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ARTIFICIAL INTELLIGENCE AS INVENTOR?

The UK Supreme Court's ruling in *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2024] Bus LR 47 clarifies that only natural persons can be inventors under the UK Patents Act 1977, dismissing the notion of AI as an inventor. This decision, aligned with international precedents, addresses the growing debate over AI's role in innovation. This article's position is that humans are the inventors of AI-generated inventions with AI essentially being a tool. Granting inventorship to AI would be inconsistent with the fundamental purpose of the patent law system which is to incentivise humans to make inventions and reward them for their ingenuity and labour. AI is incapable of responding to such behavioural incentives the way that humans do.

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I. Introduction

1 Artificial intelligence ("AI") is well poised to usher in another technological revolution, replacing the present digital revolution which brought us computers and the Internet.[1] It is a general-purpose technology that is able to "perform activities which used to be typically and exclusively human" as well as develop "certain autonomous and cognitive features", such as the ability to learn from experience and make decisions.[2] The technology has now become nearly ubiquitous in modern society, permeating our daily lives with innovative products such as voice recognition devices (*eg*, Siri and Alexa), virtual assistants (*eg*, Google Assistant), self-driving vehicles (*eg*, Tesla) and facial recognition on smartphones. In the healthcare sector, it is used to analyse medical images

1 In 2018, Sundar Pichai, CEO of Google, said that AI is comparable to fire and electricity in terms of its importance to humanity and that AI is one of the most profound things that humanity is working on: see Lauren Goode, "Google CEO Sundar Pichai Compares Impact of AI to Electricity and Fire" *The Verge* (19 January 2018) <https://www.theverge.com/2018/1/19/16911354/google-ceo-sundar-pichai-ai-artificial-intelligence-fire-electricity-jobs-cancer> (accessed 3 June 2024).

2 European Parliament, *Civil Law Rules on Robotics* (2017), P8_TA(2017)0051 at §Z <https://www.europarl.europa.eu/doceo/document/TA-8-2017-0051_EN.html> (accessed 3 June 2024).

and make diagnoses as well as detect defects in pharmaceutical products. It is also used to detect fraud and identify investment opportunities in the financial industry.[3] AI has even found its way into the legal profession. For instance, legal research services such as CARA[4] and vLex[5] can analyse legal briefs, considering "factors such as the procedural posture of the case, the pattern of citations, and even which citations may be missing" in order to evaluate the "strengths or weaknesses of a brief or pleading".[6]

2 It has been widely recognised that such developments pose novel and significant challenges to the existing legal framework for protecting innovation, including the rules on inventorship. Consequently, a number of international and national organisations responded by launching public consultations and conducting studies on the impact of the challenges and the appropriate legal response. For instance, in 2018, the EU's Joint Research Centre conducted a study on the interplay between intellectual property ("IP") and AI which concluded that there are several issues that call for further reflection, such as those relating to the protection of inventions generated by AI.[7] The World Economic Forum issued a White Paper entitled "Artificial Intelligence Collides with Patent Law" in April 2018 in which it considered, amongst others, the question as to who should be listed as the inventor of an invention generated entirely by AI.[8] In August 2019, the United States Patent and Trademark Office published a paper entitled "Request for Comments on Patenting Artificial Intelligence Inventions" in which it asked for comments on,

3 See, *eg*, R L Adams, "10 Powerful Examples of Artificial Intelligence in Use Today" *Forbes* (10 January 2017) <https://www.forbes.com/sites/robertadams/2017/01/10/10-powerful-examples-of-artificial-intelligence-in-use-today/?sh=741b985e420d> (accessed 3 June 2024); Sam Daley, "27 Examples of Artificial Intelligence Shaking Up Business as Usual" *Built In* (18 August 2022) <https://builtin.com/artificial-intelligence/examples-ai-in-industry> (accessed 3 June 2024); and Jessica Montgomery, "The AI Revolution in Scientific Research: Applications and New Research Directions" *The Royal Society* (6 August 2019) <https://royalsociety.org/blog/2019/08/the-ai-revolution-in-science/> (accessed 3 June 2024).

4 CARA utilises AI technology developed by Casetext to deliver relevant cases based on an uploaded legal document. See <https://casetext.com/cara-info> (accessed 3 June 2024).

5 vLex is a global legal intelligence platform that provides access to an extensive collection of legal and regulatory information. See <https://vlex.com/> (accessed 3 June 2024).

6 Bob Lambrechts, "May It Please the Algorithm: The Future of AI in the Practice of Law" (2020) 89 J Kan Bar Assn 36 at 40.

7 Maria Iglesias Portela, Shamuilia Sheron & Amanda Anderberg, *Intellectual Property and Artificial Intelligence: A Literature Review* (Publications Office of the European Union, 2021).

8 World Economic Forum, *Artificial Intelligence Collides with Patent Law* (White Paper, 20 April 2018) at p 10 <https://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf> (accessed 3 June 2024).

amongst others, whether the "[C]urrent patent laws and regulations regarding inventorship need to be revised to take into account inventions where an entity or entities other than a natural person contributed to the conception of an invention?"[9] A similar request was made by the World Intellectual Property Organisation ("WIPO") in December 2019 when it commenced consultations with stakeholders by issuing a draft "Issues Paper on Intellectual Property Policy and Artificial Intelligence" ("WIPO's Draft Issues Paper"). In that paper, it asked for responses to questions such as: "Should the law require that a human being be named as the inventor or should the law permit an AI system to be named as the inventor?"[10]

3 Such questions stem in large part from the assertion of several patent scholars that AI systems have become autonomous agents endowed with human-like capability to make decisions, solve problems and perform tasks on their own. Their clarion call is for AI to be recognised as the inventor of inventions generated "autonomously" by AI and for the patent law system to be radically updated in this regard. For instance, they boldly assert that:

> (a) "With the advent of [AI] the end of patent law is near" and "humans no longer stand at the centre of the creative universe – we are no longer the masters of innovation."[11]
>
> (b) "The traditional approach to patent law in which policy makers seek to identify the human inventor behind the patent is … no longer relevant. We are facing a new era of machines 'acting' independently, with no human being behind the inventive act itself."[12]

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9 "Request for Comments on Patenting Artificial Intelligence Inventions" *Federal Register* (27 August 2019) <https://www.federalregister.gov/documents/2019/08/27/2019-18443/request-for-comments-on-patenting-artificial-intelligence-inventions> (accessed 3 June 2024).

10 World Intellectual Property Organization, *Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence* (WIPO/IP/AI/2/GE/20/1, 13 December 2019).

11 Tim W Dornis, "Artificial Intelligence and Innovation: The End of Patent Law as We Know It" (2020) 23 *Yale Journal of Law & Technology* 97. See also Shlomid Yanisky-Ravid & Xiaoqiong (Jackie) Liu, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2018) 39 Cardozo L Rev 2215 at 2222, who advocated "abolishing patent protection of inventions by AI altogether" and suggested "promoting innovations and public disclosure of inventions by AI through alternative tools such as, *eg*, first-mover advantages, social recognition of AIs, and alternative technologies that prevent infringement of rights, rather than relying on traditional intellectual property law to accomplish these goals."

12 Shlomid Yanisky-Ravid & Xiaoqiong (Jackie) Liu, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2018) 39 Cardozo L Rev 2215 at 2216–2217. See also Anna C Comer, "AI: Artificial

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> (c) "[T]he framework for evaluating patents must be re-examined in light of the new paradigm to determine whether the rationale supporting the old framework supports the maintenance of this framework during the transformation of the invention process."[13]

4 However, it has been observed that such anthropomorphic depictions of AI by these scholars were based on their "somewhat breathless and overwrought perspective" of AI technology and its claimed capabilities.[14] They proceeded on the erroneous assumption of AI autonomy as a current technological reality and merely relied on a handful of examples, "without providing or referencing a technical analysis [of the AI systems], which could explain how the 'intelligent systems' were designed, and how the overall computational process leading to an invention was set up".[15]

5 The thesis of this article is that humans are the inventors of AI-generated inventions and AI is essentially a tool, albeit an "intelligent" computational tool. Granting inventorship to AI would be inconsistent with the fundamental purpose of the patent law system which is to incentivise humans to make inventions and reward them for their ingenuity and labour. That purpose has been embraced in various patent statutes since at least the 15th century and remains relevant today, especially for some industries (such as the pharmaceutical and technology industries) which require immense investment and resources to innovate. The purpose also serves to protect the human inventor's "moral right" to be recognised as such and to receive credit for his invention. In contrast, no one would seriously assert that AI is capable of responding to behavioural incentives the way that humans do. It has no mind in which the ability to conceive a solution to a problem resides. As such, it cannot by definition be an inventor. There is no necessity to make doctrinal accommodation for AI concerning the purpose of the patent law system in general and the rules on inventorship in particular.

Inventor or the Real Deal" (2021) 22 *North Carolina Journal of Law & Technology* 447 at 472–480 (arguing that "patent law should recognise AI as an inventor") and Ernest Fok, "Challenging the International Trend: The Case for Artificial Intelligence Inventorship in the United States" (2021) 19 Santa Clara J Intl L 51 at 72 (arguing that recognising AI as inventor has the potential to benefit the US patent system).

13 Liza Vertinsky & Todd M Rice, "Thinking About Thinking Machines: Implications of Machine Inventors for Patent Law" (2002) 8(2) B U J Sci & Tech L 574 at 614.

14 Dan L Burk, "AI Patents and the Self-assembling Machine" (2021) 105 *Minnesota Law Review Headnotes* 301 at 301.

15 Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight" (May 2020) 69(5) *GRUR International* 443 at 444. AI systems are routinely referred to as "intelligent systems" even though they do not possess any indicia of general intelligence at all.

6 This article unfolds as follows. It starts in Part II with an overview of the history and rationale of the patent system, with a focus on the concept of "incentive and reward" which largely underpins the patent system from its early days. It then reviews in Part III the recent decision of the UK Supreme Court in *Thaler v Comptroller-General of Patents, Designs and Trade Marks*[16] ("*Thaler*") which dismissed the notion that a machine (including a machine acting "autonomously" and powered by AI) can be an inventor for the purposes of obtaining a patent under the UK Patents Act 1977[17] (the "UK PA 1977"). The impact of this decision regarding inventorship on the legal position under the Singapore Patents Act 1994[18] (the "Singapore PA 1994") is also discussed. Part IV (entitled "Deep think") provides a brief technical perspective of the AI systems, drawing attention to the fact that humans are involved in every phase of the invention process by AI (including formulating the inventive concept), and submits that humans are thus rightly recognised in fact and in law as inventors of AI-generated inventions. This Part also points out that there is no empirical evidence that the failure to accord inventorship to AI would lead to market failure and to the general behaviour of inventors resorting to trade secret protection instead, to avoid disclosing their inventions. It submits that it is for the Legislature rather than the courts to change the *status quo*. This article concludes in Part V with a hopeful and sanguine view that patent law can surmount the challenges of AI, as it has done in the past with other technologies.

II. The patent system

A. Incentivising and rewarding human inventors

7 The patent system has long been used as a policy tool to incentivise and reward innovation, promote economic development and increase the fund of human knowledge. In particular, the concept of incentivising and rewarding innovation through the grant of exclusive rights for a limited period (the "Incentive and Reward Concept") has a long history. It was introduced in 1474 when Venice promulgated the first codified patent statute in the world.[19] Venice was then a prosperous

16 [2024] Bus LR 47.

17 c 37.

18 2020 Rev Ed.

19 See, *eg*, Frank D Prager, "A History of Intellectual Property from 1545 to 1787" (1944) 26 J Pat Off Socy 711 at 714; Ben McEniery, "Patent Eligibility and Physicality in the Early History of Patent Law and Practice" (2016) 38 U Ark Little Rock L Rev 175 at 183–184; and Stefania Fusco, "Lessons from the Past: The Venetian Republic's Tailoring of Patent Protection to the Characteristics of the Invention" (2020) 17 NW J Tech & Intell Prop 301 at 307–308.

city-state with a strategic port on the Adriatic Sea, serving as a crossroads for trade with the eastern Mediterranean as well as the Far East. It was also a leading centre for shipbuilding, glassware, lace and book printing and encouraged skilled foreign artisans with their knowledge of new technologies to come to boost the production of goods.[20] This is reflected in the preamble of the statute: "We have among us men of great genius, apt to invent and discover ingenious devices; and in view of the grandeur and virtue of our City, more such men come to us every day from diverse parts."[21]

8 The statute granted a monopoly of ten years to "every person who shall build any new and ingenious device in this City". The use of the expression "new and ingenious device" indicates that the statute rewarded novelty of the device, which is a fundamental element in the modern patent system. Other precursors of the modern patent system include a registration system whereby applicants were required to submit their applications to a central authority for acceptance, much like the present-day system of filing applications in a patents registry.[22]

9 These seminal concepts and features of the Venetian patent statute were adopted in the English Statute of Monopolies some 150 years later, in 1624. That statute declared all grants of monopolies to be void, other than patents for invention which it allowed for a limited period. Prior to the Statute of Monopolies, letters patent (literally meaning "open letters") were issued by the Crown to award monopolies in the exercise of the royal prerogative to encourage skilled foreign workmen to bring new trades and industries to the realm. However, this practice of the Crown was open to abuse and was abused. "Odious monopolies" were granted by the Crown to court favourites for goods which were already in use and enjoyed by the public, such as salt, paper, playing cards, wine and

20 One of them was John of Speyer, a printer, who introduced the new art of printing to Venice: see, *eg*, Ben McEniery, "Patent Eligibility and Physicality in the Early History of Patent Law and Practice" (2016) 38 U Ark Little Rock L Rev 175 at 182.

21 Stefania Fusco, "Lessons from the Past: The Venetian Republic's Tailoring of Patent Protection to the Characteristics of the Invention" (2020) 17 NW J Tech & Intell Prop 301 at 312–314: for three centuries after the statute, thousands of patents were granted for a wide variety of inventions, including watermills, canal-dredging equipment and irrigation pumps. By the 16th century, Venice became the centre of technological development in Europe, having changed from a nation of sailors into a nation of mainly artisans and engineers.

22 Stefania Fusco, "Lessons from the Past: The Venetian Republic's Tailoring of Patent Protection to the Characteristics of the Invention" (2020) 17 NW J Tech & Intell Prop 301 at 314.

cloth. The Statute of Monopolies represented a pushback by the English Parliament to curtail the abuses by the Crown.[23]

10 According to Sir Edward Coke, the reasoning for the monopoly granted in the Statute of Monopolies was "because the inventor bringeth to and for the Commonwealth a new manufacture by his invention, cost and charges, and therefore it is reason, that he should have a privilege for his reward (and the encouragement of others in the like) for a convenient time".[24] This describes the Incentive and Reward Concept. The monopoly was granted for 14 years "to the true and first inventor" engaged in the "making of any manner of new manufactures within this realm".[25] This is akin to rewarding "new and ingenious device" in the Venetian statute.

11 The Statute of Monopolies was the basis of the English patent law for 200 years, until the Patent Law Amendment Act 1852[26] was passed. It continued to exercise influence on the law as it was not repealed by the latter Act. For instance, letters patent continued to be treated as a privilege granted under the royal prerogative until the UK PA 1977 which simply provides for a patent certificate to be issued in a prescribed form.[27]

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23 The statute was preceded by two decisions which challenged the nature of the Crown's power to grant monopolies as well as the nature and power of the royal prerogative, namely, *Darcy v Allen* (1602) 77 ER 1260 and *The Clothworkers of Ipswich* (1653) 78 ER 147, in which the common law courts held that a monopoly which took away a person's trade was void. See also Ramon A Klitzke, "Historical Background of the English Patent Law" (1959) 41 J Pat Off Socy at 635; Edward C Walterscheid, "The Early Evolution of the United States Patent Law: Antecedents (Part 2)" (1994) 76 J Pat & Trademark Off Socy 849 at 865; and Ben McEniery, "Patent Eligibility and Physicality in the Early History of Patent Law and Practice" (2016) 38 U Ark Little Rock L Rev 175 at 184–191.

24 Edward Coke, *The Third Part of the Institutes of England: Concerning High Treason and Other Pleas of Crown and Criminal Clauses* (1797) at p 184 (altered for readability: see Ben McEniery, "Patent Eligibility and Physicality in the Early History of Patent Law and Practice" (2016) 38 U Ark Little Rock L Rev 175 at fn 107).

25 Ben McEniery, "Patent Eligibility and Physicality in the Early History of Patent Law and Practice" (2016) 38 U Ark Little Rock L Rev 175 at 192.

26 c 83 (UK).

27 See, *eg*, Fritz Machlup, *An Economic Review of the Patent System* (US Government Printing Office, 1958) at p 3 and Ben McEniery, "Patent Eligibility and Physicality in the Early History of Patent Law and Practice" (2016) 38 U Ark Little Rock L Rev 175 at 193. It has however been asserted that "[a]lthough some of the trappings of the patent system's early connection with the Crown remain, patents are better seen as the product of an administrative process than a form of Crown privilege. The shift from Crown to administration was reinforced with the passage of the [UK Patents Act 1977]": Lionel Bently & Brad Sherman, *Intellectual Property Law* (Oxford University Press, 3rd Ed, 2009) at p 337. The UK Patents Act 1977 was enacted to comply with the UK's treaty obligations under the European Patent Convention ("EPC"), the Community Patent Convention ("CPC") and the Patent Co-operation Treaty ("PCT").

The Incentive and Reward Concept which the statute embraced was regarded by the highest courts in the UK as providing justification for the patent system. For instance, the House of Lords in *Asahi Kasei Kogyo KK's Application*[28] opined that "[t]he underlying purpose of the patent system is the encouragement of improvements and innovation" and in *Goddin and Rennie's Application*,[29] the Court of Session (Outer House) in Scotland explained that "[t]he primary purpose of the patent system is to encourage the development and exploitation of new ideas".

12 The Singapore courts have also adopted the concept for the domestic patent regime. In the recent case of *IIa Technologies Pte Ltd v Element Six Technologies Ltd*,[30] the Court of Appeal said that the regime "seeks to encourage innovation by granting the patentee a monopoly over the patented invention for a limited period (meaning the right to exclude others from using that invention)".[31] The reality is that if there is no incentive or reward, no *human* inventor would expend time, money and other resources to undertake the process of invention. The period of the monopoly (typically 20 years) is considered to be sufficient for the inventor to receive enough return from his invention to justify the expenditure. After the period, the invention falls into the public domain. It is believed that, in this way, industrial progress and economic development as well as societal well-being are enhanced.

13 The *quid pro quo* for the monopoly is the inventor's obligation to disclose his invention. Specifically, he must disclose and describe the invention clearly and completely enough in the patent specification so that a person skilled in the art of reading the description can perform or practise the invention without undue burden after the monopoly has expired.[32] The theoretical basis for the obligation is that a patent is a bargain between the inventor and society at large and his disclosure is required to stimulate and incentivise further innovation and investment in innovation.[33] The bargain strikes a fine balance between protecting

28 [1991] RPC 485 at 523.
29 [1996] RPC 141 at 161.
30 [2023] 1 SLR 987.
31 *IIa Technologies Pte Ltd v Element Six Technologies Ltd* [2023] 1 SLR 987 at [57].
32 See also *IIa Technologies Pte Ltd v Element Six Technologies Ltd* [2023] 1 SLR 987 at [57] and [114]. The court explained what is meant by "undue burden" at [134]–[136] of the judgment.
33 See, *eg*, *IIa Technologies Pte Ltd v Element Six Technologies Ltd* [2023] 1 SLR 987 at [102]. The theory also has a long tradition. In *Liardet v Johnson* (1778) 1 WPC 53, Lord Mansfield, the presiding judge, said that "[t]he law relative to patents requires as a price the individual should pay the people for his monopoly, that he should enrol, to the very best of his knowledge and judgment, the fullest and most sufficient description of all the particulars on which the effect depended, that he was at the time able to do". Some scholars consider this theory to be as important

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the inventor's interest and the public interest in the invention becoming accessible to the public after the monopoly has expired.

B. Human inventiveness

14 In the patent law systems of the major industrialised countries, invention is perceived as a human function and the inventor is a natural person who makes a substantial contribution to the solution of a problem. That contribution takes the form of providing creative or intelligent conception of the invention. Conception is a mental and abstract act, requiring human ingenuity and labour. A machine is incapable of performing such a sentient act.

15 US patent law (*ie*, Title 35 of the United States Code) consistently refers to inventors as natural persons. For instance, § 101 states that "*[w]hoever* invents or discovers any new and useful process, machine, manufacture or composition of matter … may obtain a patent therefor" [emphasis added]. "Whoever" suggests a natural person.

16 US courts also entertain the notion of human inventiveness. For instance, in *Diamond v Chakrabarty*,[34] the US Supreme Court held that the subject matter of patents covers whatever is "a product of *human* ingenuity" [emphasis added] and that Congress intended this "to include anything under the sun that is made by *man*"[35] [emphasis added]. In *Burroughs Wellcome Co v Barr Labs, Inc*,[36] the US Court of Appeals for the Federal Circuit said that conception (the "touchstone of inventorship") is "the formation in the *mind of the inventor*, of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice"[37] [emphasis added]. In *Fiers v Revel*,[38] the court held that "The threshold question in determining inventorship is who conceived the invention. Unless a person contributes to the conception of the invention, he is not an inventor."[39] In *Beech Aircraft Corp v EO Corp*,[40] in which an employee of an aircraft company designated the

as the Incentive and Reward Concept: see, *eg*, Benjamin N Roin, "The Disclosure Function of the Patent System (Or Lack Thereof)" (2005) 118 Harv L Rev 2007 at 2011 ("[w]hile most scholars believe that the principal goal of the patent system is the encouragement of innovation, courts have been more willing to embrace the disclosure rationale as a centrepiece of patent policy").

34 447 US 303 (1980).

35 *Diamond v Chakrabarty* 447 US 303 at 309 (1980).

36 40 F 3d 1223 (Fed Cir, 1986).

37 *Burroughs Wellcome Co v Barr Labs, Inc* 40 F 3d 1223 at 1227–1228 (Fed Cir, 1986).

38 25 USPQ2d 1601 (Fed Cir, 1993).

39 *Fiers v Revel* 25 USPQ2d 1601 at 1604–1605 (Fed Cir, 1993).

40 990 F 2d 1237 (Fed Cir, 1993).

company as the inventor of the inventions in the patent applications, the court held that the company could not be declared an inventor and categorically stated that "only *natural persons* can be 'inventors'"[41] [emphasis added]. In *University of Utah v Max-Planck-Gesellschaft zur Forderung der Wissenschaften eV*,[42] which concerned a dispute between two state universities for the inventorship of two patents, the court held that state governments could not be inventors as they had no sovereign interest in inventorship. It said that it is "axiomatic that inventors are the *individuals* that conceive of the invention"[43] [emphasis added].

17 The notion is not endemic to US patent law. Article 81 of the European Patent Convention ("EPC") mandates that a patent application must designate an inventor. The Board of Appeal of the European Patent Office held that the designated inventor must be a person "with legal capacity".[44] It said that the purpose of the provisions dealing with the inventor and its designation were "primarily to confer and to protect rights of the inventor … to facilitate the enforcement of potential compensation claims provided under domestic law, and to identify a legal basis for entitlement to the application".[45] It further stated that designating a machine without legal capacity would serve neither of these purposes.

18 In Australia, the Patents Act 1990[46] (the "Australian PA 1990") provides at s 15(1) that an invention may only be granted to a person who is the inventor. The term "inventor" is not defined in the Act but in *Commissioner of Patents v Thaler*,[47] the Full Court of the Federal Court of Australia agreed that the term has the ordinary English meaning of a person responsible for making an invention and accepted that an inventor is the person who materially contributes to the inventive concept as described in the specification and the claims of the patent.[48]

19 In Asia, the three major patent offices in China, Japan and South Korea issued a joint statement with the United States Patent and

41 *Beech Aircraft Corp v EO Corp* 990 F 2d 1237 at 1348 (Fed Cir, 1993).
42 734 F 3d 1315 (Fed Cir, 2013).
43 *University of Utah v Max-Planck-Gesellschaft zur Forderung der Wissenschaften eV* 734 F 3d 1315 at 1323 (Fed Cir, 2013).
44 *J 0008/20 (Designation of inventor/DABUS)*, ECLI:EP:BA:2021:J000820.20211221 and *J 0009/20 (Designation of inventor/DABUS II)*, ECLI:EP:BA:2021:J000920.20211221 at para 4.3.1.
45 *J 0009/20 (Designation of inventor/DABUS II)*, ECLI:EP:BA:2021:J000920.20211221 at para 4.3.3.
46 Cth.
47 [2022] FCAFC 62.
48 *Commissioner of Patents v Thaler* [2022] FCAFC 62 at [100].

Trademark Office and the European Patent Office that only humans could be considered to be inventors.[49]

20 The above court decisions foreshadowed the recent decision of the UK Supreme Court in *Thaler*, which this article will now review.

III. *Thaler v Comptroller-General of Patents, Designs and Trade Marks*

21 In October 2018, Dr Stephen Thaler filed two patent applications in the UK Intellectual Property Office (the "UK IP Office") relating to a new type of food container based on fractal geometry which enhanced gripping, and a new kind of light beacon which had a new way of making light noticeable in an emergency. In the patent applications, he expressly declared that he was *not* the inventor of the inventions and claimed that the inventions were made by the AI of a machine known as "DABUS" (an acronym for "Device for the Autonomous Bootstrapping of Unified Sentience"). He stated that he acquired the right to file the patent applications because he owned the machine.

22 The UK IP Office rejected the applications. It found that DABUS was not a person as envisaged by ss 7 and 13 of the UK PA 1977 and was therefore not an inventor. As such, it could not transfer a patent to any person or persons, or any successor or successors in title. In particular, there could not be any transfer to Dr Thaler on the basis that he owned DABUS.

23 Section 7 of the UK PA 1977 states that a patent for an invention may be granted: (a) "primarily" to the inventor or joint inventors; (b) "in preference to" an inventor or joint inventors, any person or persons who was or were entitled to the property in the invention (other than equitable interests) by virtue of any enactment, rule of law, foreign law, international convention or any agreement entered into by the inventor; or (c) "in any event", a successor or successors in title.

24 Section 13 of the UK PA 1977 mandates that the inventor or joint inventor has the right to be mentioned as such in the patent and imposes an obligation on the applicant to file a statement identifying the person or persons whom he believes to be the inventor or inventors and indicating the derivation of his or their right to be granted the patent. If he fails to file the statement, the application would be taken to be withdrawn.

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49 European Patent Office, "Report from the IP5 Expert Round Table on Artificial Intelligence" (31 October 2018).

25 Section 13 gives effect to Art 4*ter* of the Paris Convention for the Protection of Industrial Property 1883[50] (*ie*, the Stockholm Act (1967)) which prescribes that an inventor "shall have the right to be mentioned as such in the patent". Similarly, Art 62 of the EPC stipulates that the inventor shall have the right, *vis-à-vis* the applicant for or proprietor of a European patent, to be mentioned as such before the European Patent Office. The right of an inventor to be mentioned as such in the patent is a species of moral right enabling the inventor to receive credit for his invention and to prevent fraudulent patent filing as well as passing off of his invention. It is akin to the right of attribution or paternity in copyright law. It is posited that this right would bolster the inventor's reputation, which in turn would incentivise the inventor to continue to innovate.[51] In the nature of things, only a natural person can be incentivised by this kind of right.

26 Dr Thaler's appeals to the UK High Court and the Court of Appeal were dismissed for the same reasons as those of the UK IP Office.

27 Undaunted, Dr Thaler appealed to the UK Supreme Court.[52] There, Lord Kitchin (with whom the other four judges agreed) opined that the structure of ss 7 and 13 permits only one interpretation: an inventor within the meaning of the UK PA 1977 must be a natural person. He noted that s 7 provides that the "primary" or first person to whom a patent may be granted is the inventor or joint inventors and reasoned that the section's hierarchy granting patent rights are "necessarily references to an invention devised by a person".[53] He also noted that the term "inventor" is defined in the section to mean the "actual deviser" of the invention. In his view, there was no suggestion that the word "deviser" has anything "other than its ordinary meaning, that is to say, a *person* who devises a new and non-obvious product or process"[54] [emphasis in original].

28 Lord Kitchin's understanding of the word "deviser" aligns with Lord Hoffmann's opinion in *Yeda Research and Development Co Ltd v Rhone-Poulenc Rorer International Holdings Inc*[55] ("*Yeda*"), which

50 (20 March 1883), 828 UNTS 305 (entered into force 26 April 1970).

51 See, *eg*, Jeanne C Fromer, "Expressive Incentives in Intellectual Property" (December 2012) 98(8) *Virginia Law Review* 1745 at 1790 and Nari Lee, "Inventor's Moral Right and Morality of Patent" in *Research Handbook on Intellectual Property and Moral Rights* (Ysolde Gendreau ed) (Edward Elgar, 2023) at pp 104–105.

52 [2024] Bus LR 47.

53 *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2024] Bus LR 47 at [79].

54 *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2024] Bus LR 47 at [57].

55 [2007] Bus LR 1796.

concerned a dispute between the parties as to who owned the patent for a cancer treatment based on a combination of certain chemicals. Yeda Research, which asserted that it was the assignee of the rights of the true inventors, claimed that Rhone-Poulenc Rorer, the patentee, did not make the invention which formed the basis of the patent and sought an order that the patent be transferred to the joint ownership of both parties.

29 Lord Hoffmann opined that the UK PA 1977 provides "an exhaustive code" for determining who is entitled to the grant of a patent.[56] In making such a determination, the first step is to decide who was the inventor of the claimed invention. Only when that question has been decided could consideration be given as to whether someone else might be entitled to the patent through the inventor pursuant to ss 7(2)(b) or 7(2)(c) of the UK PA 1977.[57]

30 As mentioned, the term "inventor" is defined in s 7(3) to mean the "actual deviser" of the invention. In *Yeda*, Lord Hoffmann was of the opinion that this term referred to a *natural person* who came up with the inventive concept of the invention. His contribution must relate to "the formulation of the inventive concept".[58] Whether a person is such a deviser involved assessing the evidence adduced by the parties as to the nature of the inventive concept and who contributed to it.

31 In *Thaler*, Lord Kitchin held that Dr Thaler's applications were fatally flawed because DABUS "was not and is not a person"[59] and could not therefore grant a patent. Dr Thaler's ownership of DABUS did not entitle him to apply for a patent both because DABUS could not grant a patent and because he was not a person falling within ss 7(2)(b) or 7(2)(c). As he did not file a statement identifying a natural person as an inventor and explaining how he derived the right to apply for a patent from that person, the applications were rightly treated as withdrawn by the UK IP Office.

56 *Yeda Research and Development Co Ltd v Rhone-Poulenc Rorer International Holdings Inc* [2007] Bus LR 1796 at [18].

57 *Yeda Research and Development Co Ltd v Rhone-Poulenc Rorer International Holdings Inc* [2007] Bus LR 1796 at [19].

58 *Yeda Research and Development Co Ltd v Rhone-Poulenc Rorer International Holdings Inc* [2007] Bus LR 1796 at [20], endorsing Laddie J's statement in *University of Southampton's Applications* [2005] RPC 11 at [39].

59 *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2024] Bus LR 47 at [77].

32 The court's ruling is unsurprising and aligns with earlier decisions of the US Court of Appeals for the Federal Circuit,[60] the European Patent Office[61] and the Full Court of the Federal Court of Australia[62] which had similarly rejected Dr Thaler's attempt in unequivocal terms.[63] The tribunals in these three jurisdictions also declined to depart from the literal and teleological interpretation of the word "inventor" in their respective patent statutes, deciding that inventorship is concerned with *human* conception and ingenuity. They also declined to be drawn into the ongoing debate on whether the inventorship concept should be amended and whether the patent regime should accommodate inventions generated by AI.

A. Position in Singapore

33 The equivalent provisions in the Singapore PA 1994 are ss 19 and 24 which are identical in terms. Like s 7 of the UK PA 1977, s 19 of the Singapore PA 1994 provides a hierarchy of persons to whom a patent for an invention may be granted. The primary persons are the inventor or joint inventors, and other persons (such as an assignee and a successor in title) are entitled to a patent through them. The word "inventor" is also defined to mean the "actual deviser" of the invention, in s 2(1). Like s 13 of the UK PA 1977, s 24 requires the inventor to be mentioned as such in the patent application, failing which the application would be taken to be withdrawn.

34 Due to the similar statutory provisions, it would be reasonable to suggest that, if Dr Thaler's patent applications for the two inventions were considered by the Singapore courts, it would be likely that the courts would rely on a number of important aspects of the reasoning of the UK Supreme Court in *Thaler*. There are good reasons of principle and policy to adopt the UK Supreme Court's reasoning and interpretation of the similar provisions. For instance, based on Singapore case law on

60 *Thaler v Vidal,* 43 F 4th 1207 (Fed Cir, 2022). In April 2023, the US Supreme Court denied Dr Thaler's petition to review the appeals court decision.

61 *J 0008/20 (Designation of inventor/DABUS)*, ECLI:EP:BA:2021:J000820.20211221. See also "EPO Publishes Grounds for Its Decision to Refuse Two Patent Applications Naming a Machine as Inventor" *European Patent Office* (28 January 2020) <http://www.epo.org/news-events/news/2020/20200128.html> (accessed 3 June 2024).

62 *Commissioner of Patents v Thaler* [2022] FCAFC 62.

63 Dr Thaler's patent applications have also been unsuccessful in New Zealand, Taiwan, Israel, the Republic of Korea, Canada, Brazil and India. His applications were accepted in South Africa and Saudi Arabia, which do not have a substantive examination system.

the canon of construction of documents,[64] the Singapore courts would likely adopt a textual interpretation of ss 19 and 24 which would involve considering the natural and ordinary meaning of the words.

35 In addition, there are local cases which indicate that the entitlement of a person to be granted a patent is premised on the invention being the output of the ingenuity and effort of a natural person or persons. For instance, consider *First Currency Choice Pte Ltd v Main-Line Corporate Holdings Ltd*,[65] a case which concerned a patent that provided for dynamic currency conversion for card payment systems and in which the appellant was accused of infringing the patent by offering for use a card currency recognition system which performed the same function as the patent. The Court of Appeal was quite explicit as to whom the patent system was intended to incentivise and reward. It agreed that an efficient patent system is essential for the promotion of innovation and that patents give inventors a temporary monopoly on a "new idea" in return for disclosing how it works, so that others can subsequently build upon it, whilst acknowledging the intrinsic tension between stimulating the "creative energies" of inventors and promoting the free flow of ideas and encouraging entrepreneurship.[66] It is trite that only humans are capable of developing any "new idea" and stimulating "creative energies", not machines.

36 Further support that an inventor must be a natural person under the Singapore PA 1994 is afforded by the case of *Cicada Cube Pte Ltd v National University Hospital (Singapore) Pte Ltd*,[67] in which a hospital had appointed a software engineering company to develop a software to allow specimens to be ordered and collected from patients in an automated manner for laboratory testing. Without the hospital's knowledge and consent, the company applied for and obtained a patent for the software. The patent described a system for automation of the specimen ordering and collection process from the point of physician–patient contact up to specimen delivery to the laboratory.

37 The hospital applied to the Singapore High Court for a determination of entitlement to the patent. The High Court held that the parties jointly invented the patent and that they were therefore jointly entitled to it. Both parties appealed.

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64 See, *eg*, *Zurich Insurance (Singapore) Pte Ltd v B-Gold Interior Design & Construction Pte Ltd* [2008] 3 SLR(R) 1029 at [130] and *HSBC Trustee (Singapore) Ltd v Lucky Realty Co Pte Ltd* [2015] 3 SLR 885 at [61].

65 [2008] 1 SLR(R) 335.

66 *First Currency Choice Pte Ltd v Main-Line Corporate Holdings Ltd* [2008] 1 SLR(R) 335 at [1].

67 [2018] 2 SLR 940.

38 In dismissing the appeals, the Court of Appeal noted that the word "inventor" is defined in s 2(1) of the Singapore PA 1994 to mean the "actual deviser" of the invention and accepted the notion that the deviser is a person who came up with the inventive concept of the invention – specifically, he is the person "who formulated or contributed to the formulation of the inventive concept".[68]

39 The court also accepted that the inventive concept is "the core (or kernel, or essence) of the invention – the idea or principle … which entitles the inventor's achievement to be called inventive".[69] Certain contributions would clearly be considered to be inventive, such as contribution to the solution of a particular problem ("where something in the invention helps to solve a particular problem or answer a particular question in a new way, this will generally be regarded as an inventive contribution") and contribution to the perfection or improvement of a solution.[70] A person would still be considered an inventor or deviser even though he had no capability to realise the invention into a functional product, leaving the details to another person.[71] On the other hand, a person whose contributions relate to an "unnecessary detail" of an invention or were of a managerial, administrative or financial nature would not be the deviser of the inventive concept.[72]

40 Although the Court of Appeal addressed different issues concerning co-inventorship, its ruling and reasoning did not provide any scope for suggesting that the person who formulated or contributed to the formulation of the inventive concept could be other than a natural person. It plainly had human actors in mind as it considered whether one or all of the three employees of the parties contributed to the inventive concept

68 *Cicada Cube Pte Ltd v National University Hospital (Singapore) Pte Ltd* [2018] 2 SLR 940 at [62], citing with approval *Dien Ghin Electronic (S) Pte Ltd v Khek Tai Ting* [2011] 3 SLR 227 in which Chan Seng Onn J had relied on Lord Hoffman's opinion in *Yeda Research and Development Co Ltd v Rhone-Poulenc Rorer International Holdings Inc* [2007] Bus LR 1796 at [13] that the "actual deviser" is a natural person who "came up with the inventive concept".

69 *Cicada Cube Pte Ltd v National University Hospital (Singapore) Pte Ltd* [2018] 2 SLR 940 at [63], adopting the statement of the House of Lords in *Generics (UK) Limited v H Lundbeck A/S* [2009] Bus LR 828 at [30].

70 *Cicada Cube Pte Ltd v National University Hospital (Singapore) Pte Ltd* [2018] 2 SLR 940 at [64].

71 *Cicada Cube Pte Ltd v National University Hospital (Singapore) Pte Ltd* [2018] 2 SLR 940 at [86(b)], citing with approval the statement of Chan J in *Dien Ghin Electronic (S) Pte Ltd v Khek Tai Ting* [2011] 3 SLR 227 at [13] that "[a] person may be a deviser of an invention as claimed, even though the precise details of how the inventive concept may be realised into a functional product may be worked out by other persons".

72 *Cicada Cube Pte Ltd v National University Hospital (Singapore) Pte Ltd* [2018] 2 SLR 940 at [86(b)].

underlying the subject invention. In the event, it held that both parties were entitled to the patent as it found it difficult to attribute inventorship to one party to the exclusion of the other in such circumstances "where the Invention involved the substantial cross-pollination of ideas from two different sectors".

41 It is thus suggested that in the Singapore PA 1994, invention would also be treated as a mental act occurring in the mind of the human inventor, providing a statutory reward for his ingenuity and creativity. This approach would be consistent not only with the decision of the UK Supreme Court in *Thaler* but also the literal and teleological interpretation adopted by the Full Court of the Federal Court of Australia regarding the term "inventor" in s 15 of the Australian PA 1990 (equivalent to s 19 of the Singapore PA 1994). In the context of s 15, the Full Court opined that the term has the ordinary English meaning of a person responsible for making an invention and that an inventor is the person who materially contributes to the inventive concept as described in the specification and the claims of the patent.[73]

42 Dr Thaler's attempts to advance the notion that an AI can be an inventor under the patent regime were thus comprehensively dismissed by the highest courts. However, his court actions spawned wider issues concerning the intersection between AI and patent inventorship. These issues are addressed in Part IV.

IV. Deep think

A. What is AI?

43 Despite the copious literature on AI, there is, oddly, no uniform or definitive definition and description of AI.[74] The term was first coined

73 *Commissioner of Patents v Thaler* [2022] FCAFC 62 at [100]. The Full Court overruled the decision of Beach J in the Federal Court in *Thaler v Commissioner of Patents* [2021] FCA 879 that DABUS could be deemed an inventor under Australian law. The Australian High Court denied Thaler's application for his appeal to be heard before it, thus implicitly approving the Full Court's opinion.

74 See also Noam Shemtov, *A Study on Inventorship in Inventions Involving AI Activity* (European Patent Office, 2019) at p 9: "it is somewhat surprising that no uniform definition currently exists to describe what is meant by artificial intelligence (AI)"; World Economic Forum, *Artificial Intelligence Collides with Patent Law* (White Paper, 20 April 2018) at p 5 <https://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf> (accessed 3 June 2024): "no single definition of AI is accepted by all practitioners"; and Ryan Calo, "Artificial Intelligence Policy: A Primer and Roadmap" (2017) 51 UC Davis L Rev 399 at 403: "There is no straightforward, consensus definition of artificial intelligence."

in 1956 by John McCarthy, a founding father of AI science, to mean "the science and engineering of making intelligent machines, especially intelligent computer programs".[75] In WIPO's Draft Issues Paper, AI is defined 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".[76] According to the European Commission, AI is "a generic term that refers to any machine or algorithm that is capable of observing its environment, learning and, based on the knowledge and experience gained, taking intelligent action or proposing decisions".[77] The European Patent Office described AI as "the ability of computers and machines to perform mental tasks commonly associated with humans, such as learning, reasoning and problem solving".[78] The Alan Turing Institute of the Royal Society explained that "artificial intelligence" is an "umbrella" term which refers to "a suite of technologies that can perform complex tasks when acting in conditions of uncertainty, including visual perception, speech recognition, natural language processing, reasoning, learning from data, and a range of optimisation problems".[79] Perhaps the simplest and most succinct description was provided by IBM: "Any system capable of simulating human intelligence and thought processes is said to have 'artificial intelligence' (AI)."[80]

44 These definitions and descriptions of AI not only demonstrate a lack of consensus concerning the *nature* of AI – is it a "discipline", "machine", "algorithm", "suite of technologies" or "system"? – but also suggest that AI systems are autonomous agents endowed with the capability to make decisions, solve problems and perform tasks on their own. However, the word "autonomous" connotes free will, independence of action and the ability to make independent decisions.[81] AI systems are not autonomous in any robust sense of the word at all; they lack any hint or expectation of having human agency, the ability to develop theoretical concepts and reason on their own, or the freedom to make choices.

75 John McCarthy, "What Is Artificial Intelligence?" (12 November 2007) <http://www-formal.stanford.edu/jmc/whatisai/node1.html> (accessed 3 June 2024).

76 World Intellectual Property Organization, *Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence* (WIPO/IP/AI/2/GE/20/1, 13 December 2019) at p 3.

77 *Artificial Intelligence: A European Perspective* (Max Craglia ed) (Publications Office of the European Union, 2018).

78 "Artificial Intelligence" *European Patent Office* (2 May 2022) <https://www.epo.org/en/news-events/in-focus/ict/artificial-intelligence> (accessed 3 June 2024).

79 "The AI Revolution in Scientific Research" (The Royal Society & The Alan Turing Institute, 6 August 2019) at p 2.

80 "Artificial Intelligence" *IBM Design for AI* <https://www.ibm.com/design/ai/basics/ai/> (accessed 3 June 2024).

81 "Autonomy" *Dictionary.com* <https://www.dictionary.com/browse/autonomy> (accessed 3 June 2024).

Further, as a manifestation of free will and independence of action, humans can refuse to comply with rules and constraints. AI systems have no such ability; they are constrained by instructions pre-programmed by humans and cannot "decide" to deviate from the instructions.[82] In brief, the word "autonomous" used in the context of AI does not mean that it is free in the choices that it makes because "the conditions for deciding on how to proceed are carefully set by human actors".[83]

45 Doubtless, AI is different from traditional computer programming which involves the process of composing a set of instructions or commands (*ie*, algorithms[84]) for the computer to perform particular tasks such as solving a problem. The execution and completion of the tasks rely on the instructions or commands by humans.[85] For instance, in order to bake a cake with the aid of a computer, the recipe for the cake would have to be programmed into the computer for it to follow. In contrast, an AI system can "self-learn" to bake the cake from the many different recipes (*ie*, data) fed into the system. In response to the task or prompt "bake a cake", it would generate a cake based on what it "learnt" from the many different recipes. In technical terms, it can "self-learn" by using vast amounts of data to recognise and identify patterns in the data in order to perform a task such as drawing conclusions, discovering new information and predicting future events with similar data. It trains itself by using "learning" algorithms:[86]

> ... through which some internal state of the [computer] 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.

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82 See also Daria Kim *et al*, "Clarifying Assumptions About Artificial Intelligence Before Rationalising Patent Law" (February 2022) 71(4) *GRUR International* 295 at 307.

83 Merel Noorman & Deborah G Johnson, "Negotiating Autonomy and Responsibility in Military Robots" (2014) 16 Ethics Inf Technology 51 at 53.

84 Algorithms are generally encoded as software to enable their readability by computers.

85 Mark Summerfield, "The Impact of System Learning on Patent Law, Part 1: Can a Computer Invent" *patentology* (13 January 2018) <https://blog.patentology.com.au/2018/01/the-impact-of-machine-learning-on.html> (accessed 3 June 2024). See also, "What's the Difference Between AI and Regular Computing?" *The Royal Institution* (12 December 2023) <https://www.rigb.org/explore-science/explore/blog/whats-difference-between-ai-and-regular-computing#:~:text=Regular%20computing%20is%20reliant%20upon,on%20data%20without%20explicit%20programming> (accessed 3 June 2024).

86 Mark Summerfield, "The Impact of System Learning on Patent Law, Part 1: Can a Computer Invent" *patentology* (13 January 2018) <https://blog.patentology.com.au/2018/01/the-impact-of-machine-learning-on.html> (accessed 3 June 2024).

This is achieved by machine learning or deep learning.

46 Machine learning and deep learning are two subfields of AI. They are often referred to interchangeably, although deep learning is in fact a subfield of machine learning. There is also no uniform or definitive definition and description for each of these subfields. According to IBM, they "are comprised of AI algorithms which seek to create expert systems which make predictions or classifications based on input data".[87] The primary difference between them lies in the way the algorithms "learn" and in the amount of data used.[88]

47 Broadly speaking, machine learning is concerned with "training" algorithms in a computer to recognise and identify patterns in data and to apply the knowledge to new data without being explicitly programmed or "hard-coded" by a human. The algorithms are "trained" on complex datasets and are able to "learn" relevant patterns from "experience." The most common form of machine learning is "supervised" learning whereby the input data (*ie*, the "training data") is labelled with the correct response and the algorithm "learns" the relationship between the data and the labels to make predictions on new, previously unseen data. An example of supervised learning is an algorithm that is trained on datasets comprising many pictures labelled as either containing or not containing a cat, to then be able to identify a cat picture that it has not previously seen. By continuously feeding the training data to the algorithm, the AI system can adapt and improve its performance over time.[89]

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87 "What Is Artificial Intelligence (AI)?" *IBM* <https://www.ibm.com/topics/artificial-intelligence> (accessed 3 June 2024).

88 The word "learn" is used as a metaphor and does not imply that computer systems are artificially replicating the advanced cognitive systems of human learning. Algorithmic "learning" is not comparable to the process of human learning. The computer or algorithm is not building a theoretical understanding of the world or of the specific endeavour it is set to carry out. Rather, the word is used to denote that the algorithms learn in a functional sense, in that they are capable of continually improving the outcome of certain processes when a certain activity is repeatedly carried out by the computer or algorithm: see, *eg*, Harry Surden, "Machine Learning and Law" (2014) 89 Wash L Rev 87 at 89 and Tim W Dornis, "Artificial Intelligence and Innovation: The End of Patent Law as We Know It" (2020) 23 *Yale Journal of Law & Technology* 97 at 105–106.

89 See Hyunjong R Jin, "Think Big! The Need for Patent Rights in the Era of Big Data and Machine Learning" (2018) 7 NYU J Intell Prop & Ent L 78 at 89 and Anastasia Greenberg, "Protecting Virtual Things: Patentability of Artificial Intelligence Technology for the Internet of Things" (2020) 60(2) IDEA 328 at 334–335. See also "What Is Machine Learning (ML)?" *IBM* <https://www.ibm.com/topics/machine-learning> (accessed 3 June 2024); "What Is Deep Learning" *Amazon Web Services* <https://aws.amazon.com/what-is/deep-learning/#:~:text=Deep%20learning%20is%20a%20method,produce%20accurate%20insights%20and%20predictions> (accessed 3 June 2024); "Deep Learning vs. Machine Learning:

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48 In unsupervised learning, the algorithm is fed a complex dataset, but without any labels. The algorithm finds interesting patterns in the data without being shown any correct solutions. The data are unlabelled, unstructured and in a raw form (*eg*, in the form of text, images, voice and videos). It would identify and "learn" from the patterns in the data, assign its own labels to the datasets that it created and make predictions or decisions. An example of this is an algorithm that is given a compilation of news articles and the algorithm learns to group all the articles about the same news event into one cluster.[90]

49 Deep learning uses a layered structure of algorithms called an artificial neural network ("ANN") to mimic the learning process of the human brain. The design of the ANN is inspired by the biological neural network (comprising neurons or nerve cells[91]) in the human brain. The word "deep" refers to the depth of layers in the ANN. An ANN that consists of more than three layers is considered a deep learning algorithm. Like machine learning, a deep learning model can "learn" in a "supervised" or "unsupervised" way.[92]

50 Generative AI is powered by deep learning models that can not only ingest vast amount of unlabelled training data but also has the ability to create new data that resembles training data which it can then leverage to generate output such as audio, images, text, video and computer code in response to prompts.[93] In the case of ChatGPT which is a generative

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A Beginner's Guide" *Coursera* <https://www.coursera.org/articles/ai-vs-deep-learning-vs-machine-learning-beginners-guide> (accessed 3 June 2024); World Intellectual Property Organization, *Background Document on Patents and Emerging Technologies* (SCP/30/5, 28 May 2019) at paras 38–39.

90 Clustering is a data mining technique for grouping unlabelled data based on their similarities or differences. See also n 82 above.

91 It is estimated that there are about 86 billion neurons in the brain, each of which is connected to about 8,000 other neurons. The number of connections is therefore massive, and this contributes to the ability to do everything from breathing to talking, eating, walking and thinking.

92 See, *eg*, Yann LeCun, Yoshua Bengio & Geoffrey Hinton, "Deep Learning" (2015) 521 *Nature* 436 at 436; Eda Kavlakoglu, "AI vs Machine Learning vs Deep Learning vs Neural Networks: What's the Difference?" *IBM* (27 May 2020) <https://www.ibm.com/cloud/blog/ai-vs-machine-learning-vs-deep-learning-vs-neural-network> (accessed 3 June 2024); "What Is Machine Learning (ML)?" *IBM* <https://www.ibm.com/topics/machine-learning> (accessed 3 June 2024); "What Is Deep Learning" *Amazon Web Services* <https://aws.amazon.com/what-is/deep-learning/#:~:text=Deep%20learning%20is%20a%20method,produce%20accurate%20insights%20and%20predictions> (accessed 3 June 2024); "Deep Learning vs. Machine Learning: A Beginner's Guide" *Coursera* <https://www.coursera.org/articles/ai-vs-deep-learning-vs-machine-learning-beginners-guide> (accessed 3 June 2024).

93 A prompt is any text, question, information or coding that asks the AI to do something (*eg*, generate the desired response).

AI, the vast amount of training data consists of all the text scraped from the Internet, comprising no less than 500 billion words.[94] The generative AI can generate the output in the same medium in which it is prompted (such as ChatGPT which is a text-to-text generative AI powered by a mathematical model called a "large language model" (LLM)[95]) or in a different medium (such as DALL-E which is a text-to-image generative AI and SORA[96] which is a text-to-video generative AI[97]).[98] Its ability to generate such output (which are copyrightable works) is largely due to the exponential growth of computer power.

51 There are two main types of AI – "weak" AI and "strong" AI. "Weak" AI (also called "narrow" AI) are trained and programmed to perform specific tasks in well-defined domains to address a particular need or perform a particular task. The algorithms that power "weak" AI are trained to classify and interpret data based on how they were trained. For instance, if a "weak" AI system is created to translate language, it would do so but would not be able to carry out mathematical calculations without human intervention to change the programming. Common everyday applications of "weak" AI include self-driving vehicles (*eg*, Tesla), language translation (*eg*, Google Translate), voice recognition (*eg*, Siri and Alexa) as well as e-mail spam filters which use algorithms to learn which messages are likely to be spam and then redirect them from the inbox to the spam folder.[99]

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94 See, *eg*, Harry Guinness, "How Does ChatGPT Work" *Zapier* (6 September 2023) <https://zapier.com/blog/how-does-chatgpt-work/> (accessed 3 June 2024). "GPT" stands for "generative" (*ie*, the ability to generate the next word based on all possible combinations, and there are trillions of them), "pre-trained" (*ie*, from all the text from the Internet) and "transformer" (*ie*, a deep neural network architecture that is the foundation for the large language models that exist today).

95 See Murray Shanahan, "Talking about Large Language Models" *Cornell University* <https://arxiv.org/abs/2212.03551> (accessed 3 June 2024), who stated at p 2 that "[d]espite being hailed as general-purpose AI model, LLM can do one thing only – generate statistically likely sequences of words". See also Cal Newport, "What Kind of Mind Does ChatGPT Have?" *The New Yorker* (13 April 2023) <https://www.newyorker.com/science/annals-of-artificial-intelligence/what-kind-of-mind-does-chatgpt-have> (accessed 3 June 2024).

96 SORA is an AI model that can create realistic and imaginative scenes from text instructions. See <https://openai.com/index/sora/> (accessed 3 June 2024).

97 This can be done by combining LLMs with vision-language models ("VLMs") such as VilBERT and Flamingo, which combine a language model with an image encoder, and are trained on a multi-modal corpus of text-image pairs. This enables them to predict how a given sequence of words will continue in the context of a given image: see Murray Shanahan, "Talking about Large Language Models" *Cornell University* <https://arxiv.org/abs/2212.03551> (accessed 3 June 2024) at p 6.

98 "Artificial Intelligence" *IBM Design for AI* <https://www.ibm.com/design/ai/basics/ai/> (accessed 3 June 2024).

99 See, *eg*, "Artificial Intelligence (AI)" *IBM* <https://www.ibm.com/cloud/learn/what-is-artificial-intelligence> (accessed 3 June 2024); Bernard Marr, "What Is Weak

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52 In contrast, "strong" AI (also called "Artificial General Intelligence" ("AGI")) is a hypothetical type of AI that would have the ability to understand, learn, reason and apply knowledge across a wide range of tasks and domains.[100] It is "hypothetical" and "would have" such an ability because it *currently does not exist*. It is "merely a theoretical possibility that could arise in the distant future",[101] and is at present only fantasised about in science fiction and movies (such as the rogue computer assistant in *2001: A Space Odyssey*).

B. AI inventions

53 It is also necessary to be clear about the terms used for inventions using AI technologies. In the WIPO Draft Issues Paper, the terms "AI-generated" or "generated autonomously by AI" (which are often used interchangeably) are defined as referring to the generation of inventions by AI without human intervention. These terms are to be contrasted with "AI-assisted" which refers to the generation of inventions by AI with material human intervention and/or direction.[102]

54 "AI-assisted" inventions are inventions using AI as a tool to assist a human inventor to perform a task or find a solution, without contributing to the conception of an invention.[103] In this respect, they do not differ radically from computer-implemented inventions where the technical solution is implemented through a computer program. In respect of such inventions, a human qualifies as an "inventor" under the applicable law as long as the person is involved in the invention process (by contributing to the conception of a claimed invention by formulating or contributing to the formulation of the inventive concept of the invention). That person may well be the owner, programmer, developer or designer of the tool.

(Narrow) AI?" *Bernard Marr & Co* <https://bernardmarr.com/what-is-weak-narrow-ai-here-are-8-practical-examples/> (accessed 3 June 2024); Jake Frankenfield, "Weak AI (Artificial Intelligence): Examples and Limitations" <https://www.investopedia.com/terms/w/weak-ai.asp#:~:text=Weak%20artificial%20intelligence%20(AI)%E2%80%94,that%20humans%20sometimes%20can't> (accessed 3 June 2024); and Harry Surden, "Machine Learning and Law" (2014) 89 Wash L Rev 87 at 90–93.

100 "Artificial Intelligence (AI)" *IBM* <https://www.ibm.com/cloud/learn/what-is-artificial-intelligence> (accessed 3 June 2024).

101 *Public Views on Artificial Intelligence and Intellectual Property* (United States Patent and Trademark Office, October 2020) at p ii.

102 World Intellectual Property Organization, *Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence* (WIPO/IP/AI/2/GE/20/1, 13 December 2019) at p 4.

103 See, *eg*, "Artificial Intelligence" *European Patent Office* (2 May 2022) <https://www.epo.org/en/news-events/in-focus/ict/artificial-intelligence> (accessed 3 June 2024).

55 In contrast, the definition of the terms "AI-generated" and "generated autonomously by AI" by WIPO needs to be clarified.[104] As mentioned above at para 52, "strong" AI (or AGI) is hypothetical and has yet to exist. Whether and when it will emerge is a point of contention among AI experts. Some say that it will never emerge, stating that the perception of AI systems as "autonomous" and "self-learning" is based on an overvaluation, and superficial understanding, of their actual capabilities.[105] A committee of the European Parliament reported that "[t]he prospect of a 'strong' AI, that is to say one that is conscious of itself, seems after all still to be very futuristic".[106] It has also been said that computer science has given up on building machines that can think, in favour of building machines that can learn,[107] and that if an AGI machine is made, it would be the "last invention that man need ever make".[108] Others have however opined that the emergence of AGI machines is a matter of time. A recent survey concluded that there is a 50% probability of AI "outperforming humans in all tasks" in 2075[109] while another group of AI experts predicted the year 2099.[110] The abiding fact is that, in the meantime, there are in reality no inventions that are generated *entirely* autonomously by AI.[111]

56 Hence, the inventions that are currently generated autonomously by AI technology are based on "weak" (or "narrow") AI and machine learning (currently the most commonly used subfield of AI). Like many

104 See also Josef Drexl *et al*, *Comments of the Max Planck Institute for Innovation and Competition of 11 February 2020 on the WIPO Draft Issues Paper of the World Intellectual Property Organization on Intellectual Property Policy and Artificial Intelligence* (Max Planck Institute for Innovation and Competition, 11 February 2020) at para 10.

105 See, *eg*, Katja Grace *et al*, "Viewpoint: When Will AI Exceed Human Performance? Evidence from AI Experts" (2018) 62 *Journal of Artificial Intelligence Research* 729 and "Open Letter to the European Commission: Artificial Intelligence and Robotics" *Robotics* <http://www.robotics-openletter.eu/> (accessed 3 June 2024) at para 2.

106 European Parliament, Committee of Legal Affairs, *Report on Intellectual Property Rights for the Development of Artificial Intelligence* (2 October 2020) Explanatory Statement, at p 13.

107 Marion Fourcade & Kieran Healy, "The Production of Prediction: What Does Machine Learning Want" (2015) 18 Euro J Cult Studies 429 at 435.

108 Irving J Good, "Speculations Concerning the First Ultraintelligent Machine" (1965) 6 *Advances in Computers* 31 at 33.

109 Vincent C Müller & Nick Bostrom, "Future Progress in Artificial Intelligence: A Survey of Expert Opinion" in *Fundamental Issues of Artificial Intelligence* (Vincent C Müller ed) (Synthese Library, 2016) at p 14.

110 Martin Ford, *Architects of Intelligence: The Truth About AI from the People Building It* (Packt Publishing, 2018) at p 528.

111 The corollary is that there is at present no need to reform the patent system (including the rules on inventorship) in order to cater to such a speculative or distant development: see also Noam Shemtov, *A Study on Inventorship in Inventions Involving AI Activity* (European Patent Office, 2019) at p 10.

terms used in AI technology, the terms "weak" and "narrow" are not to be understood literally. The technology is "narrow" in the sense that it is only geared to perform specific tasks in well-defined domains. It is, however, anything but "weak" as its narrow focus has enabled it to power many technological breakthroughs such as operating self-driving vehicles and voice recognition devices.

C. Human involvement in AI-generated inventions

57 Aside from computer-assisted inventions, there is, based on the current state of AI technology, a spectrum of human involvement in the process of making AI-generated inventions. It incorporates the following:[112]

> (a) identification of a problem and conception of a solution by humans, while an AI system is used for verification, automation, adaptation or generation of the human solution; and
>
> (b) identification of a problem by humans while conception of a solution is assisted, guided or led by an AI system.

58 Scenario (a) is not radically different from the traditional invention process in which humans identify a problem in need of a solution and conceive or formulate an inventive concept (*ie*, the touchstone of inventorship) for the solution of the problem. They may be assisted by a known tool such as a mechanical instrument, an electronic calculator or an engineering and simulation tool. In this invention process, although the tool extends the human inventor's physical, mental and/or cognitive capability, it plays a supportive role. Humans occupy the driver's seat in the process.

59 In scenario (a), the AI system takes the place of such a tool. Although it is "intelligent" and able to extend the human inventor's capability to a far greater extent, the use of the AI system for verification, automation, adaptation or generation of the solution does not contribute to the formulation of an inventive concept. Its contribution may be said to relate to "unnecessary details" or is of an administrative nature. The inventions in this scenario would rightly be considered to be exclusively human-made. Humans occupy the driver's seat.

60 It is in scenario (b) that knotty questions concerning inventorship loom. The questions require close analysis of the extent of AI and human involvement in the conception of the solution. To what extent must the AI

112 World Intellectual Property Organization, *Background Document on Patents and Emerging Technologies* (SCP/30/5, 28 May 2019) at para 50.

lead, assist or guide in conceiving the solution? More philosophically, can an AI ever be an inventor if there is an element of human involvement, however minuscule?

61 With respect to inventions generated autonomously by "weak" AI and machine learning, human involvement is required for identifying the task to be performed, defining the problem to be solved as well as creating and providing the training data for the algorithms to analyse or "learn" from patterns and correlations in the data to perform the task or solve the problem.[113] As mentioned, the training data can be labelled, as in the case of "supervised" learning, or unlabelled in the form of unstructured data in its raw form (*eg*, text, images, voice and videos), as in the case of "unsupervised" learning. In the case of "supervised" learning in particular, humans annotate, verify or validate the labelled training data, and this would enable the AI to accurately classify new data (*eg*, to create an image depicting a cat, dog or horse). As the training data is the most valuable element of the machine learning process, the better the training data in terms of quantity, quality and variety, the better the performance of the process and the more accurate the output.

62 In the case of deep learning, it is a human programmer who creates the architecture of the ANN prior to the training process. The process of creation is heuristic, based on experiences and intuition rather than on any scientific methodology. It is also a complex task, as it depends on the nature of the training data, the domain and the amount of available data.[114] In this regard, the selection of datasets by a human is important.

63 The above activities involve the use of computational modelling of problem-solving by transforming the given inputs into the desired output by way of executing the given instructions contained in the algorithm. This model integrates approaches from various disciplines (such as computer science, engineering, mathematics and physics) and captures the relations between inputs and outputs by way of mathematical expressions (such as the different types of equations). Mathematical principles, rules and equations play an important role in determining the way in which the computation proceeds. The main phases of the computational problem-solving process are: (a) problem formulation; (b) abstraction and modelling; (c) designing an algorithm (or adjusting

113 See, *eg*, Josef Drexl *et al*, "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective" (Max Planck Institute for Innovation and Competition Research Paper No 19-13, October 2019).

114 World Intellectual Property Organization, *Background Document on Patents and Emerging Technologies* (SCP/30/5, 28 May 2019) at para 41.

a pre-existing algorithm) and programming (or coding) the algorithm in such a way that it can be executed on a computer; (d) data manipulation; (e) execution of the algorithm on a computer; and (f) interpretation and communication of results.[115]

64 There is human involvement in each of these phases. The preparatory step of problem formulation requires humans to identify the problem to be solved through computation. This in turn requires them to grasp the problem and define accurate assumptions, boundaries and parameters. To translate the problem into something that can be processed and solved by an AI system, humans need to abstract and reduce the problem to "a set of essential characteristics for a particular modelling purpose" by using a formal notation (*eg*, a mathematical model, functions and logic rules) so that the system can decipher and implement.[116] Humans also need to design and develop an algorithm to solve the problem. After the execution of the algorithm on a computer, humans choose which outputs to select and communicate.[117] During the development process, although "the machine learning algorithms learn from the data and come up with the outputs, human ingenuity still plays a major role". This is because decision-making by humans is still required during the process, such as "choosing which machine learning method(s) to employ for a given problem, how to curate the training data, which algorithm parameters to select, and how to test the model for accuracy".[118] Thus, "the role of human intervention remains fundamental

115 Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight" (May 2020) 69(5) *GRUR International* 443 at 448–449.

116 *Computational Modelling: Technological Futures* (Government Office for Science, 2018) at p 112. See also Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight" (May 2020) 69(5) *GRUR International* 443 at 449.

117 Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight" (May 2020) 69(5) *GRUR International* 443 at 449.

118 Hyunjong R Jin, "Think Big! The Need for Patent Rights in the Era of Big Data and Machine Learning" (2018) 7 NYU J Intell Prop & Ent L 78 at 89. See also Dr Rodney Brooks, "[FoR&AI] Machine Learning Explained" *Rodney Brooks: Robots, AI, and other stuff* (28 August 2017) <https://rodneybrooks.com/forai-machine-learning-explained/> (accessed 3 June 2024), in which Dr Brooks explained the human involvement in the process as follows:

> Every successful application of machine learning (ML) is hard won by researchers or engineers carefully analyzing the problem that is at hand. They select one or many different ML algorithms and custom design how to connect them together and to the data. In some cases, there is an extensive period of training on very large sets of data before the algorithm can be run on the problem that is being solved. In that case there may be many months of work to do in collecting the right sort of data from which ML will actually learn. In other cases, the learning algorithms will be integrated into the application and will learn while doing the task that is desired – it might require some training wheels in the early stages, and they too must be designed. In any case, there is always a big design project about how, when the ultimate system is operational,

(cont'd on the next page)

to the programming of AI devices, the selection of input data and the application of the results obtained".[119]

65 It has been said that there is nothing esoteric going on when these phases are executed by a computer.[120] Essentially, humans conceive the overall computational problem-solving process and specify instructions as to how it should be carried out. The computer contributes to problem solving by crunching numbers "obediently", and creativity is provided by a human designer of the algorithm used to generate the output. The algorithm contains instructions that determine the computational operations of the problem solving process; it defines, refines and executes a function specific to the problem being addressed. As long as computers are bound by such instructions, there is no reason to attribute "cognitive autonomy" to an algorithm or AI system and to view the system as a problem-solver and inventor. It is only because of "brute force computation" that the system can outperform humans. [121] As revealed by the following statement:[122]

> The evolution from 'traditional' programming to machine learning is not as dramatic as some of the hype might lead us to believe. Instead of coding the 'rules', machine learning developers now build systems that are able to capture and generalise from patterns that exist in their input data. These systems still operate using rules and algorithms – but now these algorithms determine how they go about doing the capturing and the generalisation, rather than how they produce the final result. Viewed at an appropriate level of abstraction, then, little has changed, except for the power and scale of our machines.

66 In sum, the claim that AI systems can autonomously generate inventions without any human involvement and guidance at all is unfounded. Humans are the ones who conceive the inventive concept of the invention to be generated by an AI system, "even though the precise details of how the inventive concept may be realised into a functional product may be worked out" by the AI system.[123] Conception is a mental and sentient act, involving abstract thinking and thought processes. It

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the data that comes in will be organized, processed and mapped before it reaches the ML component of the system.

119 European Parliament, Committee of Legal Affairs, *Report on Intellectual Property Rights for the Development of Artificial Intelligence* (2 October 2020), at pp 12–13.

120 Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight" (May 2020) 69(5) *GRUR International* 443 at 450.

121 Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight" (May 2020) 69(5) *GRUR International* 443 at 450.

122 Mark Summerfield, "The Impact of System Learning on Patent Law, Part 3: Who Is the Inventor of a Machine-assisted Invention?" *patentology* (4 February 2018). Mark Summerfield is an electrical engineer and a patent attorney.

123 Adapting the statement of Chan J in *Dien Ghin Electronic (S) Pte Ltd v Khek Tai Ting* [2011] 3 SLR 227 at [13].

requires intention, aspiration, insight and decision-making, amongst others. Although AI systems can imitate human cognitive processes, their performance still depends on human thinking and decision-making in the design and application of the systems. Technically and etymologically, they are tools, albeit very advanced tools, which augment human ability to perform tasks or solve problems rather than replace it. Machine learning systems for instance extend human pattern recognition ability in extracting correlations from vast amounts of datasets. As Prof Dan Burk posited:[124]

> Humans routinely use tools to construct other tools; manipulation of a simple screwdriver, a hammer, or a drill makes possible the construction of follow-on devices that could not have been built or devised without such aids. AI systems are the latest development on this trajectory, in the form of machines that build other machines; possibly replicating themselves or possibly designing and building other machines. The degree of automation incorporated into such machines by their designers does not change this fundamental relationship.

67 Some scholars argue that when an AI system autonomously generates an invention that is not expected, predicted, foreseen or envisaged by its human designer or programmer, there is no justification for considering the human designer or programmer as the inventor of the invention.[125] The unpredictability is considered as indicating that the system has "emergent" qualities in that their output is not pre-determined or specified in advance by a human. However, patent law has encountered such inventions before. For instance, decaffeinated coffee was accidentally discovered in 1904 and patented in 1908.[126] Research on organic synthesis, mutagenesis, cell transformation and other complex

124 Dan L Burk, "AI Patents and the Self-assembling Machine" (2021) 105 *Minnesota Law Review Headnotes* 301 at 317. Prof Burk also postulated that the user of the AI system is likely to be the one conceiving the system's output as an invention and hence qualifies as the inventor of the invention under US law, in preference to the owner, designer, programmer and operator of the system: Dan L Burk, "Causation and Conception in American Inventorship" (2023) *Duke Law & Technology Review* 116 at 125. See also Shlomid Yanisky-Ravid & Xiaoqiong (Jackie) Liu, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2018) 39 Cardozo L Rev 2215 at 2232 (discussing the range of "stakeholders with varying interests" in the inventive output of an AI system).

125 See, *eg*, Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57 Boston College Law Rev 1079 at 1095 and Liza Vertinsky & Todd M Rice, "Thinking About Thinking Machines: Implications of Machine Inventors for Patent Law" (2002) 8(2) B U J Sci & Tech L 574 at 575.

126 "US897840A Preparation of Coffee" *Espacenet* <https://worldwide.espacenet.com/patent/search/family/002966266/publication/US897840A?q=pn%3DUS897840> (accessed 3 June 2024).

reactions in biochemical systems have yielded unexpected but valuable patentable products.[127]

68 Besides, patent law does not require an invention to result from a particular type of inventive effort on the part of the inventor. It has never hesitated to bestow inventorship on serendipitous discoveries. There is no "long, laborious effort" or "a brief but intense spark of genius" requirement to obtain a patent; "[a]ccidents and surprises receive the same reward as intention and deliberation. Inventors who expected a different outcome, or no outcome, are entitled to the same rights as inventors who meticulously planned and executed their research program."[128]

D. Incentivising AI inventorship?

69 In *Thaler v Commissioner of Patents*,[129] Beach J ruled that an AI system could be an inventor under the Australian PA 1990 and reasoned that recognising the system as an inventor "would incentivise the development by computer scientists of creative machines, and also the development by others of the facilitation and use of the output of such machines, leading to new scientific advantages". The Full Court, however, disagreed with the ruling and, basing itself on the literal and teleological interpretation of the Act, held that the law relating to the entitlement of a person to the grant of a patent is premised upon an invention arising from the mind of a natural person or persons: "those who contribute to, or supply, the inventive concept are entitled to the grant. The grant of a patent for an invention rewards their ingenuity",[130] referencing the Incentive and Reward Concept.

70 The Full Court did not expressly reveal its view on the judge's reasoning, but it did say that whether a person who is an inventor should be redefined to include an AI was "a matter of policy" and cautioned against "approaching the task of statutory construction by reference

127 Dan L Burk, "AI Patents and the Self-assembling Machine" (2021) 105 *Minnesota Law Review Headnotes* 301 at 304 and 306.

128 Dan L Burk, "AI Patents and the Self-assembling Machine" (2021) 105 *Minnesota Law Review Headnotes* 301 at 307.

129 *Thaler v Commissioner of Patents* [2021] FCA 879 at [125]. Similar views were expressed by scholars: see, *eg*, Mimi S Afshar, "Artificial Intelligence and Inventorship: Does the Patent Inventor Have to be Human?" (2022) 13 Hastings Sci & Tech LJ 55 at 56–57, submitting that "AI can qualify as an inventor and allowing AI to be listed as an inventor would incentivize innovation. Furthermore, statutory recognition of AI as an inventor would encourage investment in developing inventive AI systems, as the corresponding human inventors will be assured they can patent the results."

130 *Commissioner of Patents v Thaler* [2022] FCAFC 62 at [105].

to what it might regard as desirable policy, imputing that policy to the legislation, and then characterising that as the purpose of the legislation".[131] Similar sentiment was expressed in *Thaler v Hirshfield*[132] by the US District Court for the Eastern District of Virginia, which said that "if AI reaches a level of sophistication such that it might satisfy accepted meanings of inventorship … it will be *up to Congress* to decide how, if at all, it wants to expand the scope of patent law"[133] [emphasis added]. The underlying concern for such a sentiment is that there are economic and societal welfare costs involved in establishing exclusivity for innovation and the consequences of this must be considered in the round. This falls within the purview of the Legislature, not the courts. Dr Rita Matulionyte has also astutely observed that:[134]

> … the question whether AI-generated inventions (if they become possible at all) should be patented or not is a significant policy question that needs to be answered by identifying and weighing a variety of private and public interests. This is not a discussion to be carried out by a single judge assessing one patent application.

71 It is unclear how it could be deduced by the judge and some scholars that recognising an AI system as an inventor would incentivise computer scientists to develop creative machines and others to facilitate and use the output of such machines. No empirical evidence has been adduced for the claimed nexus between the recognition and the responses of scientists and others in the manner set out by the judge. In fact, the responses indicate that scientists and others would treat the AI system as a tool for developing creative machines and facilitating the use of their output respectively. As such, the notion that scientists and others would be incentivised by the recognition of the tool as the inventor is unsupported. Further, to develop the creative machines, scientists would come up with an inventive concept for the development of the machines and set up the computational modelling and processes. In such circumstances, recognising the AI system as the inventor would take the credit (as well as the moral right) away from scientists and have a disincentivising effect upon them.[135]

131 *Commissioner of Patents v Thaler* [2022] FCAFC 62 at [119]–[120].

132 558 F Supp 3d 238 (ED Va, 2021).

133 *Thaler v Hirshfield* 558 F Supp 3d 238 (ED Va, 2021) at p 18.

134 Rita Matulionyte, "AI as an Inventor: Has the Federal Court of Australia Erred in DABUS?" (2022) 13 *Journal of Intellectual Property, Information Technology and Electronic Commerce Law* 99 at para 45.

135 See also Daria Kim *et al*, "Artificial Intelligence as Inventors? A Position Statement of 7 September 2021 in View of the Evolving Case-Law Worldwide" (Max Planck Institute for Innovation and Competition Research Paper No 21-20) at para 19.

72 Economists have also pointed out that there is no evidence and economic analysis to indicate that the failure to accord inventorship to AI would lead to market failure and concomitant injury to societal welfare. In fact, WIPO reported a healthy trend in patent filings claiming AI techniques and applications.[136] Besides, patent protection is only one means of remedying market failure. The other means include unfair competition laws and "private ordering" mechanisms such as contracts and technological protection measures.[137]

E. Trade secrets

73 Beach J agreed with the argument by Dr Thaler's counsel (Prof Ryan Abbott) that "recognising computer inventors and patents on computational inventions could promote disclosure and commercialisation … [w]ithout the ability to obtain patent protection, owners of creative computers might choose to protect patentable inventions as trade secrets without any public disclosure".[138] Prof Abbott had also written elsewhere that "[w]ithout the ability to obtain patent protection, owners of creative computers might choose to protect patentable inventions as trade secrets without any public disclosure".[139]

74 However, researchers at the Max Planck Institute for Innovation and Competition expressed doubt concerning this claim and concern, and pointed to the "surge of patenting activity claiming AI techniques and applications" even without any specific adaptations of the patent laws to account for AI-generated inventions.[140] The reasons for the surge are not difficult to discern. Trade secrets protection affords few safeguards against independent discovery and reverse engineering. For instance, in the case of the inventions allegedly generated by DABUS, *ie*, the food container and the light beacon, there is no assurance that they could not be easily reversed after being sold in the market. Also, AI systems can be partially reverse-engineered, given that there can be unrestricted access to inputs and outputs. It is moreover often difficult to enforce

136 See generally, *WIPO Technology Trends 2019: Artificial Intelligence* (World Intellectual Property Organization, 2019).

137 Josef Drexl *et al*, "Artificial Intelligence and Intellectual Property Law: Position Statement of the Max Planck Institute for Innovation and Competition of 9 April 2021 on the Current Debate" (Max Planck Institute for Innovation and Competition Research Paper No 21-10) at para 16.

138 [2021] FCA 879 at [130].

139 Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57 Boston College Law Rev 1079 at 1104–1105.

140 Daria Kim *et al*, "Artificial Intelligence as Inventors? A Position Statement of 7 September 2021 in View of the Evolving Case-Law Worldwide" (Max Planck Institute for Innovation and Competition Research Paper No 21-20) at para 18.

trade secrets and prove infringement. Trade secrets are not registrable with any governmental authority, which means that holders of the secrets must rely on internal documentation to prove that the secrets fulfil the requisite legal criteria.[141] The holders also face a high evidential burden of proving infringement because of the technical complexities of AI systems and the large amounts of technical data that are inevitably required for proof. This difficulty is aggravated if the trade secrets are to be enforced internationally.

V. Concluding remarks

75 Technological change is a constant. It is often followed in its wake by concerns regarding the ability of intellectual property law to cope with change. Not too long ago, the digital revolution and the concomitant Internet phenomenon created an immense conundrum in copyright law. This author wrote:[142]

> The problem, starkly stated, if difficult to resolve, is this: if copyright works can easily and speedily be copied, revised, distributed, transmitted or otherwise manipulated in cyberspace, can copyright still perform its legal, social and ethical functions of serving and balancing the interests of its various stakeholders? Can it meet a profoundly new kind of challenge posed by the galloping convergence of computer and telecommunications technologies? Indeed, should we leave it to self-destruct in the face of the onslaught and replace a moribund system with a new legal edifice?

76 The author concluded by offering a hopeful and sanguine view because the history of copyright law since the advent of the printing press in the late 15th century shows that it has been capable of addressing the challenges of new technological developments by making doctrinal changes and fashioning new rules. In the event, copyright reform and legislative amendments were carried out to make the law relevant to the new digital age.[143]

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141 In Singapore, the protection may be afforded by the law on confidential information which recently underwent some revamping: see *LVM Law Chambers LLC v Wan Hoe Keet* [2020] 1 SLR 1083; *I-Admin (Singapore) Pte Ltd v Hong Ying Ting* [2020] 1 SLR 1130; and *Lim Oon Kuin v Rajah & Tann LLP* [2022] 2 SLR 280.

142 Tan Tee Jim SC, "Net Effect: Copyright Conundrum in Cyberspace" (1997) 9 SAcLJ 229 at 229.

143 For example, in November 2021, Singapore revamped its copyright law to enhance "[Singapore's] copyright regime through … updated provisions, which factor in technological developments that have impacted how content is created, distributed, accessed and used": see Ministry of Law, "Commencement of the Copyright Act", press release (19 November 2021).

77 Patent law is equally adaptable and resilient. Although the core rules of the law were established at a time when inventions were mechanical, its history also indicates an ability to recast the rules to accommodate new technologies. For example, there was much debate in the US and the UK about 30 years ago as to whether computer programs and business methods could be admitted to the pantheon of patentable subject matter. In the US, in the seminal case of *Diamond v Chakrabarty*,[144] the Supreme Court held that the types of patentable invention in the US Patent Act should be given "wide scope" and the eligible inventions "include anything under the sun that is made by man". This led the way for the Court of Appeals for the Federal Circuit to decide in 1994 and 1998 respectively that computer programs and business methods as such are patentable.[145] In the UK, computer programs, without more, have been excluded from patentability.[146] However, implementation of a technical process on a computer that solves a technical problem with a technical solution was considered enough to overcome an excluded subject matter objection, provided the claimed subject matter does not fall within the category of schemes, rules and methods for performing mental acts. Whether the claimed subject matter falls within one or more of these exclusions is to be decided based on a four-step test propounded by its Court of Appeal in 2006.[147]

78 There is no necessity to fret over the clarion call by several well-meaning patent scholars to replace the human inventor. The anthropomorphisms surrounding AI technology are irrelevant and distracting. AI is essentially a tool in the hands of the human inventor, however impressive it may be in terms of the nature and extent of its application in our daily lives. It is imperative that the Incentive and Reward Concept should continue to be applicable to encourage the making of new AI-generated inventions by humans.

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144 447 US 303 at 100 (1980). The case was about microorganisms.

145 *Re Alappat* 33 F 3d 1526 (1994) and *State Street Bank & Trust Co v Signature Financial Group Inc* 149 F 3d 1368 (1998).

146 See s 1(2)(c) of the UK Patents Act 1977 which declares that anything which consists of a scheme, rule or method for performing a mental act, playing a game or doing business, or a program for a computer is not an invention but "only to the extent that a patent or application for a patent relates to that thing as such". This provision is not adopted in the Singapore Patents Act 1994; instead, s 13(2) of the Act prohibits patenting an invention if its publication or exploitation "would be generally expected to encourage offensive, immoral or anti-social behaviour".

147 See *Aerotel Ltd v Telco Holdings Ltd* [2007] Bus LR 634.