11

Artificial Intelligence and Intellectual Property Law

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11.1 INTRODUCTION

This chapter reflects on the interaction between AI and Intellectual Property (IP) law. IP rights are exclusive rights vested in intangible assets that grant their owner a temporary monopoly as to the use thereof in a given territory. IP rights may be divided into industrial property and literary and artistic property. Industrial property rights protect creations that play a largely economic role and primarily include patents, trademarks, and design rights. The concept of literary and artistic property rights refers to copyright and related rights. Copyright offers the author(s) protection for literary and artistic works, while the three main related rights are granted to performing artists, producers, and broadcasting organizations.

The interface of AI and IP law has been the subject of much research already.[1] This chapter analyzes some of the relevant legal issues from a primarily civil law perspective, with a focus on the European Union (EU), and with the caveat that its limited length leaves little leeway for the nuance that this intricate, multifaceted topic demands. Section 11.2 treats the avenues open to innovators who seek to protect AI technology. Section 11.3 examines whether AI systems qualify as an author or inventor and who "owns" AI-powered content. Section 11.4 briefly notes the issues surrounding IP infringement by AI systems, the potential impact of AI on certain key concepts of IP law and the growing use of AI in IP practice.

[1] See, for example, Christian Hartmann, Jacqueline Allan, P. Bernt Hugenholtz, João Pedro Quintais, and Daniel Gervais, "Trends and developments in artificial intelligence. Challenges to the intellectual property rights framework," Brussels, 2020, https://bit.ly/3XgBPPa; Reto Hilty, Jyh-An Lee, and Kung-Chung Liu, *Artificial Intelligence and Intellectual Property* (Oxford University Press, 2021); Ryan Abbott (ed), *Research Handbook on Intellectual Property and Artificial Intelligence* (Edward Elgar Publishing, 2022); Larry A DiMatteo, Cristina Poncibò, and Michel Cannarsa (eds), *The Cambridge Handbook of Artificial Intelligence. Global Perspectives on Law and Ethics* (Cambridge University Press, 2022), pp. 87–160; Jozefien Vanherpe, "AI and IP: Great Expectations" in Jan De Bruyne and Cedric Vanleenhove (eds), *Artificial Intelligence and the Law* (2nd ed, Intersentia, 2023) pp. 233–267; Anke Moerland, "Intellectual property law and AI" in Ernest Lim and Phillip Morgan (eds), *The Cambridge Handbook of Private Law and Artificial Intelligence* (Cambridge University Press, 2024), 362–83.

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11.2 PROTECTION OF AI TECHNOLOGY

Companies may protect innovation relating to AI technology through patent law and/or copyright law. Both avenues are treated in turn below.

11.2.1 *Protection under Patent Law*

Patent law seeks to reward investment into research and development in order to spur future innovation. It does so by providing patentees with a temporary right to exclude others from using a certain "invention," a technological improvement that takes the form of a product or a process (or both). This monopoly right is limited to 20 years following the patent application, subject to payment of the applicable annual fees.[2] It is also limited in scope: while patentees can bring both direct and indirect infringements of their patent(s) to an end, they must accept certain exceptions as a defense to their claims, including use for experimental purposes and noncommercial use.[3] In order to be eligible for a patent, the invention must satisfy a number of conditions.

First, certain exclusions apply. The list of excluded subject matter under the European Patent Convention (EPC)[4] includes ideas that are deemed too abstract, such as computer programs as such, methods for performing mental acts and mathematical methods.[5] Pure abstract algorithms, which are essential to AI systems, qualify as a mathematical method, and are thus ineligible for patent protection *as such*.[6] However, this does not exclude patent protection for computer-implemented inventions such as technology related to AI algorithms, especially given the lenient interpretation of the "as such" proviso in practice. If the invention has a technical effect beyond its implementation on a computer – a connection to a material object in the "real" world – patentability may yet arise.[7] This will for example be the case for a neural network used "in a heart monitoring apparatus for the purpose of identifying irregular heartbeats," as well as – in certain circumstances – methods for training AI systems.[8]

Further, a patentable invention must satisfy a number of substantive conditions: it must be novel and inventive as well as industrially applicable.[9] The novelty requirement implies that the invention may not have been made available to the public

[2] Article 63 European Patent Convention (EPC).
[3] The definition of "infringement" is left to national law, see Article 64(3) EPC.
[4] See from a US perspective, https://tinyurl.com/37a763c3, accessed August 14, 2024.
[5] Articles 52–53 EPC.
[6] EPO, "Guidelines for Examination, Part G, Chapter II, 3.3.1," https://bit.ly/3SNGMyG, accessed August 14, 2024.
[7] EBA Decision 10 March 2021 re patent application 03793825.5, G 0001/19, https://bit.ly/3108x9g, accessed August 14, 2024.
[8] EPO, "Guidelines for Examination, Part G, Chapter II, 3.3.1," 2018, https://bit.ly/3BQb8W9, accessed August 14, 2024.
[9] Articles 52 *juncto* 54–57 EPC.

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at the date of filing of the patent application, indicated as the "state of the art."[10] The condition of inventive step requires the invention to not have been obvious to a theoretical person skilled in the art (PSA) on the basis of this state of the art.[11] Finally, the invention must be susceptible to use in an industrial context.[12] Both the novelty and industrial applicability requirements do not appear to pose any challenges specific to AI-related innovation.[13] However, the inventiveness analysis only takes account of the patent claim features that contribute to the "technical character" of the invention, to the solution of a technical problem. Conversely, nontechnical features (such as the abstract algorithm) are removed from the equation.[14]

The "patent bargain" between patentee and issuing government may lead to another obstacle. This implies that a prospective patentee must disclose their invention in a way that is sufficiently clear and complete for it to be carried out by a PSA, in return for patent protection.[15] This requirement of disclosure may be at odds with the apparent "black box" nature of many forms of AI technology, particularly in a deep learning context. This refers to a situation where we know which data were provided to the system (input A) and which result is reached (output B), but where it is unclear what exactly makes the AI system go from A to B.[16] Arguably, certain AI-related inventions cannot be explained in a sufficiently clear and complete manner, excluding the procurement of a patent therefor. However, experts will generally be able to disclose the AI system's structure, the applicable parameters and the basic principles to which it adheres.[17] It is plausible that patent offices will deem this to be sufficient. The risk of being excluded from patent protection constitutes an additional incentive to invest in so-called "explainable" and transparent AI.[18] The transparency requirements established by the EU AI Act also play a role in

[10] Articles 54–55 EPC. In case priority is claimed, the relevant date is the priority date.

[11] Article 56 EPC. In determining whether a certain invention involves inventive step (and is therefore not "obvious"), the EPO applies the so-called "problem-solution approach." This approach involves (1) determining the so-called "closest prior art," (2) establishing the "objective technical problem" in the state of the art, and (3) considering whether or not the claimed invention, starting from the closest prior art and the objective technical problem, would have been obvious to the skilled person ("could-would approach," see in more detail EPO, "Guidelines for Examination, Part G, Chapter VII.5," https://bit.ly/3GQL5ln, accessed August 14, 2024).

[12] Article 57 EPC.

[13] See however in relation to patent protection of AI-generated output below, Section 11.3.2.

[14] EBA Decision 10 March 2021 re patent application 03793825.5, G 0001/19, in particular paras 106–138; Timo Minssen and Mateo Aboy, "The patentability of computer-implemented simulations and implications for computer-implemented inventions (CIIs)" (2021) *JIPLP*, 16: 633, 633–35.

[15] Article 83 EPC.

[16] Mizuki Hashiguchi, "The global artificial intelligence revolution challenges patent eligibility laws" (2017) *J Bus & Tech L*, 13: 1, 29–30.

[17] Brian Higgins, "The role of explainable artificial intelligence in patent law" (2019) *Intell Prop & Tech LJ*, 31: 3, 7.

[18] See, for example, Wojciech Samek et al. (eds), *Explainable AI: Interpreting, Explaining and Visualizing Deep Learning*, vol 11700 (Lecture Notes in Computer Science, Springer International Publishing, 2019).

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this context.[19] Simultaneously, an overly strict assessment of the requirement of disclosure may push innovators toward trade secrets as an alternative way to protect AI-related innovation.[20]

It is often difficult to predict the outcome of the patenting process of AI-related innovation. This uncertainty does not seem to deter prospective patentees, as evidenced by the rising number of AI-related patent applications.[21] Since the 1950s, over 300,000 AI-related patent applications have been filed worldwide, with a sharp increase in the past decade: in 2019, it was already noted that more than half of these applications had been published since 2013.[22] It is to be expected that more recent numbers will confirm this evolving trend.

11.2.2 *Protection under Copyright Law*

AI-related innovation may also enjoy copyright protection. Copyright protection is generated automatically upon the creation of a literary and artistic work that constitutes a concrete and original expression by the author(s).[23] It offers exclusive exploitation rights as to protected works, such as the right of reproduction and the right of communication to the public (subject to a number of exceptions), as well as certain moral rights.[24] Copyright protection lasts until a minimum period of 50 years has passed following the death of the longest living author, a period that has been extended to 70 years in, for example, the EU Member States.[25]

[19] See Articles 11, 53 and Annexes IV, XI Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 [2024] OJ L1689/1 (hereinafter the "AI Act"). See on this topic, for example, Balint Gyevnar, Nick Ferguson and Burkhard Schafer, "Bridging the transparency gap: what can explainable AI learn from the AI Act?" (2023) DOI: 10.3233/FAIA230367. See also Thomas Gils, Frederic Heymans and Wannes Ooms, "Report: from policy to practice: prototyping the EU AI Act's transparency requirements" (2024), https://tinyurl.com/2s3w8jhp, accessed August 14, 2024.

[20] Cf. Katarina Foss-Solbrekk, "Three Routes to Protecting AI Systems and Their Algorithms under IP Law: The Good, the Bad and the Ugly" (2021) 16 *JIPLP* 247, 256–58.

[21] "WIPO Technology Trends 2019 – Artificial Intelligence," 2019, 14, https://bit.ly/3wlRQH5, accessed August 14, 2024.

[22] WIPO Technology Trends 2019, p. 13; "WIPO Technology Trends 2021, Assistive Technology," 2022, https://bit.ly/3EO8T7z, accessed August 14, 2024.

[23] Articles 2 and 5(2) Berne Convention.

[24] See, for example, Articles 6*bis*-14*ter* Berne Convention; Articles 2–4 Directive 2001/29/EC on the harmonisation of certain aspects of copyright and related rights in the information society [2001] OJ L167/10 (InfoSoc Directive). See on this topic Christophe Geiger, Franciska Schönherr, Irini Stamatoudi, Paul Torremans, and Stavroula Karapapa, "Chapter 11: the Information Society Directive," in Irini Stamatoudi and Paul Torremans (eds), *EU Copyright Law. A Commentary* (Edward Elgar Publishing, 2021), 279–380.

[25] Article 7 Berne Convention; Article 12 TRIPS Agreement; Article 1 Directive 2006/116/EC on the term of protection of copyright and certain related rights (codified version) [2006] OJ L 372/12 (Term Directive).

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The validity conditions for copyright are the requirement of concrete form and the requirement of originality. First, copyright protection is not available to mere abstract ideas and principles; these must be expressed in a concrete way.[26] Second, the condition of originality implies that the work must be an intellectual creation of the author(s), reflecting their personality and expressing free and creative choices.[27] Applied to AI-related works in particular, the functional algorithm in its purest sense does not satisfy the first condition and is therefore not susceptible to copyright protection.[28] However, the object and source code of the computer program expressing this idea are sufficiently concrete, allowing for copyright protection once the condition of originality is fulfilled.[29] Given the low threshold set for originality in practice, software that implements AI technology is likely to receive automatic protection as a computer program under copyright law upon its creation.[30]

11.3 PROTECTION OF AI-ASSISTED AND AI-GENERATED OUTPUT

This section analyzes whether AI systems could – and, if not, should – claim authorship and/or inventorship in their output.[31] It then focuses on IP ownership as to such output.

11.3.1 *AI Authorship*

Can AI systems ever claim authorship? To answer this question, we must first ascertain whether "creative" machines already exist. Second, we discuss whether an AI system can be considered an author and, if not, whether it should be.

Certain AI systems available today can be used as a tool to create works that would satisfy the conditions for copyright protection if they had been solely created by humans. Many examples can be found in the music sector.[32] You may be reading

[26] Article 9(2) TRIPS Agreement. A common example of this requirement is that styles (such as Cubism) are not susceptible to copyright protection, while concrete expressions of such styles (such as a specific painting by Picasso in the Cubist style) may qualify for copyright protection, subject to the fulfilment of the condition of originality.

[27] C-5/08 *Infopaq* [2009] ECLI:EU:C:2009:465; C-393/09 *BSA* [2010] ECLI:EU:C:2010:816; C-145/10 *Painer* [2011] ECLI:EU:C:2011:798.

[28] C-406/10 *SAS Institute* [2012] ECLI:EU:C:2012:259.

[29] C-393/09 *BSA* [2010] ECLI:EU:C:2010:816.

[30] See Foss-Solbrekk, "Three Routes," pp. 249–253; Begoña Gonzalez Otero, "Machine learning models under the copyright microscope: Is EU copyright fit for purpose?" (2021) *GRUR International*, 70: 1043, 1–13.

[31] See re design law: Hasan Yılmaztekin, *Artificial Intelligence, Design Law and Fashion* (Routledge, 2023).

[32] See in detail Oleksandr Bulayenko, João Pedro Quintais, Daniel Gervais, and Joost Poort, "AI music outputs: Challenges to the copyright legal framework," 2022, https://ssrn.com/abstract=4072806, accessed August 14, 2024.

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this chapter with AI-generated music playing, such as piano music by Google's "DeepMind" AI,[33] an album released by the "Auxuman"[34] algorithm, a soundscape created by the "Endel"[35] app or one of the unfinished symphonies of Franz Schubert or Ludwig van Beethoven as completed with the aid of an AI system.[36] If you would rather create music yourself, Sony's "Flow Machines" project may offer assistance by augmenting your creativity through its AI algorithm.[37] If you are bored with this text, which was written (solely) by a human author, you may instead start a conversation with "ChatGPT 4,"[38] read a novel[39] drafted by an AI algorithm or translate it using "DeepL."[40] AI-generated artwork is also available.[41] Most famously, Rembrandt van Rijn's paintings were fed to an AI algorithm that went on to create a 3D-printed painting in Rembrandt's style in 2016.[42] Since then, the use of AI in artwork has skyrocketed, with AI-powered image-generating applications such as "DALL-E 3"[43] and "Midjourney"[44] gaining exponential popularity.[45]

In most cases, there is still some human intervention, be it by a programmer, a person training the AI system through data input or somebody who modifies and/or selects output deemed "worthy" to disclose.[46] If such human(s) were to have created the work(s) without the intervention of an AI system, copyright protection would likely be available.

Copyright law requires the work at issue to show *authorship*; the personal stamp of the *author*. The author is considered to be a physical person, especially in the civil law tradition, where copyright protection is viewed as a natural right, granted to the author to protect emanations of their personality.[47] Creativity is viewed as a quintessentially human faculty, whereby a sentient being expresses their personality by

[33] Video available at youtu.be/Y8UawLT4ito accessed August 14, 2024.
[34] See www.auxuman.space accessed August 14, 2024.
[35] See https://endel.io accessed August 14, 2024.
[36] See https://bit.ly/3whiQHy and https://bit.ly/3wrGrFO accessed August 14, 2024.
[37] See www.flow-machines.com accessed August 14, 2024.
[38] See https://chat.openai.com accessed August 14, 2024.
[39] See, for example, Thomas Hornigold, "The first novel written by AI is here – and it's as weird as you'd expect it to be," *Singularity Hub* (October 25, 2018), https://bit.ly/3mOs4rP, accessed August 14, 2024. See however Gary Smith, "The Great American Novel will not be written by a computer," *Mind Matters* (June 30, 2021), https://bit.ly/3HOUQRy.
[40] See www.deepl.com, accessed August 14, 2024.
[41] See, for example, https://aiartists.org/ai-timeline-art, accessed August 14, 2024.
[42] See www.nextrembrandt.com, accessed August 14, 2024.
[43] See https://openai.com/dall-e-3, accessed August 14, 2024.
[44] See www.midjourney.com, accessed August 14, 2024.
[45] See Pesala Bandara, "The best AI image generators in 2023" (*PetaPixel*, January 3, 2023), https://bit.ly/3Xxj1ej, accessed August 14, 2024; see also, for example, https://aiartists.org; www.artaigallery.com.
[46] By way of example, users provide the DeepL translation app with relevant input and may manually modify the translated text.
[47] See however also under US law, for example: US Copyright Office, "Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence," 2023, 37 CFR Part 202, https://bit.ly/4dxQIEQ; US District Court for the District of Columbia 18 August 2023, 22-1564, https://bit.ly/4ckMr6l.

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making free, deliberate choices.[48] This tenet pervades all aspects of copyright law. First, copyright laws grant initial ownership of copyright in a certain work to its author.[49] Further, the term of protection is calculated from the author's death. Also, certain provisions expressly seek to protect the author, such as those included in copyright contract law as well as the resale right applicable to original works of art. Moreover, particular copyright exceptions only apply if the author is acknowledged and/or if an equitable remuneration is paid to the author, such as the exception for private copies. The focus on the human author also explains the importance of the author's moral rights to disclosure, integrity, and attribution.[50] Such a system leaves no room for the authorship of a nonhuman entity.[51] If there is insufficient human input in the form of free and creative choices on the part of an author, if the AI crosses a certain threshold of autonomy, copyright protection is unavailable.[52] This anthropocentric view is unsurprising, since IP laws were largely drafted at a time when the concept of nonhuman "creators" belonged squarely in the realm of fiction.

However, the core of the issue is whether the abstract idea of originality *should* be held to include the creating behavior of an AI system. Account must hereby be taken of the broad range of potential AI activity and the ensuing distinction between AI-*assisted* and truly AI-*generated* content. At the one end of the spectrum, we may find AI systems that function as a tool to assist and/or enhance human creativity, where the AI itself acts as a mere executer.[53] We can compare this to the quill used by William Shakespeare.[54] Further down the line, there are many forms of AI-exhibited creativity that still result from creative choices made by a human, where the output flows directly from previously set parameters.[55] Such AI activity may still be viewed as pure execution. In such cases, copyright should be reserved to the human actor behind the machine.

[48] Cf. Annemarie Bridy, "Coding creativity: Copyright and the artificially intelligent author" [2012] STLR 28, 4.

[49] See, for example, Article 2(6) Berne Convention, which conceptualizes copyright as a form of protection for the *author* and their successors in title. An AI system *as such* is not a legal entity, which implies that it cannot be endowed with rights of any kind, including ownership rights. Notably, continental EU law does not have a rule similar to the "work-made-for-hire" doctrine that applies in the United States, which allows employers to be treated as the author of a work created by a human employee.

[50] Annemarie Bridy, "The evolution of authorship: Work made by code" (2016) *Colum JL & Arts*, 39: 9, 401.

[51] See, for example, Andres Guadamuz, "Do Androids dream of electric copyright? Comparative analysis of originality in artificial intelligence generated works" [2017] *IPQ* 169: 173–74.

[52] Daniel Gervais, "The machine as author" (2020) *Iowa L Rev*, 105: 2053, 2062, 2098–101, 2106.

[53] James Grimmelmann, "There's no such thing as a computer-authored work—And it's a good thing, too" (2016) *Colum JL & Arts*, 39: 403, 403, 406–08; Erica Fraser, "Computers as inventors – legal and policy implications of artificial intelligence on patent law" (2016) *SCRIPTed*, 13: 305, 305, 306; Samantha Fink Hedrick, "I 'Think,' therefore I create: Claiming copyright in the outputs of algorithms" (2019) *NYU Journal of Intell Prop & Ent Law*, 8: 324, 329.

[54] Cf. Margot E Kaminski, "Authorship, disrupted: AI authors in copyright and first amendment law" (2017) *UCD L Rev*, 51: 589, 595.

[55] Hedrick, "I 'Think,' therefore I create," 353, 358–60.

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At the far end of the spectrum, we could find a hypothetical, more autonomous, "creative" AI, having independently created a work that exhibits the requisite creativity, which experts and nonexperts alike cannot distinguish from a work generated by a human. Even in such a case, it may be argued that there is no real act of "conception" in the AI system, given that every piece of AI-generated output is the result of prior human input.[56] Arguably, precisely this act, the *process* of creation, is the essence of creativity. As long as the human thought process cannot be formulated as an algorithm that may be implemented by a computer, this process will remain human, thus excluding AI authorship. However, the "prior input" argument also applies *mutatis mutandis* to humans, who create literary and artistic works while "standing on the shoulders of giants."[57] This could render the "act of conception" argument against AI authorship moot, as could choosing the end result and thus the originality of the output as a (functionalist) focal point instead of the creative process.[58] Additionally, it is argued that granting AI systems authorship may stimulate further creative efforts on the part of AI systems. This appears to be in line with the economic, utilitarian rationale of copyright.[59] However, copyright seeks to incentivize human creators, not AI systems.[60] Moreover, it is difficult to see how AI systems may respond to incentives in the absence of human consciousness.[61] Without convincing economic evidence, caution is advised against tearing down one of the fundamental principles of copyright law. The mere fact that we *can* create certain incentives does not in itself imply that we *should*. Further, if we were to allow AI authorship, we must be prepared for an upsurge in algorithmic creations, as well as the effects on human artistic freedom that this would entail.[62]

The risk of extending authorship to AI systems could be mitigated by instead establishing a related or *sui generis* right to AI-generated works and provide a limited

[56] See also Noam Shemtov, "A study on inventorship in inventions involving AI activity" (*European Patent Office*, 2019) 6, 20, 35. See for a more recent example Rhiannon Williams, "What happened when 20 comedians got AI to write their routines" (*MIT Technology Review* 17 June 2024), https://tinyurl.com/yxad3bse, accessed August 14, 2024.

[57] "If I have seen further, it is by standing upon the shoulders of Giants." – Sir Isaac Newton (1675).

[58] Cf. in relation to patent law Shemtov, "A study on inventorship in inventions involving AI activity," pp. 28–29; Ryan Abbott, "I think, therefore I invent: Creative computers and the future of patent law" (2016) *BC L Rev*, 57: 1079, 1082, 1099, 1108–11.

[59] Peter Blok, "The inventor's new tool: Artificial intelligence – how does it fit in the European patent system?" (2017) *EIPR*, 39: 69, 69, 72.

[60] Kaminski, "Authorship, disrupted," pp. 589, 599; Shlomit Yanisky-Ravid and Xiaoqiong (Jackie) Liu, "When artificial intelligence systems produce inventions: An alternative model for patent law at the 3A era" (2018) *Cardozo L Rev*, 39: 2215, 2243–46.

[61] Pamela Samuelson, "Allocating ownership rights in computer-generated works" (1986) *U Pitt L Rev*, 47: 1185, 1199; Hedrick, "I 'Think,' therefore I create," 334–336; Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," pp. 2239–41; Garry A Gabison, "Who holds the right to exclude for machine work products?" [2020] *IPQ* 20, 20, 37.

[62] Cf. Gervais, "The machine as author," pp. 2060–2061.

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degree of exclusivity in order to protect investments and incentivize research in this area. Such a right could be modelled in a similar way to the database right established by the EU in 1996.[63] This requires a substantial investment for protection to be available.[64]

11.3.2 *AI Inventorship*

We now turn to AI inventorship. By analogy to the previous section, the first question is whether "inventive" machines already exist. Such systems are much scarcer than AI systems engaged in creative endeavors.[65] However, progress on this front is undeniable.[66] The AI sector's primary allegedly inventive champion is "DABUS,"[67] labelled the "Creativity Machine" by its inventor, physicist Dr Stephen Thaler.[68] DABUS is a neural network-based system meant to generate "useful information" autonomously, thereby "simulating human creativity."[69] In 2018, a number of patent applications were filed for two of DABUS' inventions.[70] The prosecution files indicate DABUS as the inventor and clarify that Dr Thaler obtained the right to the inventions as its successor in title.[71] These patent applications offer a test case for the topic of AI inventorship.

Patent law requires inventors to be human. While relevant legislative provisions do not contain any explicit requirement in this sense, the inventor's need for physical personhood is implied in the law.[72] While the focus on the human *inventor* is much less pronounced than it is on the human *author*, a number of provisions would make no sense if we were to accept AI inventorship. First, many patent laws stipulate that the "inventor" is the first owner of an invention, except in an

[63] Directive 96/9/EC on the legal protection of databases [1996] OJ L77/20. See on this topic Estelle Derclaye, "Chapter 9: The database directive," in Irini Stamatoudi and Paul Torremans (eds), *EU Copyright Law. A commentary* (Edward Elgar Publishing, 2021), pp. 216–254.

[64] Article 7 Database Directive.

[65] See Dan Burk, "AI patents and the self-assembling machine" (2021) *Minn Law Rev Headnotes*, 105: 301; Daria Kim et al., "Ten assumptions about artificial intelligence that can mislead patent law analysis" [2021] SSRN Electronic Journal.

[66] See, for example, Robert Plotkin, *The Genie in the Machine; How Computer-Automated Inventing Is Revolutionizing Law and Business* (Stanford University Press, 2009).

[67] An acronym for "Device for the Autonomous Bootstrapping of Unified Sentience."

[68] See https://bit.ly/3qgbWSd; https://bit.ly/3CQNf26, accessed August 14, 2024.

[69] Dr Thaler has obtained several patents in relation to the technology behind DABUS. See Abbott, "I think, therefore I invent," 1083–1086.

[70] EP application with number 18275163.6 (EP 3 564 144 A1), filed on October 17, 2018 and EP application with number 18275174.3 (EP 3 563 896 A1), filed on November 7, 2018.

[71] See Legal Board of Appeal Decision December 21, 2021 re EP applications 18275163.6 and 18275174.3, J 0008/20, paras I–III, https://bit.ly/3WzzdNb, accessed August 14, 2024.

[72] See, for example, with regard to the priority right to a patent Article 4(A) Paris Convention for the Protection of Industrial Property, 20 March 1883, as amended. See also Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," p. 2230; Eva Stanková, "Human inventorship in European patent law" (2021) *The Cambridge Law Journal*, 80: 338.

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employment context, where the employer is deemed to be the first owner under the laws of some countries.[73] Since AI systems do not have legal personality (as of yet), they cannot have ownership rights, nor can they be an employee as such.[74] Given that those are the only two available options, AI systems cannot be considered "inventors" as the law currently stands, as confirmed in the DABUS case, not only by the Boards of Appeal of the European Patent Office in the DABUS case, but also by the UK Supreme Court and the German Federal Supreme Court.[75] Another argument against AI inventorship may be drawn from the inventor's right of attribution. Every inventor has the right to be mentioned as such and all patent applications must designate the inventor.[76] This moral right, which is meant to incentivize the inventor to innovate further, may become meaningless upon the extension of the concept of inventorship to AI systems.[77]

The second aspect of the discussion is whether there *should* be room for AI inventorship. The main argument in favor of this is that it would incentivize research and development in the field of AI.[78] However, in the absence of compelling empirical evidence, the incentive argument is not convincing, especially since AI systems as such are not susceptible to incentives and the cost of AI invention will likely decrease over time.[79] Another reason to accept AI inventorship would be to avoid humans incorrectly claiming inventorship. However, the as of yet instrumental nature of AI systems provides a counterargument.[80] Further, there is no AI-generated output without some form of prior human input. The resulting absence of an act of "conception," of the *process* of invention, excludes any extension of the scope of inventorship to nonhuman actors such as AI systems.[81] Again, however, the "prior input" argument also applies *mutatis mutandis* to humans. Also as to patent law, therefore, the "act of conception" argument against AI inventorship is susceptible to counterarguments.[82]

[73] See Article 60 EPC.

[74] Shemtov, "A study on inventorship in inventions involving AI activity," pp. 10–11, 20; Blok, "The inventor's new tool," pp. 71–72.

[75] Legal Board of Appeal Decision 21 December 2021 re patent applications 18275163.6 and 18275174.3, Sections 4.1–4.4; UK Supreme Court 20 December 2023, UKSC 49, https://bit.ly/3YMYBBV, accessed August 14, 2024; German Federal Supreme Court 11 June 2024, case number X ZB 5/22, https://bit.ly/3YFkT8N, accessed August 14, 2024.

[76] See Article 4*ter* Paris Convention. See also respectively Articles 62 and 81 *jo*. 90 and Rule 19.1 EPC. See also Shemtov, "A study on inventorship in inventions involving AI activity," p. 8.

[77] Shemtov, "A study on inventorship in inventions involving AI activity," pp. 5, 23–25, 27.

[78] Abbott, "I think, therefore I invent," pp. 1081–82, 1098–99, 1104; Alexandra George and Toby Walsh, "Artificial intelligence is breaking patent law" (2022) *Nature*, 605: 7911, 616. See, however, Rose Hughes, "Artificial intelligence is not breaking patent law: EPO publishes DABUS decision (J 8/20)" (*The IPKat*, July 11, 2022), https://bit.ly/3H8YMy6, accessed August 14, 2024.

[79] Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," p. 2239.

[80] Blok, "The inventor's new tool," p. 73; Shemtov, "A study on inventorship in inventions involving AI activity," pp. 5, 17, 19.

[81] Shemtov, "A study on inventorship in inventions involving AI activity," pp. 6, 20, 35.

[82] Cf. Shemtov, "A study on inventorship in inventions involving AI activity," pp. 28–29; Abbott, "I think, therefore I invent," pp. 1082, 1099, 1108–11.

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A final aspect is that allowing AI inventorship would entail an increased risk of both overlapping sets of patents indicated as "patent thickets," and the so-called "patent trolls," which are nonpracticing entities that maintain an aggressive patent enforcement strategy while not exploiting the patent(s) at issue themselves.[83]

11.3.3 *Ownership*

The next question is how ownership rights in AI-powered creations should be allocated.[84] As explained earlier, IP law does not allow AI systems to be recognized as either an author or an inventor. This begs the question whether the intervention of a creative and/or inventive AI excludes *any* kind of human authorship or inventorship (and thus ownership) as to the output at issue. It is submitted that it does not, as long as there is a physical person who commands the AI system and maintains the requisite level of control over its output.[85] In such a case, IP rights may fulfil their role of protecting the interests of creators as well as provide an indirect incentive for future creation and/or innovation.[86] However, if there is no sufficient causal relationship between the (in)actions of a human and the eventual end result, the argument in favor of a human author and/or inventor becomes untenable. What exactly constitutes "sufficient" control is tough to establish. A further layer of complexity is added by the black box nature of some AI systems: How can we determine whether a sufficient causal link exists between the human and the output, if it is impossible to find out exactly why this output was reached?[87] However, both copyright and patent protection may be available to works and/or inventions that result from coincidence or even dumb luck.[88] If we take a step back, both AI systems and serendipity may be considered as a factor outside the scope of human control. Given that Jackson Pollock may claim protection in his action paintings and given the role that chance plays in Pollock's creation process, can we really deny such protection to the person(s) behind "the next Rembrandt"?

In copyright jargon, we could say that for a human to be able to claim copyright in a work created through the intervention of AI, their "personal stamp" must be discernible in the end result. If we continue the above analogy, Pollock's paintings clearly reflect his personal choices as an artist. In patent law terms,

[83] See Blok, "The inventor's new tool," p. 73.

[84] IP ownership is (as of yet) primarily a matter of national law.

[85] Cf. Bridy, "Coding creativity," p. 20; Shemtov, "A study on inventorship in inventions involving AI activity," pp. 12–13, 19–20; Hedrick, "I 'think,' therefore I create," pp. 328–29, 332, 352. See, however, Tim W. Dornis, "Of 'authorless works' and 'inventions without inventor' – the muddy waters of 'AI autonomy' in intellectual property doctrine" (2021) *EIPR*, 43: 570.

[86] Hedrick, "I 'think,' therefore I create," pp. 337, 440.

[87] Cf. Hedrick, "I 'think,' therefore I create," pp. 367, 371–374.

[88] Grimmelmann, "There's no such thing as a computer-authored work," p. 413; Blok, "The inventor's new tool," p. 73; Shemtov, "A study on inventorship in inventions involving AI activity," p. 20. Patent protection is not available to "discoveries" as such (Article 52 EPC).

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human inventorship may arise in case of a contribution that transcends the purely financial, abstract or administrative and that is aimed at conceiving the claimed invention – be it through input or output selection, algorithm design, or otherwise.[89] In an AI context, different categories of people may stake a claim in this regard.

First in line are the programmer(s),[90] designer(s),[91] and/or producer(s) of the AI system (hereinafter collectively referred to as "AI creators"). By creating the AI system itself, these actors play a substantive role in the production of AI-generated output.[92] However, the allocation of rights to the creator sits uneasily with the unpredictable nature of AI-generated output.[93] While the AI creator's choices define the AI system, they do not define the final form of the output.[94] This argument gains in strength the more autonomous the AI algorithm becomes.[95] Then again, a programmer who is somehow dissatisfied with the AI's initial output may tweak the AI's algorithm, thus manipulating and shaping further output, as well as curate the AI output based on their personal choices.[96] However, an economic argument against granting the AI creator rights in AI-generated output is that this may lead to "double-dipping." This would be the case if the creator also holds rights in patents granted as to the AI system or the copyright therein, or if the AI system is acquired by a third party for a fee and the output at issue postdates this transfer.[97] In both cases, the creator would obtain two separate sources of income for essentially the same thing. Moreover, enforcing the AI creator's ownership rights would be problematic if the AI system generates the output at issue after a third party has started using it. Indeed, knowing that ownership rights would be allocated to the creator, the user would have strong incentives not to report back on the (modalities of) creation of output.[98]

[89] Shemtov, "A study on inventorship in inventions involving AI activity," pp. 19–21, 31; AIPPI resolution on inventorship of inventions made using artificial intelligence, October 14, 2020, https://bit.ly/3DRMOoN, accessed August 14, 2024.

[90] Cf. Paul Sawers, "Chinese court rules AI-written article is protected by copyright," *Venture Beat* (January 10, 2020), https://bit.ly/3DW5SlD, accessed August 14, 2024.

[91] See Mark Summerfield, "The impact of machine learning on patent law, Part 3: Who is the inventor of a machine-assisted invention?," *Patentology* (February 4, 2018), https://bit.ly/3xlHNlM, accessed August 14, 2024.

[92] Samuelson, "Allocating ownership rights in computer-generated works," p. 1205; Shemtov, "A study on inventorship in inventions involving AI activity," p. 22; Gabison, "Who holds the right to exclude for machine work products?," p. 23.

[93] Samuelson, "Allocating ownership rights in computer-generated works," p. 1209; Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," pp. 2231–2232.

[94] Bridy, "Coding creativity," p. 25.

[95] Hedrick, "I 'think,' therefore I create," pp. 354, 362.

[96] Cf. Hedrick, "I 'think,' therefore I create," pp. 338–339, 343, 354.

[97] Samuelson, "Allocating ownership rights in computer-generated works," pp. 1207–1208, 1225; Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions", p. 2233; Shemtov, "A study on inventorship in inventions involving AI activity," p. 31.

[98] Samuelson, "Allocating ownership rights in computer-generated works," p. 1208.

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A similar claim to the AI system's creator may be made by the AI's trainer who feeds input to the AI system.[99] Alternatively, the user who has contributed substantially to the output at issue may claim ownership.[100] The list of stakeholders continues with the investor, the owner of the AI system and/or the data used to train the algorithm, the publisher of the work, the general public, and even the government. Moreover, some form of joint ownership may be envisaged.[101] However, this would entail other issues, such as an unnecessary fragmentation of ownership rights and difficulties in proving (the extent of) ownership claims.[102] It could even be argued that, in view of the ever-rising number of players involved, no individual entity can rightfully claim to have made a significant contribution "worthy" of IP ownership.[103]

As of yet, no solution to the ownership conundrum appears to be wholly satisfactory. The void left by this lingering uncertainty will likely be filled with contractual solutions.[104] Consequent to unequal bargaining power, instances of unfair ownership and licensing arrangements are to be expected.[105] A preferable solution could be to not allocate ownership in AI-generated output to anyone at all and instead allot such output to the public domain. Stakeholders could sufficiently protect their investment in AI-related innovation by relying on patent protection for the AI system itself, first-mover advantage, trade secret law, contractual arrangements, and technological protection measures, as well as general civil liability and the law of unfair competition.[106] However, there is a very pragmatic reason not to ban AI-generated output to the public domain, namely that it is increasingly difficult to distinguish output in the creation of which AI played a certain role from creations that were made solely by a human author.[107] This could be remedied by requiring aspiring IP owners to disclose the intervention of an AI-powered system in the creation and/or innovation process. However, the practical application of such a requirement remains problematic at present. The prospect of having a work be banished to the public domain would provide stakeholders seeking a return on investment with strong incentives to keep quiet

[99] Shemtov, "A study on inventorship in inventions involving AI activity," p. 31.

[100] Samuelson, "Allocating ownership rights in computer-generated works," pp. 1201–04; Hedrick, "I 'think,' therefore I create," p. 344; Gabison, "Who holds the right to exclude for machine work products?," p. 35; Tim Dornis, "Artificial intelligence and innovation: The end of patent law as we know it" (2020) *Yale J L & Tech*, 23: 97, 154–57.

[101] Shemtov, "A study on inventorship in inventions involving AI activity," pp. 6, 30.

[102] Samuelson, "Allocating ownership rights in computer-generated works," pp. 1221–24; Hedrick, "I 'think,' therefore I create," p. 348. See extensively Paulien Wymeersch, "Terms of use on the commercialisation of AI-produced images and copyright protection", (2024) *EIPR* pp. 374–381.

[103] Cf. Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," p. 2235.

[104] Hedrick, "I 'Think,' therefore I create," p. 348.

[105] Cf. Abbott, "I think, therefore I invent," p. 1117; Hedrick, "I 'Think,' therefore I create," p. 347.

[106] Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," pp. 2222, 2252–2256; Shemtov, "A study on inventorship in inventions involving AI activity," p. 24; Gabison, "Who holds the right to exclude for machine work products?," pp. 32–33, 39; Gervais, "The machine as author," p. 2060.

[107] See, for example, Jamie Grierson, "Photographer admits prize-winning image was AI-generated" (*The Guardian* April 17, 2023), https://bit.ly/4cq4xEd, accessed August 14, 2024.

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on this point. This could invite misleading statements on authorship and/or inventorship of AI-generated output in the future.[108] Transparency obligations, such as the watermarking requirement imposed on providers of certain AI systems (including general-purpose AI models) under the EU AI Act, may bring us closer to a solution in this regard, likely combined with a "General-Purpose AI Code of Practice" that is to be drafted under the auspices of the AI Office at the EU level.[109]

11.4 MISCELLANEOUS TOPICS

In addition to the above, the interface between AI and IP has many other dimensions. Without any pretense of exhaustivity, this section treats some of them briefly, namely the issues surrounding IP infringement by AI systems, the potential impact of AI on certain key concepts of IP law and the growing use of AI in IP practice.

11.4.1 *IP Infringement*

First, in order to train an AI algorithm, a significant amount of data is often required. If (part of) the relevant training data is subject to IP protection, the reproduction and/or communication to the public thereof in principle requires authorization by the owner, subject to the applicability of relevant exceptions and limitations to copyright. The question thus arises whether actively scraping the internet for artists' work to reuse in the context of, for example, generative AI art tools constitutes an infringement. At the time of writing, several legal proceedings are pending on this question across the globe.[110] Importantly, the EU AI Act (1) confirms the applicability of text and data mining exceptions to the training of general-purpose AI models, subject to a potential opt-out on the part of rightholders; and (2) mandates the drawing up and public availability of "a sufficiently detailed summary about the content used for training of the general-purpose AI model."[111] Further, in order to ensure that authors, performers and other rightholders receive fair and appropriate

[108] Abbott, "I think, therefore I invent," pp. 1097–98; Higgins, "The role of explainable artificial intelligence in patent law," p. 29.

[109] See Article 50 AI Act; Thomas Gils, "A detailed analysis of Article 50 of the EU's Artificial Intelligence Act" (2024), https://ssrn.com/abstract=4865427, accessed August 14, 2024. See also https://tinyurl.com/m3bhr5a5, accessed August 14, 2024. For an extensive discussion of the AI Act, see also Chapter 12 of this book, authored by Nathalie A. Smuha and Karen Yeung, "The European Union's AI Act: beyond motherhood and apple pie?", 228–258.

[110] See for an overview https://tinyurl.com/j6wvr7ez, accessed August 14, 2024.

[111] Article 53(1)(c)–(d) AI Act. See also in particular Recitals 105, 107 AI Act. A template for such a "sufficiently detailed summary" is to be provided by the AI Office. See for a valiant attempt at operationalization of this requirement, https://tinyurl.com/yeu723r5, accessed August 14, 2024. See however extensively Tim W. Dornis and Sebastian Stober, "Urheberrecht und Training generativer KI-Modelle - technologische und juristische Grundlagen" (August 2024), https://ssrn.com/abstract_id=4946214, accessed 20 September 2024.

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remuneration for the use of their content as training data, contractual solutions may be envisaged.[112]

Also after the training process, AI systems may infringe IP rights. By way of example, an AI program could create a song containing original elements of a preexisting work, thus infringing the reproduction right of the owner of the copyright in the musical work at issue. An inventive machine may develop a process and/or product that infringes a patent, or devise a sign that is confusingly similar to a registered trademark, or a product that falls within the scope of a protected (un)registered design. This in turn leads to further contentious matters, such as whether or not relevant exceptions and/or limitations (should) apply and whether fundamental rights such as freedom of expression may still play a role.[113]

11.4.2 *Impact of AI on Key Concepts of IP Law*

Next, the rise of AI may significantly affect a number of key concepts of IP law that are clearly tailored to humans, in addition to the concepts of "authorship" and "inventorship." First in line in this regard is the inventiveness standard under patent law, which centers around the so-called "person skilled in the art" (PSA).[114] This is a hypothetical person (or team) whose level of knowledge and skill depend on the field of technology.[115] If it is found that the PSA would have arrived at the invention, the invention will be deemed obvious and not patentable. If the use of inventive machines becomes commonplace in certain sectors of technology, the PSA standard will evolve into a PSA using such an inventive machine – and maybe even an inventive machine as such.[116] This would raise the bar for inventive step and ensuing patentability, since such a machine would be able to innovate based on the entirety of available prior art.[117] Taken to its logical extreme, this argument could shake the foundations of our patent system. Indeed, if the "artificially superintelligent" PSA is capable of an inventive step, everything becomes obvious, leaving no more room for patentable inventions.[118]

[112] See, for example, Martin Senftleben, "Generative AI and author remuneration" (2023) *IIC*, 54, 1535–60; Martin Senftleben, "AI Act and author remuneration – A model for other regions?" (2024), https://ssrn.com/abstract=4740268, accessed August 14, 2024.

[113] Camille Vermosen, "Copyright, liability and artificial intelligence: Who is responsible when an artificial intelligence system infringes copyright in the context of the EU?" (KU Leuven, 2017); Bridget Watson, "A mind of its own – direct infringement by users of artificial intelligence systems" (2017) *IDEA*, 58: 31; Alina Škiljić, "When art meets technology or vice versa: Key challenges at the crossroads of AI-generated artworks and copyright law" (2021) *IIC*, 52: 1338.

[114] Dornis, "Artificial intelligence and innovation," pp. 104, 124–134.

[115] EPO, "Guidelines for examination, Part G, Chapter VII.3," https://bit.ly/3xBzu5H, accessed August 14, 2024.

[116] Blok, "The inventor's new Tool," p. 72; Ryan Abbott, "Everything is obvious" (2018) 66 UCLA L Rev 2, 2, 5–6, 17, 34–37.

[117] Yanisky-Ravid and Liu, "When artificial intelligence systems produce inventions," pp. 2248–49.

[118] Abbott, "Everything is obvious," pp. 8–9, 31, 34, 37–38.

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We therefore need to start thinking about alternatives and/or supplements to the current nonobviousness analysis – and maybe even to the patent regime as a way to incentivize innovation.[119]

Questions also arise in a trademark law context, such as how the increased intervention of AI in the online product suggestion and purchasing process may be reconciled with the anthropocentric conception of trademark law, as apparent from the use of criteria such as the "average consumer," "confusion," "imperfect recollection" – all of which are criteria that have a built-in margin for *human* error.[120]

11.4.3 *Use of AI in IP Practice*

Finally, the clear hesitancy of the IP community toward catering for additional incentive creation in the AI sphere by amending existing IP laws may be contrasted with apparent enthusiasm as to the use of AI in IP practice. Indeed, the increased (and still increasing) use of AI systems as a tool in the IP sector is striking. The ability of AI systems to process and analyze vast amounts of data quickly and efficiently offers a broad range of opportunities. First, the World Intellectual Property Organization (WIPO) has been mining the possibilities offered by AI with regard to the automatic categorization of patents and trademarks as well as prior art searches, machine translations, and formality checks.[121] Other IP offices are following suit.[122] Second, AI technology may be applied to the benefit of registrants. On a formal level, AI technology may be used to suggest relevant classes of goods and services for trademarks and/or designs. On a substantive level, AI technology may be used to aid in patent drafting and to screen registers for existing registrations to minimize risk. AI technology may assist in determining the similarity of trademarks and/or designs and even in evaluating prior art relating to patents.[123] AI-based IP

[119] Abbott, "Everything is obvious," pp. 48–50, 52.

[120] See Michael Grynberg, "AI and the 'death of trademark'" (2019) *Ky L J*, 108: 199–238; Anke Moerland and Conrado Freitas, "Artificial intelligence and trademark assessment" in Reto Hilty, Jyh-An Lee, and Kung-Chung Liu, *Artificial Intelligence and Intellectual Property* (Oxford University Press, 2021), 266–291; Marie-Christine Janssens and Viltė Kristina Dessers, "The artificially intelligent consumer in EU trademark law" in Veronika Fischer, Georg Nolte, Martin Senftleben, and Louisa Specht-Riemenschneider, *Gestaltung der Informationsordnung. Festschrift Commemorating the 65th Anniversary of Professor Thomas Dreier* (CH Beck, 2022), 143–160.

[121] See, for example, the tools and applications listed at https://bit.ly/3YPSlJV, including and WIPO's Vienna Classification Assistant https://bit.ly/3WQmCqj, accessed August 14, 2024.

[122] See, for example, the EUIPO https://bit.ly/30XlRRJ and the UKIPO https://bit.ly/3DOiNWX, accessed August 14, 2024.

[123] Re trademarks, see, for example, Brandstock https://bit.ly/30Voofc; CompuMark https://clarivate.com/compumark; Rocketeer https://bit.ly/311euZX; TrademarkNow www.trademarknow.com; and Corsearch https://corsearch.com, all accessed August 14, 2024. Re patents, see, for example, Rowan Patents https://rowanpatents.com, accessed August 14, 2024.

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analytics and management software is also available.[124] Finally, AI-powered applications are used in the fight against counterfeit products.[125]

11.5 CONCLUSION

The analysis of the interface between AI and IP reveals a field of law and technology of increasing intricacy. As the term suggests, "intellectual" property law has traditionally catered for creations of the human mind. Technological evolutions in the field of AI have prompted challenges to this anthropocentric view. The most contentious questions are whether authorship and inventorship should be extended to AI systems and who, if anybody, should acquire ownership rights as to AI-generated content. Valid points may be raised on all sides of the argument. However, we should not unreservedly start tearing down the foundations of IP law for the mere sake of additional incentive creation.

In any case, regardless of the eventual (legislative) outcome, the cross-border exploitation of AI-assisted or -generated output and the pressing need for transparency of the legal framework require a harmonized solution based on a multi-stakeholder conversation, preferably on a global scale. Who knows, maybe one day an artificially super-intelligent computer will be able to find this solution in our stead. Awaiting such further hypothetical technological evolutions, however, the role of WIPO as a key interlocutor on AI and IP remains paramount, in tandem with the newly established AI Office at the EU level.[126]

[124] See, for example, Cipher https://cipher.ai; elementary IP https://elementaryip.com; IP Check-Up https://bit.ly/3E3Dxdr; Octimine www.octimine.com; and SHIP Global IP https://shipglobalip.com, all accessed August 14, 2024.

[125] See, for example, Visual-AI https://bit.ly/3HQtt9B, accessed August 14, 2024.

[126] The WIPO consultation process on AI and IP garnered over 250 substantive submissions, while the virtual WIPO seminars on AI and IP that WIPO has organized since 2019 attracted almost 9000 participants from all over the world. The submissions to the consultation process are available online at https://bit.ly/3GU9M09, accessed August 14, 2024. More information on the so-called 'WIPO Conversation on Intellectual Property and Frontier Technologies' is available online at https://bit.ly/3WO0s8f, accessed August 14, 2024.

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