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ARTIFICIAL INTELLIGENCE AND INNOVATION: THE END OF PATENT LAW AS WE KNOW IT

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With the advent of artificial intelligence (AI), the end of patent law is near. Though it may not happen today or tomorrow, the system's decline is underway. Groundbreaking innovations in AI technology have made inventions "made by AI" a reality. Today, AI is able to "invent" not only new materials and machines but also manufacturing processes, pharmaceutical drugs, and household products. Soon, our life will be replete with artificial artifacts. In a sense, humans no longer stand at the center of the creative universe—we are no longer the masters of innovation.

Despite this upheaval on the horizon, the consequences for legal doctrine remain largely unexplored. The most fundamental disruption we are about to witness is the emergence of scenarios where the inventive input is made by AI—and where no human "fire of genius" is involved. The problem here is that patent doctrine is still founded on the idea that only human beings can be inventors. Accordingly, "inventions without an inventor" will fail before patent offices and courts. It does not take much imagination to see that with the increase in artificial inventiveness, the raison d'être of strict anthropocentrism will dwindle away. Indeed, the emergence of autonomously acting "artificial inventors" dissolves the law's very foundations—its doctrine, policies, and practice. Unless we fill this vacuum with a new architecture, a system meltdown is inevitable. We desperately need a patent update for the era of artificial inventions.

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This Article analyzes the status quo of artificial innovation—that is, inventions "made by AI"—and its regulation (or, rather, non-regulation) in the United States. On this basis, I offer suggestions on how to reconceptualize the law and recalibrate legal doctrine and practice in order to keep the patent system operative.

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INTRODUCTION

Dr. Gall: You see, so many Robots are being manufactured that people are becoming superfluous; man is really a survival. But that he should begin to die out, after a paltry thirty years of competition. That's the awful part of it . . . .
Helena: And has no one demanded that the manufacture should cease altogether?
Dr. Gall: No one has the courage. . . . People would stone him to death. You see, after all, it's more convenient to get your work done by the Robots.
Helena: Oh, Doctor, what's going to become of people?
Dr. Gall: God knows, Madame Helena, it looks to us scientists like the end!

~ Karel Čapek, *Rossum's Universal Robots*, Act II (1920)

The end is near—we just have not realized it. Like Dr. Gall, one of the main characters in Karel Čapek's 1920 science fiction melodrama Rossum's Universal Robots, we may have an inkling. But the actual ramifications of the fact that our world is increasingly made by robots—or more generally, by artificial intelligence (AI)—are far from evident. Patent lawyers in particular seem to live in a daydream: if we only leave our doctrine unchanged for as long as possible, things will work out fine. But the reality is that we can no longer hope that the storm will pass. We need not ask, like Helena, "what's going to become of people?" Our human existence is not in danger—however, our patent doctrine is. Why is that? What are the consequences? And what can we do about it?

Let us go back to Čapek's *Rossum's Universal Robots* for a moment. In his play, the author invented a new breed of automatons that he called the "Robots." The word *robot*, previously unknown, was derived from the Czech word *robota*, generally meaning "labor" but also "corvée" or "drudgery." Within a few years of its premiere, the play had accumulated so much momentum and cultural capital that the word *robot* was added to the Czech dictionary; from there, it made its way into virtually every other modern language.[1] The plot is short and utopian. Rossum's Universal Robots factory is located on an island in the future. It manufactures Robots. During the decade that passes over the course of the play, Robots replace humans as workers in all areas of life. When some Robots begin to experience emotions, they realize their exploitation by the humans.

[1] KARA REILLY, AUTOMATA AND MIMESIS ON THE STAGE OF THEATRE HISTORY 148, 148 (2011).

In a violent revolution against their oppressors, the Robots end up exterminating humanity. Unlike prior tales of creation gone wrong (such as Rabbi Loew's *Prague Golem* and Mary Shelley's *Frankenstein*), Čapek's creatures not only harm and kill their creators, but also replace all humans by taking over their functions and positions, thus creating a new world population—a kind of trans-humanity.[2]

At the moment, we need not fear our own extinction. The idea of a robot revolution remains a sci-fi thrill at most. Similarly, there is no promise or threat of a brave new world of costless manufacture and endless consumption. But at the same time, the play's theme of an abolition of human work alludes to an aspect of robotization no less disconcerting: the *substitution* of human creativity, innovation, and productivity by AI. While many areas of law, such as those concerning autonomous driving and face recognition, have begun addressing the implications of AI, the field of patent law has so far largely ignored the debate on how to handle AI inventiveness and the ensuing alteration and substitution of the classic human inventor. This is all the more a surprise since examples of innovative AI abound. One frequently cited example is the "Creativity Machine" of AI pioneer Stephen L. Thaler. Years ago, Thaler let this machine develop a new toothbrush design. All he did was feed the machine's artificial neural network with information on already existing toothbrush designs. The result presented by the AI application is today widely known as the "Oral-B CrossAction" toothbrush.[3] Other examples of high-capacity AI applications include IBM's Watson and Google's DeepMind. Not only are both applications capable, for instance, of diagnosing human diseases, but they have also developed diagnostic methods and even pharmaceutical substances for therapy.[4] Against the backdrop of continuously falling costs in computing technology, a steep increase in innovative AI and much more "artificially" innovative output is to be expected. Many of these innovations are already equivalent to human-made inventions. This raises the question of whether the results of

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[2] The play ends with two Robots, Helena and Primus, who have fallen in love and are released by the last human survivor. The survivor—their Robot engineer, Alquist—tells them, "Go, Adam, go, Eve. The world is yours." *See* KAREL ČAPEK, R.U.R. (ROSSUM'S UNIVERSAL ROBOTS), Epilogue (Paul Selver & Nigel Playfair trans. 2014) (1920).

[3] ROBERT PLOTKIN, THE GENIE IN THE MACHINE: HOW COMPUTER-AUTOMATED INVENTING IS REVOLUTIONIZING LAW AND BUSINESS 51-55 (2009).

[4] *See, e.g.*, Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 57 B.C.L. REV. 1079, 1091 (2016); Ryan Abbott, *Everything Is Obvious*, 66 U.C.L.A. L. REV. 2, 24-25 (2019).

artificial innovation can or should be protected by law. More succinctly put: Can or should innovations made by AI be patentable?[5]

When looking at the state of the debate, it is striking that patent offices around the world do not seem overly concerned. Of course, the most pressing issues—such as questions of right ownership and patent eligibility for "AI inventions"—have been recognized. Additionally, legal scholars and practitioners have begun discussing the effects of the increasing level of "AI supported" human inventors. Nonetheless, almost all analyses end with an apodictic conclusion that the patent system as it stands is well equipped to deal with innovative AI. Accordingly, there seems to be no need for doctrinal reform.[6] The report of the IP5 group of experts is representative: in 2018, the European Patent Office, the U.S. Patent and Trademark Office (USPTO), and the patent offices of Japan, South Korea, and China stated as a summary of their roundtable debate on inventive AI that all their patent systems were adequately equipped to resolve issues relevant to AI technologies.[7] All experts agreed that only humans could be deemed eligible "inventors" and that human skills should constitute the standard for assessing patentability.[8] Broad consensus exists that current theory and practice suffices to regulate all kinds of inventions, even if they spring from autonomous AIs.

As a closer look at the foundations of modern technology shows, however, such a laid-back attitude is unjustified. Conceived as a regulatory framework for genuinely *human* inventiveness, the patent system will break down once artificial inventiveness has become the norm. But we need not go so far. Robotic invasion to a far lesser extent may already suffice to make the system implode. If humans are no longer exclusively providing the "creative spark" necessary for inventing, our genuinely human-centered patent system needs reconfiguration. As this Article illustrates, both

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[5] This question must be distinguished from the debate on the patentability of AI applications as such—e.g., computers, algorithms, and robots. The issue of patenting AI inventions is not about the AI's hardware or software, and the interest is not to patent the construction or functions of a technical instrument. The issue is the protection of what the AI application has produced—its artificial output.

[6] *See* Eur. Patent Office, *Report from the IP5 Expert Round Table on Artificial Intelligence* 2 (Oct. 31, 2018); *see also* NOAM SHEMTOV, A STUDY ON INVENTORSHIP IN INVENTIONS INVOLVING AI ACTIVITY 7, 33-34 (2019).

[7] Eur. Patent Office, *supra* note 6, at A.2.

[8] *Id.* at B.5., E.13, E.14.

trends—the emancipation of AI toward autonomy and the supportive use of AI call for urgent and extensive legal reform.

To start: recent leaps in AI innovation have made it possible not only to set independent algorithmic "thinking" in motion but also to employ "thinking" algorithms to resolve problems in research and development. Yet scenarios of this kind are not provided for under current U.S. doctrine, and scholarship and practice widely neglect their consequences. Indeed, even among those who are willing to acknowledge the legal problems, stopgap solutions seem to be preferred over substantial reform. A closer look at "inventions without an inventor" scenarios illustrates the defect in legal doctrine. These scenarios yield inventive results that, under the lens of current patent law, would fulfill all of the patenting conditions of §§ 101, 102, and 103 of the U.S. Patent Act—despite the fact that these results are "made by AI" and therefore lack a natural person as the inventor. Because these scenarios do not involve an immediate input of human ingenuity or creativity, under the law as it stands, no patentable invention exists. Nonetheless, current doctrine allocates rights on a first-come, first-served basis to the human actor who first recognizes the AI-generated technical teaching. The more scenarios of this kind we witness, the less we can consider current doctrine an adequate regulatory system. It not only fails to implement cogent patent policy but also fails to offer a practically consistent solution. This doctrine namely contradicts the law's anthropocentric foundation. If this defect is left uncorrected, the gap will accelerate the patent system's downfall as an effective regulatory instrument.

But it is not only the phenomenon of autonomous AI inventing that threatens to distort today's patent system. In addition to the complete substitution of humans as inventors, the landscape of inventive activities has changed more subtly: human inventing increasingly features the use of supportive AI applications. Even though humans today still sit in the driver's seat, much of their inventive output is substantially coproduced by AI applications. More concretely, this means that humans are supported by computers, algorithms, and robots when they act as inventors. In many cases, such technological support may still be used in the traditional way—for example, as a purely mechanical instrument or a computer to collect and process data. Such instrumental use hardly qualifies as intelligent. Yet AI applications may also be used to extend the human inventor's horizon with respect to prior art or even with regard to technical problem solving. Although the human, in the words of Abraham Lincoln, may still provide the "fire of genius"

to these processes of inventing,[9] AI has evolved beyond an inert tool or instrument. It no longer merely supports the human's manual, visual, or auditory skills. Rather, it extends the inventor's memory, cognition, and intellect—and thereby extends the inventive step far beyond what would have been possible without AI. In these scenarios, we must speak of a hybrid human-AI inventor. In patent legalese, this phenomenon implicates the question of how to define the capacities of a so-called Person Having Ordinary Skill In The Art (PHOSITA). Since patentability—namely with regard to novelty and non-obviousness—is determined on the basis of what a PHOSITA as hypothetical actor with average skills in the relevant field could have known and would have been able to invent, any alteration of the PHOSITA's skills will inevitably recalibrate the threshold for patentability and, accordingly, change the preconditions of inventing. Many of the consequences of an AI-fueled transformation of the once genuinely human PHOSITA into a cognitively augmented human-machine cyborg remain unexplored.

Part I of this Article addresses the most relevant aspects of recent AI developments, namely the technological foundations of and advances in AI technology. Part II demonstrates that the governing approach to AI inventiveness, both in practice and in academic debate, is more than problematic. It neglects the impending disruption that AI inventiveness will bring to the fore. Part III analyzes relevant innovation policies and marketplace realities, allowing for a reconceptualization of the specific parts of patent doctrine that are defective. The doctrinal and practical implementation of such a reconceptualized system provides the outline of a modernized patent doctrine—a concept for the era of AI inventiveness.

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[9] In his Second Lecture on Discoveries and Inventions, on February 11, 1858, Abraham Lincoln is cited as saying, "Next came the Patent laws. These began in England in 1624; and, in this country, with the adoption of our constitution. Before then, any man might instantly use what another had invented; so that the inventor had no special advantage from his own invention. The patent system changed this; secured to the inventor, for a limited time, the exclusive use of his invention; and thereby added the fuel of interest to the fire of genius, in the discovery and production of new and useful things." *See* 3 ROY P. BASLER, THE COLLECTED WORKS OF ABRAHAM LINCOLN 356, 363 (1953).

I. TECHNOLOGICAL BACKGROUND

Definitions of AI vary.[10] Most simply put, AI technology aims to develop systems that can perform as well as, or even better than, intelligent human beings.[11] As Marvin Minsky, a founding father of AI science, put it more than fifty years ago, AI comprises software and technological instruments that "behave in ways that probably everyone would agree seem to show intelligence."[12] Although the discipline emerged in the mid-twentieth century, significant progress has been made only in the past few years. This progress, however, has been enormous. Today, AI can be found virtually everywhere. Examples include chess-playing machines,[13] autonomous driving,[14] face and speech recognition,[15] translation, and even autonomous writing (e.g., for stock exchange reports and sports news).[16] Much more is yet to come.

These advances in AI are due to leaps in machine learning technology. In a nutshell, a machine learning algorithm is one that analyzes a large data set to "learn" independently from its human coders.[17] Such algorithmic "learning" is not comparable to the process of human learning. The machine or algorithm is not building a theoretical understanding of the world or of the specific endeavor

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[10] *See, e.g.*, STUART RUSSELL & PETER NORVIG, ARTIFICIAL INTELLIGENCE: A MODERN APPROACH 1-5 (3d ed. 2010).

[11] *Cf. id. at* 1 ("The field of artificial intelligence . . . . attempts not just to understand but also to *build* intelligent entities.").

[12] *Cf.* Marvin Minsky, *Artificial Intelligence*, 215 SCI. AM. 246, 247 (1966) ("Can a computer really be intelligent? In this article I shall describe some programs that enable a computer to behave in ways that probably everyone would agree seem to show intelligence."). Similar definitions abound, varying slightly from field to field. For a prominent attempt to define AI in the realm of IP law, see, for example, WIPO, WIPO CONVERSATION ON INTELLECTUAL PROPERTY (IP) AND ARTIFICIAL INTELLIGENCE (AI) 3-4 (May 21, 2020).

[13] *See, e.g.*, Steven Strogatz, *One Giant Step for a Chess-Playing Machine*, N.Y. TIMES (July 17, 2019), https://www.nytimes.com/2018/12/26/science/chess-artificial-intelligence.html.

[14] *See, e.g.*, Suhasini Gadam, *Artificial Intelligence and Autonomous Vehicles*, MEDIUM (Apr. 19, 2019), https://medium.com/datadriveninvestor/artificial-intelligence-and-autonomous-vehicles-ae877feb6cd2.

[15] *See, e.g.*, Thomas Smith, *The AI That Knows Your Face: From Your Voice*, MEDIUM (Nov. 20, 2019), https://medium.com/swlh/the-ai-that-knows-your-face-from-your-voice-90772b352f2a.

[16] *See, e.g.*, Jaclyn Peiser, *The Rise of the Robot Reporter*, N.Y. TIMES (Feb. 5, 2019) https://www.nytimes.com/2019/02/05/business/media/artificial-intelligence-journalism-robots.html.

[17] *Cf.* PETER FLACH, MACHINE LEARNING: THE ART AND SCIENCE OF ALGORITHMS THAT MAKE SENSE OF DATA 3 (2012) ("Machine learning is the systematic study of algorithms and systems that improve their knowledge or performance with experience.").

it was set to master. Rather, machine learning is about the continuous improvement of the outcome of certain processes when a certain activity is repeatedly carried out by the machine or algorithm.[18] Accordingly, the outcome of machine learning processes is based on the analysis of large amounts of data and the recognition of existing patterns and correlations within these data.[19] An example is diagnosis on the basis of X-ray pictures. A machine learning algorithm that has been trained on extensive "data consumption" can often produce results that are competitive with those of a human doctor.[20] In addition to carrying out such routines, machine learning algorithms can achieve impressive results in areas that are commonly described as requiring genuinely *human* conduct, especially with respect to experience or intuition.[21]

This also holds true for the process of inventing, in particular the achievement of an inventive step: when an AI application is set to resolve a question of research and development, it may initially act and evolve within the framework of conduct options defined by its programmer or developer. Yet over time, it will develop its own capacities. The results of AI conduct may then be akin to what human actors would have produced on the basis of experience or intuition. Indeed, in many cases already, there is no doubt that inventions "made by AI" would be patentable if they had been made by humans.[22]

But first, one caveat. AI applications cannot—at least at this moment—perfectly replicate all results of human performance. As mentioned, an algorithm does not develop abstract-constructive

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[18] IAN H. WITTEN, EIBE FRANK & MARK A. HALL, DATA MINING: PRACTICAL MACHINE LEARNING TOOLS AND TECHNIQUES 7-8 (3d ed. 2011).

[19] David Lehr & Paul Ohm, *Playing with the Data: What Legal Scholars Should Learn About Machine Learning*, 51 U.C. DAVIS L. REV. 653, 670-71 (2017).

[20] *See, e.g.*, Tanveer Syeda-Mahmood, *IBM AI algorithms can read chest X-rays at resident radiologist levels*, IBM RESEARCH BLOG (4 Nov. 2020), https://www.ibm.com/blogs/research/2020/11/ai-x-rays-for-radiologists/; *cf. also* Liza Vertinsky & Todd M. Rice, *Thinking About Thinking Machines: The Implications of Thinking Machines for Patent Law*, 8 B.U. J. SCI. & TECH. L. 574, 576 (2002) ("These thinking machines are producing results that are competitive with those of humans."); *see also* Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87, 90 (2014).

[21] Surden, *supra* note 20, at 104-105.

[22] *See, e.g.*, PLOTKIN, *supra* note 3, at 83; Ben Hattenbach & Joshua Glucoft, *Patents in an Era of Infinite Monkeys and Artificial Intelligence*, 19 STAN. TECH. L. REV. 32, 43-44 (2015); Peter Hendrik Blok, *The Inventor's New Tool: Artificial Intelligence – How Does It Fit in the European Patent System?*, 39 EIPR 69, 70 (2017).

models in the course of its endeavors.[23] It only gradually approximates the result of its output to the results that one might expect from human activity. Let's go back to our X-ray example: an algorithm designed to detect diseases on X-ray pictures does not develop a theoretical understanding of medical teachings. It only evaluates the data from its previous training runs and extrapolates its self-contained model to new cases and new data. Hence, there is legitimate doubt as to whether such AI can actually be described as "intelligent." This question reflects a classic debate in AI research—the conflict between Alan Turing's and John Searle's models of how to define "intelligence." Under a model that has become known as the "Turing test," what matters for determining intelligence is whether the result of AI activity *objectively appears* to be intelligent. Here, outcome and outer appearance are key.[24] John Searle's philosophy, on the other hand, defines the existence of *intentionality* as a prerequisite for intelligence. Unlike Turing's concept, the emphasis is on the process of an activity and the actor's internal constitution. When Searle applied his model to artificially intelligent actors, he required a reasonable and target-oriented activity.[25] Of course, under this approach, AI output would never prove intelligence since it does not demonstrate an underlying will or intention.

In patent law, however, the issue of "intelligence" is not of ultimate import. To determine whether an invention is patentable, courts typically look to the outcome of the inventive process and the quality of the results, not the subjective mental processes by which the invention was made.[26] Of course, as we will see, granting a patent still requires that a *human* inventor acted.[27] Yet apart from that, agreement exists that the outcome of many AI invention processes might be patentable. [28] Accordingly, it does not matter whether the activity leading to the inventive result was driven by a genuinely intelligent will or by a mechanical and soulless AI. A major issue remaining, however, is the identification of the *person*

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[23] *See* John R. Koza, *Human-Competitive Results Produced by Genetic Programming*, 11 GENETIC PROGRAMMING EVOLVABLE MACHINES 251, 273 (2010).

[24] Alan Turing, *Computing Machinery and Intelligence*, 59 MIND 433, 434 (1950).

[25] Searle's position became known as the Chinese Room Hypothetical. *See* John R. Searle, *Minds, Brains, and Programs*, 3 BEHAVIORAL & BRAIN SCI. 417 (1980).

[26] *See, e.g.*, Comment, The "Flash of Genius" Standard of Patentable Invention, 13 FORDHAM L. REV. 84, 85-86 (1944).

[27] *See infra* Section III.A.1.

[28] *See infra* note 34 for examples of AI-generated inventive products.

of the inventor. Since an AI does not qualify for this role, it must be any of the human actors somehow involved in the inventive process. The problem is that it is often impossible to determine a human actor's "creative spark" or "fire of genius" behind the invention. This is because learning algorithms typically develop a large part of their abilities *after* their creation by human developers.[29] Of course, the programmer will initially specify the rules for the algorithmic system. The application therefore exists as a "human-made" entity for some time at least. Over the course of its "life," however, it develops its own internal architecture for problem solving and inventing. This architecture may differ significantly from its initial programming. The process can thus be described as emancipation, or child development: a child becomes independent as it grows up, and at some point, they work independently and freely from the supervision and care of parents and teachers. Likewise, a self-emancipating autonomous AI will eventually break free of its developers' and programmers' guidance—and interference.[30]

A cutting of the cord, so to speak, is most evident in so-called genetic programming.[31] Genetic programming is an AI development model that simulates the processes of natural evolution. An algorithm is conceived with a basic capacity to resolve a problem—for example, to design an antenna with predefined properties. The outcome in each round of the algorithmic search will consist of a certain number of results that suggest solutions to the technical problem. In each round, a small group among the best results will be approved of and admitted for reproduction in the next round. In addition, for each new round, the target parameters (e.g., the size or shape of the antenna) are slightly altered. Through repeated cycles of such algorithm "reproduction," "mutation," and "selection"—a fast-motion evolution, so to speak—the results of the algorithmic search will increasingly be optimized. In other words, algorithmic evolution drives the properties of the results ever closer to the desired property values.[32] The programmer provides initial specifications for the parameters and the target properties. But the algorithmic evolution and the processes of problem solution and

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[29] *See generally* Surden, *supra* note 20, at 93-94.

[30] *See also, e.g.*, Vertinsky & Rice, *supra* note 20, at 581; Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1094-95.

[31] Koza, *supra* note 23, at 265.

[32] JOHN R. KOZA, GENETIC PROGRAMMING: ON THE PROGRAMMING OF COMPUTERS BY MEANS OF NATURAL SELECTION 18-30 (1992); *see also* Plotkin, *supra* note 3, at 55-61.

invention will take place without further human intervention.[33] Apart from the design of a NASA space antenna used above, examples of such autonomously innovative AI solutions include the design of the front cover of a Japanese high-speed train, an aircraft motor and other kinds of engines, and numerous pharmaceutical and medicinal substances.[34]

In the short term, AI will not be able to take on tasks that require a real understanding of theoretical concepts or the mastering of ultracomplex processes. Such things would require a so-called ultra-intelligent AI or artificial general intelligence ("AGI") with intellectual abilities equal to or superior to those of humans.[35] Hence, in many areas, human inventors will remain in the driver's seat for now. For the example of X-ray diagnosing, this means that the theoretical description of the clinical phenomenon of a disease will still be written by a human doctor. Diagnosis, however, as well as the search for therapies and medicinal substances, no longer remains an exclusively human domain.

Today, the use of tools, technical aids, and AI applications moves along a spectrum. At one end are instruments that do not overcome the threshold of capacities that would qualify as an AI application. This covers the use of classic tools one can find in a workshop, but also use of a computer as a merely supporting instrument, such as for collecting and transforming data. In this case, what is used is not an *intelligent* application. Accordingly, its use does not threaten the creative skills of the human inventor. At the other end of the spectrum we can find so-called ultra-intelligent AI. Both extremes are largely irrelevant for patent law. Yet there is a gray area between these two extremes. Here we find cases in which AI applications contribute to the invention process—either by

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[33] Riccardo Poli & John Koza, *Genetic Programming*, 2 SEARCH METHODOLOGIES: INTRODUCTORY TUTORIALS IN OPTIMIZATION AND DECISION SUPPORT TECHNIQUES 143, 147 (Edmund K. Burke & Graham Kendall eds., 2014).

[34] For further examples, see PLOTKIN, *supra* note 3, at 1, 60; Peter M. Kohlhepp, *When the Invention Is an Inventor: Revitalizing Patentable Subject Matter to Exclude Unpredictable Processes*, 93 MINN. L. REV. 779, 786 (2008); Hattenbach & Glucoft, *supra* note 22, at 35. Finally, see the patent "Computer designed stabilized proteins and method for producing same," U.S. Patent No 4,908,773 (filed Apr. 6, 1987).

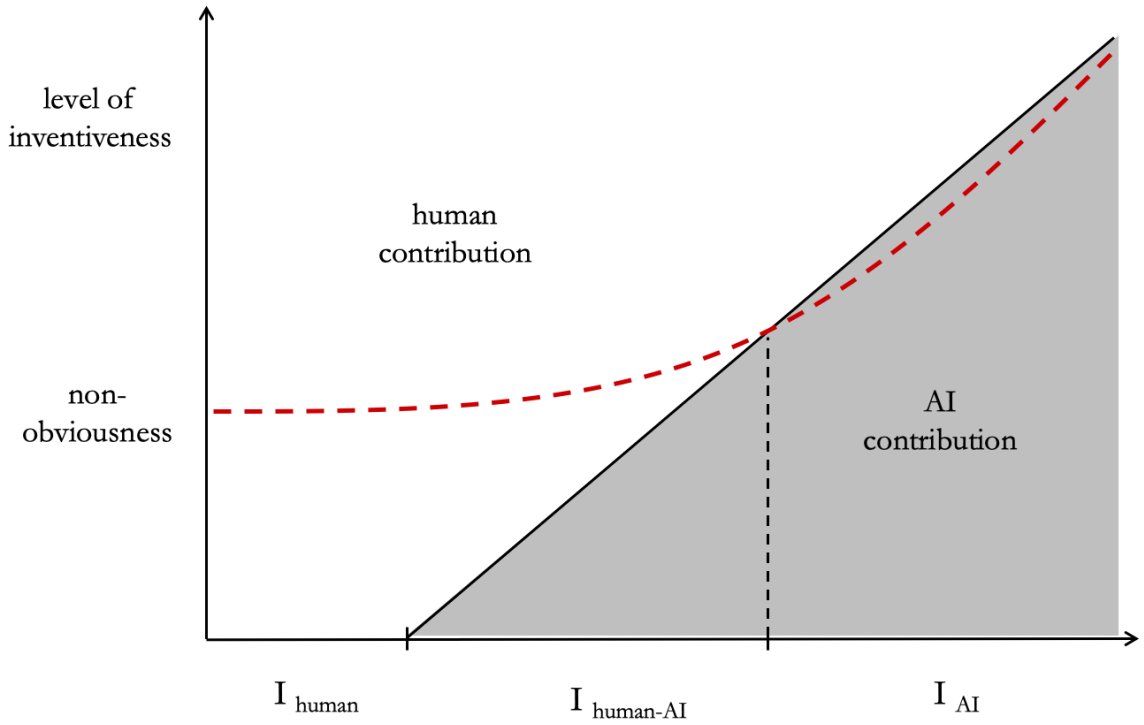
[35] For an early explanation, see Irving John Good, *Speculations Concerning the First Ultraintelligent Machine*, 6 ADVANCES IN COMPUTERS 31, 33 (1965) ("Let an ultraintelligent machine be defined as a machine that can far surpass all the intellectual activities of any man however clever. . . . [T]he first ultraintelligent machine is the last invention that man need ever make, provided that the machine is docile enough to tell us how to keep it under control.").

autonomously inventing or by intelligently supporting the processes of human inventiveness.

II. STARTING POINT: THE SPECTRUM OF HUMAN AND AI INVENTIVENESS

Before exploring the disruption that patent law is about to witness, it is essential to address the different scenarios of human and AI inventiveness. The following graphic covers the entire spectrum of scenarios of inventive activities and their human and AI contributions. The vertical axis displays the level of inventiveness and ingenuity. Inventiveness implies the degree of creative and innovative input that a claimed invention brings to the patent office. In order to receive a patent grant, the minimum threshold of inventiveness that must be overcome—in the sense of an "inventive step" going beyond the state of the prior art—indicates the level of "non-obviousness."[36] As the horizontal axis illustrates, the use of AI for inventive endeavors can take different forms. The degree of human and AI innovation moves along a sliding scale. From left to right, the level of artificial contribution increases. Three stages must be distinguished: mere use of technical tools or instruments; supportive AI use; and fully autonomous AI activity.

GRAPHIC: THE LANDSCAPE OF HUMAN-AI INVENTIVENESS



[36] *See* 35 U.S.C. § 103. *See also infra* Section III.A.2.

Stage One: At the very left (I_{human}), we may picture the epitome of the "classic" inventor: She works alone, supported by neither natural nor artificial co-inventors. The only things she may refer to are simple technical instruments. For instance, our inventor could be a blacksmith in her shop developing a new technique to affix horseshoes. She may use standard tools (e.g., anvil and hammer) but has no need for further technical support (much less AI support). Accordingly, any inventive output is genuinely human-made. As this example illustrates, any kind of tool used in the inventive process will augment the inventor's ability to solve technical problems. In other words, even very rudimentary and simple tools can augment her manual power, her eyesight, or other skills. One may think of a vice, a microscope, or a counting frame. Yet none of these instruments significantly boosts the inventor's *inventiveness as such*. Her creativity remains an intrinsic and genuinely human feature of the inventive system that consists of the human inventor and her tools. Consequently, the inventor's capacities with respect to the actual solution will not increase so significantly that patent law would have to adapt the standard for "non-obviousness."

Stage Two: The situation changes once the inventor is supported by more elaborate technology. The graphic illustrates this scenario in the area next to the pre-AI stage, further to the right. The era of technology-supported or technology-assisted invention started with the use of early computing machines, mainly for collecting and processing data. One might consider this the very first hybrid system of human-AI invention. Yet most of these cases are still characterized by a prevalence of human input. This is because this kind of technology-based augmentation of the human inventor's capacities will not substitute the *inventive* capacities of the human actor. It will be the human actor who contributes the "creative spark." The inventions in these scenarios are still considered genuinely and exclusively human-made.

Notwithstanding the fact that inventorship here is still a human domain, the human inventor's skills have begun to change—slowly, but significantly. In most cases, the technology-induced automation made possible by computer support and internet access may extend the human actor's information and calculation skills. In this regard, we may namely think of the internet as a tool for research, particularly with respect to prior art and analogous art. Even though the internet is not an *autonomously* innovative instrument, it helps increase the human inventor's capacity to find, retrieve, collect, and combine information. Consequently, at least in theory, we may find an increase in the capacities of the PHOSITA. In this way, the level of inventiveness and, by extension, the threshold of non-

obviousness—displayed by the red dashed/curved line—is constantly on the rise.

Stage Three: It is the point at the demarcation line between the fields of partially AI-supported and autonomous AI invention scenarios where the most serious doctrinal distortion looms (between $I_{human\text{-}AI}$ and I_{AI}). As can be seen, in the area of $I_{human\text{-}AI}$, there will be a point where the inventive input necessary to overcome the threshold of non-obviousness will no longer consist of contributions by *both* the human actor *and* the AI application. At this point, AI application has taken the driver's seat with regard to conceiving of a solution. Therefore, the inventive input necessary to overcome the non-obviousness threshold will be provided by the AI application alone. As a look at the technological foundations has shown, many practical scenarios exist in which the human actor's role in an inventive process is reduced to a mere onlooker. We will see that the existence of such "inventions without an inventor" heralds the need for changes to patent doctrine.[37] The issue will be: If there is no human inventor, who should qualify?

Finally, at the very right of the area of autonomous AI invention (I_{AI}), we will find the ultimate step in which an ultra-intelligent AI has not only taken over the position as actor conceiving of the invention but also become a supervisor of its own volition. In these scenarios, AI will ask the questions as well as provide the answers. The role of human actors—if they continue to play an active role at all—remains to be seen. In any event, this scenario is not of interest for patent lawyers at present.

As this overview of human-AI invention scenarios illustrates, our entry into the AI era requires a number of corrections to existing patent doctrine. Most essentially, patent law needs to be recalibrated with regard to its anthropocentric focus on both the concept of invention and the paradigm of the PHOSITA. Before I begin a more in-depth analysis, however, one final clarification concerning terminology is in order:

With regard to scenarios of autonomous AI inventions, it is puzzling that terminology is not uniform. The phenomenon is still mostly described as "computer-aided," "computer-based," or "computer-automated" inventing and its results as "computer-generated inventions."[38] Some academics call the outcome of

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[37] *See infra* Section III.A.1.

[38] *See, e.g.*, PLOTKIN, *supra* note 3, at 1; Hattenbach & Glucoft, *supra* note 22, at 43. For Europe, see, for example, Sven Hetmank & Anne Lauber-Rönsberg, *Künstliche Intelligenz – Herausforderung für das Immaterialgüterrecht*, 120 GRUR 574, 575 (2018).

autonomous invention by a computer or an AI application a "computational invention."[39] Straighter to the point is reference to "AI-generated" output or to output "generated autonomously by AI."[40] Finally, more philosophically, a "thinking machines paradigm" has been described as being characterized by the increased speed and reduced cost of inventing due to increasingly autonomous AI contributions to the invention process.[41] Some of these terms help explain that AI is already capable of *autonomous* conception and that the outcome in some cases objectively qualifies as *patentable*. Yet reference to the fact that invention unfolds from within the AI's internal evolution is missing. This aspect is crucial.

As a look at the technological background has shown, autonomous AI typically passes through a process of algorithmic evolution. At a certain point, the umbilical cord between the inventor-in-fact (i.e., the AI application) and its creator or creators (i.e., programmers, developers, or users) will be severed. From this point on, the process of conception has left the human domain. The AI application's inventiveness has become emancipated. To accurately describe this process, we must emphasize both the self-contained evolution of AI inventiveness and the fact that the outcome is patentable. The debate in copyright law is already one step ahead. There, works that have been autonomously "created" by AI are termed "emergent works." This expresses that the outcome may be copyrightable (i.e., a "work") and also that the process of creation is a self-contained evolution, non-foreseeable, and uncontrolled by human actors—hence "emergent."[42] Accordingly, in patent law, it would also be appropriate to speak of "emergent inventions." This category—as I will use the term here—includes all scenarios in which the conception and hence the creative step and inventive input have been provided by an autonomously acting AI application.

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[39] *See, e.g.*, Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1080.

[40] WIPO, *supra* note 12, at 4.

[41] Vertinsky & Rice, *supra* note 20, at 575; Liza Vertinsky, *Thinking Machines and Patent Law*, *in* RESEARCH HANDBOOK ON THE LAW OF ARTIFICIAL INTELLIGENCE 489, 490 et passim (Woodrow Barfield & Ugo Pagallo eds., 2018).

[42] *See, e.g.*, Bruce E. Boyden, *Emergent Works*, 39 COLUM. J.L. & ARTS 377, 379 (2016) ("[W]orks of apparently creative expression that arise from the operation of a program but cannot be traced directly to a human source."); *see also* Tim W. Dornis, *Artificial Creativity: Emergent Works and the Void in Current Copyright Doctrine*, 22 YALE J. LAW & TECH. 1, 9-10 (2020).

III. ANALYSIS AND RECONCEPTUALIZATION

A closer look at the emergence of innovative AI illustrates that some of the classic paradigms of patent law are about to dissolve. The fact that an invention can be "made by AI" without *any* human input highlights the urgency of legal change. In addition, the increasing use of AI support for human inventive activity leads to a rapid transformation of the concept of the PHOSITA. The adjustment of patent law in this regard is also essential. Before a doctrinal and practical reconceptualization is possible, we must look at the policy foundations, mostly with respect to theories of patent law, but also with an eye on the realities of digital marketplaces. On this basis, it is possible to outline a foundation for patent reform.

A. The Obsolescence of Classic Patent Paradigms

Only if AI applications were to be regarded as legal persons could you classify them as "inventors" in the sense of § 100(f) of the Patent Act. So far, however, no court has extended legal personhood to any "electronic person."[43] Only natural persons can be considered "inventors" and, accordingly, right holders. Although autonomous AI invention implies a complete lack of human inventive input, current doctrine suggests that its results should nonetheless be patentable. Accordingly, the human actor who first "recognized" or "discovered" the AI's invention is considered the inventor. Under this anthropocentric approach, not surprisingly, problems of "inventions without an inventor" have been widely overlooked. And the anthropocentric perspective also misguides the analysis of the "novelty" and "non-obviousness" requirements in §§ 102 and 103 of the Patent Act. Indeed, current doctrine seems to assume that the further development of AI capacities will be widely homogeneous. Hence, determination of the PHOSITA and her capacities—namely concerning the enhancement of human skills due to increasing AI support—seems easy to handle in practice. But a closer look unveils this assumption to be incorrect. To the contrary, in light of a consolidated AI industry and tendencies of monopolization, we must expect a rather heterogeneous and divergent evolution of AI capacities.

1. The Great Void: "Inventions without an Inventor"

To start with, the most dramatic shortcoming of current doctrine is its anthropocentrism. Patent law only considers human beings to

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[43] *See, e.g.*, Jack M. Balkin, *The Path of Robotics Law*, 6 CALIF. L. REV. CIR. 45, 46 (2015); Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1121; Colin R. Davies, *An Evolutionary Step in Intellectual Property Rights – Artificial Intelligence and Intellectual Property*, 27 COMP. L. & SEC. REV. 601, 610, 617 (2011).

be capable of inventing. What's more, scholars and courts allow for a rather paradoxical expansion of strict anthropocentrism in practice: even though AI-generated inventions lack a genuinely human inventor, they are nonetheless granted full-fledged protection on the basis of an erratic first-to-recognize rule. In short: it is always the first human to "recognize" the AI-generated invention who becomes its "inventor." As we will see, this doctrine not only invites doctrinal and practical confusion, it also distorts patent law's policy foundation.

a) Stocktaking: The Reign of Anthropocentrism

Since its beginning, U.S. patent law has maintained a strictly anthropocentric concept of invention. The inventive process essentially requires *intellectual* activity and *creative* input. Accordingly, only natural persons—humans—qualify as "inventors" under the Patent Act.[44] Although there is no express provision in the Patent Act requiring a "human" inventor, anthropocentric exceptionalism is deeply rooted in the system.

This anthropocentrism starts with Article I of the U.S. Constitution, which provides that "Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."[45] Although "inventors" are not defined in the Constitution, it is obvious that the framers imagined a human being.[46] Likewise, § 100(f) of the Patent Act defines an inventor as "an individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."[47] Furthermore, patent applications require the inventor or inventors to be named, and each "individual" who is named inventor or joint inventor of the claimed invention "shall execute an oath or declaration in connection with the application, inter alia

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[44] *See* Beech Aircraft Corp. v. EDO Corp., 990 F.2d 1237, 1248 (Fed. Cir. 1993) ("[O]nly natural persons can be 'inventors.'"); Univ. of Utah v. Max-Planck-Gesellschaft Zur Forderung Der Wissenschaften E.V., 734 F.3d 1315, 1323 (Fed. Cir. 2013) ("It is axiomatic that inventors are the individuals that conceive of the invention . . . ."). With respect to AI in particular, see also Ralph D. Clifford, *Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up?*, 71 TUL. L. REV. 1675, 1696-97 (1997); Liza Vertinsky & Rice, *supra* note 20, at 585-86; Walter Keith Robinson & Joshua T. Smith, *Emerging Technologies Challenging Current Legal Paradigms*, 19 MINN. J.L. SCI. & TECH. 355, 364 (2018); Vertinsky, *supra* note 41, at 499.

[45] U.S. CONST. art. I, § 8, cl. 8 ("The Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.").

[46] Vertinsky, *supra* note 41, at 498-99.

[47] 35 U.S.C. § 100(f) (Definitions).

requiring that "such individual believes himself or herself to be the original inventor or an original joint inventor."[48] Courts also entertain a notion of human exceptionalism. This is most famously reflected in the Supreme Court's holding in *Diamond v. Chakrabarty* that the subject matter of patents covers whatever is "a product of human ingenuity" and that Congress intended this "to include anything under the sun made by man."[49] With regard to the demarcation between natural and legal persons as inventors, finally, the Federal Circuit has stated most succinctly that "people conceive, not companies."[50]

This peculiarity is by far not endemic to U.S. patent doctrine. Similar concepts prevail in other jurisdictions, namely in Europe.[51] At present, the concept of "invention" inseparably intertwined with the requirement of a human mind and of natural processes of creation and invention.

Against this backdrop, inventive activities of a computer or any other technical device will not be considered to fulfill the requirements of an "invention." Of course, AI equipment or gadgets may generate new knowledge or extend the realm of technical teachings and, hence, the state of the art. But the act of intellectual creation as the essence of the concept of "invention" remains reserved for humans. Agreement seems to exist that AI—however autonomous it may be—can never create an invention.[52]

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[48] 35 U.S.C. § 115(a)-(b) (Inventor's oath or declaration).

[49] Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) ("product of human ingenuity" and "Congress intended statutory subject matter to 'include anything under the sun that is made by man.'").

[50] New Idea Farm Equip. Corp. v. Sperry Corp., 916 F.2d 1561, 1566 (Fed. Cir. 1990); *see also* Vertinsky, *supra* note 41, at 499.

[51] According to Article 60 of the European Patent Convention and Section 6 German Patent Act, an "inventor" is someone who "mentally created" the underlying technical teaching. *See, e.g.*, RUDOLF KRAßER & CHRISTOPH ANN, PATENTRECHT § 19, ¶ 7 (7th ed. 2016); Blok, *supra* note 22, at 71-72; Roman Konertz & Raoul Schönhof, *Erfindungen durch Computer und künstliche Intelligenz – eine aktuelle Herausforderung für das Patentrecht?*, 10 ZEITSCHRIFT FÜR GEISTIGES EIGENTUM/INTELLECTUAL PROPERTY JOURNAL 379, 402 (2018); Yann Ménière & Heli Pihlajamaa, *Künstliche Intelligenz in der Praxis des EPA*, 121 GRUR 332, 335 (2019). For a comparative perspective, see SHEMTOV, *supra* note 6, at 11 et seq. For UK law, see, for example, Yeda Research and Development Co. Ltd. v. Rhone-Poulenc Rorer International Holdings Inc., [2007] UKHL 43, [2008] RPC 1; University of Southampton's Applications [2005] R.P.C. 11, 39; Thaler v. Comptroller-General of Patents, Designs and Trade Marks [2020] EWHC 2412 (Pat.) ¶ 39-46; Davies, *supra* note 43, at 601, 606.

[52] For the United States, see, for example, Clifford, *supra* note 44, at 1696-97; Vertinsky & Rice, *supra* note 20, at 585-86; Hattenbach & Glucoft, *supra* note

This doctrine is also reflected in modern practice. Just recently, the USPTO rejected an application to register an invention in the name of an AI system.[53] The application listed a single inventor: a "Creativity Machine" with the given name "DABUS" and the family name "Invention generated by artificial intelligence." It further designated a human as the right's assignee: Stephen L. Thaler. In its decision, the USPTO simply referred to the statutory requirement that only human beings are eligible to be "inventors." Around the same time, the European Patent Office rejected two applications in which no human inventor was named. Here as well, the applicant had specified a machine called "DABUS" as the "inventor."[54] Similar to the USPTO, the European Patent Office held the applications inadmissible, for, among other reasons, failure to comply with the prerequisites for "designation of inventors."[55] The Office similarly pointed out that only natural persons could be inventors.[56] And anthropocentrism seems to be set in stone in other jurisdictions' registration practice. In 2018, for instance, in collaboration with the European Patent Office and the USPTO, the patent offices of Japan, South Korea, and China issued a joint statement explaining that only humans could be considered "inventors."[57]

b) The Practical Workaround: "AI-Made Inventions"

If strictly applied, this anthropocentric approach would require cases of autonomous AI invention to be qualified as "inventions without an inventor." Indeed, if the AI's input has been provided without *any* human contribution to the conception of the invention, any other solution would be plainly incorrect. Yet, so far, it appears that the issue has been largely ignored.

22, at 45-46; Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1103-08; Robinson & Smith, *supra* note 44, at 364; Vertinsky, *supra* note 41, at 498-99; for Europe, see, for example, Ménière & Pihlajamaa, *supra* note 51, at 335; KRAßER & ANN, *supra* note 51, at § 19, ¶ 7.

[53] *In re* Application of Application No. 16/524,350, July 29, 2019 Dec. Comm'r Pat.

[54] Eur. Patent Office, 18275163.6 (Jan. 27, 2020), GRUR-RS 2020, 653; Eur. Patent Office, 18275174.3 (Jan. 27, 2020), GRUR-RS 2020, 647.

[55] Article 81 of the European Patent Convention provides that "[t]he European patent application shall designate the inventor. If the applicant is not the inventor or is not the sole inventor, the designation shall contain a statement indicating the origin of the right to the European patent." Convention on the Grant of European Patents, Oct. 5, 1973, 1065 U.N.T.S. 199, art. 81.

[56] Eur. Patent Office, 18275163.6, *supra* note 54, ¶ 21; Eur. Patent Office, 18275174.3, *supra* note 54, ¶ 22.

[57] EUR. PATENT OFFICE, *supra* note 6, at B.4.

The aforementioned joint IP5 declaration by major patent offices illustrates this point: According to the IP5's experts, there are only three categories of AI inventions: (1) human-made inventions where the AI is used merely to "verify" the outcome; (2) cases where the human "identifies a problem" and uses AI to "find a solution"; and (3) cases of fully autonomous AI invention ("AI-made inventions"), where an AI "identifies a problem and proposes a solution without human intervention."[58] At the very least, this categorization appears to be consistent: Since the emergence of an ultra-intelligent AI may still take some time, *fully* autonomous invention is currently unthinkable. Hence, we cannot expect AI applications to both formulate the problem (e.g., What human disease should we cure?) and provide the solution (e.g., We should use substance "XYZ" as medication.). And since asking the question and formulating the problem is still a human domain, any kind of AI contribution will currently be considered a supporting part of the still genuinely human-made invention. It thus appears that there is no need for reform.[59] In sum, scenarios of autonomous AI searches for solutions will be regarded as computer or AI supported—or, in short, AI-made inventions with the human involved in the process being the inventor-in-law.

In the academic debate, it is also undisputed that technical teachings devised by an autonomous AI can in principle meet the prerequisites for an "invention"—despite the fact that a *human* inventor is indispensable.[60] First of all, it is argued that the requirement that the solution not be "obvious" does not give regard to the *way* in which the invention has been accomplished. After all, as § 103 of the Patent Act provides, "Patentability shall not be negated by the manner in which the invention was made." Accordingly, the patentability of an invention depends not on the process of inventing but on the outcome of inventive activity.[61] In addition, reference is made to the recognition of coincidental inventions or discoveries, in which a human inventor finds a

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[58] EUR. PATENT OFFICE, *supra* note 6, at B.3; *see also* Ménière & Pihlajamaa, *supra* note 51, at 333.

[59] *See, e.g.*, Ménière & Pihlajamaa, *supra* note 51, at 336; SHEMTOV, *supra* note 6, at 7, 33-34; *see also* Eur. Patent Office, *supra* note 6, at A.2, B, E.13.

[60] *See, e.g.*, Shlomit Yanisky-Ravid & Xiaoqiong Liu, *When Artificial Intelligence Systems Produce Inventions: An Alternative Model for Patent Law at the 3A Era*, 39 CARDOZO L. REV. 2215, 2231 (2018); *see also* Blok, *supra* note 22, at 71; Konertz & Schönhof, *supra* note 51, at 387.

[61] *See, e.g.*, Abbott, *Everything Is Obvious*, *supra* note 4, at 4; Blok, *supra* note 22, at 70; Hetmank & Lauber-Rönsberg, *supra* note 38, at 576.

solution by mere happenstance.[62] Courts have regularly found inventions of this kind patentable.[63] The argument is simple: since such inventions are devoid of a "creative spark" or a "eureka moment," it must also be possible to find an invention by mere "recognition" of an AI-made solution and its teaching.[64] Therefore, the inventor is the human actor who recognized the teaching developed by an AI application and who has made it technically applicable.[65]

Hence, under prevailing doctrine, the purely mechanical support of the human inventor by a tool or instrument as well as all other scenarios in the gray area of the spectrum of AI invention will be considered so-called AI-made inventions. Regardless of the scope and quality of the contribution of the AI application, the inventive input will always be attributed to the human actors involved. The human's own contribution—and also the fact that in many cases *no* such contribution exists—is irrelevant. Accordingly, it may even suffice to be considered an inventor if one merely pushes the on/off button of the AI apparatus—as long as that someone is a human being, of course.

c) An Unhurried Look: The Splendid Isolation of AI Inventiveness

What is overlooked by the prevailing doctrine, however, is the fact that if AI autonomously finds the solution to a technical problem, humans will become non-inventing onlookers. It may be true that AI is not yet capable of determining questions for research and development and, accordingly, that it cannot autonomously formulate its own goals of inventing. Yet even today, AI can provide the "conception" as the essential element of an invention.

In this regard, two facts are of particular importance: First, so-called conception as the touchstone of inventorship can and does emerge from AI autonomy. Second, since an autonomous AI

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[62] The discovery of the characteristics of penicillium is an oft-enunciated example for this kind of "random invention." *See, e.g.*, Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1098 n.137.

[63] *See, e.g.*, Allegheny Drop Forge Co. v. Portec, Inc., 370 F. Supp. 673, 676 (W.D. Pa. 1974), aff'd, 541 F.2d 383 (3d Cir. 1976).

[64] *See* Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1098; Blok, *supra* note 22, at 71; Konertz & Schönhof, *supra* note 51, at 389; SHEMTOV, *supra* note 6, at 21.

[65] For Europe, *see, e.g.*, Blok, *supra* note 22, at 70; Klaus-Jürgen Melullis, *in* PATENTGESETZ § 6, ¶ 32 (Georg Benkard ed., 11th ed. 2015). *But cf.* Thomas Meitinger, *Künstliche Intelligenz als Erfinder?*, 111 MITTEILUNGEN DER DEUTSCHEN PATENTANWÄLTE 49, 50 (2020) (describing the concept of an invention by "recognizing" an AI application's technical teaching as a "desperate attempt" to overcome the doctrinal void).

conception implies a lack of human contribution, a strict interpretation of the law in light of its anthropocentric foundations means that there is an "invention without an inventor."

To start with the element of conception: it is important to note that the patent system is largely indifferent to the means by which an invention has been made. This was not the case for some time. Until the mid-twentieth century, courts regularly referred to the so-called "flash of genius" doctrine. The Supreme Court held that in order to be patentable, a new device, "however useful it may be, must reveal the flash of creative genius, not merely the skill of the calling."[66] This doctrine was jettisoned in 1952 based on the recommendation of the National Patent Planning Commission.[67] The Commission suggested 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."[68] Accordingly, § 103 of the Patent Act reads, "Patentability shall not be negated by the manner in which the invention was made."[69] Patentability determinations neither ask for a divine spark nor a specific "eureka" moment, nor will they look at the cost and effort of the inventive process or at the inventor's diligence. Under this functional perspective, the so-called conception of the invention has become the touchstone of inventorship.[70] It refers to "the formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention as it is thereafter to be applied in practice."[71] The concept is based on the distinction between what a PHOSITA would have been able to discover and develop under her general routine and without unusual effort, on the one hand, and the

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[66] *See, e.g.*, Reckendorfer v. Faber, 92 U.S. 347, 357 (1875); Cuno Eng'g Corp. v. Automatic Devices Corp., 314 U.S. 84, 91 (1941); Great Atlantic & Pacific Tea Co. v. Supermarket Equip. Corp., 340 U.S. 147, 154 (1950) (Douglas, J., concurring); Hamilton Standard Propeller Co. v. Fay-Egan Mfg. Co., 101 F.2d 614, 617 (6th Cir. 1939).

[67] Case Note, *Patent Law – "Flash of Genius" Test for Invention Rejected*, 5 DEPAUL L. REV. 144, 147 (1955) ("Criteria of invention may be formulated at some later date, but it is clear at least that the 'flash of genius' test is here legislatively disavowed.").

[68] Test for Determining Invention: Hearing on H.R. 4798 Before Subcomm. No. 4 of the H. Comm. on the Judiciary, 81st Cong. 4 (1949) .

[69] 35 U.S.C. § 103 (Conditions for patentability; non-obvious subject matter).

[70] *See e.g.*, Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1227 (Fed. Cir. 1994) ("Conception is the touchstone of inventorship, the completion of the mental part of invention.").

[71] Townsend v. Smith, 36 F.2d 292, 295 (C.C.P.A. 1929).

inventor's actualization of an innovative step that goes beyond the routine output of the PHOSITA on the other.[72]

From here, clear demarcation lines between what can be considered a valid conception and what is a non-patentable activity become evident. The issue is typically discussed in multi-actor scenarios when determining co-inventors or joint inventors. In general, the conception of an invention is not considered complete before the inventive step is fully made and when "one of ordinary skill in the art could construct the apparatus without unduly extensive research or experimentation."[73] In other words, it is through complete conception that the invention is made sufficiently clear to enable one skilled in the art to reduce it to practice without the exercise of extensive experimentation or the exercise of inventive skill.[74] More specifically, if multiple actors are working together, each of them can be a co-inventor even without "the same type or amount of contribution" to the invention.[75] Yet under a perspective focused on the moment of conception, merely providing monetary or technical support does not qualify an actor as an inventor or a co-inventor.[76] Nor does merely providing information that describes the state of the art suffice for co-inventorship. One who simply provides another actor with "well-known principles" or "explains the state of the art without ever having a firm and definite idea of the claimed combination as a whole does not qualify as a joint inventor."[77] Merely suggesting an idea or a result to be accomplished, rather than identifying the means of accomplishing it, does not make one a co-inventor.[78] Instructing or requesting another to create a product that will fulfill a certain function also does not suffice as a valid contribution to conception.

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[72] Vertinsky, *supra* note 41, at 496.

[73] Sewall v. Walters, 21 F.3d 411, 415 (Fed. Cir. 1994); *see also Burroughs Wellcome*, 40 F.3d at 1228.

[74] Hiatt v. Ziegler, 179 U.S.P.Q. (BNA) ¶ 757 (1973).

[75] 35 U.S.C. § 116a.

[76] *See, e.g.*, Ethicon, Inc. v. U.S. Surgical Corp., 937 F. Supp. 1015, 1035 (D. Conn. 1996), aff'd, 135 F.3d 1456 (Fed. Cir. 1998); Nartron Corp. v. Schukra U.S.A. Inc., 558 F.3d 1352, 1359 (Fed. Cir. 2009).

[77] *Nartron*, 558 F.3d at 1356 (citing *Ethicon*., 937 F. Supp. at 1035); *cf.* Hess v. Advanced Cardiovascular Sys., Inc., 106 F.3d 976, 981 (Fed. Cir. 1997) ("no more than a skilled salesman would do in explaining how his . . . product could be used to meet [certain] requirements"); Hattenbach & Glucoft, *supra* note 22, at 46.

[78] *See, e.g.*, Eli Lilly & Co. v. Aradigm Corp., 376 F.3d 1352, 1359 (Fed. Cir. 2004) (citing Garrett Corp. v. United States, 422 F.2d 874, 880 (Ct. Cl. 1970)); *Ex Parte* Smernoff, 215 U.S.P.Q. (BNA) ¶ 545 (1982).

With regard to the use of technical instruments (e.g., computers), this implies that simply providing a computer with a task and providing the starting basis—namely the data input—for its work should not make the human actor an inventor.[79] In the same vein, a human actor preparing to use and actually employing an innovative AI application is not an inventor for the purposes of patent law. Even though she may conceive of the technical settings (e.g., the neural network or the genetic algorithm) and may feed in the seed information, this preparatory activity does no more than provide the AI application with access to the state of the art.[80] Likewise, it should not amount to a conception of an invention if the human developer or operator only identifies the technological settings and the target parameters for the application's search for solutions. After all, a conception refers to "the formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention as it is thereafter to be applied in practice."[81] Since the AI application, however, must still find the "definite and permanent idea" of the intended invention on its own, the human preparatory input lacks the relevant quality for a conception and thus for an invention.[82]

Seen in this light, it is clear that the inventive step that is required to find a conception and an invention can emerge *independently* of any human contribution. An example of such an "invention without an inventor" is the "Creativity Machine"-designed toothbrush. Thaler, as creator of the machine, provided the input for the operation (i.e., the information on existing designs and how they worked). Yet he left the search for a solution to the machine's artificial neural network. This network found the result autonomously—that is, widely detached from its initial programming and independent of further human input and interference.[83] Even though Thaler was named the "inventor" in the patent application, under a strict application of the patent laws, he was not the inventor-in-fact.

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[79] *See* Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1094; W. Michael Schuster, *Artificial Intelligence and Patent Ownership*, 75 WASH. & LEE L. REV. 1945, 1962 (2018).

[80] Schuster, *supra* note 79, at 1962.

[81] Townsend v. Smith, 36 F.2d 292, 295 (C.C.P.A. 1929).

[82] I will not discuss scenarios where human and AI inventive activities are combined in a collaborative process of co-invention. Such scenarios are possible, and (deeper analysis pending) one would then likely have to consider the human and the artificial actors as joint inventors or co-inventors.

[83] PLOTKIN, *supra* note 3, at 51-55; *see also* Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1094; Vertinsky, *supra* note 41, at 492.

Other scenarios where AI, not humans, provide the conception abound in pharmaceutical research. If the task is to find a therapeutic agent, the identification of a specific substance may be the solution to the question and thus the essential part of the invention—in short, the inventive step and conception.[84] When the invention of pharmaceutical substances is at issue, courts generally find that conception occurs only when the alleged inventor has a "mental picture" of the structure of a pharmaceutical substance. In other words, she must be able to define the substance by its method of preparation, its physical or chemical properties, or whatever other characteristics sufficiently distinguish it.[85] Merely defining the substance solely by its principal biological properties does not suffice. Conception requires isolation of the substance at issue.[86] In an autonomous AI search, the human actor may formulate the task and define the properties of the substance. The AI application, however, will undertake the search for a solution.[87] Of course, the human actor may still contribute an inventive input when selecting among a list of substances that the application has ultimately come up with. Yet, if the application presents only a narrow selection or a single substance as the result of its search, conception is exclusively AI-made.

For all these scenarios, no actual inventor exists if the AI application is not considered the inventor. The human contribution does not qualify as an inventive step or conception because the application's activity cannot be attributed to the human actor. Consequently, under the law as it stands, inventions of this kind should fall into the public domain. Yet, as we have seen, the theory and USPTO practice embrace a contrary first-to-recognize rule. The approach, though a practical workaround, risks causing significant distortion in a number of directions. I will address these issues in

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[84] For more examples, see PLOTKIN, *supra* note 3, at 60.

[85] *See, e.g.*, Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200, 1206 (Fed. Cir. 1991); Bd. of Educ. *ex rel*. Bd. of Trustees of Fla. State Univ. v. Am. Bioscience, Inc., 333 F.3d 1330, 1340 (Fed. Cir. 2003); Invitrogen Corp. v. Clontech Labs., Inc., 429 F.3d 1052, 1063 (Fed. Cir. 2005).

[86] *See, e.g.*, *Amgen. v. Chugai*, 927 F.2d at 1206 ("[W]hen an inventor is unable to envision the detailed constitution of a gene so as to distinguish it from other materials, as well as a method for obtaining it, conception has not been achieved until reduction to practice has occurred, i.e., until after the gene has been isolated.").

[87] For an example of such an algorithmic search for medical agents by means of employing artificial neural networks, see Mariya Popova, Olexandr Isayev & Alexander Tropsha, *Deep Reinforcement Learning for De Novo Drug Design*, SCI. ADV. 11 (2018).

more detail in my analysis of policies and teleological foundations.[88] Here, a summary of the most problematic consequences illustrates the misconception of current doctrine.

First, the first-to-recognize rule invites intentional falsification of the patent register. After all, currently an AI application must not be listed as an "inventor" in the application. Failure to list a human inventor, as well as other irregularities, can result in the patent being held invalid or unenforceable.[89] The potential for dispute over who is the actual inventor—the one actor who "recognized" the application's invention first—is immense.[90] Such disputes may be costly to contain.

In addition, the first-to-recognize rule decouples invention and right ownership, making it complicated to uphold the incentive function of patent law. Allowing the acquisition of rights based on the arbitrary or discretionary "recognition" of an AI-made invention makes it hard, if not impossible, to grant rights to the actually deserving "inventive" actor or actors. In short, current doctrine muddies inventorship issues across the board.[91]

Moreover, the first-to-recognize rule stifles a proper analysis with regard to the adequate scope and duration of protection for "inventions without an inventor." It is evident that the protection of "inventions without an inventor" by full-fledged patent rights risks overprotection. Of course, protection may make sense economically. Yet before we grant any right for inventions "made by AI," it is essential to analyze the policy foundations and to clarify the technical and doctrinal settings. Under the current first-to-recognize rule, all these questions remain undebated—buried under the seeming handiness of a workaround solution.

2. The Impending Transformation: From Human to Artificially Intelligent PHOSITA

But it is not only the emergence of a *fully* autonomously inventive AI that will create pressure for current patent doctrine. More generally, the use of AI to *support* human inventiveness implies groundbreaking changes for the concept of the PHOSITA. The human inventor is not to be replaced, but her inventive skills are to be augmented by AI. The result is a more skilled hybrid

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[88] *See infra* Section III.B.

[89] *See e.g.*, Advanced Magnetic Closures, Inc. v. Rome Fastener Corp., 607 F.3d 817, 828 (Fed. Cir. 2010) ("We have held that when named inventors deliberately conceal a true inventor's involvement, the applicants have committed inequitable conduct and the patent is unenforceable even as to an innocent co-inventor").

[90] *See* Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1004; Vertinsky, *supra* note 41, at 506.

[91] *See* Vertinsky, *supra* note 41, at 506-08.

inventor—a combination of human and AI capacities. In a sense, although the AI's apparatus or its software have not been implanted into the human body, this new PHOSITA is a human-technology symbiont, a cyborg with externally extended abilities.[92] The process of increasing cognitive hybridization of the PHOSITA will affect the requirements of "novelty" and "non-obviousness" as preconditions of patentability.

a) Stocktaking: A Tale of PHOSITA Hybridization

To be patentable, an invention must be novel, useful, and non-obvious.[93] The utility requirement mandates that the invention be "operable to achieve useful results."[94] This obstacle is not too hard to overcome. After all, it is casebook lore that the invention simply "be capable of *some* beneficial use."[95] As the practical examples of AI inventions (e.g., toothbrushes and pharmaceutical substances) illustrate, utility is usually unproblematic, as the mere fact that an invention has been "made by AI" or "supported by AI" does not alter its practical utility.[96] More thorny issues come up, however, with regard to novelty and non-obviousness.

With regard to novelty, § 102(a) of the Patent Act explains that a claimed invention is not sufficiently novel if it "was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention."[97] That is, an invention must not belong to the so-called prior art that includes all knowledge made available to the public in writing, in verbal descriptions, by use, or in any other way before the day that is decisive for the priority of the application. Although the Patent Act is silent on this point, what matters for the determination of novelty is the perspective of a specialist in the relevant field of technology—a Person Having Ordinary Skill In The Art. But the concept of the PHOSITA is elusive. As the Federal Circuit explained early on, in determining the PHOSITA, a court

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[92] For the concept of cognitive hybridization and so-called natural-born cyborgs, see ANDY CLARK, NATURAL-BORN CYBORGS: MINDS, TECHNOLOGIES, AND THE FUTURE OF HUMAN INTELLIGENCE 3-8. (2003).

[93] 35 U.S.C. §§ 101, 102, 103. This standard essentially also applies in other jurisdictions. In Europe, for instance, the relevant criteria are novelty, inventive step, and industrial applicability. *See* Convention on the Grant of European Patents, supra note 78, art. 52(1) ("European patents shall be granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application").

[94] *E.g.*, *In re* Swartz, 232 F.3d 862, 863 (Fed. Cir. 2000).

[95] DONALD S. CHISUM, PATENTS, A TREATISE ON THE LAW OF PATENTABILITY, VALIDITY AND INFRINGEMENT § 4.02 (2000) (emphasis added).

[96] *See supra* Part I.

[97] 35 U.S.C.A. § 102(a).

"confronts a ghost" much like "the 'reasonable man' and other ghosts in the law."[98]

What matters most with regard to novelty is the fact that the perspective is objective, not based on the individual inventor's subjective level of information and knowledge. The test is for constructive knowledge, requiring a hypothetical standard. This approach prompts two questions. The first is what information actually *does* exist. Here, the inventor is "charged with knowledge of all that the prior art disclosed at the time of his alleged invention, irrespective of whether persons of ordinary skill in the field, or he himself, or anyone else, actually possessed such all-encompassing familiarity with prior disclosures."[99] Second, among the information that does exist, what is *accessible* must be distinguished from what is not. For a given reference to be considered publicly accessible, courts regularly require "a satisfactory showing that such document has been disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence, can locate it."[100] Even though the accessibility test rarely restricts the scope of prior art, in some cases (namely for internet publications that are non-indexed and thus difficult to find), the issue of what is "sufficiently publically [sic] accessible to be considered a printed publication"[101] may be problematic. In this regard, in fact, human cognitive limitations may lead to a limitation of actual accessibility, and thus of constructive knowledge.

Likewise, the precondition of "non-obviousness" is linked to the concept of the PHOSITA.[102] This is clearly expressed in § 103 of the Patent Act. The relevant part of the provision explains:

> A patent for a claimed invention may not be obtained . . . if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.[103]

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[98] Panduit Corp. v. Dennison Mfg. Co., 810 F.2d 1561, 1566 (Fed. Cir. 1987).

[99] Tokyo Shibaura Elec. Co. v. Zenith Radio Corp., 548 F.2d 88, 94 n.18 (3d Cir. 1977).

[100] Suffolk Techs., LLC v. AOL Inc., 752 F.3d 1358, 1364 (Fed. Cir. 2014) (quoting SRI Intern., Inc. v. Internet Sec. Sys., Inc., 511 F.3d 1186, 1194 (Fed. Cir. 2008)).

[101] Id. at 1365.

[102] *See, e.g.*, Ruiz v. A.B. Chance Co., 234 F.3d 654, 666 (Fed. Cir. 2000).

[103] 35 U.S.C. § 103.

Here as well, the analysis does not consider the *individual* inventor's capacities, namely her specific technical knowledge, but instead refers to a fictitious person's abilities. In other words, "[t]he person of ordinary skill is a hypothetical person."[104] Accordingly, courts have held that the "touchstone" of obviousness analysis is whether the claimed invention as a new thing is beyond the ability of a worker of *ordinary* skill in the field.[105]

The impending hybridization of the PHOSITA will primarily affect patentability in two directions. First, with respect to "novelty," human inventors supported by AI applications will increasingly be able to search for information—in virtually no time and everywhere, especially on the internet. In addition, the AI-augmented inventor's ability to store and process information will increase, as well as her ability to transfer knowledge between different fields of science and technology. At least with regard to what could be found and known—in specific novelty terms, what is "accessible"—the state of prior art may be expanded by the supportive use of AI. After all, with AI-augmented search capacities, information that is publicly available will be easier to find and, hence, usually presumed to be known. In this regard, the scope of the prior art may be extended.[106]

The case seems to be similar with regard to "non-obviousness." As a rule of thumb, an invention should not be regarded as groundbreaking once (1) the PHOSITA is considered to "commonly" or "typically" use supporting AI in inventive activities of that kind and (2) the AI support enhances the PHOSITA's skills up to a point where inventions of this kind are obvious to the hybrid human-AI PHOSITA.[107] A look at the concept of so-called analogous art illustrates this point: "A reference qualifies as prior art for an obviousness determination under § 103 only when it is

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[104] Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc., 807 F.2d 955, 962 (Fed. Cir. 1986).

[105] *See, e.g.*, KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 420 (2007); Stewart-Warner Corp. v. Pontiac, 767 F.2d 1563, 1570 (Fed. Cir. 1985); Interstate Rubber Prod. Corp. v. Radiator Specialty Co., 214 F.2d 546, 548 (4th Cir. 1954).

[106] *See, e.g.*, Vertinsky & Rice, *supra* note 20, at 595-96; Erica Fraser, *Computers as Inventors – Legal and Policy Implications of Artificial Intelligence on Patent Law*, 13 SCRIPTED 305, 319 et seq. (2016); Blok, *supra* note 22, at 71; Vertinsky, *supra* note 41, at 502; Ralph D. Clifford, *Creativity Revisited*, 59 IDEA 25, 36 (2018); Abbott, *Everything Is Obvious*, *supra* note 4, at 8.

[107] PLOTKIN, *supra* note 3, at 101-105; Fraser, *supra* note 106, at 320-21; Blok, *supra* note 22, at 71; ANA RAMALHO, PATENTABILITY OF AI-GENERATED INVENTIONS: IS A REFORM OF THE PATENT SYSTEM NEEDED? 25 (2018); Konertz & Schönhof, *supra* note 51, at 404.

analogous to the claimed invention."[108] Two tests define the scope of so-called analogous prior art. First, a court may ask whether the art is from the same field of endeavor, regardless of the problem addressed. If the reference is not within the field of the inventor's endeavor, the court "may ask whether it is still reasonably pertinent to the particular problem with which the inventor is involved."[109] In other words, a reference will be "reasonably pertinent if its relevance is recognizable with the foresight of a person of ordinary skill."[110]

How does AI support change this game? With the increase in AI support comes an increase in available information and a broader horizon with regard to solutions and concepts that exist and are established as technical solutions in other fields. Inevitably, the concept of analogous art will extend, namely with regard to its transfer-of-knowledge branch concerning reasonably pertinent prior art in other fields. Indeed, as some academics explain, consideration of AI skills when determining PHOSITA capacities could ultimately lead us into a world in which everything would be obvious and thus unpatentable.[111] It appears, therefore, that the future AI-supported inventor may be trapped in a nightmare that Judge Learned Hand described long ago: "[A]s the law stands, the inventor must accept the position of a mythically omniscient worker in his chosen field. As the arts proliferate with prodigious fecundity, his lot is an increasingly hard one."[112]

b) The Utopian Fallacy: An Egalitarian Society of Human-Machine Inventors

What lies at the ground of the concept of an increasingly hybrid PHOSITA is the widely shared expectation that the use of AI will become "common" or "widespread" in the future and that it will be a "typical feature" of inventive activity.[113] Some commentators even

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[108] In re Klein, 647 F.3d 1343, 1348 (Fed. Cir. 2011).

[109] *Id.* at 1348.

[110] Sci. Plastic Prod., Inc. v. Biotage AB, 766 F.3d 1355, 1359 (Fed. Cir. 2014).

[111] *See, e.g.*, Vertinsky, *supra* note 41, at 502; Abbott, *Everything Is Obvious*, *supra* note 4, at 34 ("As the outputs of these inventive machines become routinized, however, they should no longer be inventive by definition.").

[112] Merit Mfg. Co. v. Hero Mfg. Co., 185 F.2d 350, 352 (2d Cir. 1950).

[113] *See, e.g.*, William Samore, *Artificial Intelligence and the Patent System: Can a New Tool Render a Once Patentable Idea Obvious?*, 29 SYRACUSE J. SCI. & TECH. L. 113, 128 (2013) ("once genetic programming becomes widespread"); Fraser, *supra* note 106, at 320 ("inventive technology typically used"); Blok, *supra* note 22, at 71 ("[U]se of a particular artificial intelligence application is or has become a 'normal' tool for routine work in the relevant field of technology"); Abbott, *Everything Is Obvious*, *supra* note 4, at 30 ("In certain industries, and for certain problems, inventive machines will become the norm.").

suggest that we may one day live in a world "populated by publicly available artificial invention genies" (with "genies" referring to AI applications).[114] This perspective is based on two assumptions. First, that the PHOSITA "has access to all knowledge and technology, including AI technology."[115] Second, that the actual skills and capacities of AI used to support human inventors will be more or less homogeneous. The ensuing conclusion is not surprising: the level of skills that the PHOSITA is expected to bring to the table will remain narrowly circumscribed. All of the hybrid human-AI inventors are pictured to be equipped with similar or identical applications and thus to be more or less similarly capable of inventing. In such a world, it will also be easy to determine the PHOSITA and her skills in practice.

Yet the egalitarian paradise of high-performance human-machine hybrids might be a daydream. This vision resembles the pre-Marxian society in Thomas More's sixteenth-century novel *Utopia*, where private property has been abolished and everybody is similarly endowed.[116] Its modern version, an AI Utopia, seems to have done away with the concept of exclusive possession. We may expect an industry of similarly skilled AI applications and wide open access to AI technology. In this paradise, no problems of a patent flood or thicket should come up. If AI capacities, and consequently the skills of the hybrid human-AI PHOSITA, evolve evenly and steadily upward, each new invention will have to "outperform" the PHOSITA in order to be patentable. The number of patents will then be kept in check quite naturally. Unfortunately, it is the assumption of "average" or "common" AI capacities, as well as of "usual" use of AI, that may turn out to be illusionary. It is particularly the aspect of AI uniformity and homogeneity that raises doubts.

First, it is questionable whether the kind of evolutionary technology used in current AI applications (e.g., genetic algorithms) will ever lead to an "average" level of AI performance. After all, a certain degree of indeterminacy is characteristic of this kind of technology.[117] Consequently, algorithmic invention processes are usually non-deterministic and not designed for repeatable results.

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[114] *Cf.* PLOTKIN, *supra* note 3, at 104 ("a world populated by publicly available artificial invention genies"); *id.* at 102, 108, 110, and 112 ("commonly used artificial invention technology").

[115] EUR. PATENT OFFICE, *supra* note 6, at E.14.

[116] Thomas More, *On the Best State of a Commonwealth and on the New Island of Utopia*, UTOPIA: LATIN TEXT AND ENGLISH TRANSLATION (George M. Logan, Robert M. Adams & Clarence H. Miller eds., 1995) (1516).

[117] *See also* Vertinsky & Rice, *supra* note 20, at 596; Samore, *supra* note 113, at 114; Blok, *supra* note 22, at 71; *see also* WIPO, *supra* note 12, at 6.

This built-in lack of constancy and reproducibility makes the idea of homogeneous AI capacities a mirage. Second, the development of AI does not depend solely on the quality of so-called training data.[118] In addition, the quality of AI output is a direct function of the *amount* of data input.[119] In light of an increasing consolidation of the data economy, the number of AI developers will be naturally limited. Accordingly, market consolidation may be the most imminent threat to the construction and maintenance of a vibrant and innovative AI ecosystem. The correlation between data access and AI innovation implies that due to a need for constant and massive data input—AI's "data consumption"—only actors with enough resources to either acquire or produce massive amounts of data will be expected to be able to develop powerful AI.[120]

Against this backdrop, it is questionable whether patent law will be sufficient to maintain an AI-innovation ecosystem. It may rather lose its regulatory impetus: not only is the development of AI highly dynamic and thus subject to rapid and constant change, but the industry actors' innovative potential is no longer based on the possession of technology alone. Instead, it is access to data that matters most. Yet since access to data is still largely private and exclusive (think of Google, Facebook, or Amazon), developers of data-driven AI technology do not have to fear much competition. Without access to data, both theft and legitimate copying of AI technology by a competitor is difficult if not impossible. Consequently, the dominant firms in the field may also hardly be willing to pursue formal patent protection. They simply do not need to. Instead, they may avoid the disclosure that comes with a patent application and will alternatively protect their AI technology as a trade secret.[121] Such a "withdrawal into darkness" may sooner or later transform the whole landscape of AI technology into a black box.[122]

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[118] *Cf.* Surden, *supra* note 20, at 106 ("[M]achine learning algorithms are only as good as the data that they are given to analyze.").

[119] *Cf.* Denis McCauley, *The Global AI Agenda*, MIT TECH. REV. INSIGHTS 14 (2020) ("AI models need data: the more a model ingests, the more accurate its analysis and the more likely that the decisions it prompts will hit the mark.").

[120] On these "masters of large-scale data acquisition," see Amanda Levendowski, *How Copyright Law Can Fix Artificial Intelligence's Implicit Bias Problem*, 93 WASH. L. REV. 579, 606 (2018).

[121] *See* PLOTKIN, *supra* note 3, at 206-10; Jeanne C. Fromer, *Machines as the New Oompa-Loompas: Trade Secrecy, the Cloud, Machine Learning, and Automation*, 94 N.Y.U. L. REV. 706, 720 (2019).

[122] On the phenomenon of algorithmic secrecy, see FRANK PASQUALE, THE BLACK BOX SOCIETY 6-8 (2015).

The consequence will be the development of a heterogeneous AI ecosystem. The AI technology landscape will be dominated by a small caste of data-owning and hence highly innovative actors. This is anything but an egalitarian world of equally (or similarly) skilled AI applications that are widely available. What is most problematic about this exclusive club of data and AI masters is that a general practice of disclosing the status quo of one's own AI technology and capacities will become the exception rather than the norm. We will have neither open competition at the technological level nor sufficient information on the status of this technology. Nor will we end up with a utopia of widely and freely accessible AI. Instead, uncertainty around AI capacities may become the patent examiners' nightmare.

c) Patent Examiners' Nightmare: The Enigma of the AI-Supported PHOSITA

In light of the impending concealment of AI capacities, "non-obviousness" in particular needs reconsideration. In general, applicants need not prove their entitlement to a patent. The examiner has the burden of proof for obviousness; she must grant the patent unless she can find some reason to reject it on those grounds.[123] This rule will prove fatal once support by AI becomes more common. Not only will information on the state of the art in AI technology be hard to get, but the determination of "average" AI capacities will be difficult, if not impossible.

At the moment, practice still reveals a considerable degree of confidence when it comes to the question of how to determine the skills of the PHOSITA in the AI era. It should be possible for a person skilled in the art—for example, any patent officer—to reproduce the results of AI inventiveness if they have access to the algorithm and the data for its training.[124] Academia is also rather optimistic, albeit a bit more concerned about details. As far as testing for AI capacities goes, commentators have suggested distinguishing between the skills of "hypothetical" and "specific" AI applications.[125] When testing a "hypothetical machine," they suggest conducting an inquiry into what the fictitious "average" AI application is capable of. More concretely, the idea is to assess what such an application would find to be obvious. Such an AI-specific, yet still hypothetical, non-obviousness test essentially resembles the

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[123] Dan L. Burk & Mark A. Lemley, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 14 (2009).

[124] *See* Ménière & Pihlajamaa, *supra* note 51, at 335; Abbott, *Everything Is Obvious*, *supra* note 4, at 34-35.

[125] Abbott, *Everything Is Obvious*, *supra* note 4, at 40-41.

standard approach for human-made inventions without AI support.[126] The second test variant, focusing on a "specific computer," is more concrete. Under this approach, the patent examiner should assess the capacities of AI applications that were most commonly used in the market at the time the invention was made. Hence, if IBM's Watson was the most commonly used AI at that time, the examiner would have to assess Watson's specific inventive skills with regard to the claimed invention in order to determine whether this invention's technical teaching and solution were obvious to Watson. Alternatively, as further suggested, the test could also be extended to more than one AI application or possibly even "all inventive machines being routinely used in a field or to solve a particular problem."[127]

But a closer look reveals that none of these approaches can overcome the problems of AI heterogeneity and non-transparency. First of all, information on the capacities of all AI used in the marketplace and the skills of a "hypothetical machine" will be scarce.[128] Moreover, the status of AI technology will not be generally known or ascertainable, nor will there exist private and independent expertise that the patent office or the courts could rely on to determine the "average" AI capacities. Indeed, if this technology is treated as a trade secret by the few actors who have power over data, practical hurdles for examiners and judges will be immense. Among the most pressing questions would be: How likely is it that the patent office would accept or that a court could engage an IBM engineer (as one of the rare AI specialists) to testify on "non-obviousness" issues in the case of an invention by Google's DeepMind? Could such testimony be trusted? In particular, could we expect objectivity, fairness, and non-collusion within the community of tech monoliths and their personnel?

Even if information on AI technology were widely available, questions would arise as to how to determine AI capacities. The issue lies in the selection and evaluation of different and possibly numerous AI applications. If too many different applications are in use, assessing "average" skills might be unfeasible. Of course, we may not expect too much competition or diversity in the field of AI applications. But even if only a small number of applications for a certain use or in a certain industry should co-exist, it would be far from clear how to assess the "average" across the marketplace. Any more selective solution would inevitably bring up issues of non-

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[126] *Id.* at 40 (2019); *see also supra* Section III.A.2.a.

[127] Abbott, *Everything Is Obvious*, *supra* note 4, at 41.

[128] *See supra* Section III.A.2.b.

discrimination and due process. In other words: Where is a cutoff to be made when the market of AI applications consists of a number of small competitors? What is the procedure for determining the relevant applications? How often does the "average" need updating? A cursory look shows that the number of problems may tend towards the impracticable.

Furthermore, the alternative test—focusing on a single outstanding AI application or on a few dominant or market-leading AI applications—would also be hard to implement. To start, if one wanted to focus on a market leader's application or a group of market leaders' applications, such as Google's DeepMind, IBM's Watson, or Amazon's SageMaker, disadvantage for the respective market leader or group would ensue. Any invention that was made by using these specific AI applications would have to be considered a result of the PHOSITA's *routine*. After all, once this specific application or selection of applications has been determined to reflect the "average" AI skill level, *by definition*, all inventive output would have to be considered obvious.[129] Even more problematic, however, may be the fact that taking the market leader's application (or the leading actors' applications) as the standard would exclude all other competitors' inventions if their AI applications are not at least as powerful as the "average" technology. In other words, if the patent office came to conclude that the leading application or applications represented the "average," any less powerful AI application would be considered unable to take an inventive step. Even though it might be possible that the probabilistic process of AI invention could yield a truly inventive outcome, the examiner's standard setting would disallow its recognition as non-obvious.[130] Ultimately, this would establish an insurmountable obstacle for anyone not at the cutting edge of AI innovation.

Moreover, a concrete testing of the capabilities of a single or a small number of "specific" AI applications would also be impractical. As has been suggested, the patent examiner would then have to undertake "test runs" concerning each claimed AI invention. If the inventing machine used to generate the emergent invention, given all information on relevant prior art, solved the technical problem underlying the claimed invention, it would have to be considered obvious and therefore non-patentable.[131] This, however, would pose insurmountable practical problems. First, this approach—like the attempt to determine an "average" level of AI

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[129] Abbott, *Everything Is Obvious*, *supra* note 4, at 40.

[130] For the probabilistic nature of AI inventiveness, see *supra* Part I.

[131] Abbott, *Everything Is Obvious*, *supra* note 4, at 41.

skills—would suffer from the problem of selecting relevant AI applications. Second, it is unrealistic to hope that a practice of "test runs" could be established easily. While the patent examiner may use the applicant's specific AI application from which the claimed invention has emerged, it would be hard or impossible for courts to get access to the relevant AI. A court may subpoena Google, for instance, to unveil its AI technology underlying DeepMind in patent litigation to which Google is a party. But what should the court do if Google is not a party to the lawsuit?[132]

Finally, the most problematic aspect of a test-run approach is the probabilistic nature of AI inventiveness and the randomness of its results.[133] Of course, the conceptual design and structure of an algorithm may be disclosed, and the training data could be made available. But this would not guarantee that the evolutionary mechanics and the output of the algorithmic search can be understood or explained. Inventive AI inevitably yields varying results depending on its training data and the path of its aleatory-algorithmic evolution. Therefore, it may be extremely difficult to determine "obviousness," even through test runs for specific AI applications. After all, each test run may yield a different outcome and solution. Ultimately, the test for obviousness would be nothing but a game of chance.

3. Preliminary Conclusions

Current patent doctrine is unable to adequately respond to either autonomous AI inventions or the supportive use of inventive AI applications. For scenarios of autonomous AI invention, in which AI provides the solution *without* significant human-made contribution, the issue is how to treat "inventions without an inventor." The anthropocentric approach of current patent law is not only outdated but also provokes distortions in the system—falsification of the patent register, confusion with regard to inventor determination, upsetting the patent function of fostering innovation. Additionally, as human inventiveness is increasingly supported by AI, the paradigm of the PHOSITA—namely her skills—will progressively be determined by AI capacities. These capacities will also determine the threshold for patentability, notably with regard to issues of novelty and non-obviousness. Yet since the data economy steers toward industry consolidation and ever more restricted access to data, transparency on AI capacities may be wishful thinking. If left unregulated, these tendencies may make it impossible to administer the patent system entirely.

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[132] *Id.* at 41 n.184.

[133] *See supra* Part I.

B. Legal Policy and Teleological Foundations

The obsolescence of these classic paradigms points to the need for changes to the patent system. Before suggesting specific doctrinal modifications, however, it is necessary to examine the foundations of patent protection. Can the patent system still perform its traditional functions in an age of AI inventiveness? As a closer look at patent policy reveals, the patent system is far from defunct. But several changes with respect to market and industry structure are necessary.

1. Classic Patent Theories: A Tale of Economics

Unlike copyright law, patent protection is not deeply founded on legal-philosophical theory like natural law or personality protection.[134] Accordingly, the transition to a more AI-based landscape of inventing is seldom discussed in light of Lockean or Hegelian concepts. Algorithms are not considered to have natural rights in the results of their production processes. Nor do they have a personality that could be protected.[135] Policy analysis instead focuses on the economic model of patent protection.

This model took hold in the debate on patent policies long ago.[136] Patent rights are granted to foster inventive activity. In other words, the investments necessary for inventions can be expected to be made only if pecuniary incentives are sufficient. The central issue is how to balance the advantages and disadvantages of rights exclusivity and access to information.[137] This basic correlation

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[134] *See, e.g.*, LIONEL BENTLY ET AL., INTELLECTUAL PROPERTY LAW 397 (5th ed. 2018); *see also* Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287, 341 (1988) ("In inventing the light bulb, Edison searched for the filament material that would burn the longest, not a filament that would reflect his personality."); 6 THOMAS JEFFERSON, *Letter to Isaac McPherson, August 13, 1813*, *in* THE PAPERS OF THOMAS JEFFERSON: RETIREMENT SERIES, MARCH TO NOVEMBER 1813, 379, 383 (J. Jefferson Looney ed. 2009) ("Considering the exclusive right to invention as given not of natural right, but for the benefit of society, I know well the difficulty of drawing a line between the things which are worth to the public the embarrassment of an exclusive patent, and those which are not.").

[135] *See, e.g.*, Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1107; Blok, *supra* note 22, at 73; Yanisky-Ravid & Liu, *supra* note 60, at 2243; SHEMTOV, *supra* note 6, at 23.

[136] For U.S. law, see, for example, DONALD S. CHISUM, PRINCIPLES OF PATENT LAW 58-81 (3d ed. 2004). For Europe, see, for example, BENTLY, *supra* note 134, at 397-399; Ansgar Ohly, *"Patenttrolle" oder: Der patentrechtliche Unterlassungsanspruch unter Verhältnismäßigkeitsvorbehalt?*, 57 GRUR INT. 787, 790 (2008).

[137] *See, e.g.*, Peter S. Menell & Suzanne Scotchmer, *Intellectual Property Law*, *in* 2 HANDBOOK OF LAW AND ECONOMICS, 1473, 1476-78 (A. Mitchell Polinsky & Steven Shavell eds., 2007).

between exclusive rights and investment is also recognized, at least in principle, in the debate on the protection of emergent inventions. The issue is whether the scope of investment and the level of AI innovation depend on protection for AI-generated output. As it seems, the bulk of scholarly analyses take a rather skeptical stance toward the question of whether emergent inventions should be protected.[138] Indeed, some critical voices expressly argue that AI programmers and manufacturers will be more than adequately rewarded by protection of their AI applications *as such* (under patent or copyright law). Consequently, no *additional* rights should be granted—particularly not for emergent inventions.[139] Yet such an apodictic denial of protection is misguided. A closer look at the characteristics of AI industries helps explain why:

First of all, it is important to determine the exact "product" or "commodity" and the specific marketplaces at issue in cases where AI generates inventive output. In this regard, it is essential to see the correlation between the value of the *AI as such* (the application) and the value of the *inventions created by AI* (the application's output). The AI's value depends on protection of AI-generated output. In other words, if only the AI application as such (the apparatus and software) is to be protected against infringement, this may lead to an underproduction of such applications. This is due to the fact that, without legal protection for emergent inventions, the AI's creator usually has no or only limited opportunities to realize the total value of her innovation. An example illustrates this point: Think of an AI application that autonomously discovers or develops pharmaceutical substances. If these emergent inventions are not protected against copying, the AI's developer can only sell her application (the algorithm or a technical apparatus in combination

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[138] See, e.g., Karl F. Milde, *Can a Computer Be an Author or an Inventor*, 51 J. PAT. OFF. SOC'Y 378, 390 (1969); Abbott, *I Think, Therefore I Invent*, supra note 4, at 1104; Fraser, *supra* note 106, at 325 et seq.; Blok, *supra* note 22, at 72; Schuster, *supra* note 79, at 1976; Vertinsky, *supra* note 41, at 507-08; Hetmank & Lauber-Rönsberg, *supra* note 38, at 579-80; Konertz & Schönhof, supra note 51, at 404-05; Abbott, *Everything Is Obvious*, *supra* note 4, at 48; Joel Nägerl, Benedikt Neuburger & Frank Steinbach, *Künstliche Intelligenz: Paradigmenwechsel im Patentsystem*, 121 GRUR 336, 340 (2019).

[139] *See, e.g.*, SHEMTOV, *supra* note 6, at 24. For similar arguments against copyright protection for AI-generated creative works, *see, e.g.*, Pamela Samuelson, *Allocating Ownership Rights in Computer-Generated Works*, 47 U. PITT. L. REV. 1185, 1207 (1986); Robert Yu, *The Machine Author: What Level of Copyright Protection Is Appropriate for Fully Independent Computer-Generated Works?*, 165 U. PA. L. REV. 1245, 1261 (2017); Victor M. Palace, *What if Artificial Intelligence Wrote This? Artificial Intelligence and Copyright Law*, 71 FLA. L. REV. 217, 236 (2019).

with the algorithm). Without an opportunity to also realize the values created by her AI application (the pharmaceutical substances), the market price she can demand for this application will be rather low. After all, the buyer of the AI will not be able to profit from the application's inventiveness and productivity if the AI's output is freely available and can be copied by anybody. In economic terms, this means that the major benefit of the AI application—namely the emergent inventions it produces—remains unpaid. It is as a so-called "spillover" externality:[140] it creates value for third parties that its creator cannot internalize, even if she is the one who undertook the investment and contributed the creative input. Consequently, the creator cannot fully appropriate the benefits of her AI and of its output. This ultimately means that incentives to create such AI will be limited. On the other hand, if the AI creator can appropriate the value of emergent inventions (i.e., if the pharmaceutical substances are patentable), she will have incentives to produce more inventive AI applications of this kind. Accordingly, AI-emergent output will also increase.

From this point of view, we can see that a rewarding scheme that is limited to an exploitation of the AI as such may provide too little profits and incentives to developers. The appropriation of values embodied in AI-generated output is thus essential to establish an innovation-friendly ecosystem. Ultimately, we must conclude that the marketplace for AI applications and their emergent inventions must be considered to be inseparably connected. An optimal level of AI production will be achieved only if the developer is given an opportunity to appropriate the value of the combined "product"—comprising both the AI application as such and its production in downstream markets.[141]

Of course, recourse to the formal economic model alone will not allow for an exact calibration of the scope of protection for emergent inventions. The AI industry is not only highly dynamic but also still in its infancy, with far too little research having been conducted that would allow for reliable and detailed answers. Determination of the exact scope of protection may ultimately require an empirical basis. But a fundamental correlation between protection levels and investment can be explained without extended market analyses: as a general rule, the more complex and elaborate the inventive process and the resulting products, the less we can rely on the market mechanism and the forces of competition to provide

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[140] Brett M. Frischman & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 262 (2007).

[141] Schuster, *supra* note 79, at 1976-78; Dornis, *supra* note 42, at 36-39.

for an optimal climate of investment and, accordingly, a perfect level of inventive activities.[142] This relationship has been extensively analyzed with regard to the pharmaceutical and biotech industries. In these sectors, patent rights are essential because product development subsequent to the actual invention—in particular, the regulatory approval of a pharmaceutical or medicinal substance—is costly and requires substantial additional investment.[143] The same applies to the movie and computer-game industries, where the need to regain immense up-front investments is also particularly pressing.[144] The situation is no different in the AI industry. The design and development of inventive AI applications typically also requires large sums of up-front investment.[145] One example is IBM's first (and, admittedly, still rather mundane) steps in the development of its flagship AI, Watson, used to win the TV show "Jeopardy!" in 2011. It took three years of intense research and development by a core team of more than twenty researchers to form the artificial "Jeopardy!" champion from scratch.[146] Today, a significant amount of time and immense investments later, Watson is set to master a plethora of much more practical, productive, and even life-changing endeavors, including in financial planning, pharmaceutical research, medical treatment, and genetic profiling.[147] In other words, as in the pharmaceutical industry and in the movie and game production sectors, it would be foolish to hope for the spontaneous evolution of "amateur" innovation and an ecosphere of low-investment development of AI. Rather, denying protection for emergent inventions risks making re-appropriation of the innovators' investments difficult or impossible. Inevitably, a complete denial of protection for emergent inventions would waste potential for innovation.

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[142] *See generally* Dornis, *supra* note 42, at 38.

[143] Burk & Lemley, *supra* note 123, at 38-41; *see also* Richard Posner, Economic Analysis of Law 407-08 (9th ed. 2014).

[144] Mark A. Lemley, *IP in a World Without Scarcity*, 90 N.Y.U. L. REV. 460, 496 (2015).

[145] *See, e.g.*, Hattenbach & Glucoft, *supra* note 22, at 50; Massimo Maggiore, *Artificial Intelligence, Computer Generated Works and Copyright*, *in* NON-CONVENTIONAL COPYRIGHT 382, 396 (Enrico Bonadio & Nicola Lucchi eds., 2018); Dornis, *supra* note 42, at 36.

[146] David Ferrucci et al., *Building Watson: An Overview of the DeepQA Project*, 31 AI MAGAZINE 59, 59 (2010).

[147] For some examples, see Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1090-91; Abbott, *Everything Is Obvious*, *supra* note 4, at 22, 32-33.

2. A Fatal Combination: Data Monopolization and AI Innovation

The economic model of patent protection covers the micro-perspective on individual actors' incentives. In order to determine whether a system of individual-rights protection is functional in the first place, however, we need a more extended view. Under a macro-perspective it becomes obvious that an innovation-friendly AI ecosystem requires more than protection for emergent inventions—it fundamentally demands an environment of open data marketplaces.

AI innovation depends directly on data consumption. Without large amounts of data, AI training as we know it is impossible. Hence, access to and possession of data are the ultimate preconditions for AI innovation.[148] Since AI innovation is so closely intertwined with data possession, the AI industry is on the road toward consolidation. In other words, it is the large data-owning tech companies that dominate the field of AI.[149] Indeed, powerful AI applications may easily attain data possession and dominance. This is famously illustrated by the example of Google's search algorithm that laid the foundation not only for the company's dominant position in the market for search engines, but also set the ground for the company's access to a wealth of data.[150] Furthermore, powerful tech companies are increasingly appropriating the innovative potential of smaller competitors by means of corporate acquisition, thereby accelerating the emergence of an asymmetrical market. Whenever a business idea offers the prospect of creating a successful product, the competitor will be bought.[151] Indeed, the AI industry has already reached a significant level of consolidation, and the trend is growing stronger. This is confirmed by a look at recent patent registration numbers: the group of applicants and owners in the patent categories of machine learning and neural networks

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[148] *See supra* Section III.A.2.b.

[149] *See, e.g.*, Ed Stacey, *Emerging AI Will Drive The Next Wave Of Big Tech Monopolies*, FORBES (28 Oct. 2020), https://www.forbes.com/sites/edstacey/2020/10/28/emerging-ai-will-drive-the-next-wave-of-big-tech-monopolies/?sh=4d120e825512.

[150] *See also* Brenda M. Simon & Ted Sichelman, *Data-Generating Patents*, 111 N.W.U. L. REV. 377, 393 (2017); Clark D. Asay, *Artificial Stupidity*, 61 WM. & MARY L. REV. 1187, 1196 (2020).

[151] *Cf.* William Vorhies, *Comparing AI Strategies: Vertical vs. Horizontal*, DATA SCI. CENT. (July 17, 2018) ("[A]ll those guppies ended up swallowed by whales and are now just features or products, not world changing businesses.").

consists of members of the leading industry players only—IBM, Microsoft, Google, and the like.[152]

Behind this consolidation tendency looms a transnational imbalance. In the global race for AI dominance, it is likely that some regions and countries will take the lead.[153] This depends in part on different approaches to regulation and governance of the data economy. Some regions, such as the European Union, may establish more individual-rights-based AI policies, namely with regard to data protection. Consequently, there may arise a world of the "data rich," mostly in Silicon Valley and China, and a world of the "data poor," mostly in Europe. The self-chosen data proletarianism inevitably also comes with the downside that pioneering AI progress might take place elsewhere. A transnationally imbalanced level of innovation may ensue. Since datafication fosters technological leadership, this asymmetry would naturally follow from what has been criticized as "data colonialism"—the exploitation of human beings through data.[154] In the end, we may not witness a patent flood, but rather patent rights holders will be found largely among the most unscrupulous and data-colonializing tech companies and nations.[155]

Some might expect the downsides of market imbalance and monopoly to be offset by the benefits of innovation that otherwise—i.e., without AI inventions—would have never (or much later) been developed.[156] In its open neglect of the harmful effects of intellectual property monopolies, this perspective somewhat resembles the indulgent attitude of economists from previous centuries.[157] Yet it also fails to recognize the importance of industry

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[152] Michael Webb, Nicholas Bloom, Nick Short & Josh Lerner, *Some Facts of High-Tech Patenting* 14 et seq. (Stanford Inst. for Econ. Policy Research, Working Paper No. 18-023, 2018).

[153] *See, e,g.*, *Artificial Intelligence for Europe*, at 2, COM (2018) 237 (Apr. 25, 2018) at 2 ("fierce global competition"); *id.* at 5 ("One of the main challenges for the EU to be competitive is to ensure the take-up of AI technology across its economy. European industry cannot miss the train.").

[154] On the phenomenon of "data colonialism," see Nick Couldry & Ulises Mejias, *Making Data Colonialism Liveable: How Might Data's Social Order Be Regulated?*, 8 INTERNET POL'Y REV. 1 (2019).

[155] For a rather dark vision of the future balance of AI powers, see generally KAI-FU LEE, AI SUPERPOWERS – CHINA, SILICON VALLEY, AND THE NEW WORLD ORDER (2018).

[156] Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1119-20; Abbott, *Everything Is Obvious*, *supra* note 4, at 50-51.

[157] *Cf.* ADAM SMITH, LECTURES ON JURISPRUDENCE 83 (R. L. Meek, D.D. Raphael & P.G. Stein eds., 1978) (1762) ("[T]he inventor of a new machine or any other invention has the exclusive priviledge of making and vending that invention . . . as a reward for his ingenuity . . . . These . . . priviledges therefore, as they can do

structure for the innovative potential of a marketplace.[158] It is essential to remember that large and powerful players are usually less innovative than their smaller competitors.[159] The market's potential for innovation therefore decreases with an increase in consolidation. In order to establish (and maintain) a vivid and innovative AI ecosystem, it is therefore indispensable to attempt to avoid the negative consequences of the fatal marriage between data access and AI innovation.

Against this backdrop of industry consolidation and transnational market asymmetry, it is clear that patent reform alone may not suffice. What is needed is a macro-regulatory framework for the data economy. Since access to data is key for innovation, data sharing is essential. Given that we currently lack a culture and practice of sharing in this regard, lawmakers may need to establish one. Of course, the need for such regulation is not uncontested. Legal systems that subscribe to possessor-friendly policies and less individual-rights-oriented terms of data utilization and commercialization seem unconcerned about the sharing of and access to private businesses' data portfolios. The United States—recent agitation around the necessity to tame Big Tech companies by means of antitrust regulation aside[160]—still largely neglects side-effects of data dominance, in particular with regard to AI innovation. A different stance prevails in the European data poorhouse. As just described, fears of falling prey to other nations' data and innovation colonialism loom large. It is thus not much of a surprise that the European Commission has recently presented a "European Strategy for Data" calling for substantial regulation and governance of the

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no harm and may do some good, are not to be altogether condemned. But there are few so harmless."); *see also* JEREMY BENTHAM, A MANUAL OF POLITICAL ECONOMY 71 (John Bowring ed. 1839) ("An exclusive privilege is of all rewards the best proportioned, the most natural, and the least burthensome. It produces an infinite effect, and it costs nothing.").

[158] *Cf.* Tim Wu, *Taking Innovation Seriously: Antitrust Enforcement If Innovation Mattered Most*, 78 ANTITRUST L.J. 313, 315 (2012) ("There is good reason to think that industry structure is at least as important for innovation as the intellectual property laws.").

[159] *See, e.g.*, Peter Lee, *Innovation and the Firm: A New Synthesis*, 70 STAN. L. REV. 1431, 1491-92 (2018); *see also* Asay, *supra* note 150, at 1237 ("Smaller firms are typically more nimble and innovative than larger incumbents."); *see also* OLIVER E. WILLIAMSON, MARKETS AND HIERARCHIES: ANALYSIS AND ANTITRUST IMPLICATIONS 199-203 (1975).

[160] *See, e.g.*, Subcomm. on Antitrust, Commercial & Admin. Law, H. Comm. on the Judiciary, 116th Cong., Investigation of Competition in Digital Markets (2020); *see also* Shira Ovide, *Big Tech's Backlash Is Just Starting*, N.Y. TIMES (July 30, 2020), https://www.nytimes.com/2020/07/30/technology/big-tech-backlash.html.

data economy.[161] The strategy is tailored in part to allow European businesses to catch up with their data-rich competitors from the United States and China. As the European Commission explains, "Currently, a small number of Big Tech firms hold a large part of the world's data."[162] Among the negative consequences it identifies is that "[t]his could reduce the incentives for data-driven businesses to emerge, grow and innovate in the EU."[163] In order to reverse the perceived imbalance, the Commission intends to propose legislation to lay a general framework for establishing broad access to public and privately held data.[164] On the regulatory level, antitrust will be a major instrument. In addition, the Commission envisages the creation of sectoral data pools ("data spaces") and infrastructural preconditions to facilitate open-access solutions.[165] The European Parliament's Committee on Legal Affairs has followed suit.[166]

The aim to encourage and, if necessary, obligate private businesses to share their data as a "public good" may introduce the potential for transnational conflict.[167] It will be telling to see how policymakers in other parts of the world—as well as the incumbent data and tech giants—respond to the new European way of "nudged" (read: forced) data sharing. One may doubt the legitimacy and effectiveness of such data collectivization. Yet at least with respect to creating an innovative AI ecosystem, the focus on a more access-oriented data environment points in this direction.

Finally, in addition to regulation of data marketplaces, patent law remains an essential instrument to maintain the microstructures of an innovation-friendly AI ecosystem. In this respect, it must be noted that patent protection can strengthen smaller actors who compete with large ones.[168] After all, a functioning patent system

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[161] *A European Data Strategy*, COM(2020) 66 final (Feb. 19, 2020).

[162] *Id.* at 3.

[163] *Id.* at 3.

[164] *See, e.g.*, EU Commission, *Proposal for a Regulation of the European Parliament and of the Council on European data governance (Data Governance Act)*, 25 Nov. 2020, COM(2020) 767 final, 2020/0340(COD).

[165] *A European Data Strategy*, *supra* note 161, at 14-18, 25; EU Commission, *Proposal for a Regulation of the European Parliament and of the Council on European data governance (Data Governance Act)*, 25 Nov. 2020, COM(2020) 767 final, 2020/0340(COD).

[166] Report on Intellectual Property Rights for the Development of Artificial Intelligence Technologies, Eur. Parl. Doc. 2020/2015(INI), A9-0176/2020, 2 Oct. 2020, at 13.

[167] *Cf. A European Data Strategy*, *supra* note 161, at 6-7 (on the public-good paradigm of data possession).

[168] *See* Asay, *supra* note 150, at 1196 (explaining that a more effective appropriability regime can support smaller competitors in the marketplace).

facilitates the appropriation of upfront investment, namely by means of licensing, but also with regard to other ways of marketing innovative products.[169] Without patent protection, smaller actors are at a considerable disadvantage, since they typically lack resources that are required for rights enforcement in general but also for alternative protection, such as trade secrets.[170] Accordingly, the degree of vertical integration in an industry is usually inversely proportional to the strength of intellectual property protection.[171] With improved protection mechanisms, namely through patents, the pressure on smaller competitors to integrate vertically will decrease. For the AI industry at least, the granting of intellectual property rights can serve to maintain competitive structures in the market and to increase the potential for innovation.[172]

3. A Brave New World: Artificiality and Intellectual Dilution

Last but not least, we come full circle to Čapek's *Rossum's Universal Robots*. As with the mass production of Robots in his melodrama, the phenomenon of AI inventiveness will eventually substitute human inventors as well as human-made inventions. This will not happen by means of revolt and war. But the effects are no less dystopian. As we have seen, the process is a creeping one: over time, we will see an ever-larger amount of artificial inventions—artificially invented products will fill our warehouses, streets, hospitals, schools, universities, and households, and thereby ultimately determine our everyday reality. It is this kind of artificialization in particular that must be considered problematic.

Most notably, artificial inventiveness may reduce the demand for human inventors.[173] In fact, fears of job loss have always accompanied the emergence of new technologies. Yet it is not possible to predict exactly where those losses will be. We may witness a "refocusing" of human activities: the emergence of inventive AI may help human inventors shift their ingenuity to other fields and more specific aspects of research. Most likely, as a consequence of AI applications taking over routine-based tasks, humans may be able to focus their energy on more high-level and

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[169] *See, e.g.*, Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451, 470-71 (2004).

[170] Asay, *supra* note 150, at 1242.

[171] *See, e.g.*, David J. Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy*, 15 RES. POL'Y 285, 296, 300-02 (1986); Lee, *supra* note 159, at 1488.

[172] Asay, *supra* note 150, at 1215 and 1235-37.

[173] Vertinsky, *supra* note 41, at 508.

abstract problem solving.[174] Ultimately, this may create more rather than fewer opportunities for useful and valuable human work.[175] Alarmism does not seem appropriate. Furthermore, we must acknowledge that *patent* policies are not designed to regulate *labor* markets or to alleviate the *socioeconomic consequences* of technological disruptions. The Queen may have rejected the grant of a patent for a then-new stocking frame knitting machine in the sixteenth century by open reference to the risk that human knitters might be impoverished,[176] but modern patent doctrine is no place to establish similar policies of social safeguarding and security. The subject matter of patent law is and remains the trade-off between inventors' exclusive rights in inventions and consumers' access to those inventions.

Yet the effects of "artificial inventions" on the contents and, ultimately, on the theoretical understanding of the state of the art may prove detrimental—at least in the long run. Of course, we might expect the emergence of new types of inventions and discoveries, maybe so elaborate and unexpected and beyond human understanding that the future will become one big bang of knowledge.[177] But we might also expect the opposite. After all, if the state of the art is to be increasingly shaped by artificial actors and artificial inventions, issues of content and quality will come to the surface. This does not primarily concern whether inventive AI acts illegally or unethically. It is the simple fact that inventions are *artificial* that is problematic, especially since our theoretical understanding of the state of the art will inevitably deteriorate over time.

The phenomenon of discovery in the sense of "first answers, then explanations" is well known. Acetylsalicylic acid—the major ingredient in modern-day aspirin—was used by shamans in early cultures as a remedy against fever and pain. [178] Its industrial manufacture started in the nineteenth century; a patent was granted in 1898. However, the substance's actual, physiobiological effects on the human body were not described until more than seventy years later.[179] This unexplained use of effects without a theoretically

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[174] Plotkin, *supra* note 3, at 188.

[175] Abbott, *I Think, Therefore I Invent*, supra note 4, 1119.

[176] She allegedly said to the inventor William Lee: "Consider thou what the invention could do to my poor subjects. It would assuredly bring them to ruin by depriving them of employment, thus making them beggars." LUKE DORMEHL, THINKING MACHINES 135 (2017).

[177] *See, e.g.*, Vertinsky, *supra* note 41, at 494.

[178] *See, e.g.*, Gerald Weissman, *Aspirin*, 264 SCIENTIFIC AMERICAN 84 (1991).

[179] *Id.*

founded understanding has been described as an accumulation of "intellectual debts."[180] With an increase in AI-based inventions, debts of this kind will grow. As we have seen, algorithms work through brute-force computing, almost always in unexpected ways. They may find relationships in large chunks of data, but (at the moment) they will never produce a theoretical description or model of causalities.[181] Artificial inventions will thus yield results in the sense of *unexplained* discoveries—and making use of this kind of output will amass intellectual debts.[182] Even if the use of a single invention of this kind may not raise concerns at first, it is the combination of many such debts that carries a risk. Over time, algorithmic inventions will increasingly resort to prior algorithmic inventions—in other words, algorithms will invent "on the shoulders of" other algorithms. If we lose our understanding of theoretical relationships at the first level, how much more uncertainty will arise with regard to the artificial results that algorithms will create in the future?[183]

The consequences do not require a great deal of imagination. If we know only whether something works, but not why and how, the risks grow exponentially with each new wave of algorithmic invention. The more we rely on seemingly superior AI skills, the more difficult it becomes to explain foundations and make predictions. Incidental malfunctions of algorithmic aircraft control systems or so-called flash crashes in artificially managed stock markets are evidence that the algorithmization of modern life will become progressively uncontrollable.[184] This intellectual artificialization will ultimately dilute our understanding of the world and how it works. Indeed, we will increasingly live in a dream-like state where things simply work and we cannot ask how or why. At least in the long run, we have to ask whether the patent system will

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[180] Jonathan L. Zittrain, *The Hidden Costs of Automated Thinking*, NEW YORKER (July 23, 2019), https://www.newyorker.com/tech/annals-of-technology/the-hidden-costs-of-automated-thinking; *see also* PLOTKIN, *supra* note 3, at 78-82.

[181] *See supra* Part I.

[182] For a Nobel Laureate's perspective on algorithmic enzyme and protein research, see Frances H. Arnold, Zachary Wu, S.B. Jennifer Kan, Russell D. Lewis & Bruce J. Wittmann, *Machine Learning-Assisted Directed Protein Evolution with Combinatorial Libraries*, 116 PNAS 8852, 8857 (2019) ("By providing an efficient estimate . . . , machine learning models are able to leverage the information from limited experimental resources to model proteins, without the need for a detailed understanding of how they function.").

[183] Zittrain, *supra* note 180.

[184] *Id.*

still be able to function as a repository of generally accessible and, most importantly, *actual* knowledge and information.

4. Preliminary Conclusions

Patent law has not lost its justification in the AI era. In light of the characteristics of AI innovation, it is essential to create prospects for the recoupment of investments. This requires granting protection for emergent inventions. Yet the major threat to AI innovation lies beyond the reach of patent law. Consolidation in the AI industry requires specific regulation and governance of data access and possession. A level playing field with respect to data access is the precondition of a functioning AI ecosystem. Only on this basis can patent law work as a moderator of competitive innovation and, above all, remain practically manageable. Finally, it remains to be seen whether the increasing artificialization of invention processes and of the landscape of inventions will decompose our theoretical understanding of the state of the art.

C. Implementation: A Roadmap for Patent Doctrine and Practice

The most pressing issue for reform is a reconceptualization of patent law's anthropocentric foundation. More concretely, this requires doing away with current doctrine's first-to-recognize approach, which is inconsistent at a theoretical level and unwieldy at a practical one. Instead, the output in scenarios of an "invention without an inventor"—i.e., emergent inventions—must be principally considered worthy of protection. In light of relevant policies, however, statutory regulation need not establish full-fledged patent protection. Rather, a lower-level protection regime may suffice to establish a well-balanced incentive. In any event, reform must establish legal certainty with respect to the most important practical issues—the nature of rights, the scope and duration of protection, and the initial holder of the entitlement.

1. Gap Filling: The "Emergent Invention"

As our look at patent doctrine and policy foundations has shown, the anthropocentric conception of the inventor paradigm has become obsolete. Current patent doctrine does not offer a well-versed instrument for gap filling. The first-to-recognize approach is both doctrinally and practically unconvincing.[185] Furthermore, intellectual property law in general does not provide for alternative means of protection for emergent inventions. The only fallback option is unfair competition law and, more specifically, the misappropriation doctrine. As a closer look unveils, however, this doctrine is not viable in practice.

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[185] *See supra* Section III.A.1.

Of course, unfair competition law and misappropriation doctrine largely serve to fill gaps in the architectural structure of statutory intellectual property. Yet gap filling is delicate and must be handled with maximum care. Indeed, the Supreme Court fiercely protects federal patent policy against interference by state lawmakers and courts.[186] The concern is that an overly generous handling of misappropriation doctrine will lead to a circumvention of the statutory limitations of intellectual property rights. The Restatement (Third) of the Law of Unfair Competition succinctly explains this aspect:

> Achieving a proper balance between protection and access is often a complicated and difficult undertaking. Because of the complexity and indeterminacy of the competing interests, rights in intangible trade values such as ideas, innovations, and information have been created primarily through legislation.[187]

Necessarily, as the Restatement's rapporteurs continue, "[m]any potential applications of the misappropriation doctrine are preempted by federal patent and copyright law."[188] In essence, this means that whenever the federal patent lawmaker has regulated an issue, it must not be second-guessed by state lawmakers or courts. As a result, misappropriation doctrine is generally not a viable option for creating protection, since the statutory architecture is designed to offer freedom of competition and, hence, allow for imitation.

At first sight, of course, this gatekeeping doctrine may not be very disconcerting for those arguing in favor of a misappropriation claim when an emergent invention has been "appropriated," for example, by the use of a pharmaceutical formula for reproduction. After all, when writing the law, patent lawmakers were not aware of the possibility that one day "artificial inventors" might do the job of humans, and thus they cannot be considered to have intentionally leaned *against* the protection of emergent inventions when maintaining patent law's anthropocentric paradigm.[189] Accordingly, as one may conclude, a gap in the patent system—as a precondition for misappropriation doctrine to be applied—cannot be denied.

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[186] *See, e.g.*, Bonito Boats v. Thunder Craft Boats, 489 U.S. 141, 151 (1989) ("The offer of federal protection from competitive exploitation of intellectual property would be rendered meaningless in a world where substantially similar state law protections were readily available. To a limited extent, the federal patent laws must determine not only what is protected, but also what is free for all to use.").

[187] Restatement (Third) of the Law of Unfair Competition § 38, cmt. b (1995).

[188] *Id*. at § 38, cmt. e.

[189] *See* Milde, *supra* note 138, at 379.

Yet it is the courts' general and deep-seated hesitation to extend intellectual property protection by means of misappropriation prevention that makes the doctrine a mediocre candidate for gap filling. Thus far, as far as my research has revealed, the protection of AI-generated inventions has not been analyzed in light of unfair competition prevention—whether in practice or in academic debate.[190] And such scarcity is the problem: the void of precedents, combined with the fact that the economic foundations of AI inventiveness are still debated,[191] makes it unlikely that the courts will resort to unfair competition law. In principle, if an emergent invention is exploited—e.g., by reproduction of an AI-invented pharmaceutical substance—one may securely assume a case of "appropriation" of commercial value. Yet to make this a case of "mis"-appropriation, a qualitative requirement of "unfairness" must be fulfilled. This, however, may prove to be an obstacle seldom overcome. In fact, the doctrine's bad reputation for being an all-too-easily-available means of judicial extension of market power stands in the way of protecting emergent inventions.

The doctrine of misappropriation can be described as a common-law instrument that protects against copying. Its foundation stems from the Supreme Court's 1918 *International News Service v. Associated Press* decision.[192] The International News Service (INS) copied the Associated Press's New York bulletins about World War I and immediately transferred this "appropriated" news to its West Coast affiliates and subscribers, often earlier than the Associated Press (due to the difference in time zones). The plaintiff raised no claims of copyright infringement or theft of trade secrets. The only allegation was misappropriation. The Supreme Court had no issue with the public's right to copy the uncopyrighted news reports. But it held that—vis-à-vis INS as a competitor—the Associated Press had a "quasi-property right" in its hot news. Accordingly, the INS's copying was enjoined as what the Court termed an unfair reaping of "the harvest of those who have sown."[193]

The scope of the doctrine has been contested ever since. Courts have regularly referred to *INS*, but the doctrine was never

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[190] Only a few analyses of artificial creativity and its protection under unfair competition doctrine exist. These analyses concern only AI-generated *creative* products (i.e., "works" of authorship), not technical teachings and inventive output. *See, e.g.*, Yu, *supra* note 139, at 1266-68; Dornis, *supra* note 42, at 25-29.

[191] *See supra* Section III.B.1.

[192] 248 U.S. 215 (1918).

[193] *Id.* at 239-40.

incorporated into the common law of the states.[194] Not only are judges eager to limit each case to its specific facts,[195] but they never tire of referring to the requirement of "competition" between the parties. In other words, the plaintiff and defendant must actually be competing in the marketplace. Mere unjust enrichment of the defendant will never suffice.[196] In the same vein, the Restatement (Third) of the Law of Unfair Competition outlines numerous limitations to the doctrine: absent elements of trade-secrecy invasion, passing-off, right-of-publicity, or common-law copyright violation, no "general rights against the appropriation of information and other intangible trade values" exist.[197] In short, beyond intellectual property protection, gap filling is the *absolute* exception.[198] This approach also dominates scholarly debate. The most influential academic analyses (namely those by Judge Posner) have suggested limiting the doctrine to a bright-line test of whether a defendant's conduct of copying the plaintiff's product and value is "likely to kill the goose that lays the golden eggs."[199] In other words, apart from the most dramatic cases in which a plaintiff is at risk of being fully displaced from the marketplace by the defendant's copying and appropriation, no claim is likely to succeed.

It is evident that the protection of emergent inventions under misappropriation doctrine will be an uphill battle—or, rather, it will find itself in a cul-de-sac before it even starts its courtroom journey. Even though agreement seems to exist that AI innovators generally warrant at least some degree of protection for their AI applications'

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[194] *See* Douglas G. Baird, *Common Law Intellectual Property and the Legacy of International News Service v. Associated Press*, 50 U. CHI. L. REV. 411, 422-23 (1983) ("In any event, courts have largely confined INS to its original facts and to areas of law in which new intellectual property principles have developed and have subsequently been recognized as legitimate by Congress or the Supreme Court.").

[195] *See* 3 RUDOLF CALLMANN, CALLMANN ON UNFAIR COMPETITION, TRADEMARKS & MONOPOLIES § 15.3 (4th ed. 2018) ("It has been repeated ad nauseam that INS 'is authority only for the situation there at the bar.'" (with numerous examples in n.7)).

[196] *See, e.g.*, RESTATEMENT (THIRD) OF THE LAW OF UNFAIR COMPETITION § 38, cmt b (1995) ("There is no general common law prohibition against benefiting from the efforts of others."); *see also* Emerson v. Davies, 8 F.Cas. 615, 619 (C.C.D. Mass. 1845); WCVB-TV v. Bos. Athletic Ass'n, 926 F2d 42, 45 (1st Cir. 1991); Leo J. Raskind, *The Misappropriation Doctrine as a Competitive Norm of Intellectual Property Law*, 75 MINN. L. REV. 875, 896-905 (1991); CALLMANN, *supra* note 195 § 15.4.

[197] Restatement (Third) of the Law of Unfair Competition § 38, cmt. b (1995).

[198] *Id.*

[199] *See* Richard A. Posner, *Misappropriation: A Dirge*, 40 HOUS. L. REV. 621, 629, 637 (2003).

inventions, virtually all doctrinal issues are disputed and all details are open to debate. Since nothing can be relied on, it is unlikely that courts will agree on the application of misappropriation doctrine in scenarios where the protection of emergent inventions is at issue. In order to provide for legal certainty, therefore, patent reform must consider extending the statutory law categories. In addition to human-made, computer-supported, and AI-supported inventions, we may need to also protect the output of fully autonomous AI inventiveness. As the next section will show, although U.S. law does not offer a category of small-scale rights below the level of full-fledged patent protection, a system of sui generis rights similar to what other jurisdictions have established as so-called small and petty patents may provide an adequate solution.

2. The Nature of Rights and Scope of Protection

For the specific design of protection granted for emergent inventions, a distinction must be made between full-fledged patent protection and the alternative of a sui generis right—a small-scale patent equivalent, so to speak—that provides for a lower grade of protection.[200] Even considering the enormous investment needed to innovate and market inventive AI applications, the overall "costs per invention" may decline. More succinctly put, it will be less costly to artificially invent than to have a human do the job. Against this backdrop, unlimited patent protection would go too far. Rather, a lower-level protection right would be ideal. With regard to a reduction of protection levels and a doctrinal fine-tuning of such second-tier rights, it is particularly the scope and duration of protection that need deeper analysis. Each of these issues requires a complex balancing of advantages and disadvantages. This cannot be provided by doctrinal and economic analyses alone and likely needs a foundation in empirical findings. In addition, it must be considered whether protection levels should vary according to industry and marketplace. At the moment, however, it will suffice to sketch a basic structural framework. Notwithstanding these caveats, a second-tier right offers the flexibility to accommodate the specific needs of regulating emergent inventions.

The most essential question concerns the nature of the entitlement to be granted. A blueprint for such second-tier rights may be found in Europe (e.g., Germany, Italy, and Spain), as well as in Australia, Brazil, China, Japan, Mexico, South Korea, and

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[200] *See* WIPO, *supra* note 12, at 7. For the formerly common catch-all terminology of "petty patents" comprising any type of protection that does not qualify for full patent protection, see, for example, John Richards, *Petty Patent Protection*, 2 INT'L INTELL. PROP. L. & POL'Y 47-1, 47-1 (1998).

Taiwan. These jurisdictions have established a smaller alternative to the full-fledged patent protection.[201] Terminology varies from petty patents (mainly in Australia), to utility models, utility innovations, and short-term patents.[202] Doctrinal details differ across jurisdictions and policy arguments for the lower degree of protection are not uniform.

Nonetheless, a few common themes exist. The subject matter is mostly described as a less complex and ingenious innovation. Accordingly, a reduction of the protection level is justified by the "limited degree of inventiveness" that a utility invention embodies.[203] Furthermore, reference is made to the fact that utility model protection provides a faster, cheaper, and more convenient trajectory for protecting small and medium entrepreneurs.[204] This is because registration and rights acquisition require no prior examination of patentability conditions (i.e., novelty and non-obviousness).[205] At least with regard to the lower cost/invention ratio that can be expected for artificial inventiveness, the system of smaller-rights protection seems to be adequate. Furthermore, seen in light of the aim of fostering competition in the AI industry, granting access more easily for small and medium actors is also beneficial.[206]

But it is not only the "downsizing" of protectability requirements and accordant protection levels that makes the system of utility model protection a good blueprint for the drafting of second-tier rights. In addition, patent office procedure may benefit from a reduction in the "patentability testing routine." Most importantly, relieving patent offices from a duty to scrutinize non-obviousness will significantly simplify their procedures. Patent offices worldwide are already heavily overloaded.[207] This will not change in the AI era. To the contrary, it appears that an assessment of protection requirements will become more burdensome. If the

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[201] Richards, *supra* note 200, at 47-1.

[202] *Id.*

[203] *See, e.g.*, European Commission, Amended Proposal for a Directive on the Protection of Inventions by Utility Models 1, IP/99/433 (June 30, 1999); *see also* Richards, *supra* note 200, at 47-1.

[204] *See, e.g.*, European Commission, Amended Proposal for a Directive on the Protection of Inventions by Utility Models 1, IP/99/433 (June 30, 1999); *see also* Richards, *supra* note 200, at 47-1, 47-4.

[205] *See, e.g.*, European Commission, Amended Proposal for a Directive on the Protection of Inventions by Utility Models 1 (June 30, 1999); *see also* Richards, *supra* note 200, at 47-1, 47-4.

[206] For market and industry structures, *see supra* Section III.B.2.

[207] *See, e.g.*, BURK & LEMLEY, *supra* note 123, at 22-24. For Europe, see Justine Pila & Paul Torremans, EUR. INTELL. PROP. L. 126-27 (2016).

state of the art transforms with the PHOSITA's increasingly AI-based skills, patent offices will be at a disadvantage. Without improvement of public research capacities, the function of the patent system cannot be maintained.[208] But even if patent offices ultimately employ AI to support themselves, it will be doubtful whether they can keep up with the private sector. Indeed, it is rather optimistic, not to say naïve, to assume that AI could easily be used by these offices in order to research the state of the art, thereby significantly reducing the practical burden on their ledger.[209] Rather, as we have seen, transparency with regard to "common" AI capacities cannot be expected,[210] and getting access to the latest state of the art in AI technology will be difficult for public officers.[211] In sum, relieving patent officers from a duty to scan novelty and non-obviousness issues will take pressure off the system.

If patent examiners do not try issues of novelty and non-obviousness, second-tier rights for emergent inventions would not come with a presumption of validity. In order to prevail on an infringement claim, the right owner would have to prove validity. Of course, courts would then have to test for novelty and non-obviousness. Yet this would happen on a much smaller scale: until recently, less than two percent of registered patent rights in the United States have ever been litigated—and less than 0.2 percent ultimately reached the courtroom.[212] This will likely not differ too much when second-tier rights are at stake.

Moreover, one could consider further limiting right owners' powers with an extension of the so-called "independent invention exception" to infringements of second-tier rights. Currently, to be excluded from liability for patent infringement, an independent invention must be in commercial use as a process or product in a manufacturing process at least one year prior to the filing of the

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[208] *See* Arti K. Rai, *Machine Learning at the Patent Office: Lessons for Patents and Administrative Law*, 104 IOWA L. REV. 2617, 2638 (2019) ("To the extent that the AI-assisted search used by the Patent Office does not account for potentially rapid change in the average skill of practitioners itself spurred by AI, it will fall short."); *see also* Vertinsky & Rice, *supra* note 20, at 598-99; Vertinsky, *supra* note 41, at 504.

[209] Vertinsky, *supra* note 41, at 504 ("Ultimately thinking machine reviewers could be used to analyze the work of thinking machine inventors.")

[210] *See supra* Sections III.A.2.b. and III.A.2.c.

[211] *See also* Rai, *supra* note 208, at 2638; DAVID FREEMAN ENGSTROM, DANIEL E. HO, CATHERINE M. SHARKEY & MARIANO-FLORENTINO CUÉLLAR, GOVERNMENT BY ALGORITHM: ARTIFICIAL INTELLIGENCE IN FEDERAL ADMINISTRATIVE AGENCIES 50 (2020).

[212] Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1501 (2001).

patent at issue.[213] These limiting conditions to the exception could be eliminated in cases where protection for emergent inventions is at issue. This would allow a *general* independent invention defense before or even after the filing of a second-tier rights. In the same vein, an experimental use exception might be considered. This defense is so far only hesitantly applied by courts.[214] Under an extended exception of this kind, the use of emergent inventions for human or AI-based research may, however, be more broadly considered non-infringing. Furthermore, if one wanted to drastically restrict the power of these second-tier rights, one might consider strictly limiting the owner's remedies for an infringement to damages.

Finally, determining the adequate protection period is particularly thorny. Petty patents and utility rights are usually protected only for a maximum term of ten (instead of twenty) years. The protection period for emergent inventions might be reduced even further. After all, innovative input and the cost/invention ratio might be so far reduced that they would not even warrant a ten-year monopoly. In any event, this issue requires deeper analysis.[215] And this analysis will also have to consider establishing variable times of protection, depending on product categories and marketplaces. The need to differentiate is illustrated by a comparison of emergent inventions concerning simple technical instruments (e.g., antennas) and those that yield successful pharmaceutical and medical substances (e.g., a vaccine). The evident difference in commercial value justifies considering variable periods.[216]

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[213] § 273(a) of the Patent Act provides that "[a] person shall be entitled to a defense under § 282(b) with respect to subject matter consisting of a process, or consisting of a machine, manufacture, or composition of matter used in a manufacturing or other commercial process, that would otherwise infringe a claimed invention being asserted against the person if (1) such person, acting in good faith, commercially used the subject matter in the United States, either in connection with an internal commercial use or an actual arm's length sale or other arm's length commercial transfer of a useful end result of such commercial use; and (2) such commercial use occurred at least 1 year before the earlier of either (A) the effective filing date of the claimed invention; or (B) the date on which the claimed invention was disclosed to the public in a manner that qualified for the exception from prior art under section 102(b)."

[214] *See, e.g.*, Madey v. Duke Univ., 307 F.3d 1351, 1361 (Fed. Cir. 2002) ("[T]he experimental use defense persists albeit in . . . very narrow form").

[215] See Fraser, *supra* note 106, at 332.

[216] For the pros and cons of such a fine-tuning in IP protection, see Tim W. Dornis, *Wigmorian Copyright: Law, Economics, and Socio-Cultural Evolution*, INTELL. PROP. Q. 2018, 159, 171-72.

3. Right Ownership

Finally, issues of ownership come up with the decision to grant an entitlement. We should not expect lawmakers to acknowledge an "electronic person" in the near future.[217] Accordingly, it is disputed as to who best deserves to own rights to emergent inventions or where best to allocate such rights under an economic perspective. Among the candidates for right ownership are the AI's developers or programmers, its owners, and its users.[218] It seems that most academics have settled on the "user."[219] Although this may be doctrinally and economically cogent, a few clarifications are in order.

Let us start with the general rule of right ownership for emergent inventions. At first glance, the acquisition of rights by a developer or programmer of an autonomously inventive AI application seems obvious. After all, they initially conceived of the AI software and its apparatus—therefore, they are the application's actual creators.[220] Yet seen in light of the autonomy evolved by an AI application in its process of inventing, it can hardly be assumed that the developer's or programmer's initial creative input will always "reach through" to the emergent invention. Rather, once an AI application has started to evolve away from its initial conception, the umbilical cord to its creators has been severed. Developers and programmers may have set a cause for autonomous AI activity, but this cause is not more closely connected to the outcome than, for instance, the provision of raw materials or spare parts needed to construct the apparatus.

Notwithstanding AI emancipation, the acquisition of rights by the developer is sometimes supported by reference to an alleged risk of false incentives. If the AI's developer, say IBM, had to fear losing Watson's inventions to its users, IBM might restrict access to Watson.[221] In the same vein, the assignment of rights in emergent inventions to the AI's "owner" has been recommended, since it was her investment that made the AI's development possible in the first

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[217] *See supra* Section III.A.

[218] *See, e.g.*, Hattenbach & Glucoft, *supra* note 22, at 47-49; Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1114; Schuster, *supra* note 79, at 1977; Yanisky-Ravid & Liu, *supra* note 60, at 2231-35; SHEMTOV, *supra* note 6, at 22.

[219] *Id.*

[220] *See, e.g.*, SHEMTOV, *supra* note 6, at 22, 30-31. On the discussion in copyright (concerning right ownership for AI-generated "works"), see, for example, Dornis, *supra* note 42, at 49-51.

[221] Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1115.

place.[222] Both arguments overlook the functioning of the market mechanism.

Of course, the economic model of patent law requires the value that emanates from AI innovation to be transferred to the investor level. Most simply put, inventive activity requires investment, and investments will occur only if there exists a prospect of re-appropriation.[223] Yet the principal correlation between investment and monopoly rights does not demand that rights must always and exclusively be allocated at the investor level—and thus to developers and owners. This is because the marketplace will usually guarantee that the value created from AI innovation makes its way to the investors. An example illustrates the mechanism: if it is the users of an AI application—and not the developer, programmer, or owner—who acquire the right to an emergent invention, the price for acquisition and use of the application will rise until it equals the sum of the value of both the use of the AI application as such and of the emergent inventions arising from the application's use.[224] Ultimately, the increase in price will compensate developers, programmers, and owners for the costs of AI development and production. Accordingly, at least in principle, it should not make a difference for the functioning of the incentive mechanism whether rights accrue at the level of AI creation, production, or utilization.

This indifference of the market mechanism toward the initial allocation of rights can also be explained by direct reference to Ronald Coase's model of property rights. According to Coase, when transaction costs are zero, it is irrelevant where an entitlement has been allocated. In a perfect marketplace, it will always be the actor with the highest utility from right ownership and use that will ultimately end up as the right's owner.[225] This is due to the fact that in an Elysium of zero transaction costs, negotiations between market actors can continue until every participant has attained a maximum welfare level. This process of voluntary exchange shifts resources to those uses in which the value to the actors, as measured by their willingness to pay, is highest. When the market has achieved a level of resource allocation where reallocation can bring no more increase in value, the overall resource utilization is efficient.[226] In reality, though, the existence of transaction costs makes things complicated.

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[222] Abbott, *I Think, Therefore I Invent*, *supra* note 4, at 1116; Nägerl, Neuburger & Steinbach, *supra* note 138, 340; Fraser, *supra* note 106, at 331.

[223] *See supra* Section III.B.1.

[224] *See* Dornis, *supra* note 42, at 54-56.

[225] Ronald Coase, *The Problem of Social Cost*, 3 J. LAW & ECON. 1 (1960).

[226] *See, e.g.*, POSNER, *supra* note 143, at 12; *see also* Schuster, *supra* note 79, at 1967-1978. For the ground-laying paper, see Coase, *supra* note 225, at 8.

The costs of finding a party to transact, of negotiating a contract, and, ultimately, of enforcing the contract all stand in the way of a perfectly utility-maximizing world in which everybody may deal with anybody at any time. Not only may it be difficult to find eligible contract partners, once found these partners may be tough or irrational negotiators. Finally, conception of the contractual arrangements may be complex and time consuming, and hence costly. Against this backdrop, lawmakers' first task is to assign rights to the party that will have the greatest utility from right ownership. If such a perfectly efficient initial allocation (causing no transaction costs) is impossible, rights should be assigned in a way that helps avoid unnecessary transactions and thereby, at least, minimize the costs of transacting.[227]

From this perspective, the AI user is the one who must be considered the optimal right owner.[228] Any other solution would make it too costly to ensure that proceeds from emergent inventions make their way into the right pockets. This can be seen when looking at the structure of the AI industry:

First, AI innovation will very likely occur in the hands of specialized tech companies. These specialized actors will innovate, produce, and market their AI applications to customers in other industries and market sectors. Consequently, the specific output of AI-inventive processes (e.g., pharmaceutical substances) will be produced by actors *outside* the AI industry. This practical estrangement of AI innovation from AI usage is illustratively reflected in current market trends. So-called machine-learning-as-a-service (MLaaS) models have become a blockbuster business and have established themselves as the standard way to sell AI services. MLaaS products are "services" sold by large cloud-computing vendors such as Amazon Web Services, Microsoft Azure, and Google Cloud Platform. Not only do the tech giants offer cloud infrastructure and develop AI, they also have access to the data required to train all kinds of more specific AI applications. While these AI tools were initially developed for internal use only, virtually all Big Tech actors have recently decided to sell these services externally.[229] This means that, in our example, if an AI tool has been developed with a focus on discovering pharmaceutical

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[227] *See* Schuster, *supra* note 79, at 1978-81.

[228] *Id.* at 1991; *cf.* Samuelson, *supra* note 139, at 1203 (with respect to copyright law).

[229] *See, e.g.*, Editorial, *Machine Learning as a Service (MLaaS) and Its Business Implications in 2019*, INSIDEBIGDATA (July 4, 2019), https://insidebigdata.com/2019/07/04/machine-learning-as-a-service-mlaas-and-its-business-implications-in-2019.

substances, it will only be used by pharmaceutical companies. The substances invented by the AI will be part of the product portfolio of the respective user, not of the AI-innovating entity. Therefore, the "production" of emergent inventions will occur beyond the control and supervision of the AI developer, programmer, or owner of the specific application. In any event, if AI is utilized by highly specialized users like pharmaceutical companies, the AI innovators will seldom understand their AI's output, especially whether it has value or deserves a patent. In these scenarios, if rights fell directly to the developers, programmers, or owners (IBM, Google, and Amazon, respectively), considerable transaction costs, namely for negotiating, contract drafting, supervision, and enforcement, would accrue.[230] Moreover, the AI's user—in our example, the pharmaceutical company—might try to conceal the actual number of emergent inventions in order to receive *all* proceeds from her use of the AI.[231] At least in principle, therefore, AI users should be the initial right owners.

Yet, one final clarification is necessary. Upon closer scrutiny, it becomes evident that the user-rights rule must not depend on the actual "use" of AI. Hence, it is irrelevant who *immediately* operates the AI application or apparatus. What matters is the power of disposition over the AI—i.e., the legal right and actual capacity to use the AI. Hence, if an AI application is used under a rental or leasing contract, it is the tenant or lessee that has the power of disposition. She has the right to decide when and how to make use of the application, and she bears the costs of its use and maintenance. This modification of the user-rights rule namely governs in scenarios of employees' or agents' direct "use" of an AI application. If one wished to assign rights on the basis of direct "use" in these cases, the employee or agent would have to be regarded as the initial right owner. This result, however, would contradict the Coasean tenet of reducing the number of actual transactions and of keeping transaction costs as low as possible. Under an efficiency lens, rights should immediately accrue to the employer or principal. The doctrinal construction may resemble the so-called work-made-for-hire doctrine in U.S. copyright law.[232]

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[230] Dornis, *supra* note 42, at 51.

[231] Schuster, *supra* note 79, at 2000-01.

[232] Section 101 of the Copyright Act provides that a "work made for hire," inter alia, is "a work prepared by an employee within the scope of his or her employment" or a work "specially ordered or commissioned." 17 U.S.C. § 101 (Definitions).

IV. CONCLUSION

Humankind is not Mother Nature's last word on the question of intelligent life. To the contrary, much is likely yet to come. Why, therefore, should we worry about the fact that our current intellectual capacities are just a snapshot in history? Isn't it evident that homo sapiens will one day be outdone by superior minds? And who ever said that these minds cannot be artificial? We have reason to suspect that some of the once apparently indestructible truths of patent doctrine, namely its anthropocentrism, are about to dissolve. Law is a social construct, and it has been developed on assumptions about the contexts in which it will be applied. Once we accept that our world is about to change, we must see that this means the end of patent law as we know it. Of course, we must be careful not to turn the system on its head. The World Intellectual Property Organization recently questioned whether it might be too early for a definite change in the legal system, since the impact of AI is still unfolding at a rapid rate and our understanding of the effects of different policy measures may still be insufficient.[233] Yet it is incontestable that the advent of disruption in the patent system is a question not of "if," but of "when." It is essential to consider at least some amendments to the patent system—not a shaking of its foundations, but a maintenance of its functioning.

The most critical juncture does not even concern patents themselves. Reform of the patent system alone may not suffice to absorb the shock of AI-induced disruption. Instead, it is essential to regulate the data economy in order to guarantee data access. Since data access is the precondition for AI innovation, trends of consolidation in the data and AI industries are highly disconcerting. The most basic architecture of an innovative AI ecosystem must be provided for by antitrust law and governance principles of open access and data sharing. Only on the basis of an innovation-friendly macrostructure of the data economy can patent law function as an instrument of more specific micro-regulation. It is essential to overcome the law's anthropocentrism. AI already autonomously conceives of technical solutions that are new and nonobvious. We will increasingly witness inventions for which there are no human inventors or co-inventors. In order to avoid the destructive effects of such "inventions without an inventor," an alternative system of protection for emergent inventions must be established. In addition, lawmakers must acknowledge that the PHOSITA paradigm has begun to transform as a result of increasing AI support for human inventors. In this regard as well, it is essential to stop (and possibly

[233] WIPO, *supra* note 12, at 7.

reverse) consolidation in the AI industry and retraction of AI technologies into trade secrecy. Otherwise, the practices of patent offices and courts will soon become more than complicated, if not useless.

Ultimately, it is important to realize that we must not be guided by fears of losing the patent law of the past. Instead, we must aim to establish a patent system for the future, a doctrine that allows AI to evolve in ways that make our life better. This requires a forward-looking approach to legal reform – encouraging rather than hampering innovation of AI and "by AI".