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Artificial Intelligence as Inventor: Exploring the Consequences for Patent Law

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INTRODUCTION

Intelligence is notoriously difficult to define. When two dozen prominent theorists were asked to provide a description of the term, they gave an equal number of "somewhat different" definitions.[1] Likewise, defining artificial intelligence (AI) is not an easy task. There is no uniform or universally agreed definition;[2] moreover, AI includes a diverse range of subsets such as machine learning, natural language processing and genetic programming—each of which functions differently. In more general terms, AI is commonly used to refer to various algorithms which broadly mimic the human brain's cognitive functions. Examples include self-driving cars, Apple's Siri (a virtual assistant which uses a natural-language user interface to respond to voice queries) and DeepMind's AlphaGo which forced former Go (a board game where the aim is to surround more territory than the opponent) world champion Lee Se-dol to retire in 2019 because—in his own words—"AI cannot be defeated".[3]

Modern AI is now also able to generate a diverse range of sophisticated creative outputs. In November 2019, the Prague Philharmonic performed an AI-generated composition based on an unfinished work by Antonín Dvořák, 115 years after his death.[4] Similarly, algorithms such

[1] Neisser U et al, "Intelligence: Knowns and unknowns" (1996) 51(2) *American Psychologist* 77, 77.
[2] Shemtov N, "A study on inventorship in inventions involving AI activity" (2019) p. 9 <http://documents.epo.org/projects/babylon/eponet.nsf/0/3918F57B010A3540C125841900280653/$File/Concept_of_Inventorship_in_Inventions_involving_AI_Activity_en.pdf> accessed 30 May 2020. Leading computer science books have defined AI as the study of "intelligent agents"—devices that perceive their environment and take action to successfully achieve a particular goal; see Poole D et al, *Computational Intelligence* (OUP, 1998) p. 1 (using "computational intelligence" as a synonym).
[3] Vincent J, "Former Go champion beaten by DeepMind retires after declaring AI invincible" <https://www.theverge.com/2019/11/27/20985260/ai-go-alphago-lee-se-dol-retired-deepmind-defeat> accessed 28 July 2020.
[4] Rudra S, "An AI Completes an Unfinished Composition 115 Years After Composer's Death" <https://www.vice.com/en_uk/article/neakqm/an-ai-completes-an-unfinished-composition-115-years-after-composers-death> accessed 28 July 2020.

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as OpenAI's GPT-2 language program can generate poetry and other literary works (with varying levels of success).[5] In addition to these creative works (which may in theory be protected by copyright),[6] AI is now increasingly being utilised to produce *inventive* outputs (which may be subject to patent protection). In fact, AI systems have already generated a wide array of inventions essential to products such as medical devices, kitchen appliances and drug synthesizers.[7]

It is therefore hardly surprising that the intellectual property (IP) implications of this cutting-edge technology have attracted considerable attention in recent years. The World Intellectual Property Organization (WIPO), for instance, has initiated a public consultation on the interplay between AI and IP, acknowledging the significant socio-economic potential of the technology and inviting stakeholders to participate in the debate.[8] Similarly, the EU's Joint Research Centre (JRC)—the Commission's science and knowledge service—recently published a Technical Report on AI and IP, identifying various gaps and areas of the law which require further examination to provide legal certainty.[9] But while the relationship between AI and copyright has been discussed in detail in the academic literature, there are certain aspects of patent law which have not been fully explored yet.

Patent law has traditionally developed with human inventors in mind. At the same time, the use of inventive AI systems raises a range of novel issues which the existing patent framework may not be able to accommodate easily. For instance, it is unclear whether AI algorithms

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[5] Tang D, "The Machines Are Coming, and They Write Really Bad Poetry" <https://lithub.com/the-machines-are-coming-and-they-write-really-bad-poetry> accessed 28 July 2020.

[6] For an academic discussion on whether AI-generated works may attract copyright see Bonadio E – McDonagh L., Artificial Intelligence as Producer and Consumer of Copyright Works: Evaluating the Consequences of Algorithmic Creativity, Intellectual Property Quarterly 2020, 2, pp. 112-137.

[7] Yanisky-Ravid S & Liu X, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2017) 39 *Cardozo Law Review* 2215, p. 2219.

[8] World Intellectual Property Organization, "WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI)" WIPO/IP/AI/2/GE/20/1 *Draft Issues Paper* <https://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1.pdf> accessed 28 June 2020. In its Draft Issues Paper, the WIPO identified a range of key IP issues which require consideration, including the issue of inventorship and ownership in patent law in cases where there has been little or no human involvement in the inventive process, IP infringement and exceptions, etc. These issues, among others, will be explored in detail in the sections below.

[9] Iglesias M, Shamuilia S & Anderberg A, "Intellectual Property and Artificial Intelligence - A literature review" <https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119102/intellectual_property_and_artificial_intelligence_jrc_template_final.pdf> accessed 25 July 2020; see also European Parliament "Intellectual property rights for the development of artificial intelligence technologies" (2020/2015(INI)) para 6. ("…to consider what route will provide innovators with the broadest and most robust means of IP protection that combine legal certainty and encourage new investment in private enterprises, universities, SMEs and clusters using public-private collaboration to support research and development.") <https://www.europarl.europa.eu/doceo/document/A-9-2020-0176_EN.html> accessed 25 October 2020.

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should be subject to patent protection, or whether the proliferation of AI-generated inventions should require us to re-evaluate core patent concepts such as inventive step. There is no consensus over whether a machine can be designated as inventor. Who would be the owner of the patent where an AI system has generated the invention with little or no human intervention? Who would be liable for AI-induced infringement in cases where machines act "autonomously"? A thorough examination of the above issues can help to ensure that patent law is able to keep up with new technological developments. Although in this article our primary focus is on patent law in European jurisdictions, we make comparative references to other key jurisdictions, especially the US given its rich legal scholarship on point.

Crucially, we argue that the way patent law responds to the advent of AI could have direct implications for social welfare more generally. While maintaining a legal environment that encourages and incentivises the production of valuable inventive outputs via patents is sensible, no philosophical rationale can justify a system in which granting exclusive rights over AI-generated inventions results in unwarranted monopoly control in the hands of a select few large global entities such as Google, Amazon, Huawei or Apple.

OVERVIEW OF MACHINE-GENERATED INVENTIONS

Computer-generated inventions are not new. Machines and computers have been used as tools to produce various patentable inventions in fields such as chemistry and biotechnology for a considerable amount of time.[10] Nowadays, artificial intelligence systems—such as artificial neural networks—are able to test and find solutions to certain problems with little or no human involvement.[11] In other words, there are instances where machines generate inventive output with a significant degree of autonomy and are no longer merely tools which assist humans.[12]

[10] Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32, p. 43 (computers have aided the invention of a range of new compounds and electrical products).

[11] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1083 ("…machines have been autonomously generating patentable results for at least twenty years and…the pace of such invention is likely increasing"); see also Blok P, "The inventor's new tool: artificial intelligence - how does it fit in the European patent system?" (2017) 39(2) European Intellectual Property Review 69, p. 70. Since the 1950s, innovators have filed approximately 340,000 applications for "AI-related" inventions and authored more than 1.6 million scientific works on AI. Machine learning is the most commonly used AI technique in this regard, accounting for more than one-third of all relevant inventions (134,777 patent documents); see World Intellectual Property Organization, "Artificial Intelligence" (2019) at 13-14 <https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf> accessed 30 May 2020.

[12] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) *Emory Legal Studies Research Paper* 1 <https://ssrn.com/abstract=3036030> accessed 30 May 2020; McLaughlin M, 'Computer-Generated Inventions' (2018) p. 17 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3097822> accessed 28 June

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Therefore, computer involvement in the inventive process can be conceptualised on a spectrum which gradually moves from purely human-made inventions to computer-*assisted* inventions and, finally, computer-*generated* inventions (whereby the role of humans progressively diminishes).[13] Unsurprisingly, and as explored below, it is the latter end of this spectrum which is particularly controversial in the context of patent law.

Abbott argues that computers have been "autonomously" producing patentable results for at least two decades.[14] In the mid-1990s, Stephen Thaler created (and patented)[15] an AI system named the "Creativity Machine".[16] The machine—based on artificial neural networks—aims to generate novel ideas by altering the connections within its network, effectively mimicking the human brain's cognitive functions. It is able to adapt to changing circumstances without further human intervention, which distinguishes it from more conventional software.[17] Thaler claims that his AI is responsible for creating patentable inventions such as the cross-bristle design of the Oral-B CrossAciton toothbrush as well as various new materials and devices.[18] Critically, he has obtained patents for some of those inventions despite the fact that—if his claims are correct—the machine generated the inventions autonomously.[19]

The Creativity Machine is not the only such example. In the late 1990s, John Koza created a GP-based (genetic programming) AI system named the "Invention Machine".[20] Genetic programming is a method of generating computer programs by emulating the natural genetic processes of biological evolution.[21] Abbott argues that GP-based AI was already capable of autonomously creating patentable subject matter by the mid-1990s and that, as of 2010, there

2020; Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1094.

[13] McLaughlin M, 'Computer-Generated Inventions' (2018) p. 17 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3097822> accessed 28 June 2020.

[14] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1083.

[15] US Patent No. 5,659,666 (filed 13 October 1994).

[16] Thaler S, "Synaptic Perturbation and Consciousness" (2014) 6(2) International Journal of Machine Consciousness 75.

[17] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, pp. 1084-5.

[18] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p 1085.

[19] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p 1085.

[20] Yanisky-Ravid S & Liu X, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2017) 39 Cardozo Law Review 2215, p. 2221.

[21] Banzhaf W, "Artificial Intelligence: Genetic Programming" (2001) International Encyclopedia of the Social & Behavioral Sciences 789 <https://www.sciencedirect.com/science/article/pii/B008043076700557X> accessed 30 May 2020 (the process begins by determining what has to be done; it then automatically generates a program to solve a particular problem).

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were at least 31 instances where GP had "generated a result that duplicated a previously patented invention, infringed a previously issued patent, or created a patentable new invention".[22] Importantly, Koza has earned a US patent for a system designed to make factories more efficient which was reportedly generated by his AI "without human intervention and in a single pass".[23] Koza did *not* disclose the AI's involvement in the process to the patent examiners either. He argues that his legal representatives advised his team to designate *themselves* as inventors, even though the entire invention was "made by the AI".[24] Presumably, this was done to avoid a challenge on the grounds of a lack of human inventorship.

It therefore appears that at least one major patent office (the USPTO)[25] has granted patents for AI-generated products *without being aware* that a machine was—if the claims are accurate—fully *responsible for the invention*. Would the examiners have reached a different decision if Thaler and Koza had disclosed this information? Before addressing the issue of machine inventorship, we will consider the interplay between AI-generated inventions and the existing rules on patentable subject matter and core patentability requirements such as novelty, inventive step as well as disclosure.

SUBJECT MATTER, PATENTABILITY REQUIREMENTS AND DISCLOSURE

As is well-known, patents are granted as part of a statutory bargain – they are time-limited monopolies granted to private parties in exchange for the disclosure of new inventions into the public realm (and eventually, into the public domain). The rationale behind this is that while the patent owner gets a set of temporary exclusive rights, the technical information disclosed by the patentee can be utilised by competitors and the general public upon expiry after 20 years.

Patents are granted solely for inventions which are of appropriate subject matter, novel, involve an inventive step, and are capable of industrial application.[26]

[22] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1086.
[23] US Patent No. 6,847,851.
[24] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079.
[25] United States Patent and Trademark Office (USPTO).
[26] For instance, see Article 52(1) of the European Patent Convention (EPC) (discussed in detail below).

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Patentable subject matter

The European Patent Convention (EPC)[27] provides a legal framework for the granting of European patents. In terms of subject matter, the EPC excludes from patentability, *inter alia*, discoveries, mathematical methods, mental acts and computer programs but "only to the extent to which a European patent application or European patent relates to such subject-matter or activities *as such*" (emphasis added).[28] For instance, computer programs or mathematical methods can still qualify as patentable subject matter provided that they have a technical character. This would typically be the case where e.g. a program "brings about, or is capable of bringing about, a technical effect which goes beyond the "normal" physical interactions between the program (software) and the computer (hardware) on which it is run".[29]

For the purposes of the present analysis, it is useful to distinguish between the patentability of the AI system *itself* and its *output*. First, a typical AI algorithm—such as a neural network or support vector machine—is likely to be regarded as a mere mathematical method or mental act and thus unpatentable *per se* due to the lack of a technical effect.[30] Nevertheless, the EPO has now issued specific guidance on AI and machine learning, recognising that, for instance, using a neural network to identify irregular heartbeats would have the necessary technical contribution so as to qualify as patentable subject matter (in contrast, a system for classifying text purely in terms of its literal content is unlikely to satisfy this criterion).[31] The specificity of the claims is likely to be key in these circumstances; non-specific, vague, or high-level claims would presumably fail.[32] Confining the claim to a specific technical purpose, on the

[27] European Patent Convention (Convention on the Grant of European Patents) of 5 October 1973 as revised by the Act revising Article 63 EPC of 17 December 1991 and the Act revising the EPC of 29 November 2000.
[28] See Article 52(2) EPC; Article 52(3) EPC.
[29] Case T-1173/97 *Computer Program Product/IBM*, Technical Board of Appeal 1/7/1998, 13.
[30] European Patent Office, Guidelines for Examination, G-II 3.3.
[31] European Patent Office, Guidelines for Examination, G-II 3.3.1; see also European Parliament, "Intellectual property rights for the development of artificial intelligence technologies" 2020/2015(INI) at G. ("…whereas AI and related technologies are based on computational models and algorithms, which are regarded as mathematical methods within the meaning of the European Patent Convention (EPC) and are therefore not patentable as such; whereas mathematical methods and computer programs may be protected by patents under Article 52(3) of the EPC when they are used as part of an AI system that contributes to producing a further technical effect...") <https://www.europarl.europa.eu/doceo/document/A-9-2020-0176_EN.html> accessed 25 October 2020.
[32] Borella M, "How to Draft Patent Claims for Machine Learning Inventions" (2018) <https://www.patentdocs.org/2018/11/how-to-draft-patent-claims-for-machine-learning-inventions.html> accessed 30 May 2020. Moreover, as Lim points out, a great deal of AI patents refer to generic computer implementations of abstract processes or incorporate components that are routine and well-known, such as running input data through an algorithm; see Lim D, "AI & IP Innovation & Creativity in an Age of Accelerated Change" (2018) 52 Akron Law Review 813, 868.

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other hand, may be sufficient to impart a technical effect.[33] Accordingly, inventions that rely on machine learning or AI to solve a specific problem, often without restricting the solution to a specific algorithm, may be deemed patentable. This is the case with European Patents No 2377044B1 (using a machine learning algorithm to detect anomalous patterns in video data over long time periods) and No EP2930578B1 (a method for classifying the cause of machine failure by using machine learning to analyse features obtained from sensors). These inventions are characterised by the fact that they are focused on the application area, e.g. machine failure, rather than the machine learning or artificial intelligence algorithms used.

Second, the EPC does not explicitly exclude from patentability inventive *output* generated by AI systems, and the way in which an invention has been made is irrelevant.[34] Furthermore, Article 27 TRIPS[35] and Article 52 EPC both state that patents should be granted without discrimination as to the field of technology. It could thus be argued that inventions should be considered patentable even where they are generated autonomously via AI.

Novelty

In order to be patentable, the invention must be "new".[36] The novelty condition is satisfied where the invention does not form part of the "state of the art", a concept broadly defined to include all matter available to the public anywhere in the world before the priority date.[37]

In terms of machine-generated inventions, novelty is likely to be absent where the AI algorithm does not have any variability as to its outputs and merely relies on data sets already used before the patent application.[38] In contrast, an algorithm which relies on randomness or other variability is more likely to satisfy this requirement.[39] The key challenge here, however, is the risk that AI systems may make it considerably more difficult for an applicant to establish

[33] Hashiguchi M, "The Global Artificial Intelligence Revolution Challenges Patent Eligibility Laws" (2017) Journal of Business & Technology Law 1 (2017) 15-16 (although mainly focusing on computer implemented inventions in the US context, the author confirms the importance of specificity and technical contribution in establishing the patent eligibility of AI).
[34] Blok P, "The inventor's new tool: artificial intelligence - how does it fit in the European patent system?" (2017) 39(2) European Intellectual Property Review 69, p. 70.
[35] The Agreement on Trade-Related Aspects of Intellectual Property Rights.
[36] Article 52(1) EPC.
[37] Article 54(1)-(2) EPC.
[38] See Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, 319.
[39] See Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, 319.

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novelty generally. Indeed, AI could dramatically expand the prior art universe—which is fundamental in terms of assessing novelty:

> *Where thinking machines … expand what is understandable by humans, the universe of prior art may become much larger… making it harder to establish novelty… The concept of public availability and use might need to be revisited, for example, where thinking machines generate huge volumes of discoveries and make these discoveries available in ways easily accessible by machines but not understandable by people.*[40]

AI-generated claims (e.g. those produced by the French company Cloem which applies natural language processing technologies to assist patent applicants)[41] could also be purposely created to saturate the technical space around patented inventions with the aim of preventing a patentee's competitors from obtaining improvement patents in the same area.[42] However, not all information published online should be considered capable of destroying the novelty of an invention. Physical accessibility of such information is not determinative "if the computer-generated texts would not actually be instructive to the skilled reader."[43] The High Court in England and Wales, for instance, has held that the term "available to the public" does not merely mean "physically accessible"; information must be "sufficiently intellectually instructive [to] the skilled person using their common general knowledge", especially where "the matter may be contained in a document but so submerged in it as not to be available".[44] Fraser thus argues that this may be a barrier to considering AI companies' computer-generated patent texts as part of the state of the art, especially if the relevant prior art is effectively hidden within large amounts of nonsensical text.[45] In these circumstances, one would have to evaluate the quantity and proportion of published useful art and the difficulty associated with locating it.[46] Therefore, whether such prior claims constitute enabling disclosure capable of destroying

[40] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, 15 <https://ssrn.com/abstract=3036030> accessed 30 May 2020.
[41] See website <https://www.cloem.com/flat/faq/> accessed 28 June 2020 (Cloem uses linguistic manipulation software which adds or deletes sentences; it relies on brute-force computing to compose texts for thousands of claims which may cover new inventions).
[42] Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32, pp. 42-43.
[43] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, p. 310.
[44] *H Lundbeck A/S v Norpharma SpA*, [2011] EWHC 907 (Pat).
[45] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, p. 310; however, see also p. 311 ("If these patent text-generation technologies became better known and widely used, the argument could be made that the skilled person would know to consult them. Were this the case, any argument to exclude these texts would be less persuasive.").
[46] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, p. 311.

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the novelty of subsequent inventions would have to be carefully assessed on a case-by-case basis.[47]

In addition to the legal considerations above, there are also sound policy reasons to deny large volumes of nonsensical computer-generated text prior art status, including the need to discourage the fabrication of knowledge aimed at preventing competitors from obtaining patents in that specific area. Such disclosures could be considered as being artificially constructed in bad faith by entities which are exclusively interested in preventing the acquisition of patents by those who actually invest time and resources in research and development. Hattenbach and Glucoft further argue that publishing large amounts of nonsensical claims may impinge on the fundamental aims of the patent system and ultimately have a negative effect on social welfare:

> *Publishing masses of nonsense achieves the opposite of what these requirements seek to accomplish—it dilutes the set of actual public knowledge, burying genuinely useful information and leaving society worse off.*[48]

From a more practical standpoint, there are also genuine concerns that the proliferation of claims produced via AI may burden the patent offices by increasing their workload to an unprecedented extent.[49] The growth of prior art references requiring examination may jeopardise the efficiency, sustainability and the level of scrutiny currently applied to applications.[50] Maintaining the existing examination standards may therefore require more resources to be allocated to survey the enormous prior art universe, greatly increasing the costs associated with examination and requiring examiners who are both knowledgeable in the field and skilled at analysing computer-generated texts.[51]

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[47] Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32. It is also worth noting that the current state of the art in computerized inventing produces mere claims which often lack specification or other background information. The issue here is that even if a page displaying a computer-generated claim does technically qualify as a printed publication, it would also need to be enabling in order to constitute invalidating prior art (see p. 38); see also Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, 312.

[48] See also Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32, p. 42.

[49] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, 17 <https://ssrn.com/abstract=3036030> accessed 30 May 2020; Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, 319.

[50] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, p. 312.

[51] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, p. 312.

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On the other hand, AI could have a positive impact on the patent examination process as it may increase efficiency, reducing the cost of review and assessment of patent applications.[52] The use of AI would be particularly useful in relation to tasks where machines outperform human examiners, allowing officers to prioritise their time on more substantive issues and delegating other time-consuming tasks to AI.[53]

Inventive step

In order to be patentable, an invention must satisfy the inventive step requirement.[54] This condition is met where (having regard to the state of the art) the invention would not be obvious to "a person skilled in the art".[55] The person skilled in the art is construed as "a skilled practitioner in the relevant field of technology, who is possessed of average knowledge and ability".[56] Therefore, patents cannot be granted for inventions which are within the reach of the average expert in the field—who, Blok argues, is "generally assumed" (albeit implicitly) to be a *human being*.[57] The use of terms such as "person" and "practitioner" adds further weight to this argument.

Taking into account a 21st century machine's (potentially) high level of intelligence, its inventive output – the invention - would in many cases meet the requisite inventive step threshold. To take one high-profile example, some of Watson's[58] output results have surprised even its developers - this is "encouraging" regarding inventiveness, given that unexpected results are sometimes taken into account when examiners assess the issue of non-obviousness.[59]

Conversely, certain claims which have been mechanically generated by AI may be regarded as obvious. For example, the above-mentioned company, Cloem, uses linguistic manipulation

[52] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, 17 <https://ssrn.com/abstract=3036030> accessed 30 May 2020; Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, 319.
[53] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, 18 <https://ssrn.com/abstract=3036030> accessed 30 May 2020.
[54] Article 52(1) EPC.
[55] Article 56 EPC.
[56] European Patent Office, Guidelines for Examination, G-VIII.3.
[57] Blok P, "The inventor's new tool: artificial intelligence - how does it fit in the European patent system?" (2017) 39(2) European Intellectual Property Review 69, p. 70.

[58] An IBM-developed computer capable of answering questions posed in natural language.

[59] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1091.

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software which merely adds or deletes sentences.[60] It relies on brute-force computing to compose texts for thousands of claims which may cover new inventions. Cloem's AI substitutes hyponyms, meronyms and antonyms for the components of the original seed claims. While it may generate many non-sensical claims, it does also produce grammatically correct phrases which provide interesting variations on the original claims.[61] However, many of those claims would be "the result of relatively slight rearrangement, and these minor modifications that work in predictable ways would by definition be considered obvious".[62]

Crucially, the increasing usage of AI may require us to completely rethink the existing inventive step standard in the long term, given that computers have extensive knowledge of the prior art—potentially far beyond any human being.[63] The proliferation of AI may necessitate raising the bar to patentability and amending the existing "person skilled in the art" benchmark to include a person "equipped with AI", effectively elevating the notional person's ability to that of a sophisticated machine.[64] Thus, the inventive step test may end up including the routine use of AI by skilled persons as an important aspect to be taken into consideration,[65] and applicants could be required to disclose the specific contribution of the machine to the invention's conception.[66]

Abbott even argues that computational innovation may gradually result in a complete substitution of the concept of the skilled person with that of a "skilled computer", as a result of which "everything would be obvious" to a super-intelligent machine:[67]

[60] See Cloem's FAQ <https://www.cloem.com/flat/faq/> accessed 28 June 2020.
[61] Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32, pp. 36 and 51 et seqq.
[62] Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32, p. 45.
[63] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305, 320.
[64] Tull S & Miller P, "Patenting Artificial Intelligence: Issues of Obviousness, Inventorship, and Patent Eligibility" (2018) 1(5) The Journal of Robotics, Artificial Intelligence & Law p. 320.
[65] Lim D, "AI & IP: Innovation & Creativity in an Age of Accelerated Change" (2019) 52 Akron Law Review 813, p. 863; see also See Ramalho A, "Will Robots Rule the (Artistic) World? A Proposed Model for the Legal Status of Creations by Artificial Intelligence Systems" (2017) 21(1) Journal of Internet Law 12, 26 (suggests adding a "made by AI" factor when assessing obviousness).
[66] Abbott R, "Inside Views: Everything is Obvious" Intellectual Property Watch (25 March 2019) <https://www.ip-watch.org/2019/03/25/everything-is-obvious/> accessed 28 June 2020.
[67] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, pp. 1124-1125.

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> *As inventive machines continue to improve, this will increasingly raise the bar to patentability, eventually rendering innovative activities obvious. The end of obviousness means the end of patents, at least as they are now.*[68]

An overly expansive approach to obviousness would therefore mean that few things would be eligible for patent protection.[69] Consider the example of combination patents. Whereas a human may not necessarily think of combining cooking recipes with recent advances in the medical sector, a computer would not be limited by such restrictions.[70] Therefore, the more prior art that can be taken into account, the less likely an invention would be regarded as non-obvious.[71] Moreover, while stricter patent procedures are to be generally welcomed (especially as patent offices are often criticised for being overly generous), a patent system where the benchmark involves a "skilled computer" is not without its problems. Examiners and judges would have to put themselves in the mindset of a machine and consider prior art which may be within the reach of computers, but not human beings.[72] This might be practically impossible.

Industrial application

This requirement is satisfied where the invention can be made or used in any industry.[73] While this is a core requirement, AI-generated inventions do not raise any major novel issues in this regard. For instance, the bristle design of the above mentioned Oral-B toothbrush—invented by Thaler's Creativity Machine—would likely satisfy this requirement.

Disclosure

An invention needs to be disclosed in a sufficiently clear and complete manner so as to allow a person skilled in the art to understand and work it.[74] The disclosure requirement incentivizes innovation: it prevents wasteful duplication of research, allows follow-on innovation by informing patentees as to the boundaries of a patented invention, and benefits the public at large by securing the dissemination of new technology.

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[68] Abbot R, "Everything is Obvious" (2018) 66(2) UCLA Law Review 2.
[69] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, 15 <https://ssrn.com/abstract=3036030> accessed 30 May 2020.
[70] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1125
[71] Abbott R, "Everything is Obvious" (2018) 66(2) UCLA Law Review 2, p. 20
[72] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1125.
[73] Article 57 EPC.
[74] Article 83 EPC.

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In terms of AI-generated inventions, it is often difficult to describe how the algorithm actually works. As Rich explains, "[m]achine learning tends to create models that are so complex that they become 'black boxes', where even the original programmers of the algorithm have little idea exactly how or why the generated model creates accurate predictions".[75] Consider the example of an AI system which is trained on a highly specific data set whereby the configuration is not fully known or cannot be duplicated by others. The key issue here is that if the invention is not reproducible, it will not be regarded as being sufficiently disclosed.[76] On this basis, Frueh argues that "patent law's disclosure requirement … is under attack by AI and this may negatively affect the patent system as a whole, particularly its legitimacy that builds on the *quid pro quo*-bargain of the so-called contract theory."[77] Moreover, the use of AI may lead to new disclosure deficits if the person skilled in the art requires AI to determine whether there has been adequate disclosure.[78]

INVENTORSHIP

In terms of definitions, neither the EPC nor the national laws of most European States define the term "inventor" in great detail (if at all). The EPC stipulates that "[t]he right to a European patent (...) belong[s] to the inventor or his successor in title".[79] It further states that applications need to designate an inventor,[80] including her family name, given names and full address,[81] which may be interpreted as suggesting that the inventor must be a natural person.[82] In support of this argument, national courts and lawmakers in Europe have consistently linked the concept

[75] Rich M, "Machine Learning, Automated Suspicion Algorithms, and the Fourth Amendment" (2016) 164 University of Pennsylvania Law Review 871, p. 886. On the issue of "black boxes" and AI in the context of patent landscaping, see also Toole A et al, "The Promise of Machine Learning for Patent Landscaping " (2020) USPTO Economic Working Paper No. 2020-1 (arguing that both traditional query and machine learning are beneficial in patent landscaping and complement each other) available at SSRN <https://ssrn.com/abstract=3555834> accessed 28 June 2020.
[76] Frueh A, "Transparency in the Patent System – Artificial Intelligence and the Disclosure Requirement", in Pacud Z & Sikorski R (eds.), Rethinking Patent Law as an Incentive to Innovation (2019).
[77] Frueh A, "Transparency in the Patent System – Artificial Intelligence and the Disclosure Requirement", in Pacud Z & Sikorski R (eds.), Rethinking Patent Law as an Incentive to Innovation (2019) (see Conclusion).
[78] Frueh A, "Transparency in the Patent System – Artificial Intelligence and the Disclosure Requirement", in Pacud Z & Sikorski R (eds.), Rethinking Patent Law as an Incentive to Innovation (2019).
[79] Article 60(1). Article 60(3) EPC further stipulates that in terms of proceedings, '[the] applicant shall be deemed to be entitled to exercise the right to a European patent'.
[80] EPC Rule 19(1); see also Article 41(2)(j) EPC which confirms that the request for a grant of a European patent shall contain the designation of the inventor.
[81] EPC Rule 19(1).
[82] In 2013, the EU IPR Helpdesk published a Fact Sheet relating to inventorship, authorship and ownership, which noted: that "…the inventor is always a natural person and the first owner"; see European IPR Helpdesk, 'Fact Sheet Inventorship, Authorship and Ownership' (2013) at p. 3 <https://www.iprhelpdesk.eu/sites/default/files/newsdocuments/Fact-Sheet-Inventorship-Authorship-Ownership.pdf> accessed 30 May 2020.

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of inventorship to the "contribution to the inventive concept".[83] For instance, in the UK, s.7(3) of the Patents Act 1977 states that "inventor" refers to "the actual deviser" of the invention, and s.7(1) adds that any "person" may make an application for a patent; moreover, s.13(2) requires the applicant to identify the "person" who is believed to be the inventor. Inventorship is not defined in the statute under German law, but courts have referred to the inventor as the *person* who has "creatively contributed to the subject matter of the patent in view of the entire content of the patent application".[84] Similarly, the French patent statute does not provide a definition but the inventor is presumed to be the person who conceived and made the invention.[85]

DABUS and machine inventorship in Europe: human, after all?

The issue of inventorship in an AI context was debated in the famous DABUS case. In January 2020, the EPO published its grounds for refusing two patent applications—filed by Steven Thaler's legal representatives as part of the Artificial Intelligence Project (AIP)—naming a machine (DABUS) as inventor.[86] The Artificial Intelligence Project's (AIP) Team is led by Ryan Abbott (an academic at the University of Surrey) and seeks the recognition of intellectual property rights for the autonomous output of artificial intelligence.[87] The Team recognises that although in the majority of cases an AI system acts as a mere "tool", there are instances where the inventive act may be functionally automated by a machine.[88] It does not advocate for AI systems to *own* the resulting invention, given that a machine has no legal personality and cannot

[83] See Ballardini R et al, "AI-Generated Content: Authorship and Inventorship in the Age of Artificial Intelligence" in Pihlajarinne T et al (eds), Online Distribution of Content in the EU (Edward Elgar, 2019).
[84] BGH X ZR 70/11 of 22 January 2013; BGH X ZR 53/08 of 17 May 2011 - *Atemgasdrucksteuerung*; BRG GRUR 1979 - 540 (541) - *Biedermeiermanschetten*; BRG GRUR 1978 - *Motorkettensäge*; BRG GRUR 1966 – *Spanplatten*, as reported in Ballardini R et al, "AI-Generated Content: Authorship and Inventorship in the Age of Artificial Intelligence" in Pihlajarinne T et al (eds), *Online Distribution of Content in the EU* (Edward Elgar, 2019).
[85] Ballardini R et al, "AI-Generated Content: Authorship and Inventorship in the Age of Artificial Intelligence" in Pihlajarinne T et al (eds), *Online Distribution of Content in the EU* (Edward Elgar, 2019).
[86] EPO, "EPO publishes grounds for its decision to refuse two patent applications naming a machine as inventor" (2020) <https://www.epo.org/news-events/news/2020/20200128.html> accessed 30 May 2020. We should also note that, in early December 2019, the UK Intellectual Property Office also rejected Thaler's applications, stating that "DABUS is not a person as envisaged by ss. 7 and 13 of the Act and so cannot be considered an inventor"; see UK Patent Decision BL O/741/19 <https://www.boult.com/wp-content/uploads/2020/02/by-the-UKIPO.pdf> at para. 30, accessed 30 May 2020.
[87] Artificial Inventor Project, "Frequently Asked Questions" <http://artificialinventor.com/frequently-asked-questions/> accessed 28 June 2020.
[88] Moreover, the Team argues that there are cases involving AI inventorship where there is no natural person who would traditionally qualify as inventor in the first place.

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own property.[89] Rather, they argue that it is the AI's owner who should be entitled to own the AI's output.

Thaler filed two separate applications at the EPO (in addition to the USPTO, UKIPO and the Israeli Patent Office) whereby DABUS was designated as inventor.[90] The first application claimed a plastic beverage container (EP18275163); the other application referred to a flashing beacon light intended to be used in search and rescue missions (EP18275174). The Applicant's Team argued that "the machine only received training in general knowledge in the field and proceeded to *independently* conceive of the invention and to *identify it as novel*" (emphasis added).[91] According to the applicant, the machine had "identified the novelty of its own idea before a natural person did".[92] For the sake of simplicity, we will focus on the first application mentioned above (the reasoning is the same in both decisions).

When the applications were initially filed with the EPO, the applicant left the space for indicating the inventor blank. Thaler was allowed to remedy this, as the application did not comply with Article 81 and Rule 19(1) EPC which state that a European patent application shall designate an inventor. He subsequently designated "DABUS" as the inventor, describing it as a "type of connectionist artificial intelligence."[93] Thaler further argued that Rule 19(1) EPC did not require the inventor to be a human being and that the actual purpose of the provision was to *correctly* designate the inventor. He also argued that, given that the AI system created the invention on its own, naming someone else as inventor (even himself) would contravene important principles of patent law (see, for example, s.7(3) of the UK Patent Act 1977 which requires the "actual deviser" of the invention to be named); moreover, he claimed

[89] However, see Davies C, "An evolutionary step in intellectual property rights – Artificial intelligence and intellectual property" (2011) 26(6) Computer Law & Security Review, p. 602. Davies has proposed attributing inventions to the "body best entitled to them", i.e. the computer, and determining the claims by the interested parties through negotiated contractual terms ("[r]evolutionary this may be, but no more so than granting intellectual property rights, as we currently do, to a body corporate.").
[90] For a full list of the Artificial Inventor Project's patent applications, see AIP, "Patent Applications" <http://artificialinventor.com/patent-applications/> accessed 28 June 2020.
[91] EPO, "Letter concerning the inventor" (EP18275163) <https://register.epo.org/application?documentId=E3L3E6US2358DSU&number=EP18275163&lng=en&npl=false> accessed 30 May 2020.
[92] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at para. 5, accessed 30 May 2020.
[93] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at para. 3, accessed 30 May 2020.

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that "[i]naccurately listing a natural person as inventor would be misleading to the public."[94] Thaler further submitted that designating DABUS as inventor was in accordance with the core aims of the patent system, namely to "incentivise disclosure of information, commercialisation and development of inventions."[95] Requiring the designation of inventor to include both a given name and a surname—the argument goes—would result in the unfair treatment of mononymous people. Finally, Thaler claimed that he had acquired the right to a patent from DABUS by being its "successor in title". He asserted that, as the machine's owner, he was entitled to any intellectual property generated by the AI.[96]

The EPO rejected both applications on the grounds that there was no human designated as inventor, which was deemed contrary to Article 81 and Rule 19(1) EPC. The Office noted that, under Rule 19(1) EPC, the designation is required to include a surname, given name and address; merely giving a machine a name (which was the case here) was not enough.[97] Moreover, it stated that (i) the EPC *Travaux Préparatoires* "consistently refer to the inventor as being a natural person";[98] (ii) the interpretation of the term "inventor" as referring to a natural person is an "internationally applicable standard"; (iii) the "human-only" approach is followed by various domestic courts,[99] most EPC members,[100] and major patent offices including those of Japan, the US, and China;[101] (iv) the patent laws of some EPC Contracting

[94] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at para. 12, accessed 30 May 2020.
[95] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at para. 5, accessed 30 May 2020.
[96] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at paras. 4-5, accessed 30 May 2020.
[97] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at paras. 20-21, accessed 30 May 2020.
[98] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> at para. 24, accessed 30 May 2020.
[99] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> accessed 30 May 2020. In particular, the EPO referred to UK cases such as *University of Southampton's Applications* [2004] EHWC 2107 (Pat) [39] per Laddie J; *Yeda Research v Rhone-Poulenc* [2007] UKHL 43 [20] per Hoffmann LJ.
[100] EPO, "Legal aspects of patenting inventions involving artificial intelligence (AI)" (2019) <https://documents.epo.org/projects/babylon/eponet.nsf/0/3918F57B010A3540C125841900280653/$File/AI_inventorship_summary_of_answers_en.pdf> accessed 30 May 2020.
[101] IP5, "Report of the IP5 expert round table on artificial intelligence, EPO" (2018) <https://www.fiveipoffices.org/material/ai_roundtable_2018_report/ai_roundtable_2018_report> accessed 30 May 2020.

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States expressly define "inventor" as the *natural* person who created the invention;[102] and (v) no national legislation has recognised an AI machine as inventor yet.[103]

The EPO also rejected Thaler's argument that failing to accept AI systems as inventors would effectively exclude AI-generated inventions from patentability and violate Article 27 TRIPS which, as mentioned, provides that there should be no discrimination as to the field of technology when it comes to granting patents.[104] It stated that designating the inventor and addressing the issue of whether the invention satisfies the relevant patentability requirements are two distinct aspects, the former taking place before, and independently of, the substantive assessment carried out by the office.

Finally, the EPO dismissed the argument that the applicant was the "employer" of DABUS—and thus successor in title as per Article 60(1) EPC. The reason for this was that AI systems, and machines generally, can neither be employed nor transfer any rights to a human due to their lack of legal personality.[105]

Patent proceedings in the UK

The UK Intellectual Property Office (UKIPO) reached a similar verdict on DABUS in December 2019, which was later upheld by the High Court of England and Wales (see below).[106] In the UKIPO proceedings, the key questions were whether i) a non-human inventor can be regarded as inventor under the UK Patents Act 1977; and whether ii) Mr Thaler (the applicant) was entitled to apply for a patent (in preference to DABUS) merely because he was the AI's owner. The UKIPO, referring to s.7 (concerning the right to apply for a patent) and s.13 of the Act (*inter alia*, requiring the applicant to explain how she derives the right to a patent in cases where she is not the inventor), answered both questions in the negative. In response to the first question, the UKIPO accepted that DABUS had created the inventions (the practice of the Office is to accept the indication of inventor at face value) but stated that a machine cannot be named as inventor because it is not a natural person.[107] Moreover, the

[102] Article 2(8) of the Patent Law of Lithuania; §13 of the Patent Act of Estonia.
[103] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163", para 29.
[104] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163", paras 34-36.
[105] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163", para. 30.
[106] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020 (this concerned patent applications GB1816909.4 and GB1818161.0); *Stephen L Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat).
[107] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) paras. 15, 18 <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020. It is also worth noting that, although the Hearing Officer stated that this had no bearing on the instant case, in October 2019, the

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UKIPO argued that while there is no directly relevant case law on the matter, there is a "clear expectation that the inventor and person for the purpose of s. 7 and 13 respectively are one and the same, namely a natural person – a human and not an AI machine."[108] It further stated that it was not for the UKIPO to take an interpretation of the law that was not intended upon implementation, especially in the absence of any indications from the legislature and courts that a "person" may refer to anything other than a natural person.[109] In response to the second question (whether Thaler could apply for a patent in preference to DABUS by virtue of his ownership of the AI system), the UKIPO stated that as DABUS is a machine, which cannot own intellectual property due to its lack of legal personality, it "has no rights to its inventions and cannot enter into any contract to assign its right to apply for a patent to the applicant".[110]

Crucially, while the UKIPO's stance on the above issues is not surprising, the Office acknowledged that, as AI-generated inventions are likely to become significantly more prevalent in the future, there should be wider debate on the question of how the patent system handles such inventions.[111] Acknowledging that the existing framework "does not cater for such inventions and it was never anticipated that it would", the UKIPO concluded that any changes to the law should be considered in the context of this debate, as opposed to being arbitrarily shoehorned into existing legislation.[112]

The High Court of Appeal (England and Wales) upheld the decision of the UKIPO in September 2020.[113] In *Thaler v Comptroller-General*, the appellant (Thaler) argued that he had not been given an impartial hearing; that the UKIPO Hearing Officer had misdirected himself when construing the relevant legislation; and that the Patents Act 1977 had been used as an illegitimate means to deny him a right that he would otherwise have. Smith J dismissed all

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UKIPO updated its Formalities Manual to state that "AI inventorship" is not accepted ("Where the stated inventor is an 'AI Inventor', the Formalities Examiner request a replacement F7. An 'AI Inventor' is not acceptable as this does not identify 'a person' which is required by law. The consequence of failing to supply this is that the application is taken to be withdrawn under s.13(2)."); see Paragraph 3.05 of the Manual <https://www.gov.uk/guidance/formalities-manual-online-version/chapter-3-the-inventor> accessed 18 July 2020.

[108] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) para. 18 <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020. As also discussed above, both s.7 and s.13 of the Act heavily use the term "person" in the context of inventorship.

[109] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) para. 19 <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020.

[110] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) para. 21 <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020.

[111] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) paras. 28-29 <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020.

[112] UK Intellectual Property Office, Patent Decision BL O/741/19 of 4 December 2019 (2019) para. 29 <https://www.ipo.gov.uk/p-challenge-decision-results/o74119.pdf> accessed 18 July 2020.

[113] *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat).

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points of appeal, focusing on the third argument. Critically, he held that whatever the meaning of "inventor" is, a patent can only be granted to a *human* under s. 7 of the Patents Act 1977 as the Act refers to the grant of a patent to a "person".[114] As DABUS is not a person, the machine is unable to transfer its property to Thaler or anybody else.[115] Smith J further held that while it might be theoretically possible to interpret the term "inventor" so as to include both persons and "things", this would be an "unlikely construction" of the Act.[116] Interestingly, despite finding that only humans can be named as inventors, he did not dispute the assertion that DABUS is itself capable of an inventive concept and proceeded on the basis that DABUS had actually "invented" the inventions.[117] In postscript to the judgment, Smith J concluded that:

> *I in no way regard the argument that the owner/controller of an artificially intelligent machine is the 'actual deviser of the invention' as an improper one. Whether the argument succeeds or not is a different question and not one for this appeal: but it would be wrong to regard this judgment as discouraging an applicant from at least advancing the contention, if so advised.*[118]

Smith J further acknowledged that "[t]he questions raised by the Appellant are undoubtedly interesting: but they are interesting in terms of legal policy regarding artificial intelligence and raise no matter of interest on an appeal".[119]

It is therefore evident that the High Court placed significant emphasis on the wording of the Act and refused to depart from its literal interpretation. The Court made it clear that the law as it stands now does not cater for AI-generated inventions and any changes to this stance would require *legislative* action. Parliament could theoretically amend sections 7 and 13 of the Act so as to include AI systems as inventors and, for instance, automatically grant any patents generated by the AI to the machine's owner. Ideally, however, any such reform should be informed by a thorough cost-benefit analysis and an open consultation (such as the recent initiatives launched by the UKIPO and WIPO) to assess the policy implications in this area.[120]

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[114] *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat), para. 40.
[115] *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat), para. 49(2).
[116] *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat), para. 45.
[117] *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat), para. 46.
[118] *Thaler v Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat), para. 52(2).
[119] Thaler v Comptroller-General of Patents, Designs and Trade Marks, Case No. CH-2019-000339, Order, para.7(b) https://www.lawgazette.co.uk/download?ac=93150 [Accessed 20 December 2020].
[120] UKIPO, "Open consultation Artificial intelligence call for views: patents" (2020) <https://www.gov.uk/government/consultations/artificial-intelligence-and-intellectual-property-call-for-views/artificial-intelligence-call-for-views-patents> accessed 28 October 2020; WIPO, "The WIPO Conversation on Intellectual Property and Artificial Intelligence" (2019) <https://www.wipo.int/about-

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Following the decision of the High Court, Prof Ryan Abbott (leader of the Artificial Inventor Project which coordinates the DABUS applications) stated that this approach fails to provide protection for an increasing number of inventions that lack a human inventor.[121] Moreover, he stressed that this allows people to take credit for work they haven't done, thus devaluing human inventorship and misleading the public.[122] Abbott also welcomed the recent consultation on AI and IP launched by the UKIPO, stating that "if current patent laws do not protect AI-generated inventions, it is time these laws were reviewed."[123]

Patent proceedings in the US

Following the decisions of the EPO and UKIPO, the United States Patent and Trademark Office (USPTO) reached a similar conclusion over a parallel application filed by Thaler in the US.[124] In this case, the application listed Thaler as assignee and applicant. "DABUS" was designated as the inventor's given name and "Invention generated by artificial intelligence" as surname. The USPTO emphasised that various US patent provisions consistently refer to "inventors" as natural persons; e.g. 35 USC § 101 uses the language "[w]hoever invents or discovers", and 35 USC § 115 uses terms such as "himself", "herself", "individual", and "person". Drawing on relevant case law, the USPTO also argued that it was evident that the conception of the invention ("the touchstone of inventorship") must be carried out by a natural person.[125] Lastly, it rejected Thaler's argument that recognising a machine as inventor would incentivise the creation of inventive AI systems and concluded that:

> *The granting of a patent … for an invention that covers a machine does not mean that the patent statutes provide for that machine to be listed as an inventor in another patent*

ip/en/artificial_intelligence/conversation.html> accessed 28 October 0202.

[121] Nurton J, "UK Judge Upholds Refusal of DABUS Patents" <https://www.ipwatchdog.com/2020/09/24/uk-judge-upholds-refusal-dabus-patents/id=125584/> accessed 28 October 2020.

[122] Nurton J, "UK Judge Upholds Refusal of DABUS Patents" <https://www.ipwatchdog.com/2020/09/24/uk-judge-upholds-refusal-dabus-patents/id=125584/> accessed 28 October 2020.

[123] UKIPO, "Open consultation Artificial intelligence call for views: patents" (2020) <https://www.gov.uk/government/consultations/artificial-intelligence-and-intellectual-property-call-for-views/artificial-intelligence-call-for-views-patents> accessed 28 October 2020.

[124] USPTO, "Petition decision: Inventorship limited to natural persons" (2020) <https://content.govdelivery.com/accounts/USPTO/bulletins/287fdc9> accessed 30 May 2020; Nurton J, "UK Judge Upholds Refusal of DABUS Patents" <https://www.ipwatchdog.com/2020/09/24/uk-judge-upholds-refusal-dabus-patents/id=125584/> accessed 28 October 2020.

[125] *Univ. of Utah v.Max-Planck-Gesellschafl zur Forderung der Wissenschaflen e. V, (*holding that a state cannot be inventor)*; Beech Aircraft Corp. v. EDO Corp.* ("only natural persons can be "inventors"); see also Feldman R Robin & Thieme N, "Competition at the Dawn of Artificial Intelligence" (forthcoming) Journal of Antitrust Enforcement, pp. 6-7 (arguing that, in the context of the issue of conception under US law, i.e. performing the mental part of the inventive act, "computers do not have "minds" and cannot perform "the mental part of the inventive act.") available at SSRN <https://ssrn.com/abstract=3218559> accessed 28 June 2020.

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> *application—any more than a patent for a camera allows the camera to hold a copyright…[A] machine does not qualify as an inventor under patent laws*.[126]

Following the decision, on 6 August 2020, Thaler's legal team launched a lawsuit against the USPTO at the District Court for the Eastern District of Virginia.[127] In *Thaler v Iancu*,[128] the AIP Team is now arguing that the Office should follow a 1943 report by the National Patent Planning Commission which states that "patentability shall be determined objectively by the nature of the contribution to the advancement of the art, and not subjectively by the nature of the process by which the invention may have been accomplished", thus paving the way for AI inventorship.[129] The Team explained its reasoning as follows:

> *What we want is to have innovation. AI has been used to help generate innovation for decades and AI is getting better and better at doing these things, and people aren't… The law is not clear on whether you can have a patent if the AI does that sort of work, but if you can't protect inventions coming out of AI, you're going to under-produce them.*[130]

The District Court case is still pending as of January 2021.

Is this approach optimal?

It is evident from the DABUS proceedings that AI systems cannot be named as inventors in either Europe or the US at present. Is this approach optimal? In light of the patent bargain, how might we judge this situation's net social welfare effect? There is no scholarly consensus.

Indeed, patent applicants may now choose *not to disclose* the role AI has played in reaching an

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[126] USPTO, "Petition decision: Inventorship limited to natural persons" (2020) p. 7 <https://content.govdelivery.com/accounts/USPTO/bulletins/287fdc9> accessed 30 May 2020.
[127] *Thaler v Iancu et al* (1:20-cv-00903) <https://www.courtlistener.com/recap/gov.uscourts.vaed.483404/gov.uscourts.vaed.483404.1.0.pdf> accessed 25 October 2020; see also Lilly P, "Should AI Be Allowed To Patent Inventions? A New Lawsuit Aims To Sort It Out" (Hothardware, 26 August 2020) <https://hothardware.com/news/ai-beings-allowed-patent-inventions-lawsuit> accessed 25 October 2020.
[128] *Thaler v Iancu et al* (1:20-cv-00903) <https://www.courtlistener.com/recap/gov.uscourts.vaed.483404/gov.uscourts.vaed.483404.1.0.pdf> accessed 25 October 2020.
[129] Jarratt W, US National Patent Planning Commission (1944) 153 *Nature* 12, 14; *Thaler v Iancu et al* (1:20-cv-00903) para. 66 <https://www.courtlistener.com/recap/gov.uscourts.vaed.483404/gov.uscourts.vaed.483404.1.0.pdf> accessed 25 October 2020.
[130] Feathers T, "This Guy is Suing the Patent Office for Deciding an AI Can't Invent Things" (Vice, 24 August 2020) <https://www.vice.com/en/article/5dz44b/this-guy-is-suing-the-patent-office-for-deciding-ai-cant-invent-things> accessed 25 October 2020.

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invention (and name themselves as inventors instead) in order to avoid being challenged on the grounds highlighted by the patent offices above. The law, in other words, essentially sanctions a *lie* in cases where the human has in reality had little, or no, role in the inventive process.[131] Rather than indirectly encouraging dishonesty, patent offices should introduce a requirement for applicants to be transparent and disclose the role of computers in the inventive process.[132]

With AI-invented patent applications unlikely to succeed, there is a risk that inventors may choose to rely on trade secrets instead, keeping the invention secret, and effectively undermining the core rationale of the "patent bargain" (where both the inventor and the general public benefit from the disclosure and commercialization of the invention).[133] Drawing on the utilitarian patent theory, Abbott further argues that "computers can be inventors because although AI would not be motivated to invent by the prospect of a patent, computer inventorship would incentivize the development of creative machines."[134] He stresses that AI inventions do not exist simply "waiting to be discovered" and only come about because someone has made the arrangements necessary for the AI system to generate the invention.[135] Other scholars question Abbot's stance:

> *…Abbott's conclusion seems to undercut his argument, because crediting the AI instead of the developer may act as more of a deterrent for development than the other way around. If developers do not receive credit for the products produced by their work, then it stands to reason that they would be less inclined to perform their work.*[136]

Interestingly, Hughes argues that the entire argument as to designating a machine as inventor is "premature until the existence of an AI truly capable of a (sic) inventive act has been

[131] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1103.
[132] Abbott R, "Everything is Obvious" (2018) 66(2) UCLA Law Review 2, p. 34
[133] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1104.
[134] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1081.
[135] Abbott R, "Hal the Inventor: Big Data and Its Use by Artificial Intelligence" in Sugimoto C et al (eds), *Big Data Is Not a Monolith* (MIT Press, 2016) <https://ssrn.com/abstract=2565950> at p. 18, accessed 30 May 2020.
[136] Ford B, "Artificial Intelligence Inventor Asks If 'WHO' Can Be an Inventor Is the Wrong Question?" (2019) <https://www.ipwatchdog.com/2019/08/05/artificial-intelligence-inventor-asks-whether-can-inventor-wrong-question/id=111896/> accessed 30 May 2020.

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proved."[137] She further argues that the issue of whether a machine can be listed as inventor is "irrelevant" and that what really matters is *ownership*,[138] an issue which we now discuss.

OWNERSHIP

As is known, inventorship and ownership are distinct . While the inventor, i.e. the person who develops and reaches the invention, can also be the owner of the patent (for example, when she files the application herself), what usually happens in practice is that a legal person such as a company files and prosecutes the application for e.g. the employee's invention, and thus becomes owner of the patent. As a result, the inventor (often an employee of the company/applicant) is left with little else than the moral right to be designated as inventor, though an employee may receive a bonus or royalty based via contractual terms). Indeed, the default position under EPC rules is that a European patent belongs to the inventor or her successor in title; in cases where the inventor is an employee, whether the latter or the employer is the owner is determined in accordance with the relevant national law.[139]

In its DABUS decision, the EPO stated that computers and AI systems do not currently have any legal rights, including the right to own a patent (and cannot be designated as inventors, either). In particular, it held that due to their lack of legal personality, "AI systems or machines cannot have rights that come from being an inventor".[140] Yet, the EPO also confirmed that the owner of the AI may be entitled to ownership of any qualifying output generated by the machine, provided that the necessary conditions are satisfied.[141] This is in line with the position of the Artificial Intelligence Project Team—responsible for filing the DABUS Application—which has consistently argued that while the AI should be designated as inventor, it is the AI's owner who should own the resulting patents.

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[137] Hughes R, "EPO refuses "AI inventor" applications in short order - AI Inventor team intend to appeal" (2019) <http://ipkitten.blogspot.com/2019/12/epo-refuses-ai-inventor-applications-in.html> accessed 30 May 2020.

[138] Hughes R, "EPO refuses "AI inventor" applications in short order - AI Inventor team intend to appeal" (2019) <http://ipkitten.blogspot.com/2019/12/epo-refuses-ai-inventor-applications-in.html> accessed 30 May 2020.

[139] Article 60 EPC.

[140] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163" para. 27 <https://register.epo.org/application?documentId=E4B63SD62191498&number=EP18275163&lng=en&npl=false> accessed 30 May 2020.

[141] EPO, "Grounds for the EPO decision of 27 January 2020 on EP 18 275 163", para 32 ("[t]he owner of an AI system may, in accordance with national law, own the output of that system, just as an owner of any machine may own the output of that machine").

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If machines are to be accepted as inventors in the future (and patents for such inventions are granted), a number of possible candidates for ownership would emerge. These candidates would include the AI's owner; the programmer of the AI software (the person who creates the AI system capable of generating inventive output, training it on specific aspects, correcting errors, etc); the user who sets out the specific tasks (e.g. making specific arrangements in terms of output and outlining the problem to be solved); the data provider (e.g. a medical professional who provides the data set); and the first person who recognises the significance of the result.[142]

There are some important policy arguments to consider in this regard. On the one hand, if an AI system (e.g. IBM's Watson) generates an invention while being operated by a third party, attributing ownership to the end user could have a negative effect on social welfare, given that AI developers to intentionally restrict access to their AI.[143] Instead, attributing ownership to the developers may encourage them to seek to enable—rather than restrict—access to the system.[144] Conversely, a programmer who merely creates a general purpose claim-generating code does not actually contribute to an important element of the claimed invention; rather, this code would merely serve as a tool to be used by others (i.e. end users) to make such contributions.[145] Finally, Banterle argues that the most "economically efficient" solution would be to allocate ownership to end users as they would "hold these patents in highest value, and thus, aggregate welfare is maximized".[146]

This issue is undoubtedly difficult to resolve and adopting a case-by-case approach is likely to be a sensible option. However, in light of the fact that machines cannot be designated as inventors, this discussion is merely hypothetical at the present time.

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[142] Shemtov N, "A study on inventorship in inventions involving AI activity" (2019) p. 31<http://documents.epo.org/projects/babylon/eponet.nsf/0/3918F57B010A3540C125841900280653/$File/Concept_of_Inventorship_in_Inventions_involving_AI_Activity_en.pdf> accessed 30 May 2020; Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1114; Tull S & Miller P, "Patenting Artificial Intelligence: Issues of Obviousness, Inventorship, and Patent Eligibility" (2018) 1(5) The Journal of Robotics, Artificial Intelligence & Law p. 318; Banterle F, "Ownership of Inventions Created by Artificial Intelligence" (2018) AIDA, pp. 19-20, available at SSRN <https://ssrn.com/abstract=3276702> accessed 28 June 2020.

[143] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1115.

[144] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1115.

[144] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1115.

[145] Hattenbach B & Glucoft J, "Patents in an Era of Infinite Monkeys and Artificial Intelligence" (2015) 19 Stanford Technology Law Review 32, p. 49.

[146] Banterle F, "Ownership of Inventions Created by Artificial Intelligence" (2018) AIDA, p. 21, available at SSRN <https://ssrn.com/abstract=3276702> accessed 28 June 2020.

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INFRINGEMENT

A patent is infringed where a third party commercially exploits a product or process incorporating the invention without the patentee's authorisation. As AI systems may use previously patented technology to generate outputs, some inventive acts could certainly amount to infringement. The key question is: who should be liable where a machine uses patented technology to produce an output when that machine is operating with a significant degree of autonomy? Failing to hold any party accountable for such acts might encourage the use of AI systems for infringement purposes.[147]

If, on the other hand, liability for AI-induced infringement is affirmed, there are a number of possible candidates for liability, including the end user of the machine, the developer, and the AI system itself.[148] As AI systems have no legal personality, future discussions will likely focus on considering whether either the end user(s) or the developer(s) should be accountable.

In a recent Motion for a Resolution on the regulation of robotics, the European Parliament considered the possibility of holding, inter alia, end users accountable where the user of a product is liable for behaviour which leads to harm.[149] While this discussion concerned product liability, we could apply the same principle in relation to patent infringement and AI. Yet, it is questionable whether holding end users accountable is desirable. It may create uncertainty for users while also discouraging the use of (otherwise helpful) AI. This option may also be regarded as unfair, given that the end users of AI would often not be able to foresee the risk of patent infringement; moreover, in many instances, such users will be unsophisticated individuals rather than corporations with dedicated legal teams. Patent owners also tend to sue companies that develop and/or sell products, as opposed to their end users. Even where end users are sued, they are often indemnified through contractual arrangements.[150]

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[147] Watson B, "A Mind of Its Own - Direct Infringement by Users of Artificial Intelligence Systems" (2017) 58(1) IDEA: The Journal of the Franklin Pierce Center for Intellectual Property 65, 70. Some have noted that, when addressing this, we must be cautious not to hinder the advancement of AI technology; see Schaal E, "Infringing a Fantasy: Future Obstacles Arise for the United States Patent Office and Software Manufacturers Utilizing Artificial Intelligence" (2004) 11 *Jeffrey S. Moorad Sports Law Journal* 173, 201.

[148] World Economic Forum, "Artificial Intelligence Collides with Patent Law" (2018) <http://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf> accessed 30 May 2020.

[149] European Parliament, "Report with recommendations to the Commission on Civil Law Rules on Robotics" (2015/2103(INL)) <https://www.europarl.europa.eu/doceo/document/A-8-2017-0005_EN.html> accessed 28 June 2020 (see "Liability").

[150] Contractual tools could also be used by programmers to protect themselves from infringement induced by the users of their AI systems; see Watson B, "A Mind of Its Own - Direct Infringement by Users of Artificial Intelligence Systems" (2017) 58(1) IDEA: The Journal of the Franklin Pierce Center for Intellectual Property 65, p. 85.

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Another possibility would be to hold the AI developer or manufacturer accountable – this is already common practice in patent litigation (to sue the producer of the infringing goods).[151] This could be a more appropriate approach in the AI context, especially as programmers are arguably in a better position to foresee that their AI system may infringe a patent (when compared to end users). Crucially, they are also more likely to acquire economic value from the AI by, for instance, selling it to end users.[152]

Finally, it should be noted that a number of jurisdictions in Europe offer exemptions to patent infringement, including private and non-commercial and/or experimental use.[153] AI systems may be used for such purposes in many circumstances, and as such those provisions are likely to be particularly relevant. If AI systems become more widespread—and the risk of AI-induced infringement increases significantly—patent owners are likely to campaign for reducing the scope of the above exemptions in this context.

ALTERNATIVE APPROACHES

While the analysis thus far has focused on whether AI-generated inventions *could* qualify as patentable subject matter under the existing legal framework, it is worth noting that not everyone agrees that such output *should* be subject to patent protection in the first place.

First, several commentators argue that inventions generated by AI without human involvement should be left in the public domain.[154] In particular, some contend that personality and incentive-based theories (which are used to justify IP rights) are largely inapplicable when it comes to such inventions. Yanisky-Ravid and Liu, for example, argue that these theories have been conceived solely with human beings in mind,[155] and that they are inapplicable in this

[151] World Economic Forum, "Artificial Intelligence Collides with Patent Law" White Paper (April 2018) pp. 11-12 <http://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf> accessed 28 June 2020.
[152] World Economic Forum, "Artificial Intelligence Collides with Patent Law" White Paper (April 2018) <http://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf> accessed 28 June 2020.
[153] World Intellectual Property Organization, "Exceptions and Limitations to Patent Rights: Private and/or Non Commercial Use" (2014) <https://www.wipo.int/edocs/mdocs/patent_policy/en/scp_20/scp_20_3.pdf> accessed 30 May 2020; see also, for instance, UK Patent Act 1977, s. 60(5) (private and non-commercial use).
[154] McLaughlin M, 'Computer-Generated Inventions' (2018) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3097822> 17, 28; Yanisky-Ravid S & Liu X, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2017) 39 Cardozo Law Review 2215.
[155] Yanisky-Ravid S & Liu X, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2017) 39 Cardozo Law Review 2215, p. 2216.

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context because AI systems are "autonomous, creative, unpredictable, rational".[156] McLaughlin makes a similar point by placing the emphasis on the distinction between computer-*assisted* and computer-*generated* inventions. In his view, in light of the "prevailing theoretical justifications" for IP rights, an invention should enter the public domain where a sufficient "nexus to human inventorship" is lacking - which would be the case where inventions are autonomously generated by AI.[157] The issue of requiring a sufficient degree of human contribution was also raised in a recent position paper by the UK Chartered Institute of Patent Attorneys (CIPA). The Institute acknowledged that while many in CIPA believe that patent protection should be available as long as the relevant substantive provisions are satisfied—regardless of whether they have been created by AI—others are in favour of maintaining the existing inventorship requirements and allowing patent protection for AI-generated inventions only to the extent that there is a "genuine human contribution".[158]

Another argument in favour of adopting a public domain approach is made on the basis of competition-related considerations and the potential for over-proliferation of IP rights. There are concerns as to the ownership of both AI-generated inventions and the AI systems themselves,[159] particularly because a high number of patents in this field may end up in the hands of a few large corporations, thus creating patent thickets and entrenched monopolies.[160] A small number of major companies such as IBM, Microsoft, Qualcomm, Google and Huawei are already highly active in the AI industry, and a move towards "AI patenting" may strengthen their existing dominant positions.[161]

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[156] Yanisky-Ravid S & Liu X, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2017) 39 Cardozo Law Review 2215, p. 2221 (noting that "We analyze AI systems as autonomous, creative, unpredictable, rational, and evolving systems, and argue that these characteristics make justifications such as personality theories and incentive/efficiency arguments irrelevant. We conclude that one cannot conclusively determine an owner for these rights within the scope of patent law. Therefore, the rights fall outside the scope of traditional patent law.").

[157] McLaughlin M, 'Computer-Generated Inventions' (2018) pp. 32-34 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3097822> accessed 28 June 2020.

[158] Chartered Institute of Patent Attorneys, "Patenting Inventions created using an AI system A CIPA Discussion Paper" p. 2 <https://www.cipa.org.uk/_resources/assets/attachment/full/0/260456.pdf> accessed 28 June 2020.

[159] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, pp. 22-23 <https://ssrn.com/abstract=3036030> accessed 30 May 2020. There are also concerns about patent trolls; see Tech Dirt, "Cloem's business model seems custom-built for patent trolls" (2015) <https://www.techdirt.com/articles/20150220/08414930087/patent-not-sufficiently-broad-generic-cloem-will-help-you-automatically-generating-dozens-nearly-identical-patents.shtml> accessed 30 May 2020; see also European Parliament, "Intellectual property rights for the development of artificial intelligence technologies" 2020/2015(INI) (listing market concentration as a key concern in its motion for resolution) <https://www.europarl.europa.eu/doceo/document/A-9-2020-0176_EN.html> accessed 25 October 2020.

[160] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1119.

[161] Robotics Business Review, "AI Research Among Record 9,100 Patents for IBM in 2018" (2019)

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Yet, not all commentators agree that a public domain approach is appropriate. Without the lure of the exclusive rights offered by patent law, the incentives to develop AI systems capable of generating valuable inventive output may be lessened.[162] As noted earlier, denying patentability to AI-generated inventions may merely result in a greater reliance on trade secrets instead, which could ultimately harm the public and do nothing to expand the public domain.[163] Trade secrets would be enforced through contracts and via technologies such as encryption or firewalls (e.g. electronic and cyber controls over inventions).[164]

Another solution would be to merely limit the term of protection for inventions generated by machines without any human input. Fraser, for instance, suggests applying different terms of protection depending on the degree of human involvement (which, however, may be difficult to determine and implement in practice).[165] Similarly, Lauber-Roensberg and Hetmank argue in favour of shortening the term of protection on the basis that "in the era of AI innovation cycles may become increasingly shorter and patent thickets increasingly denser".[166] Banterle opines that 20 years of protection is far too long in this context.[167] Nevertheless, at present, the above proposals seem more theoretical than practical, because Article 27(1) TRIPS – as mentioned - prohibits discrimination based on the field of technology.

<https://www.roboticsbusinessreview.com/ai/ai-research-among-record-9100-patents-for-ibm-in-2018/> accessed 30 May 2020; see also Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) Boston College Law Review 1079, p. 1119; for a detailed overview of AI patent data, see also Haney B, "AI Patents: A Data Driven Approach" (2020) 19 Chicago-Kent Journal of Intellectual Property 407 (2020), pp. 479-480. In addition to these concerns, the existing AI industry has been criticised for its "invisible worker" problem where large tech companies hire thousands of isolated, low-paid gig workers (earning $2 per hour and given no opportunities to develop their skills) to carry out various tasks such as labeling data and transcribing audio - crucial for AI-powered products and services such as Amazon's Alexa. The "invisibility" of the problem leaves these workers more vulnerable to poor working conditions; see W. Heaven, "AI needs to face up to its invisible-worker problem" (MIT Technology Review, 11 December 2020), https://www.technologyreview.com/2020/12/11/1014081/ai-machine-learning-crowd-gig-worker-problem-amazon-mechanical-turk [Accessed 7 January 2021]; see also K. Hao, "The AI gig economy is coming for you" (MIT Technology Review, 29 May 2019) https://www.technologyreview.com/2019/05/31/103015/the-ai-gig-economy-is-coming-for-you/ [Accessed 7 January 2021].

[162] Bonadio E, McDonagh L & Arvidsson C, 'Intellectual property aspects of robotics' (2018) 9(4) European Journal of Risk Regulation 655–676.

[163] Vertinsky L, "Thinking Machines and Patent Law" (12 September 2017) Emory Legal Studies Research Paper 1, 19 <https://ssrn.com/abstract=3036030> accessed 30 May 2020.

[164] Yanisky-Ravid S & Liu X, "When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law" (2017) 39 *Cardozo Law Review* 2215, p. 2255.

[165] Fraser E, "Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law", (2016) 13(3) SCRIPTed 305.

[166] Lauber-Rosensberg A & Hetmank S, "The concept of authorship and inventorship under pressure: Does artificial intelligence shift paradigms?" (2019) 14(7) Journal of Intellectual Property Law & Practice, p. 578.

[167] Banterle F, "Ownership of Inventions Created by Artificial Intelligence" (2018) AIDA, p. 23, available at SSRN < https://ssrn.com/abstract=3276702> accessed 28 June 2020.

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Even in absence of IP rights, AI developers may be further incentivised and motivated to create on the basis that they would be the first to program and use the inventive machine (the so-called first-mover advantage theory) or because of general social recognition, satisfaction of scientific curiosity and collaboration with peers.[168] IP rights are not the only motivation that spurs innovation.[169]

CONCLUSION

AI systems are now able to generate inventive outputs autonomously. Yet, as patent law has traditionally developed with human actors in mind, many of its core principles do not fit comfortably with machine inventorship. In this contribution, we have navigated through this complex relationship and explored the various issues that AI raises in the patent context in light of recent EPO and UK decisions.

It is important to stress that not everyone agrees that AI-generated inventions *should* be subject to patent protection in the first place. One potential alternative is an approach whereby AI-generated inventions automatically enter the public domain and are freely available to the general public. This could be justified on the grounds that, for instance, the proliferation of inventive machines could amount to an excessive number of patents being granted in the future, concentrated in the hands of a few large corporations. However, such an approach may encourage dishonesty from patent applications, who may conceal evidence of AI inventorship.

Rather than denying AI-generated inventions patent protection altogether, it would be preferable that the term and scope of protection applicable to such inventions be reduced. Imposing a lesser term of protection for purely AI-generated inventions is likely to provide a reasonable balance between the need to incentivise AI developers and users (who can still recoup the costs and gain a first-mover advantage) and allowing the general public to access the invention within a reasonable period of time. This balanced approach would ensure that all competing interests are fairly represented. However, we note that existing rules, such as Article 27(1) TRIPS, explicitly prohibit discrimination as to the field of technology. In other words, implementing the above proposal is likely to require substantial reform.[170] Reshaping the patent

[168] Abbott R, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57(4) *Boston College Law Review* 1079, p. 1106.
[169] Silbey, J. The Eureka Myth (Stanford University Press, 2014).

[170] Firth-Butterfield K & Chae Y, "Robot inventors are on the rise. But are they welcomed by the patent system?" (2018) <https://www.weforum.org/agenda/2018/04/robot-inventors-on-rise-patent-system-US/> accessed 30 May 2020.

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framework to deal with the advent of AI could therefore turn into one of the major tasks of lawyers, academics and policymakers in the years to come.

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