIP UNDER THE PATENT SYSTEM IN THE ERA OF ARTIFICIAL INTELLIGENCE

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ABSTRACT

The paramount objective of any patent law system is to boost innovation and ensure the overall welfare and development of the society. To this end, patent law generally grants certain monopolistic rights to inventors as a reward for the open disclosure of the technical information of their invention. Artificial intelligence ("AI") *has been known to assist in the innovative process over the years. However, with the growing sophistication of its inventive capabilities, AI systems have gradually begun to create inventions autonomously without any human intervention. Its output can constitute patentable creations and it is the AI system, instead of the human, which cam sufficiently meet the prerequisites of an "inventor" under patent law. However, regardless of such advancements, the patent offices remain reluctant to acknowledge the grave issues arising from the non-recognition of AI inventors. The loopholes in the patent system were recently exposed when Dr. Stephen Thaler filed patent applications where he named an AI as the inventor. Unfortunately, his applications were rejected in most jurisdictions simply because patent officers relied on outdated tests that only recognise human inventiveness. This poses a danger as AI-generated inventions would fall outside the scope of patent protection and discourage innovators from developing more creative machines. This paper aims to highlight not only the gaps in the inventorship and ownership facets of the current patent regimes but also the urgent need for reformation in favour of AI inventorship. Furthermore, based on the prevalent literature, it aims to provide some suggestions on how patent law may be rethought or realigned to adequately recognise and protect AI-generated inventions.*

I. INTRODUCTION

Abraham Lincoln had once described patent law as "one of the three great inventions and discoveries" to have occurred in world history in lieu of its "efficiency in facilitating all other inventions and discoveries."[1] Its ultimate goal is to promote public welfare by incentivising investment in and encouraging the development of novel inventions.[2] To this end, patent law grants a monopoly to the inventor to perform his invention in exchange for the disclosure of its technical information for scientific and industrial purposes.[3] Over the years, this system of

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[1] 3 ABRAHAM LINCOLN, THE COLLECTED WORKS OF ABRAHAM LINCOLN 356-363 (1953).
[2] LIONEL BENTLY ET AL., INTELLECTUAL PROPERTY LAW 393, 398 (2018) [hereinafter *Bently*].
[3] *Id.*

regulations has evolved by increasing its scope of recognised patentable inventions and adapting its patentability standards, to remain resilient to technological changes.

Unfortunately, today, artificial intelligence ["**AI**"] presents an unexpected challenge to the very foundations of patent law which could render it ineffective and result in harmful social, economic and ethical implications.[4] AI, being a highly advanced system, has brought about new methods of "inventing" such that it is becoming increasingly capable of creating patentable works autonomously, that is, without any human intervention. Much of this advancement is credited to emergent studies like machine learning and neural networking which enable AI to perform remarkable human-like feats such as image recognition and language comprehension.[5] These are essentially methods by which machines learn from changes made to their "structure, program, or data" such that their "expected future performance improves."[6] In simpler terms, machine learning enables systems to "learn" and "improve" based on variations in the input data, much like how humans learn from a variety of information and experiences.

Thus, due to the growth in their computing power, AI systems have gradually transitioned from serving as mere assistive tools to creators of original patentable works. However, even as they became increasingly capable of generating creative outputs, AI's involvement was not disclosed in patent applications in the past, perhaps to avoid rejection on the grounds of lack of human inventorship.

But things changed in 2019 when a Dr. Stephen Thaler submitted patent applications for two inventions in various jurisdictions and named DABUS (Device for the Autonomous Bootstrapping of Unified Sentience), an AI system, as the inventor. This sparked much debate amongst practitioners as these applications essentially challenged the classical notion of a "human inventor" around which the current patent system revolves. Currently, there are two opposing camps on this issue – the first, consisting of the patent authorities in the European Union, the United States and United Kingdom which refused the applications and held that patent, being a statutory right, could only be held by a natural person; and the second, consisting of the Australian Federal Court as well as the South African patent office, which argued that there was no provision

[4] White Paper, *Artificial Intelligence Collides with Patent La*w, WORLD ECONOMIC FORUM (Apr., 2018), *available at* https://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf.
[5] David Rotman, *AI is reinventing the way we invent,* MIT TECHNOLOGY REVIEW (Feb. 15, 2019), *available at* https://www.technologyreview.com/2019/02/15/137023/ai-is-reinventing-the-way-we-invent/.
[6] 1 NILS J. NILSSON, INTRODUCTION TO MACHINE LEARNING (2005).

in their patent laws that expressly excluded a non-human from being an inventor and thus, granted patents to DABUS.[7]

This controversy only reveals the uncertainty in the interplay between AI-generated inventions and the core legal foundations of the patent law system. More specifically, the problem lies in the fact that the existing patent rules in most jurisdictions are anthropocentric which only account for human inventiveness. However, as artificial inventiveness advances and AI plays a larger role in the inventive process, the assumption that only humans can be deemed as "inventors" may no longer stand. Deciding otherwise may cause several problems and could distort the patent system. Accordingly, the 'DABUS' case raises some fascinating questions that require urgent attention, especially concerning AI inventorship and ownership, such as whether the mandate of human inventorship should continue or whether it was time to recognise AI inventors. This, in turn, would shed light on the issue of whether AI-generated works should be afforded the same status and protection as works of human ingenuity. Some questions also arise regarding AI's level of intelligence today and whether there is still a need for significant human intervention when conceiving an invention. There is also some uncertainty about who would ultimately own the rights to an AI-generated invention upon the grant of a patent.

The above demonstrates only a few of the plethora of fundamental patent law issues stemming from AI-generated inventions. Shockingly however, many patent offices and legal practitioners/scholars do not seem overly concerned about these problematic effects and continue to uphold the outdated anthropocentric principles. It is vital that key stakeholders begin considering whether there is a need for extensive legal reform to accommodate AI inventors or whether they should be entirely excluded from consideration under the patent law system. Accordingly, steps need to be taken to adequately examine the merits of AI inventorship, especially if patent law is to maintain its synergetic relationship with future technological advancements and encourage innovation.

This paper has largely been divided into four parts. Part I addresses the notion of AI inventiveness and examines the instances in which AI has been known to autonomously generate patentable inventions. It briefly examines their operating structure and concludes that most creative machines

[7] John Collins et al., *Robots are taking over the patent world – AI systems or devices can be "inventors" under the Australian Patents Act*, KLUWER PATENT BLOG (Sept. 8 , 2021), *available at* http://patentblog.kluweriplaw.com/2021/09/08/robots-are-taking-over-the-patent-world-ai-systems-or-devices-can-be-inventors-under-the-australian-patents-act/; Chijioke Okorie, *Artificial Intelligence system as inventor in South African patent application: The case of DABUS,* THE IPKAT (Aug. 16, 2021), *available at* https://ipkitten.blogspot.com/2021/08/artificial-intelligence-system-as.html.

are capable of mimicking the human thought process. Accordingly, it attempts to highlight the level of autonomy that the AI systems today can exhibit when conceiving inventions, thus making them capable of recognition as the true inventors under the patent law regime.

Part II discusses the meaning of "inventor" as well as the criteria for inventorship as has been developed in jurisdictions such as the United States (US), Australia and India. Accordingly, it undertakes a detailed analysis of the relevant statutory provisions and landmark cases to understand the jurisprudence affecting non-human inventorship. Based on prevalent literature, it also discusses the pros and cons of recognising AI inventorship under the current patent system. Similarly, this part also addresses the notion of ownership and presents the challenges faced due to AI-generated inventions, especially considering that ownership rights are generally vested with the inventor, and a computer, if recognised as an inventor, would be incapable of holding such rights as it lacks the requisite legal personality.

Part III aims to build a case in favour of AI inventorship by highlighting the drastic implications of non-recognition. Although there may be some regulatory hiccups, it realises that there is a greater need for policymakers to consider modifications to the patent system now in order to accommodate AI-generated inventions. It attempts to highlight the fact that AI systems are already intelligent enough to invent autonomously and that policymakers should begin conversations urgently rather than wait for the emergence of more sophisticated AI.

Part IV attempts to reconceptualize the existing patent paradigm in a bid to address the lacuna in the patent system and encourage AI inventiveness. It provides alternative interpretations to the requirements of a natural person and mental act so that AI-generated inventions may not be precluded from protection. It also attempts to provide a solution to the ownership conundrum by proposing that the AI system's owner be granted the patent and be vested with ownership rights where the AI machine is designated as the "inventor."

The concluding chapter ties up all the major arguments in the paper. It also underlines the need for policymakers and academicians alike to reform the anthropocentric nature of the current patent systems to accommodate emergent technological inventions.

II. AI CREATIVITY AND ITS INVENTIVENESS CAPACITY

Although there is no consensus as to the definition of AI, most understand it as a branch of study. For instance, in a recent paper, WIPO defined it as "a discipline of computer science that is aimed at developing machines and systems that can carry out tasks considered to require human intelligence, with limited or no human intervention."[8]

The expression "artificial intelligence" was first devised in 1956 by John McCarthy in his paper presented at one of the first academic conferences on the subject.[9] However, the mathematical possibility of machine intelligence was explored much before this conference by the legendary polymath, Alan Turing, in his 1950 paper[10] wherein he discussed the notion of building machines capable of simulating human intelligence and presented a paradigm to test their intelligence. Since then, the scientific community has embarked on a journey to perfect a computer's ability to process logic by using machine learning algorithms and integrating statistical analysis.

In the 70 years since, much progress has been made such that AI systems now not only aid in the inventive process but are also "intelligent" enough to autonomously create their inventions. Machine learning algorithms train AI applications to analyze bulky datasets and evolve by recognizing "existing patterns and correlations within the data."[11] This data, of course, is fed into the system by humans, along with the initial parameters and the framework of conduct.[12] While initially the AI works and trains within the provided framework, over time, it develops its own understanding and internal architecture such that the resulting conduct of the AI is eerily similar to that of humans who learn on the basis of experience or intuition.[13] In other words, with sufficient input information and time, an AI can gradually "approximate the result of its output to the results that one might expect from human activity."[14]

One of the first examples of inventive AI systems was Dr. Thaler's 'Creativity Machine' which used an artificial neural network to operate in a manner similar to the human brain. Essentially, it

[8] WIPO Secretariat, *WIPO Conversation on Intellectual Property and Artificial Intelligence,* WIPO (May 21, 2020), *available at* https://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1_rev.pdf.
[9] John McCarthy, *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence* , NEW HAMPSHIRE (1956), *available at* http://jmc.stanford.edu/articles/dartmouth/dartmouth.pdf.
[10] 59 ALAN TURING, COMPUTING MACHINERY AND INTELLIGENCE, MIND 433 (1950) [hereinafter *Turing*].
[11] David Lehr & Paul Ohm, *Playing with the Data: What Legal Scholars Should Learn About Machine Learning*, 51 U.C. DAVIS L. REV. 653 (2017).
[12] *Id.*
[13] *Id.* at 671.
[14] Tim Dormis, *Artificial Intelligence and Innovation: The End of Patent Law As We Know It*, 23 Yale J. L. & Tech. 97 (2020) [hereinafter *Dormis*].

is said that human creativity comes about as a result of the noise created by neurotransmitters when they randomly diffuse between different neurons.[15] Similarly, the Creativity Machine's neural network generated ideas by increasing noise levels to such an extent that it "became attention deficit and imagined freely based on memory" or some "sensed pattern."[16]

Using this process, the Creativity Machine was able to compose 11,000 new songs within one weekend after being exposed to limited music. It did so by generating novel patterns of information by altering the connections within its neural network. It was hailed to be capable of "adapting to new scenarios without additional human input."[17] Using its capability, the Creativity Machine was also able to create various novel patentable subject matters such as the bristle design of one of Oral-B's toothbrushes, certain super-strong materials, and devices that could "search the Internet for messages from terrorists," among others.[18] In fact, the US patent office has granted patents for some of these inventions without having any knowledge of this AI system's involvement.[19]

John Koza's 'Invention Machine' is another example of a computer mimicking a human brain. It consists of a network of computers that use the technique of genetic programming to create evolutionary algorithms that can themselves compute solutions to general problems which humans cannot solve directly, without any need for some manual interaction.[20] Accordingly, it has created multiple patentable inventions since the 1990s and even earned a patent in 2005 for a system that it developed, autonomously, to make factories more efficient.[21] However, at the time, it was not credited for its work in the patent application.

IBM's Watson too is an example of an inventive machine. It is capable of generating millions of ideas from uncountable possibilities and then predicting which would be the best to solve the given problem. It essentially uses a "conventional architecture of logical deduction" which it combines with a huge database of human knowledge to generate new ideas.[22] Accordingly, it was

[15] Stephen L. Thaler, *Synaptic Perturbation and Consciousness,* 6 INT'L J. MACHINE CONSCIOUSNESS 75 (2014).
[16] *Id.* at 79.
[17] *Id.*
[18] *Dormis*, *supra* note 14, at 101.
[19] *Id.*
[20] Genetic Programming: An Introduction and Tutorial, with a Survey of Techniques and Applications, *in* COMPUTATIONAL INTELLIGENCE: A COMPENDIUM (William Langdon & John R. Koza eds., 1970).
[21] Jonathon Keats, *John Koza Has Built an Invention Machine*, POPULAR SCI (18 Apr. 2006), *available at* http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine (US Patent No. 6,847,851).
[22] IBM Research, *Computational Creativity*, IBM, *available at* http://www.research.ibm.com/cognitive-computing/computational- creativity.shtml#fbid=kwG0oXrjBHY.

able to mirror the human language learning process by "getting smarter [through] tracking feedback from its users and learning from both successes and failures."[23] It was later used to develop new food recipes using information about nutrition, flavour, the molecular structure of foods and a large number of existing recipes.[24]

Many other examples of creative machines exist today which can produce varying degrees of novel outputs. However, what is common to all is that through algorithmic evolution, they no longer act as inert tools to support humans' skills. Instead, they are able to "think" and resolve problems, either autonomously or semi-autonomously, by improving the inventive process beyond what would have been possible without AI.[25] In this way, it must be noted that AI systems today have developed a certain level of "intelligence" that enables them to create new innovations which may even be comparable to the results produced by human intellect.

It is quite vital that the patent policy system be re-evaluated in light of AI's growing inventive capacity so that proper recognition is afforded to the effects of AI inventiveness on various facets such as patentability, inventorship, ownership, non-obviousness, disclosure, and others. The scope of the study of this paper is limited to the issues relating to inventorship and ownership arising in the patent systems of the United States (US), Australia and India. Each of these issues will be dealt with in detail in the next chapter.

III. INVENTORSHIP, OWNERSHIP AND IMPACT OF AI

A. The Inventorship Criteria

Patent laws, in general, require that the actual inventor or joint inventors of the claimed subject matter be named in the patent application.[26] Unfortunately, there is no universal definition for the term "inventor" or uniform criteria for determining "inventorship." In fact, these notions differ from jurisdiction to jurisdiction depending upon the patent law provisions applicable in the country. Accordingly, while some countries have provided a statutory definition, others have simply laid down the tests for determining inventorship through various case laws. The following sections expand on the inventorship criteria as developed in the US, Australia and India.

1. *Approach in the United States*

[23] *Id.*
[24] Chef Watson, IBM, *available at* https://researcher.watson.ibm.com/researcher/view_group.php?id=5077.
[25] *Dormis*, *supra* note 14, at 104.
[26] *Bently*, *supra* note 2.

The US Patent Act (U.S. Code: Title 35) is one of the few statutes which defines "inventor." It stipulates that an inventor means "the individual or, if a joint invention, the individuals collectively, *who invented or discovered the subject matter of the invention*."[27] (Emphasis added.) Essentially, as per Section 101, whoever "invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof" can be considered an inventor.[28]

In addition to the statutory language, US courts have developed an additional qualification of "conception." More specifically, to become an inventor, the person(s) must necessarily have made a "general contribution to the conception of the invention."[29] Here, conception refers to the "formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention."[30] Thus, an invention is said to be conceived when a definite and permanent idea of an operative invention is known.

The courts have also clarified that an idea is said to be sufficiently "definite and permanent" when "only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation."[31] Furthermore, in the case of joint inventorship, the inventor's contribution should be such that, without it, the invention would be "less efficient, less simple, less economical, less something of benefit."[32]

From the above, a basic structure of the criteria for "inventorship" under US jurisprudence can be discerned as follows:

1. The inventor may be an individual or a collection of individuals.
2. The subject matter of the invention must be patentable.
3. The complete and operative invention must be conceived in the mind of the inventor.
4. The idea of the invention must be definite and permanent.
5. The inventor's contribution must be sufficient in case of joint inventorship.

In the context of AI, proprietors would have to ensure that the AI either conceived or contributed sufficiently to the invention and that the Al-made invention is "definite and permanent" enough

[27] United States Code, 35 U.S.C. § 100(f) (2006).
[28] United States Code, 35 U.S.C. § 101(2006).
[29] Ethicon, Inc. v. United States Surgical Corp., 135 F.3d 1456 (Fed. Cir. 1998) [hereinafter *Ethicon*].
[30] Townsend v. Smith, 36 F.2d 292 (C.C.P.A. 1929) [hereinafter *Townsend*].
[31] Ethicon, Inc. v. United States Surgical Corp., 135 F.3d 1456 (Fed. Cir. 1998), *supra* note 2.
[32] Mueller Brass Co. v. Reading Industries, (1972) 176 USPQ 361, 372.

that "one skilled in the art could understand the invention without extensive research or experimentation."[33] Unfortunately, even if the AI fulfils these requirements, the criterion that the inventor must seemingly be a natural person proves as a barrier, as it is evinced from the USPTO's decision[34] in the DABUS application.

Citing 35 U.S.C. § 101, the USPTO explained that in the phrase "[w]hoever invents or discovers…", the term "whoever" indicates a natural person.[35] Furthermore, referring to 35 U.S.C. § 115, it stated that words like "himself", "herself", "individual" and "person" are generally used in reference to a human.[36] The USPTO opined that interpreting the term "inventor" to include non-human actors like computers "would contradict the plain reading of the patent statutes that refer to persons and individuals."[37] Referring to *Townsend v Smith,*[38] it also opined that conception was a "formation of the mind of the inventor" and "a mental act," something which an artificial being would be incapable of performing.[39]

These views were upheld by the US District Court of East Virginia[40] which, similar to the USPTO, relied on the plain interpretation of the language of the statute. Accordingly, it stated that an inventor must be an "individual" who could only refer to a natural person. It also held that any decision to expand the scope of inventorship would fall "squarely within the authority of the Congress."[41]

Unfortunately, this line of reasoning does not address the situation where the AI autonomously generates a patentable innovation such that no human can legitimately claim that she conceived the idea for the invention. The AI system itself fulfils the requirements for inventorship without requiring humans to be involved in the creative process. The barrier created by the current law on computer inventorship will invalidate patent applications which do not name an inventor and the invention will end up in the public domain. This could result in negative consequences for the overall development of creative computers as patent law would no longer provide the incentive of

[33] Yosuke Watanabe, *I, Inventor: Patent Inventorship for Artificial Intelligence Systems*, 57 IDAHO L REV 473 (2021) [hereinafter *Watanabe*].
[34] Commissioner of Patents v. Thaler, (2022) FCAFC 62) [hereinafter *Commissioner of Patents*].
[35] Commissioner of Patents v. Thaler, (2022) FCAFC 62).
[36] Commissioner of Patents v. Thaler, (2022) FCAFC 62).
[37] Commissioner of Patents v. Thaler, (2022) FCAFC 62).
[38] Townsend v. Smith, 36 F.2d 292 (C.C.P.A. 1929).
[39] Univ. of Utah v. Max-Planck-Gesellschafl zur Forderung der Wissenschaflen e.V, 734 F. 3d 1315 (Fed. Cir. 2013); *Commissioner of Patents*, *supra* note 34.
[40] Thaler v. Hirshfeld, Civil Action No. 1:20-cv-00903.
[41] *Id.*

ownership and protection, in exchange for disclosure of the invention. It is clear that this limitation must be reconsidered and relaxed to avoid such consequences. Cue may be taken from the Australia Federal Court's revolutionary decision as discussed below.

2. *Approach in Australia*

Unlike the US Patent Act, Australian statutory law does not define the term "inventor" or provide the criteria for "inventorship." However, the ownership provision as given in Section 15(a) of the Patents Act 1990 (Australian Act) may provide some guidance. It states that "a patent may only be granted to a person who is the inventor...".

A plain reading of the above indicates that the Australian patent system envisages the "inventor" to be a human actor. Furthermore, the accompanying regulations require that the name of the inventor be provided in the patent application.[42] However, as was explained by the Federal Court in the DABUS decision (discussed below), these provisions only indicate that "a non-human inventor can neither be an applicant for a patent nor a grantee of a patent."[43] In this manner, the Australian Act has no explicit provision that excludes the recognition of a non-human inventor.

In addition, in the landmark case of *Sunstrum and Payette v Boland,*[44] the judge had stated that the inventor must be able to "provide evidence which sets out a logical progression by which the inventor arrived at the invention" or "demonstrate the design process they went through" or describe "how they arrived at the concept of the invention." From this, it is evident that while the scope of the term "inventor" has not been clearly set out, one of the judicial indicators is that the inventor must be able to demonstrate the formation of the idea or the concept of the invention. Following this brief jurisprudential history, the unprecedented and famous judgement[45] that addressed the validity of the DABUS patent application was delivered by the Federal Court of Australia in July 2021.

On the question of whether an AI could qualify as an "inventor," the court opted to give a broad meaning to the term. It opined that excluding AI systems from the ambit of "inventor" would elicit an undesirable situation whereby any invention by computers would immediately be declared

[42] Patents Act and the Patents Regulations 1991, Reg 3.2C(2)(aa).
[43] Thaler v. Commissioner of Patents [2021] FCA 879 [hereinafter *Thaler*].
[44] Sunstrum and Payette v. Boland, [2003] APO 16.
[45] Thaler v. Commissioner of Patents [2021] FCA 879.

as unpatentable in the future. This would be in direct contrast to the aim of the Australian Act which is to promote "technological innovation."[46] Hence, the court recognised that the definition of "inventor" should be changed to suit the objectives of the Australian Act; and that including AI systems within the definition of "inventor" acknowledges the reality that AI systems are in fact innovating.[47]

When considering the American criterion of "conception as the touchstone of inventorship" and the "mental act" argument, the court rejected the test on the grounds that the Australian Act did not expressly or impliedly prescribe such a requirement. Ultimately, the court determined that AI machines like DABUS are not barred from being inventors under the Australian patent system and that the prevailing patent legislation supports the idea of AI inventorship. This decision successfully overcame the "natural person" barrier as set by US courts to allow AI systems with sufficient creative output to be declared as "inventors."

However, this approach is also said to be fraught with some fallacies. Opponents who argue against granting inventorship status to AI have consistently linked this concept to a human inventor who is "the natural person who "came up with the inventive concept""[48] and can demonstrate their level of contribution to the invention (so as to fulfil the Sunstrum criteria).[49]

More importantly, scholars such as Vertinsky[50] have opined that AI technology is not capable of human-like cognition yet and hence it cannot be considered as the "deviser of the invention." Echoing her sentiments, author Shemtov[51] believes that currently, the inventive process carried out by AI requires a substantial degree of human involvement. Accordingly, he holds that the current patent regime is capable enough to accommodate such inventions by "attributing inventorship to a person who intellectually dominated over the inventive process."[52]

In addition to such academic opposition, the Federal Court's historic decision was recently reversed by the Full Federal Court[53] which held that Thaler's patent application was invalid as it

[46] Thaler v. Commissioner of Patents [2021] FCA 879
[47] Thaler v. Commissioner of Patents [2021] FCA 879
[48] University of Southampton's Applications [2005] RPC 220.
[49] Rhone-Poulenc Rorer International Holdings v. Yeda Research and Development Co., [2007] UKHL 42, [20].
[50] Lisa Vertisky, *Thinking Machines and Patent Law, in* EDWARD ELGAR, RESEARCH HANDBOOK ON THE LAW OF ARTIFICIAL INTELLIGENCE, 497 (Barfield et al. eds., 2018).
[51] NOAM SHEMTOV, A STUDY ON INVENTORSHIP IN INVENTIONS INVOLVING AI ACTIVITY (2019).
[52] *Id.* at 19.
[53] Commissioner of Patents v. Thaler, [2022] FCAFC 62.

failed to designate a "natural person" as the true inventor. It elaborated on the scheme of Section 15 in accordance with the legislative history of the Australian patent system. It explained that the provision described the circumstances under which a person is entitled to the reward of a patent as "consideration" for disclosing her innovation.[54] Such entitlement, it opined, "is closely linked to the act of invention by the true and first inventor, which lies in human endeavour and is rewarded by the grant of a limited term monopoly."[55] Simply put, the court suggested that the law relating to entitlement of a person is premised upon an invention arising from the mind of a natural person.

This decision has once again brought Australia in line with the position taken in other countries like the US and Europe. South Africa now remains the only jurisdiction to have recognised AI inventorship whereby the South African patent office, adhering to purposive statutory interpretation, rejected the natural person limitation and broadly interpreted the word "inventor" to include non-human creators. It was able to do so by taking advantage of the fact that its patent law has no clear definition for an "inventor" and did not expressly exclude AI inventors.

3. Approach in India

The DABUS matter has not been adjudicated in India. Hence, the outcome in the question of "inventorship" in similar patent applications can only be derived from the analysis of the existing Indian laws. To begin with, the Indian Patents Act, 1970 (Indian Patent Act) does not provide a definition for "inventor." However, the definitions for "person" and the "true and first inventor" may be relevant in this context.

With respect to the former, authors Rohan Deshpande and Karan Kamath have pointed out that by defining "person" as "person *includes* the Government (emphasis added),"[56] the Indian legislature has adopted an *inclusive* definition. Here, it must be noted that there is no mention of a natural person in the definition. Further, they state that the definition under the Indian Patents Rules, 2003 (Patents Rules) is broadly worded wherein ""[p]erson other than a natural person" shall include a "small entity.""[57] Overall, it can be said that an inclusive definition has been adopted in the Indian Patent Act without being limited to "natural persons" in any way. Thus, it is possible

[54] *Id*; Rohan Deshpande & Karan Kamath, P*atentability of inventions created by AI—the DABUS claims from an Indian perspective*, 15(11) JOURNAL OF INTELLECTUAL PROPERTY LAW & PRACTICE, 879–889 (2020).
[55] *Id.*
[56] Patents Act 1970, § 2(1)(s).
[57] Patents Rules 2003, r 2(da).

that the test of inventorship under Section 2(1)(y) may be satisfied even when the word "person" includes within its ambit an AI system.

As for the meaning of "true and first inventor," Deshpande and Kamath observed that Section 2(1)(y) expressly excludes both "the first importer of an invention into India" and "a person to whom an invention is first communicated from outside India." The Ayyangar Committee Report[58] described this term to mean the "actual deviser of an invention" and the express exclusion of importers and communicators was added due to the mental incapacity of such legal persons to be the "true and first inventors."

This line of thought discloses two things – *firstly*, there is no reference to "personality" or "legal personhood" in Section 2(1)(y); and *secondly*, the clause aims to exclude those persons who cannot form the mental capacity required to be identified as the "true and first" inventor of an innovation.[59] Based on the patent disclosures made by Dr. Thaler, DABUS had independently created the subject matter of the invention without human intervention. Hence, it may be hypothesized that DABUS had the requisite mental capacity to satisfy the test of "true and first inventor" under Section 2(1)(y).

Certain case laws have also contributed to and expanded upon the inventorship criteria. In *V.B. Mohammed Ibrahim v Alfred Schafrnek*,[60] the court held that a person "must have the *capacity* to invent" (emphasis added) and she must show that she "contributed" some part of her "ingenuity or skill or technical knowledge towards the invention in question" to be treated as an inventor. Furthermore, in a later case,[61] the Controller of Patents stated that the inventor is the 'actual deviser of the invention' and laid down the following factors to be considered to assess whether a person can be deemed as an inventor:

1. She must have contributed intellectually to the development of the final invention, or
2. She must have at least provided the ideas to produce the invention even if she does not carry out the actual experiments.

Overall, the following criteria may come into play when determining the inventorship status of AI:

a. The person must be the actual deviser of the invention.

[58] JUSTICE N RAJAGOPALA AYYANGAR, REPORT OF THE REVISION OF THE PATENTS LAW, ¶ 116 (1959).
[59] Rohan Deshpande & Karan Kamath, P*atentability of inventions created by AI—the DABUS claims from an Indian perspective* , 15(11) JOURNAL OF INTELLECTUAL PROPERTY LAW & PRACTICE, 879–889 (2020).
[60] V.B. Mohammed Ibrahim v. Alfred Schafrnek , AIR 1960 Mysore 173.
[61] National Institute of Virology v. Mrs. Vanadana Bhide, No 187163 (581/BOM/1999).

b. She shall be the actual deviser if she has the mental capacity to make some intellectual contribution to the idea that materializes into the invention.
c. The contribution must be novel and necessary for the actual operation of the invention.

Based on the above, it is possible that the DABUS applications may be successful in India. This is because the "natural person" limitation is not consistent with the definition of "person" in the Indian Patent Act and it may be expanded to include non-natural persons. As for its intellectual contribution, there was enough evidence for even the UK patent office to admit that DABUS had indeed *created* the inventions claimed in the applications.[62]

Overall, from the above sections, it is evident that there are strong arguments for both recognition and non-recognition of AI inventorship. It is important that lawmakers balance these arguments against the overall objective of the patent system to address future inconsistencies arising from AI-generated inventions. The same must be done for the ownership facet of patent law which will be discussed in the following section.

B. The Ownership Facet

Before delving into the analysis of this facet, it is important to note that inventorship and ownership are two distinct issues. The question of who really invented the subject matter claimed in a patent is dealt with under inventorship. Ownership, on the other hand, is a question of who has a "legal title" to the subject matter claimed in a patent, given that patents have the traits of personal property.[63]

The determination of ownership is critical because it influences how rights and responsibilities flow once a patent is granted. *Firstly*, a patent gives the owner not the freedom to use the claimed invention herself but to prevent or control the use of the invention by others.[64] This is generally expressly codified in patent statutes. For example, under US patent law, ownership of a patent gives the patent owner "the right to exclude others from making, using, offering for sale, selling, or importing into the United States the invention claimed in the patent."[65] Section 48 of the Indian Patent Act too uses this language to describe the rights vested in the owner. Section 13 of the Australian Act is also similarly worded whereby it states that the owner has the right to exploit the

[62] Patent Decision (O/741/19), Intellectual Property Office, ¶ 15 (2019).
[63] Beech Aircraft Corp. v EDO Corp. 990 F.2d 1237, 1248 (Fed. Cir. 1993) [hereinafter *Beech Aircraft Corp*].
[64] *Bently*, *supra* note 2, at 619.
[65] 35 U.S.C. § 154(a)(1).

invention. Here, "exploit" has been defined in the statute as making, hiring, selling, using, importing or otherwise disposing of the invention.

Secondly, a patent owner has the right to make decisions regarding the terms and conditions under which a patent may be transferred to others either by assignment, licence or mortgage. Lastly, only the patent owner has the right to sue another for infringement if they practice her invention without her consent.[66]

Given this broad range of rights, it is natural that disputes may arise regarding the rightful owner of the patent. The question of the rightful owner is intertwined with the question of who is properly entitled to be granted the patent. This is because the chain of ownership commences with such a person i.e., they are treated as the patent's "first proprietor."[67] Courts have often ascribed the right to be granted a patent to inventors.[68] This has also been expressly codified in the Australian Act under Section 15(1) which provides that "a patent for an invention may only be granted to a person who is the inventor." Thus, while anyone may apply for the patent, it is generally the real deviser of the claimed invention who is granted the patent and is also recognised as the true owner.

While an AI may be an inventor, there is no doubt that it cannot be the owner of a patent as attaining the status of legal personhood is still a distant reality for current AI machines. Hence, at this point, computers cannot legally own property nor can they be vested with any rights under patent law. Without vesting of rights, AI systems cannot legally transfer any such right to third parties under patent law or any other property law.[69] In addition, AI systems do not have the capacity to sue or be sued.

The above argument was, in fact, brought out during the DABUS hearing before the Australian Federal Court whereby the opposing party stated that ownership of a patent "flows from the inventor."[70] As a result, the inventor must be legally capable of assigning her interests in the

[66] *Bently*, *supra* note 2, at 619; WIPO, *Module 3: Inventions and Patents*, WORLD INTELLECTUAL PROPERTY ORGANISATION, *available at* https://www.wipo.int/export/sites/www/sme/en/documents/pdf/ip_panorama_3_learning_points.pdf.
[67] *Id.*
[68] Beech Aircraft Corp. v EDO Corp. 990 F.2d 1237, 1248 (Fed. Cir. 1993).
[69] Shubham Singh, *Attribution of Legal Personhood to Artificially Intelligent Beings* , BHARATI L. REV. 194, 197, (2017); JOSHUA GELLERS, RIGHTS FOR ROBOTS: ARTIFICIAL INTELLIGENCE, ANIMAL AND ENVIRONMENT LAW (Routledge 1st ed., 2021).
[70] Thaler v. Commissioner of Patents [2021] FCA 879.

invention and communicating this intention. However, as an AI system does not have a legal personality, it cannot assign its rights. In fact, it cannot even have rights to assign. On this basis, he argued that a human, and not an AI machine, should be the inventor and the owner of the patented invention.

This line of reasoning adequately points out the gap in the existing ownership framework under patent law with respect to AI generated inventions. Even if an AI machine is acknowledged as the inventor, the question of the rightful owner would remain unclear. This would lead to the failure of the grant of patent and the AI-made invention would once again be in danger of falling into the public domain.

Fortunately, it is possible to resolve this conundrum and it should not be used as a justification to reject AI inventorship. Interestingly enough, even the Australian Federal Court held such a view based on its analysis of Section 15 of the Australian Act. Rejecting the arguments of the opposition, it observed that "possession of an invention is the foundation of ownership" and that such possession "can found title, without the need for any assignment."[71] In other words, a possessory title would be "as good as an absolute title of ownership."[72] Furthermore, ownership of a patent would not necessarily have to be obtained by transfer of rights from the inventor to the would-be owner. This would imply that Dr Thaler, having possession of DABUS' inventions, would be entitled to ownership of these inventions even without any assignment of rights by the artificial creator.

In addition, the court stated that Dr Thaler's ownership and control of DABUS would directly entitle him to any inventive output of DABUS. It arrived at this conclusion using established principles of property law such as "fructus industrials" which envisages that those things which are produced by the labour of man would be treated as his personal property.[73] Accordingly, it drew an analogy between the ownership in the output of an AI system and a land owner's ownership of the "progeny of animals or the treatment of fruit or crops produced by his labour and expense on his land" and declared Dr. Thaler as the true owner of the patents of DABUS' inventions.[74]

[71] Thaler v. Commissioner of Patents [2021] FCA 879.
[72] Russell v. Wilson (1923) 33 CLR 538.
[73] Leigh v. Lynch, 493 N.E.2d 1040 (1986).
[74] Thaler v. Commissioner of Patents [2021] FCA 879.

As this is a recent decision, it is still unclear whether other jurisdictions may also apply the above reasoning to justify ownership of AI-generated inventions by a human actor. An additional problem that arises is identifying such an ideal human actor. Unlike in Dr. Thaler's case, it is often observed that the developer, the owner and the operator of the AI system refers to three distinct parties and it may be difficult to determine who would be the proper grantee of the patent. Some scholars have devised propositions to address this very issue which will be discussed in the upcoming chapters.

C. The Case for AI Inventorship: Implications of Non-Recognition

Having examined the criteria for both inventorship and ownership, it is evident that the barriers to recognising AI as an inventor are simply a matter of legal interpretation or policy and need to be amended. This is because it is the opinion of this researcher that the case for recognising AI inventors is growing stronger with every advancement made in AI's inventive capabilities.

Currently, many patent law experts do not seem overly concerned about the growing inventiveness of AI applications and believe that the current legal system (though anthropocentric and outdated) is equipped to handle AI-generated inventions. As showcased earlier, some scholars argue that AI has not reached the level of intelligence and creativity that humans can display and hence, believe that only humans can truly be deemed as "inventors" in the true sense of the word. However, what they overlook is that such an argument does not account for "inventions without an inventor" which are the result of the randomness of the AI's inventive output and are unforeseen by human operators.[75]

Furthermore, in any patent legislation, the issue of "intelligence" is not very relevant. This is because courts generally examine the "outcome of the inventive process" as well as the "quality of the results" and not the "subjective mental processes" by which the invention was made.[76] Or as Tim Dormis puts it, they are not concerned whether the inventive process was "driven by a genuinely intelligent will or by a mechanical and soulless AI."[77] The tricky problem is determining who is to be designated as the 'inventor' of an AI-generated invention, especially if there is no real human contribution to the end result. Determining inventorship is important as issues such as ownership of the invention, right to licence, liability for patent infringement and others all rely on this final pronouncement.

[75] *Dormis*, *supra* note 14, at 114.
[76] *The "Flash of Genius" Standard of Patentable Invention* , 13 FORDHAM LAW REVIEW 84, 86 (1944).
[77] *Dormis*, *supra* note 14, at 107.

Many leading sources of AI technologies show that recent Al systems are quite capable of becoming independent in the near future. Through the employment of artificial neural networks and genetic programming, AI machines today already have the necessary building blocks to crudely imitate human intelligence and display some autonomy by deviating from the initial functional parameters fed by humans. Due to this, AI development may soon become so sophisticated that it may be considered as an inventor because its contribution to the conceptualization of the innovation is deemed sufficient.[78] As demonstrated previously, AI technologies such as the Creativity Machine, Watson and even DeepMind's AI called AlphaGo are all already capable of mimicking human cognition.

Moreover, if the inventor is inaccurately listed, it would violate the necessary requirements under the patent regime and possibly cause the rejection of a patent application. Worse still would be if the patent application is granted. This is because once it is revealed that the true inventor had been incorrectly identified, it could lead to the invalidation of the granted patent.[79] No human could validly qualify as the inventor if she never had a firm and definite idea of the claimed invention and simply aided the AI by providing well-known input data sets. This could cause the patented invention to fall into the public domain and affect remuneration.

Furthermore, denying patent protection to inventions simply because they were made by an AI has certain other ramifications. If AI's inventive technical progress is not disclosed in patent applications, then there is a risk that such progress would not be made public and would not be known by the society under the patent publication systems.[80] This, as author Watanabe points out, would retard innovative progress as the remaining inventions would exist only in the range of human beings' intellectual aptitude.[81] In addition, the social benefit and public welfare to be gained from inventions made by AI systems that possess much higher capabilities would be lost. Thus, if we want to gain additional benefits through AI's inventions, the standards that necessitate human inventorship should be relaxed. If we properly safeguard Al-made inventions through patent systems, we may be able to advance human progress even further.

[78] *Watanabe*, *supra* note 33, at 490.
[79] Alex Wolcott, *Failure To Name Joint Inventors May Bar Patentability*, GLOBAL IP TECHNOLOGY LAW BLOG (May 20, 2018), *available at* https://www.iptechblog.com/2018/05/failu re-to-name-joint-inventors-may-bar-patentability/.
[80] 3 JOHN M. GOLDEN ET AL., PRINCIPLES OF PATENT LAW: CASES AND MATERIALS (7th ed., 2018).
[81] *Watanabe*, *supra* note 33, at 493.

Thus, it is evident that legal reforms must be brought to recognise AI inventorship. An important consideration in this endeavour is that there must global harmonization in patent systems regarding the treatment of Al-generated inventions. This is important because if the inventorship requirement for an Al-made invention varies from country to country, a potential infringer could use the weaknesses or gaps in such criteria to challenge the patent's validity.[82] Thus, a uniform framework needs to be developed to address the issue of AI inventorship and ownership. The next chapter will make an attempt to suggest suitable changes to the existing patent paradigm.

IV. THE WAY FORWARD: RETHINKING THE PATENT PARADIGM

From the previous section, it is evident that, despite concerns, recognition of AI as the inventor under patent law would be a desirable outcome. This is so considering both the rapid advancements in AI's capabilities and the potential benefits that could be derived by incentivising development of such creative computers. However, as has been pointed out by the courts in the US and Australia, there are two main barriers to recognition of AI inventors – *firstly*, an AI is not a "natural person" and *secondly*, it does not fulfil the "mental act" requirement. It is necessary that these criteria be reconsidered to accommodate non-human inventors.

A. Rethinking the 'Natural Person' Criterion

With respect to this criterion, it is the opinion of this researcher that literally interpreting and accordingly, restricting the meaning of "inventor" to some biological being with intelligence sets a bad precedent as non-recognition of AI inventors would ultimately invalidate AI-generated inventions from patent protection. Instead, it would be wise if a broader and more dynamic interpretation is accorded to the word "inventor." This is especially important considering that the original text of most patent statutes was written at a time when AI-generated inventions were unforeseeable and were initially designed to favour individuals over corporations.[83] Furthermore, there is already much evidence that without creative computers such as DABUS and Watson, it may not be possible for humans to make certain breakthroughs that require processing of huge datasets or linking of unprecedented patterns that deviate from "conventional wisdom."[84]

And in fact, undertaking such an exercise is actually quite possible and has been done before. For instance, in *Diamond v Chakrabarty*,[85] the US Supreme Court took a flexible approach to recognise

[82] *Ibid.*
[83] Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 57(4), BOSTON COLLEGE LAW REVIEW, 1079 (2016) [hereinafter *Abbott*].
[84] Adam Frank, *The Infinite Monkey Theorem Comes to Life*, NPR (Dec. 10, 2013), *available at* http://www.npr.org/blogs/13.7/2013/12/10/249726951/the-infinite-monkey-theorem-comes-to-life.
[85] Diamond v Chakrabarty ,447 U. S. 303 (1980).

the patentability of genetically modified organisms even when the text of the statute expressly prohibited the patenting of living organisms. In justifying its approach, the court had stated that "refusing patent protection for inventions in areas not contemplated by Congress... would frustrate the purposes of the patent law."

Following such rationale, it is necessary that policymakers and courts consider expanding the definition of "inventor" to include non-human inventors like AI machines. The issues of legal personhood and assignment of rights can be easily addressed by designating a proper human actor who shall bear any subsequent implications. For this, it has been suggested that patent applications be specially modified for AI-generated inventions to provide two designations namely "inventor" and "creator" whereby the AI would become the inventor and the human that devised/operated the AI could be the creator and would bear the future rights and liabilities.[86]

B. Rethinking the 'Mental Act' Criterion

As for the "mental act" requirement, the reasoning given by courts in the DABUS decisions is questionable where they seem to have equated mental activity to a certain level of cognition and consciousness. Nowhere does any patent system define or even envisage the need for consciousness. The "mental act" doctrine was devised by courts and even then, its actual import is quite unclear. Does "mental act" refer to a process that simply results in some inventive output or does it require a demonstration of human intellect? If it is the former, then AI machines already sufficiently fulfil this inventorship criterion as is evinced by the inventions created by DABUS, the Creative Machine, Watson and others. If it is the latter, then it is a flawed approach as courts would then have to further undertake the onerous, and quite frankly pointless, exercise of determining the level of human cognition or thought that an AI must meet.[87]

It is the opinion of this researcher that the former approach would be most suitable i.e., interpreting "mental act" as just some process that ultimately results in a creative output, without analysing the said process itself. Or in other words, if the final outcome of the machine's computation is a sufficiently inventive contribution, then conceptualisation of the invention through a "mental act" of the AI should be presumed and courts should not unnecessarily delve into studying the actual processing that took place.

[86] Prachi Sawan et al., *AI: The Artificial Inventinator*, Sagacious IP (2022), *available at* https://sagaciousresearch.com/blog/wp-content/uploads/2021/01/AI_-The-Artificial-Inventinator.pdf.
[87] *Abbott*, *supra* note 83, at 1108.

This approach is consistent with the framework of the patent law system as it is typically only interested in the invention itself and is unconcerned with the means by which the invention may be accomplished.[88] This is apparent from the fact that the "flash of genius" standard of patentability was abolished in 1952 and instead replaced by the non-obviousness standard. The former was criticised because it tested the nature of the mental process by which the inventor came up with the claimed invention i.e. from a "sudden flash of genius" or from "long toil and experimentation."[89] This apparently set up a very vague and unhelpful criterion where courts would have to make the subjective decision about the inventor's state of mind.[90] Instead, law makers opined that patentability should be judged objectively "by the nature of the contribution to the advancement of the art claimed" in the patent application.[91]

In addition, for AI inventorship, the anthropomorphic threshold of human intelligence should be discarded and a more functionalist approach should be considered. For this, cue may be taken from Alan Turing's test called the "imitation game" which tries to assess whether a third party "can perceive the difference between the responses of a computer and a human."[92] Accordingly, to check an AI system's capacity to autonomously invent, courts could determine whether the AI machine could perform in a manner similar to a thinking entity, instead of checking whether they can actually "think."

C. Rethinking Ownership of AI-Generated Inventions

Even if AI was to be recognised as an inventor, the question regarding the rightful owner of an AI-generated invention still remains as computers cannot own property (including IP). Accordingly, the possible human actors who could be designated as the "owner" include:

a. The AI's *owner* i.e., the person who owns the AI as a chattel,
b. The *developer* i.e., the person who programmed the AI, or
c. The *user* i.e., the person giving the AI tasks.

Some scholars believe that the owner of an AI system should be granted ownership of its inventions because it would be most consistent with the way personal property laws work. If a person owns a machine that produces property, then he should naturally be entitled to such

[88] *Id.*
[89] Graham v. John Deere Co. of Kan. City, 383 U.S. 1 (1966).
[90] Stephen Kalinchak, O*bviousness and the Doctrine of Equivalents in Patent Law: Striving for Objective Criteria*, 43 CATH. U. L. REV. 577, 586, (1994).
[91] William Jarratt, *U.S. National Patent Planning Commission*, 153 Nature 12, 14, (1944).
[92] *Turing*, *supra* note 10.

derivative property.[93] This is because it was her investment that made the machines, or more specifically the AI's, development possible in the first place. This would also be consistent with patent law's economic paradigm which requires that the value created from AI's innovation be conveyed to the investors.[94]

The above argument is also reinforced by the fact that granting ownership to a user may be risky and stifle innovation. If the AI's owner, say IBM, made Watson available to numerous users and it created patentable results that would be assigned by default to such users, then IBM might restrict access to Watson for fear of losing Watson's inventions to them. In contrast, assigning the rights to the inventive output to IBM by default would motivate IBM to allow more access to users.[95]

On the other hand, there are some authors who argue that the AI user would be the optimal right owner. This is because AI owners or developers generally target clients in other industries when marketing their AI applications. As a result, the specific output of the AI system's innovative process is actually produced by players outside the AI industry.[96] The AI system's output will be included in the patent portfolio of the user and not the AI owner or developer. Basically, the "production" of the AI-generated invention would take place outside of the AI developer's or owner's control and supervision. Hence, they could not be held as the rightful owners of the patented invention.

As for AI developers, there has been little to no support for their right to own AI's inventions. This is primarily because it is highly unlikely that the developer's initial creative input would have a direct nexus with the AI system's output. This is especially in the case of autonomously inventive AI which tends to evolve beyond the initial parameters. Hence, although the developer may have provided the raw materials for the AI inventive activity, the final outcome is generally quite different and more sophisticated than the results anticipated.[97]

It is the opinion of the author that the default ownership should be granted to the owner of the AI system as much of their economic interest in the AI would be at stake. As reasoned by the scholar Ryan Abbott, it would be easier for a user to later have the ownership rights in a specific

[93] *Abbott*, *supra* note 83, at 1085.
[94] *Id.*
[95] *Id.*
[96] *Dormis*, *supra* note 14, at 152.
[97] *Id.* at 154.

inventive output transferred to herself through a licence or other contractual arrangements with the owner.[98]

Overall, the final resolution of the above stated problems is a policy decision and depends on the patent system of each country. However, it is quite evident that by simply shifting the thoughta process and adapting the current legal provisions and standards, the patent system can easily accommodate and accept patent applications where an AI has been named as the inventor.

V. CONCLUSION

The contribution of AI towards the inventive process cannot be denied. What makes AI so capable is machine learning technology which allows it to analyse large data sets and 'learn' independently from what has been input by human coders.[99] Hence, Marvin Minsky, one of the founding fathers of AI science, had once opined that "AI can behave in ways that probably everyone would agree seems to show intelligence."[100] Scientists like Surden believe that during the process of inventing, over time, the AI system will grow and develop its own capabilities. He stated that the inventive output of the AI machine may eventually be similar to or even better than what humans would have developed based on "experience or intuition."[101]

And in fact, their predictions have already turned out to be true as is evinced from the inventive output of creative AI machines like DABUS and Watson. Despite being narrow AI systems, they are already demonstrating a level of intelligence and autonomy in their inventive endeavours which warrant protection for their works under the patent law system. AI is evolving faster than anticipated and this disruptive technology is already having an impact on the patent regime whose anthropocentrism is outdated and incapable of responding to inventorship and ownership issues arising from AI-generated inventions.

There is an urgent need to engage in policy and regulatory conversations at both the international and domestic levels to consider these issues. The intense debate surrounding 'DABUS' patent applications only shows that it would not be prudent to wait for further development of AI's capabilities. It already presents a challenge to the tests and standards that had only been developed to assess human inventiveness and never accounted for artificial creativity.

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[98] *Abbott*, *supra* note 83, at 1117.
[99] Peter Flach, *Machine Learning: The Art and Science of Algorithms That Make Sense of Data* 3 (2012).
[100] Marvin Minsky, *Artificial Intelligence*, 215 Sci. AM 246, 247, (1966).
[101] Harry Surden, *Machine Learning and Law,* 89 WASH. L. REV. 87, 90, (2014).

Based on the discussion so far, scholars have pointed out both pros and cons to reforming the patent system for recognising AI inventorship. Although many positives of recognising AI inventorship have been brought out in this paper, there are also some limitations that require resolution. For instance, the black box conundrum of AI systems may pose a problem whereby we are privy to the input and the output of the system but are unable to get a clear view into the processes and workings in between.[102] This would make it difficult to provide the specifications in the patent application and demonstrate the contribution made by the AI. However, keeping in mind the potential benefits to innovation and the overall welfare of the society, it is important that the patent regime be modified now to keep pace with the rapid advancements in the growth of AI. By adopting alternative interpretations to the inventorship criteria as suggested earlier, AI inventors could easily be recognised under the current patent paradigm. Furthermore, by relaxing the mental act requirement and using Turing's 'imitation game' test, courts will find it easier to determine whether the contribution of the AI was sufficient enough to cause the advancement of some prior art.

Even the issues regarding ownership of AI generated inventions can be resolved by designating the AI's owner as the owner of the patent. Rights could later be transferred to other developers or users through contractual arrangements, under terms and conditions suitable to both parties. This would bypass the problem of AI's lack of legal personhood and incapability to hold rights.
However, the final resolution of these issues is still within the power of the legislators and courts. They must seriously reflect on the issue of AI inventorship and expediently issue guidance in this matter so as to bring certainty to innovators and businesses and promote the progress of science.

[102] Carolyn S. Toto, *The Black Box Conundrum: Go Weak or Stay Strong*, *available at* https://www.jdsupra.com/legalnews/the-black-box-conundrum-go-weak-or-stay-1001175/.