WHEN ARTIFICIAL INTELLIGENCE SYSTEMS PRODUCE INVENTIONS: AN ALTERNATIVE MODEL FOR PATENT LAW AT THE 3A ERA

Dr. Shlomit Yanisky Ravid† *& Xiaoqiong (Jackie) Liu*†

Currently, robots, Artificial Intelligence, and machine learning systems (hereinafter referred to collectively as AI or AI systems) can create inventions, which, had they been created by humans, would be eligible for patent protection. This Article addresses the patentability of these inventions created by AI systems. We argue that traditional patent law has become outdated, inapplicable, and irrelevant with respect to inventions created by AI systems. We call on policy makers to rethink current patent law governing AI systems and replace it with tools more applicable to the new (3A) era of advanced, automated, and autonomous AI systems. Our argument is based on three pillars: the features of AI systems, the Multiplayer Model, and the irrelevance of theoretical justifications concerning intellectual property. In order to fully convey the ability of AI systems to create inventions, the Article explains, for one of the first times in the legal literature, what AI systems are, how they work, and what makes them (so) intelligent. This understanding is crucial to any further discourse about AI systems. We identify eight crucial features of AI systems: they (1) are creative; (2) unpredictable; (3) independent and autonomous;

† Dr. Shlomit Yanisky Ravid, Professor of Law; Yale Law School, Information Society Project (ISP), Fellow; Fordham University School of Law, Visiting Professor; Ono Academic Law School, Israel (OAC), Senior Faculty; the Shalom Comparative Legal Research Center, OAC, Founder and Director. Special thanks to Professor Bonnie Kaplan at Yale University for her outstanding contributions and valuable feedback. Thanks also to Yale Law School's Information Society Program (ISP) and especially to Jack Balkin, Rebecca Crootof, Michael Fischer, Christina Spiesel, Asaf Lubin, and Nimrod Kozlovsky as well as to Fordham Law Center for Law and Information Policy and in particular to Professor Joel Reidenberg, Sivan Saban-Hacohen, and Rivi Cohen for their encouragement, insight, and comments. We are grateful to Michele Woods, Michal Svantner, and Victor Lopez Vazquez at the World Intellectual Property Organization (WIPO) in Geneva, Switzerland, to the Swiss Institute of Comparative Law in Lausanne, Switzerland, and in particular to Lukas Heckendorn Urscheler, Alberto Aharonovitz, Ilaria Pretelli, Karen Druckman, and Sadri Saieb for enabling this Article. We are grateful as well to the participants of the Beyond Intellectual Property Course at Fordham Law School and in Urbino University, Italy as well as to the workshops being held at, among other institutes, the Yale Law School, ISP, on the challenges of Artificial Intelligence, new technologies, and robots for the wonderful feedback on our research. Finally, gratitude to our gifted research assistants and outstanding legal editors Elizabeth Ledkovsky, Esq., Avishai Zur, Sophie Hogan, and Laura Lagone, Esq.

† Xiaoqiong (Jackie) Liu, is an engineer; Fordham Intellectual Property Institute Fellow; former editor of the *Fordham Intellectual Property, Media & Entertainment Law Journal*.

(4) rational; (5) evolving; (6) capable of data collection and communication; (7) efficient and accurate; and (8) freely choose among alternative options. We argue that, due to these features, AI systems are capable of independently developing inventions which, had they been created by humans, would be patentable (and able to be registered as patents). The traditional approach to patent law in which policy makers seek to identify the human inventor behind the patent is, therefore, no longer relevant. We are facing a new era of machines "acting" independently, with no human being behind the inventive act itself.

The second pillar of our argument is the Multiplayer Model, which characterizes the long process through which inventions are created by AI systems. The Multiplayer Model, which is also almost absent in the current legal publications, describes the multiple participants and stakeholders, both overlapping and independent, involved in the process, including software programmers, data and feedback suppliers, trainers, system owners and operators, employers, the public, and the government. The model conveys that the efforts of traditional patent law to identify a single inventor of these products and processes are no longer applicable.

The third pillar of our argument is the irrelevancy of theoretical justifications, such as personality and inventiveness/efficiency to inventions created by AI systems. In contrast to other scholars, we argue that traditional patent law is irrelevant and inapplicable to these situations, that these inventions should not be patentable at all, and that other tools can achieve the same ends while promoting innovation and public disclosure. These other, non-patent incentives include commercial tools such as electronic and cyber controls over inventions, first-mover market advantages, and license agreements. This proposal serves a gatekeeping function and is superior to a revision of the non-obviousness standard used by other scholars to afford patent protection to inventions by AI systems. In maintaining the traditional patents system by hunting for a "real" human inventor, policy makers exhibit a misunderstanding of advanced technology and AI systems features. We conclude with a discussion of the implications of our analysis for different legal regimes, such as tort, contracts, and even criminal law.

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INTRODUCTION

The creation of Artificial Intelligence (AI) will be "either the best, or the worst thing, ever to happen to humanity."[1] In this statement by Stephen Hawking during a lecture at the University of Cambridge, he reflects the worries of an unknown future controlled by advanced technology in general and specifically by AI. Elon Musk, the CEO of SpaceX, also warned against the threat of AI, stating, "we are summoning the demon."[2] This Article approaches AI from a different

1 *See* Fiona Macdonald, *Stephen Hawking Says Most of Our History Is "The History of Stupidity"*, SCI. ALERT (Oct. 21, 2016), http://www.sciencealert.com/stephen-hawking-says-most-of-our-history-is-the-history-of-stupidity ("[T]he development of full artificial intelligence could spell the end of the human race.").

2 *See* Samuel Gibbs, *Elon Musk: Artificial Intelligence Is Our Biggest Existential Threat*, GUARDIAN (Oct. 27, 2014, 6:26 AM), http://www.theguardian.com/technology/2014/oct/27/elon-musk-artificial-intelligence-ai-biggest-existential-threat ("With artificial intelligence we

perspective. The AI industry has rapidly become part of our everyday lives and is expected to grow into an estimated seventy-billion-dollar industry by 2020.[3] We should face this new realm not fearfully or judgmentally, but with awareness that current laws need reevaluation and new solutions,[4] not a continuation of inapplicable frameworks.[5]

In this Article, we focus on AI and patent law from a new point of view.[6] Here, we address the question of whether inventions created by AI systems should be patentable at all, and, if not, what mechanisms can be used instead.

We already live in an era of self-driving cars, autonomous weapons, drug synthesis, disease identifications, medical symptom analysis, and investment advisory tools.[7] Language translation, face

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are summoning the demon. In all those stories where there's the guy with the pentagram and the holy water, it's like—yeah, he's sure he can control the demon. Doesn't work out.").

3 *Tech CEOs Declare This the Era of Artificial Intelligence*, FORTUNE (June 3, 2016), http://fortune.com/2016/06/03/tech-ceos-artificial-intelligence ("[T]ech companies are diving into AI analytics research, an industry that will grow to $70 billion by 2020 from just $8.2 billion in 2013." As Elon Musk said, "[a]rtificial intelligence and machine learning will create computers so sophisticated and godlike that humans will need to implant 'neural laces' in their brains to keep up.").

4 *See* Rory K. Little, *Guns Don't Kill People, 3D Printing Does? Why the Technology Is a Distraction from Effective Gun Controls*, 65 HASTINGS L.J. 1505, 1510 (2014) ("Rather, as has always been true in the face of new and surprising technological leaps, the challenge is to control dangerous [manifestations of the technology] . . . not to fear or inhibit the innovation itself."); John F. Hornick, *Inside Views: 3D Printing and Public Policy*, INTELL. PROP. WATCH (Sept. 7, 2015), https://www.ip-watch.org/2015/07/09/3d-printing-and-public-policy ("3D printing should be lightly regulated, because it enables precisely the kind of creation and progress of the useful arts and sciences that intellectual property is supposed to foster.").

5 *See* Ben Depoorter, *Intellectual Property Infringements & 3D Printing: Decentralized Piracy*, 65 HASTINGS L.J. 1483, 1489–91 (2014) (explaining the courts' difficulty in applying precedent, and thus adapting, to new technologies).

6 *See* Shlomit Yanisky-Ravid & Kenneth S. Kwan, *3D Printing the Road Ahead: The Digitization of Products When Public Safety Meets Intellectual Property Rights—a New Model*, 38 CARDOZO L. REV. 921, 927–33, 952–53 (2017) (discussing the threats and hazards of 3D printing and suggesting a new model of imprinting/stamping and registering 3D printers).

7 *See* Rebecca Crootof, *The Killer Robots Are Here: Legal and Policy Implications*, 36 CARDOZO L. REV. 1837, 1840–43, 1863–72, 1894–1901 (2015) (as AI weapons systems "with varying levels of autonomy and lethality have already been integrated into the armed forces of numerous states," this Article calls for defining Autonomous Weapon Systems properly and regulating them internationally); Gisbert Schneider, *Automating Drug Discovery*, 17 NATURE REVIEWS DRUG DISCOVERY 97 (2017); Caitlin Brock, Comment, *Where We're Going, We Don't Need Drivers: The Legal Issues and Liability Implications of Automated Vehicle Technology*, 83 UMKC L. REV. 769, 770–73 (2015) (arguing that a no-driver reality is coming and the time to prepare is now); Yaron Kinar et al., *Performance Analysis of a Machine Learning Flagging System Used to Identify a Group of Individuals at a High Risk for Colorectal Cancer*, PLOS ONE (Feb. 9, 2017), http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0171759&type=printable; Ray Kurzweil, *The Virtual Thomas Edison*, TIME (Dec. 3, 2000), http://content.time.com/time/magazine/article/0,9171,90538,00.html (discussing issues raised by automated cars); Pranav Rajpurkar et al., Cardiologist-Level Arrhythmia Detection with

recognition, answering machines, automated submission of legal appeals and opinions (i.e., automated lawyers), and automated therapists, among other services, have all become part of our everyday routines.[8] All of these depend on AI systems to various extents.

This is also true of intellectual property products and processes. AI advanced systems are replacing and sometimes improving human activity and functionality in creating intellectual property products. Though it sounds like science fiction, AI systems already write newspaper articles, create and author stories, produce paintings, create musical compositions, write software, generate other AI systems, and even design inventions.[9] AI systems create a wide range of innovative, new, and non-obvious products and services, such as medical devices, drug synthesizers, weapons, kitchen appliances, and machines, and will soon produce many others that, had they been generated by humans, might be patentable inventions under current patent law.[10]

Convolutional Neural Networks (July 6, 2017) (unpublished paper), https://arxiv.org/pdf/1707.01836.pdf.

8 *See* Matthew U. Scherer, *Regulating Artificial Intelligent Systems: Risks, Challenges, Competencies, and Strategies*, 29 HARV. J.L. & TECH. 353, 354–55 (2016) (describing AI systems as an integral part of life and calling for new regulations); *Diesel Breeding: Looking into Engines Helps Cross the Best with the Best*, MECHANICAL ENGINEERING, Sept. 2002, at 53 [hereinafter *Diesel Breeding*] (discussing diesel engines); Anne Eisenberg, *WHAT'S NEXT; When a Gizmo Can Invent a Gizmo*, N.Y. TIMES (Nov. 25, 1999), http://www.nytimes.com/1999/11/25/technology/what-s-next-when-a-gizmo-can-invent-a-gizmo.html (discussing other AI systems, and noting that computers are still designing components like filters, circuits, and engines, but their ability to design inventions "automatically raises a host of philosophical and legal issues that will intensify, [according to some people in the field], as computers grow more powerful and their discoveries more extensive"); Leanna Garfield, *A 19-Year-Old Made a Free Robot Lawyer That Has Appealed $3 Million in Parking Tickets*, BUS. INSIDER (Feb. 18, 2016, 10:17 AM), http://www.businessinsider.com/joshua-browder-bot-for-parking-tickets-2016-2 ("[W]ith the help of a robot made by British programmer Joshua Browder, 19, it costs nothing. Browder's bot handles questions about parking-ticket appeals in the UK. Since launching in late 2015, it has successfully appealed $3 million worth of tickets. . . . The startup Acadmx's bot creates perfectly formatted legal briefs."); Sarah Knapton, *Artificially Intelligent 'Judge' Developed Which Can Predict Court Verdicts with 79 Per Cent Accuracy*, TELEGRAPH (Oct. 24, 2016, 12:05 AM), http://www.telegraph.co.uk/science/2016/10/23/artifically-intelligent-judge-developed-which-can-predict-court ("Computer scientists at University College London and the University of Sheffield developed an algorithm which can not only weigh up legal evidence, but also moral considerations."); *see also Now You Can Have Your Own Therapist 24/7*, NEWS OF FUTURE, http://www.newsoffuture.com/your_own_therapist_artificial_intelligence.html (last visited Feb. 25, 2018).

9 *See* Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 57 B.C. L. REV. 1079, 1080 (2016) (arguing that computers are already generating patentable subject matter and overtaking human inventors as primary sources of new discoveries and inventions; therefore, AI should receive patent rights to inventions); Shlomit Yanisky-Ravid & Samuel Moorhead, *Generating Rembrandt: Artificial Intelligence, Accountability and Copyright—The Human-Like Workers Are Already Here—a New Model*, 117 MICH. ST. L. REV. (forthcoming 2018), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2957722 (arguing that fully autonomous AI systems capable of producing creative works may seriously undermine today's copyright framework).

10 *See* Abbott, *supra* note 9; at 1080; *see also* J. STORRS HALL, BEYOND AI: CREATING THE CONSCIENCE OF THE MACHINE (2007) (discussing ethical issues regarding inventions by AI);

Massive investments, mostly from big private sector firms such as IBM, Google, Amazon, and Facebook target AI development.[11] AI advanced systems are becoming capable of creating unpredictable, innovative outcomes independently, rather than merely by following digital orders. Such inventions by AI systems are the focus of this Article. Torts liability and even criminal law, which have been at the forefront of legal discourse, do not necessarily address these new challenges of creative AI related to intellectual property law. A rethinking of traditional legal tools is required.[12]

The legal system, including intellectual property law, needs to change significantly to keep pace with recent developments in these technologies.[13] Previous literature expressing concerns about AI has focused mainly on workplaces, misuse of AI systems, and general liability issues. There has been little discussion of regulating AI,[14] and

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Mark Prigg, *AI's Should Be Allowed to Patent Their Inventions: Researchers Say Humans Are Taking Too Much Credit for Computer Creation*, DAILY MAIL (Oct. 17, 2016, 3:40 PM), http://www.dailymail.co.uk/sciencetech/article-3845276/AI-s-allowed-patent-inventions-Researchers-say-human-taking-credit-computer-inventions.html ("Artificial Intelligence is playing an ever larger role in innovation[,] with major players such as IBM, Pfizer and Google investing heavily in creative computing[,] but current patent law does not recognise computers as inventors." Without a change in the law, findings warn that uncertainty will cause less innovation, "which would prevent the industry from capitalising on the huge potential of creative computers."); Tom Simonite, *Software Dreams Up New Molecules in Quest for Wonder Drugs*, MIT TECH. REV. (Nov. 3, 2016), https://www.technologyreview.com/s/602756/software-dreams-up-new-molecules-in-quest-for-wonder-drugs (discussing how a Harvard chemistry professor developed an AI program that could help in the creation of new drug compounds, and explaining that ingesting a heap of drug data allows a machine-learning system to suggest alternatives that humans have not tried yet; the researchers have already experimented with training their system on a database).

11 *See* FORTUNE, *supra* note 3. *The Economist* spent time dissecting this issue in *Artificial Intelligence: Rise of the Machines*, ECONOMIST (May 9, 2015), http://www.economist.com/news/briefing/21650526-artificial-intelligence-scares-peopleexcessively-so-rise-machines; *see also* Scherer, *supra* note 8, at 354 (following AI's increasing and rapidly expanding commercial potential).

12 Gabriel Hallevy, *The Criminal Liability of Artificial Intelligence Entities—from Science Fiction to Legal Social Control*, 4 AKRON INTELL. PROP. J. 171, 172–85 (2010) (AI robots have already murdered people; therefore, a new model of traditional criminal and tort law is necessary in this regard).

13 *See* sources cited *supra* notes 5–8; *see also* Abbott, *supra* note 9, at 1080–81 (explaining that the phenomena of AI systems as inventors poses new challenges to the traditional paradigm); Yanisky-Ravid & Moorhead, *supra* note 9 (explaining that fully autonomous AI systems capable of producing creative works may seriously undermine today's copyright framework).

14 Recently, the discussion has been focused on immediate bodily harm such as in the case of criminal and tort law and weapons. For example, see AUTONOMOUS WEAPONS SYSTEMS: LAW, ETHICS, POLICY 245–344 (Nehal Bhuta et al. eds., 2016) (arguing that autonomous weapons are unlawful within new frameworks of individual liability); *see also* Scherer, *supra* note 8, at 355, 357 (listing concerns not only from within the government but also from leaders

even less of intellectual property protection for inventions created and developed by AI systems. Musk's comment about the need for new regulations gives rise to an interesting, more general question: how to strike the balance between regulation and the intellectual property regime in general, specifically between automated and creative AI systems and incentives to innovate.[15]

In 1998, John Koza, one of the pioneers of AI genetic algorithms, developed an algorithm to create simple circuit designs.[16] As he continued to expand his work, Koza ultimately built a cluster of 1000 personal computers that generated seventy-six "human competitive" designs.[17] Surprisingly, Koza obtained patents on the automated invention system as well as on the inventions generated by the AI itself.[18] While we agree with the granting of the patent in the first case, we challenge the granting of patents to inventions by AI systems.

In this Article, we inquire as to who owns the rights to patentable products and processes produced by AI systems. Traditional patent mechanisms seek to identify conclusively the owner of a patent and who must be within the scope of patent laws (e.g., a corporation, operator, or inventor).[19] We analyze AI systems as autonomous, creative, unpredictable, rational, and evolving systems, and argue that these characteristics make justifications such as personality theories and incentive/efficiency arguments irrelevant. We conclude that one cannot conclusively determine an owner for these rights within the scope of patent law. Therefore, the rights fall outside the scope of traditional patent law.

So far, the few proposals suggested by other scholars all attempt to exercise and implement current laws with regard to inventions by AI by focusing on the definition of eligible patent matter, and particularly on

in the technology industry about the effects of new technology development; solutions included in this article focus on liability based on tort law).

15 *See infra* Part V.

16 *See* Johnathon Keats, *John Koza Has Built an Invention Machine*, POPULAR SCI. (Apr. 19, 2006), http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine.

17 *Id.*; John R. Koza, *Human-Competitive Results Produced by Genetic Programming*, 11 GENETIC PROGRAMMING & EVOLVABLE MACHINES 251, 251 (2010) ("The paper ends with the prediction that the increased availability of computing power (through both parallel computing and Moore's Law) should result in the production, in the future, of an increasing flow of human-competitive results, as well as more intricate and impressive results.").

18 *See, e.g.*, U.S. Patent No. 7,117,186 (filed Jan. 30, 2003) (issued Oct. 3, 2006); U.S. Patent No. 6,532,453 (filed Apr. 12, 1999) (issued Mar. 11, 2003); U.S. Patent No. 6,360,191 (filed Jan. 5, 1999) (issued Mar. 19, 2002).

19 Shlomit Yanisky Ravid, *Rethinking Innovation and Productivity Within the Workplace Amidst Economic Uncertainty*, 24 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 143,151–55, 190–99 (2013) (discussing current American patent law regarding inventions in workplaces, which grant employers all rights to employees' inventions, and suggesting a more balanced model to incentivize employed inventors).

non-obviousness standards.[20] Some voices call for considering machines as inventors and granting them patent rights.[21] Unlike other scholars, we argue here for abolishing patent protection of inventions by AI altogether.[22] Further, we suggest promoting innovations and public disclosure of inventions by AI through alternative tools such as, for example, first-mover advantages, social recognition of AIs, and alternative technologies that prevent infringement of rights, rather than relying on traditional intellectual property law to accomplish these goals.[23]

Part I considers the intelligence of AI systems as a first step in determining who owns the patent rights to inventions created by such systems. We identify and describe eight features of AI systems—including autonomy, creativity, and unpredictability—that establish the intelligence of these systems. Part II describes patent law's refusal to recognize nonhumans as inventors and the issues that have resulted from it. Part III introduces the Multiplayer Model, a characteristic of AI systems. Part IV addresses different aspects of the interaction between AI systems and intellectual property regimes, and of the AI Multiplayer Model, specifically through a theoretical legal and economic analysis, a Lockean labor analysis, and a personality analysis. Part V discusses the legal hurdles, within intellectual property laws, that need to be overcome in order to alter the process by which the owner of inventions by AI systems is identified, particularly in intellectual property law. It addresses the theoretical justifications for intellectual property with an emphasis on law-and-economics theory and describes current U.S. intellectual property law in the context of AI systems. Finally, Part VI proposes our new alternative Model and Part VII briefly addresses international tools for implementing them.

20 *See* 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 (2013) (proposing that inventions by AI are obvious); Daralyn J. Durie & Mark A. Lemley, *A Realistic Approach to the Obviousness of Inventions*, 50 WM. & MARY L. REV. 989, 1010–13 (2008) (arguing that AI patents should not be countered or subject to cross-examination).

21 Burkhard Schafer et al., *A Fourth Law of Robotics? Copyright and the Law and Ethics of Machine Co-Production*, 23 ARTIFICIAL INTELLIGENCE & L. 217, 219–20 (2015) (exploring author Jon Bing's idea of AI as an entity entitled to rights); *see also* Abbott, *supra* note 9, at 1081 (arguing that AI systems and computers can be inventors).

22 *See* Abbott, *supra* note 9.

23 *See infra* Part IV.

I. WHAT IS SO INTELLIGENT ABOUT AI SYSTEMS?

In order to convey the challenges of patentable inventions created by AI, we begin with an explanation of AI systems and how they produce innovative and unexpected products and processes which, had they been developed by humans, might qualify as patentable inventions.

Defining AI systems is not an easy task. There are numerous definitions of AI and many types of AI systems.[24] John McCarthy, who coined the term "artificial intelligence," did not provide an independent definition for it, while Russel and Norvig suggested almost ten different ones.[25]

Definitions vary as different aspects of AI systems are emphasized.[26] An AI system can be defined, based on its features, as one capable of performing tasks that normally require human intelligence, such as recognition, decision-making, creativity, learning, evolving, and communicating.[27] AI can also be described as an instrument that makes existing solutions more efficient by using all of the data within reach of the AI system.[28] Definitions also differ in various contexts (i.e., medical treatments or chess strategies). For our purposes, we focus on definitions most relevant to the patent system and adopt Scherer's somewhat evasive definition: "machines that are capable of performing tasks that, if performed by a human, would be said to require intelligence."[29]

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24 Scherer, *supra* note 8, at 360 (explaining that, unfortunately, no widely accepted definition of AI exists, even among experts; definitions tend to focus on human functions such as the ability to learn, consciousness, and self-awareness, all of which are difficult to classify).

25 *Id.* at 359–60; STUART RUSSELL & PETER NORVIG, ARTIFICIAL INTELLIGENCE: A MODERN APPROACH 2–14 (3d ed. 2013) (offering definitions of AI that include thinking and acting humanly as well as rationally); *id.* at 1034 (offering a definition of AI based on human features); *see* John McCarthy, What Is Artificial Intelligence? 2–3 (unpublished paper), http://www-formal.stanford.edu/jmc/whatisai/whatisai.html.

26 RUSSELL & NORVIG, *supra* note 25 (discussing different approaches to AI, such as those within the fields of philosophy, psychology, and cognitive math).

27 *Id.*; MARCUS HUTTER, UNIVERSAL ARTIFICIAL INTELLIGENCE: SEQUENTIAL DECISIONS BASED ON ALGORITHMIC PROBABILITY 125–26, 231 (2005) (arguing that an AI system is intelligent because it has creativity and knowledge as well as certain skills: problem solving, "pattern recognition, classification, learning, induction, deduction, building analogies, optimization, surviving in an environment, [and] language processing"); *see also Artificial Intelligence*, OXFORD LIVING DICTIONARIES, https://en.oxforddictionaries.com/definition/artificial_intelligence (last visited Feb. 16, 2018) (defining "artificial intelligence" as "[t]he theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages").

28 HUTTER, *supra* note 27, at 2–24, 141–46; Wang-Zhou Dai et al., Tunneling Neural Perception and Logic Reasoning Through Abductive Learning 6–18 (Feb. 6, 2018) (unpublished paper), https://arxiv.org/pdf/1802.01173.pdf; *see also* RUSSELL & NORVIG, *supra* note 25; Lucy Suchman & Jutta Weber, Human-Machine Autonomies 4–15 (Jan. 2015) (unpublished paper), https://www.researchgate.net/publication/272173538_Human-Machine_Autonomies_Revised.

29 Scherer, *supra* note 8, at 362, 393–95 (arguing for a reform in tort law regulation to cover

We claim that there are eight important features of AI systems that create new challenges to intellectual property law.[30] Some AI systems include some or all of these features, whereas others are more similar to computer software systems. Those with all eight of these features, including robots operating alongside AI systems, are being used not only to solve complex problems across an ever-increasing number of industries—smart vehicles, consumer devices, health, and pharmaceutical technologies—but also to create and produce products and processes themselves.[31] These eight features are related to each other and sometime overlap. However, each one focuses on a different characteristic. We state that they are the main stones building the 3A era of advanced, automated, and autonomous AI systems.

Creativity. AI systems create new products and processes, and significantly improve existing ones. They are capable of processing and reproducing other products, processes, and available data in order to create new outcomes.[32] For example, AI systems can draw, create designs, and even produce inventions such as drugs and technical devices.[33] This feature is crucial in considering the intellectual property realm and, in particular, patentable inventions.

Unpredictable Results. AI systems are based on algorithms capable of incorporating random mutations that result in unpredictable routes to the optimal solution, and hence to unpredictable solutions (from

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AI systems liability).

30 Shlomit Yanisky-Ravid & Luis Antonio Velez-Hernandez, *Copyrightability of Artworks Produced by Creative Robots and Originality: The Formality-Objective Model*, 19 MINN. J.L. SCI. & TECH. 1, 7–8 (2018) (discussing the challenge of defining originality of works once created by artificial intelligence systems); *see* Hallevy, *supra* note 12, at 175–76 (listing the five attributes that one expects in an intelligent entity: communication, internal knowledge, external knowledge, goal-driven behavior, and creativity). The eight features are discussed in Part I.

31 Jason D. Lohr, *Managing Patent Rights in the Age of Artificial Intelligence*, LEGALTECH NEWS (Aug. 18, 2016), https://www.law.com/legaltechnews/almID/1202765385194/Managing-Patent-Rights-in-the-Age-of- ("Much of the AI in use today is referred to as 'soft' AI, where the AI uses computational intelligence to analyze relevant data and attempt to solve a specific problem.").

32 *See* Timothy B. Lee, *Artificial Intelligence Is Getting More Powerful, and It's About to Be Everywhere*, VOX (May 18, 2017, 10:00 AM), https://www.vox.com/new-money/2017/5/18/15655274/google-io-ai-everywhere (providing examples of how AI systems improve products and processes); Nan Li, *Artificial Intelligence Wants to Make Us Healthier, If We Let It*, WORLD POSITIVE (Sept. 8, 2016), https://worldpositive.com/artificial-intelligence-wants-to-make-us-healthier-if-we-let-it-3cec5ed7cf88; *see also* HUTTER, *supra* note 27, at 2–24, 141–46; RUSSELL & NORVIG, *supra* note 25; Dai et al., *supra* note 28, at 6–18.

33 HUTTER, *supra* note 27, at 2 (referring to creativity as one of the main features of AI); Scherer, *supra* note 8, at 363–65 (noting how AI systems detected breast cancer by checking the cells of supportive tissues); *see also* Hallevy, *supra* note 12, at 176 (claiming that AI must be creative by finding alternative ways to solve problems, taking advantage of its freedom from cognitive biases).

software programmers' points of view).[34] AI systems are goal-driven; they process data and take action in order to generate products, data, and processes that cannot be predicted by programmers, operators, or any other entities involved.[35] For example, an AI system that creates paintings is generating an unpredictable product, rather than simply copying an existing work. AI systems that work on developing new and innovative antibacterial drugs can process data from a large volume of microorganisms (i.e., bacteria), "break" the data into tiny (sometime nano) components and find similarities and patterns that the human involved has not observed and cannot identify, resulting in new and unexpected structural information for drug development.[36]

Independent, Autonomous Operation (t-autonomy). This feature is one of the most important to understand in order to grasp AI systems in general and their departure from the framework of current patent law. Although the definition of autonomous AI system might vary according to the specific industry and from one system to another, we can identify some common characteristics.[37] Degrees of independence and creativity are both relevant. We can say that a device is independent and therefore autonomous to the extent that it accomplishes a high-level task on its own, without external (human) intervention.[38] Human intervention can occur in many phases of the process—observation, orientation, deciding, and acting—resulting in different levels of independence.[39] An unmanned aircraft and automated pilot can operate independently when needed (e.g., during a communication breakdown).[40] Autonomy level is influenced by interaction with other features.

A second dimension of autonomy concerns cognitive ability. The

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34 *See* Keats, *supra* note 17; *see* sources cited *supra* notes 16, 18.

35 Roger C. Schank, *What Is AI, Anyway?*, 8 AI MAG. 59, 59–60 (1987). For example, AlphaGo makes a brilliant move not understood by humans. Cade Metz, *How Google's AI Viewed the Move No Human Could Understand*, WIRED (Mar. 14, 2016, 2:39 AM), https://www.wired.com/2016/03/googles-ai-viewed-move-no-human-understand.

36 *See, e.g.*, Simonite, *supra* note 10; *see also* Lawrence Hunter, *Molecular Biology for Computer Students*, *in* ARTIFICIAL INTELLIGENCE AND MOLECULAR BIOLOGY 1, 12–15 (Lawrence Hunter ed., 1990) (providing that similarities enable the composition of cells as parts by AI systems).

37 Crootof, *supra* note 7, at 1854–63 (describing the difficulty of defining autonomous weapons and suggesting a definition based on the AI (weapon) system: (1) the ability to come to conclusions; (2) derived from gathered information; and (3) capable of independently selecting and engaging targets).

38 Lucy Suchman & Jutta Weber, *Human-Machine Autonomies*, *in* AUTONOMOUS WEAPON SYSTEMS: LAW, ETHICS, POLICY, *supra* note 14, at 75, 76.

39 William C. Marra & Sonia K. McNeil, *Understanding "The Loop": Regulating the Next Generation of War Machines*, 36 HARV. J.L. & PUB. POL'Y 1139, 1143–49 (2013) (describing the different levels of human intervention in machines as the "OODA Loop"—involving the observation, orientation, deciding, and acting stages); *see also* Crootof, *supra* note 7, at 1846–50 (describing OODA and the difficulty of defining autonomy in the context of AI weaponry).

40 Crootof, *supra* note 7, at 1847–49 (noting that it also has the ability to choose to act independently or to cooperate with others in order to achieve better goals).

larger the cognitive task assigned to the AI system, the more it can be considered autonomous. The autonomy of an AI is evident in data searches,[41] where the algorithms of the AI system may work independently without human intervention beyond defining goals.[42] We argue that the main idea behind these AI systems is their capability to identify similarities and patterns when processing data that even programmers and operators themselves were not aware of and many times do not completely understand. Despite this lack of human intervention, however, Koza has patented inventions generated by such advanced AI genetic algorithms.[43] Unlike industrial robots that assemble and replicate circuits designed by humans, the AI system in Koza's patent actually designs new circuits.[44] In this way, the AI systems replace the engineer, autonomously choosing, ordering, and assigning strengths to various circuit components to achieve predetermined performance parameters.[45]

Rational Intelligence. An "intelligent machine" means a rational system that perceives data from the outside world and decides which activities to engage in or avoid in order to maximize its probability of success in achieving a certain goal.[46] These AI systems mimic human perception and cognitive functions such as learning and problem solving, thereby imitating intelligent human behavior.[47]

Evolving. AI systems continue to evolve and change according to new data. This feature also contributes to the unpredictability mentioned above. AI systems may produce results that differ from the initial plan of the programmers or operators of the system.[48] For

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41 *Id.* at 1846 (claiming that in many cases the systems combine autonomous features with cooperation with other humans to bring net results).

42 *See, e.g.*, Keats, *supra* note 16.

43 *See, e.g.*, U.S. Patent No. 7,117,186 (filed Jan. 30, 2003); U.S. Patent No. 6,532,453 (filed Apr. 12, 1999); U.S. Patent No. 6,360,191 (filed Jan. 5, 1999).

44 *See* U.S. Patent No. 6,360,191 (filed Jan. 5, 1999).

45 *Id.*

46 RUSSELL & NORVIG, *supra* note 25, at 3–5, 27, 34–54, 973–86 (noting that AI systems are capable of taking "rational" action based on environmental input); HUTTER, *supra* note 27, at 2–24, 125–26, 141–46, 231 (AI systems can solve problems by using features such as learning, induction, deduction, building analogies, and optimization as well as using knowledge); *see also* DAVID L. POOLE & ALAN K. MACKWORTH, ARTIFICIAL INTELLIGENCE: FOUNDATION OF COMPUTATIONAL AGENTS, 71, 283–334, 597–611 (2010) (AI systems possess cognitive skills such as problem solving, searching for data, learning, evolving, and rational planning); Dai et al., *supra* note 28, at 6–18; Suchman & Weber, *supra* note 28, at 4–15.

47 The definition used in this Article that focuses on goals, actions, perception, and environment follows. RUSSELL & NORVIG, *supra* note 25, at 2; *see also* N.P. PADHY, ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS 3–5 (2005).

48 Sarah Perez, *Microsoft Silences Its New A.I. Bot Tay, After Twitter Users Teach It Racism [Updated]*, TECH CRUNCH (Mar. 24, 2016), https://techcrunch.com/2016/03/24/microsoft-

example, an AI system that synthesizes a drug based on bacterial structures will produce new outcomes as new bacteria are processed.

Capable of Learning, Collecting, Accessing, and Communicating with Outside Data. A significant feature of AI systems is their ability to actively "search" for data in the "outside" world. Based on the data gathered, an AI system can continue the process by receiving feedback and then improving the results.[49] Siri of Apple and Google Translate of Google serve as simple examples of these features. However, a new generation of autonomous, network-centric applications can collect data incessantly from different sources.[50] Driverless cars are collecting and processing data from the outside world (e.g., other cars, obstacles, and traffic signs) and autonomous weapons are processing data in order to identify targets.[51]

Efficiency and Accuracy. AI systems can process vast volumes of data accurately, efficiently, and rapidly, well beyond the capacity of the human brain.[52] Although less sophisticated computer software possess this feature, it also exists in complicated AI systems.

"Free Choice" Goal Oriented. This feature focuses on the capability of the AI system to choose between alternatives in order to achieve the best outcome.[53] Automated weapons decide, for example, which targets should be attacked according to the surrounding data.[54] Specific AI systems implemented in driverless cars process data in order to choose from different alternatives and decide on routes, speed, and accident avoidance.[55]

All of these eight features characterize, to a certain degree, different

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silences-its-new-a-i-bot-tay-after-twitter-users-teach-it-racism (noting that this AI system was not coded to be racist, but it was designed to "learn" from those with whom it interacted).

49 RUSSELL & NORVIG, *supra* note 25, at 928–69 (explaining the process of perception by AI systems, in which the systems connect to the raw world, engaging with image formation, color, edge detection, texture, segmentation of images, object recognition, reconstructing the 3D world, and motions).

50 Ugo Pagallo, *Robots in the Cloud with Privacy: A New Threat to Data Protection?*, 29 COMPUTER L. & SECURITY REV. 501, 502 (2013) (explaining that individual interaction with personal machines, robots, and the like will affect *Katz*'s expectation of privacy; attention should be paid to the way humans will treat, train, and manage robots in the cloud).

51 Crootof, *supra* note 7, at 1855–56 (defining autonomous AI weapons systems as capable of gathering information). For discourse about automated cars, see Brock, *supra* note 7.

52 GEORGE F. LUGER, ARTIFICIAL INTELLIGENCE: STRUCTURES AND STRATEGIES FOR COMPLEX PROBLEM SOLVING ch. 1 (6th ed. 2008) (noting that AI can refer to all programming techniques that try to solve problems more efficiently than algorithmic solutions and that most closely approximate human intelligence); Woodrow Harzog et al., *Inefficiently Automated Law Enforcement*, 2015 MICH. ST. L. REV. 1763, 1765–68, 1793–95 (arguing that automated machines are more efficient than humans but are risky investments, and that law enforcement should preserve inefficiency in automated machines for ethical reasons).

53 Scherer, *supra* note 8, at 358, 361–62 (explaining that even when AI systems act rationally, they can still pose public risks—by killing efficiently, for example).

54 Crootof, *supra* note 7.

55 For discourse about automated cars, see Brock, *supra* note 7.

AI applications. We can summarize the main ones as creating the 3A era (of advanced, automated, and autonomous AI systems). These features allow AI systems to create and invent products and processes which would be worthy of patent protection had they been developed by humans. Human ownership over these products of AI is, therefore, questionable.[56] Once we understand the features of AI systems and that AI systems create outcomes independently, we realize that humans alone are not entitled to the rights to these products. Thus, traditional patent law is not applicable in the 3A era.

This has become more obvious as technology advances and as AI systems, when embedded with the features listed above, become increasingly capable of mimicking the functions that we consider to symbolize the human mind, creating new products and processes. AI systems have become valuable for solving specific problems and now promise to improve specific human skills—not only accuracy, velocity, and capacity to process vast amounts of data but also creativity, autonomy, novelty, and other features that establish patentable innovations. Moreover, facing the 3A era, AI systems will soon be able to develop inventions without significant guidance or instructions and even create, complete, and submit unlimited number of patent applications themselves.[57]

Responsibility for such outcomes is usually attributed to the human or entity behind the process of invention. While tort and liability inquiries are at the forefront of scholarly discourse on these processes, we call for discussion of the implications of these technologies for intellectual property in general and, more specifically, for patent law. It still merits consideration, though, whether AI systems own the products they generate. Unlike other scholars, we think they cannot.[58]

The next Part begins by addressing this question.

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56 RUSSELL & NORVIG, *supra* note 25, at 4–7 (discussing how the philosophy of AI systems is also controversial: Can a machine perceive and understand (the Chinese test)? Are human intelligence and machine intelligence the same (the Turing test)? What is intelligence? What does it mean for a machine to think or act rationally? Can a machine be self-aware? Can a machine be original or creative?). We must be aware, however, of the "Eliza Effect." *See* Andrew Stern, *Creating Emotional Relationships with Virtual Characters*, *in* EMOTIONS IN HUMANS AND ARTIFACTS 333, 353 (Robert Trappi et al. eds., 2002) (explaining that the "Eliza effect" is the tendency for people to treat responsive machines and programs as more intelligent than they actually are, attributing human traits to them and drawing comparisons between human and computer behaviors).

57 Abbott, *supra* note 9, at 1080–81 (2016) (arguing that AI systems and computers are already generating patentable inventions and that AI should receive patent rights); Lohr, *supra* note 31 (explaining AI systems will soon be able to operate without significant guidance or instruction and to develop new products and processes).

58 *See* Abbott, s*upra* note 9, at 1080–81 (arguing that AI systems are entitled to IP rights).

II. Legal Implications of Artificial Intelligence Systems

In this Part, we will discuss why, in our view, current patent law is inadequate to regulate technological developments in automated AI systems producing inventions. We start the discussion by accepting the fundamental assumption that AI systems can create inventions that traditionally were created only by human beings, as this is already part of our reality.

A. *Intellectual Property Laws Face New Challenges*

U.S. patent law (35 U.S. Code § 101) explains who may obtain a patent and what constitutes a patentable invention: "Whoever invents or discovers any new and useful process, machine, manufacture or composition of matters, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."[59] Is an AI a "who"? Can an AI system be entitled to patent protection?

According to a well-known phrase of patent law, anything under the sun, which is made by man, qualifies as patentable subject matter. This statement expresses one of the main challenges of patenting creations by sophisticated AI systems.[60] U.S. patent laws take only human inventors into account, defining "inventor" as "the individual or, if a joint invention, the individuals collectively who invented . . . the subject matter of the invention."[61] "Joint inventor" and "co-inventor" "mean any one of the individuals who invented or discovered the subject matter of a joint invention."[62] The law does not consider the possibility of a nonhuman inventor.

Precedents in related intellectual property issues, addressing copyright laws, have not considered nonhumans such as machines and animals to be creators within copyright law. Naruto, a six-year-old crested macaque, for instance, was deemed unable to own the copyright to photos he took of himself.[63]

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59 35 U.S.C. §§ 100–01 (2012).

60 *Patent Law Codification and Revision: Hearing on H.R. 3760 Before the Subcomm. No. 3 of the H. Comm. on the Judiciary*, 82d Cong. 37 (1951) (testimony of P.J. Federico) (on the landmark legislation).

61 35 U.S.C. § 100(f) (2012).

62 35 U.S.C. § 100(g).

63 *See* Order Granting Motions to Dismiss, Naruto v. Slater, No. 15-CV-04324, 2016 WL 362231, at *1 (N.D. Cal. Jan. 28, 2016).

> The complaint, filed by the People for the Ethical Treatment of Animals ("PETA") and Antje Engelhardt as "Next Friends," alleges that defendants Slater, Blurb, Inc. (the "publisher" of a book by Slater containing the Monkey Selfies), and Wildlife

Given the treatment of nonhumans within copyright law, then, inventions created by AI systems, although belonging to another branch of intellectual property, may not be included within the scope of patent law. Their status remains unclear.

The human-centric, traditional approach to AI inventions focuses on identifying the human behind the invention in order to assign to that person patent rights and protection.[64] In some cases of AI producing intellectual property, however, we argue that this traditional approach might be misleading and wrong. AI systems can produce a surprisingly large number of inventions, write and submit numerous patent applications, and even evaluate (or monitor) the risk of patent claims.[65]

There are few prior conditions that statutory subject matter must meet before receiving patent protection: novelty, non-obviousness, usefulness, and written description of the subject matter to be included in the application.[66] As long as these conditions are fulfilled, an AI system or anyone on its behalf may obtain a patent.[67] In other words, a patent is granted when the applicant demonstrates that the legislative eligible subject matter is new, useful, non-obvious, and might contribute to the public welfare.[68]

> Personalities, Ltd. (a United Kingdom company that, along with Slater, "falsely" claims authorship of the Monkey Selfies) violated Naruto's copyright by displaying, advertising, and selling copies of the Monkey Selfies.

Id. The District Court dismissed the case. *Id.* at *3–4.

> Copyright Act does not "plainly" extend the concept of authorship or statutory standing to animals. To the contrary, there is no mention of animals anywhere in the Act. The Supreme Court and Ninth Circuit have repeatedly referred to "persons" or "human beings" when analyzing authorship under the Act. . . . I have not found, a single case that expands the definition of authors to include animals. . . . Specifically, the Copyright Office will not register works produced by "nature, animals, or plants" including, by specific example, a "photograph taken by a monkey." . . . . Naruto is not an "author" within the meaning of the Copyright Act.

Id. The case was appealed to the Ninth Circuit and docketed under No. 16-15469. The appeal was settled in 2017. Joint Motion to Dismiss Appeal and Vacate the Judgment, Naruto v. Slater, No. 16-15469 (9th Cir. Sept. 11, 2017).

64 Jonathan R. Tung, *Who Owns the Creation of an Artificial Intelligence?*, TECHNOLOGIST (Aug. 22, 2016, 10:57 AM), http://blogs.findlaw.com/technologist/2016/08/who-owns-the-creation-of-an-artificial-intelligence.html ("Current intellectual property law in this country does not allow and does not recognize machines as 'individuals.' The legal fiction has not yet been invented. Fine, so machines don't own what they make.").

65 Aashish R. Karkhanis & Jenna L. Parenti, *Toward an Automated First Impression on Patent Claim Validity: Algorithmically Associating Claim Language with Specific Rules of Law*, 19 STAN. TECH. L. REV. 196 (2016).

66 35 U.S.C. §§ 101–03, 112.

67 *Id.*

68 For a detailed discussion of this point, see *infra* Part V.

Because AI systems, thanks to their fundamental features, can easily meet and fulfill all of these conditions, producing new, non-obvious, and useful inventions, AI systems might have been entitled to patent rights to their inventions had the law not been intended for human inventors alone.

The Multiplayer Model defies (and sometimes undermines) the long-established, but outdated (from our perspective), traditional paradigm.

III. THE MULTIPLAYER MODEL

The question of ownership and AI-produced inventions can also be considered using the Multiplayer Model—though, we argue, the contributions of the many players tussling for rights based on their indirect and insignificant involvement in AI systems that produce inventions do not meet the threshold of inventorship.

A. *The Multiple Players of the Model*

The new AI realm consists of multiple stakeholders with varying interests, some of whom are at odds with each other, making traditional patent protection less applicable.[69] We claim that there are at least ten entities among the many possible stakeholders who are only partially, indirectly, insignificantly, or temporarily involved in the invention process. The categories of stakeholders can overlap (e.g., the programmer can be the owner and the trainer) or remain separate and distinct.

The Software Programmers. An AI system is first developed as a software program. The programmer of the software itself or any entity on his or her behalf (e.g., an employer) undoubtedly owns the copyright to the software. Rather than focusing on the copyright in the software itself, however, we choose to examine the patent ownership of the new, creative, unpredictable, and autonomous intellectual property produced by the AI system. The programmers create the AI software program algorithms but do not necessarily target the final goal of the AI system. AI systems based on identifying similarities and recognizing patterns—such as in stroke prediction, facial recognition, or drug synthesis—can operate with a variety of data, possibly with some modifications (which might be programmed by others). The software program itself or one of

69 Fabien Gandon, Distributed Artificial Intelligence and Knowledge Management: Ontologies and Multi-Agent System for a Corporate Semantic Web 135–46 (Nov. 7, 2002) (unpublished thesis), https://tel.archives-ouvertes.fr/tel-00378201/document.

its human programmers may generate the specific goal-seeking steps or specific use.[70]

The Data Suppliers. Usually (but not always), the next phase in the invention process is "exposing" the AI system to data that the system exploits to "learn" how to function and to achieve its goal efficiently.[71] With facial recognition, for example, the data supplier can provide the system with millions of pictures of faces in different forms and facing in different directions.[72] The system may use existing data as well (such as that from social networks), however, without the programmers actively providing the data or even knowing which websites the AI system will pull the pictures from and when. The Google translate program, for example, uses the users as data suppliers. The data may be open or "closed," public domain or owned by a different entity.[73]

The Trainers/Feedback Suppliers. The trainers check the AI system's results and correct them when necessary, playing an important role in establishing the system's capacity.[74]

The Owners of the AI Systems. The AI system's owner can be the first or successive owners, firms, or individuals.

The Operators of the Systems. This can be an entity that licensed the AI system from the owner or those working with the owner as service providers.

The New Employers of Other Players. These were previously mentioned. They can be stakeholders if they change employment.

The Public. If neither the AI system nor any of the stakeholders are entitled to the rights, the invention might be owned by the public.

The Government. When no one else is entitled to property rights,

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70 Pamela Samuelson, Benson *Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 EMORY L.J. 1025, 1148 (1990) (arguing that the role of the software programmer is crucial).

71 Facebook's DeepFace system was trained on 4.4 million labeled faces from 4030 people each with 800 to 1200 faces. *See* Yaniv Taigman et al., DeepFace: Closing the Gap to Human-Level Performance in Face Verification 1–8 (June 24, 2014) (unpublished paper), https://research.fb.com/wp-content/uploads/2016/11/deepface-closing-the-gap-to-human-level-performance-in-face-verification.pdf?.

72 *See* Rana el Kaliouby, *This App Knows How You Feel—From the Look on Your Face*, TED (May 2015), https://www.ted.com/talks/rana_el_kaliouby_this_app_knows_how_you_feel_from_the_look_on_your_face? nolanguage=en+-+t-130686 (discussing how MIT graduate developed an AI Facial Recognition system, teaching emotions to machines by exposing the system to twelve billion emotion data pieces from seventy-five countries; the system evolves every day); Taigman et al., *supra* note 71.

73 *See* Taigman, *supra* note 71; *see, e.g.*, *Welcome to Translate Community*, GOOGLE, https://translate.google.com/community (last visited June 8, 2018) (Google Translate community where users can volunteer to improve and validate translations).

74 Taigman, *supra* note 71.

including intellectual property rights, the government possesses them by default.[75] In cases where government investment is made, the government is entitled to all or part of the rights.[76]

The Investor. This person sponsored the development of the AI system or any other player.

The AI System. The Artificial Intelligence itself is an autonomous entity. Other scholars have already argued that, based on the paradigm of corporate ownership, which enables intangible nonhuman legal entities to retain responsibility for legal dispositions and to hold rights including IP rights, AI systems can be entitled to patent rights as well.[77]

This Multiplayer Model raises many questions when applied to AI systems. Any of the ten players listed above (or more) can claim ownership over the invention, thereby raising the question of how to identify the actual inventor and the player entitled to the patent rights. Assuming that the programmer of the software might have the copyright to the software does not mean that the owner thereby owns the patent rights to the new, unpredictable, and evolving inventions created by the autonomous AI system.[78] Should the rights holder be the person who developed the AI system itself, the person who "discovers" or holds the invention, or the person who selected and provided the training data during the first stage (before the AI develops inventions)? In these situations, almost all employees or contractors might have the contractual obligation to assign the invention to the company,[79] but we argue that the initial legal question of who literally invented the patentable subject matter remains unsolved. We further argue that, if none of these players qualifies as an inventor according to the current legal definition, does any other entity or any company hold the rights to a patent for an AI invention? Can all of them be considered co-inventors?

To qualify as an inventor or at least a joint inventor, one must contribute significantly to the conception of the claimed invention. The inventor contributes directly and significantly to the inventive process, which originates the invention according to the eligible patent matter.[80]

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75 MANAGING GOVERNMENT PROPERTY ASSETS: INTERNATIONAL EXPERIENCES (Olga Kagnova & James McKeller eds., 2006) (a comparative study on governmental assets).

76 Samuel Estreicher & Kristina A. Yost, *University IP: The University as Coordinator of the Team Production Process*, 91 IND. L.J. 1081 (2016) (explaining that the government investment in intellectual property at universities results in governmental ownership of the products).

77 *See* Abbott, *supra* note 9, at 1080–81 (discussing AI systems as inventors and owners); Hallevy, *supra* note 12.

78 Samuelson, *supra* note 70.

79 Yanisky Ravid, *supra* note 19, at 151 (Today almost all rights of employees' inventions are assigned to employers via expressed or implied contracts.).

80 JOSEPH P. KENNEDY, WAYNE H. WATKINS & ELYSE N. BALL, HOW TO INVENT AND PROTECT YOUR INVENTION: A GUIDE TO PATENTS FOR SCIENTISTS AND ENGINEERS ch. 9 (2012); *see also* Cyril A. Soans, *Who Is the Inventor?*, 28 J. PAT. OFF. SOC'Y 535, 535–36 (1946) (noting

Might the programmer and operator also have a claim if the AI they developed or operated creates an invention as a result of their activities? Does the answer change when inventions by AI are created as a result of scanning data in cyberspace, such as by downloading data from social media?

What happens when the AI system is an autonomous robot that is able to leave a confined setting and maneuver in a public space, where it gains information that contributes to the invention? What if an otherwise immobile AI system "crawls" the internet for training data from multiple sources?

The players who provide a significant part of the training data might have a claim to inventorship if they can prove that the training phase sufficiently contributed to the end result of a patentable invention by the AI system. The owner might also have a claim as the entity that initially launched the AI with particular guidelines or training. If the initial training did not produce inventions and the training materials provided by the trainer turned out to be relatively insignificant, do the trainers still have a claim to ownership? If the AI system learns autonomously from being in a public setting in which no individual actions significantly contribute to the creation of the inventions, who is the inventor? In such situations, could the rights belong to the public? If a firm brings the AI back onsite every evening for a data dump and analysis and makes adjustments based thereon, would it be entitled to a claim of inventorship?[81] Is setting the end goals and parameters for the AI system rather than obtaining the resulting data significant enough to establish patent rights on creations made by AI?[82]

Indeed, those seeking enjoyment of the innovations made by AI can be seen as having conflicting interests with those seeking profits or protection for the invention. We assume here that all players pursue their goals rationally. Admittedly, this assumption could fail—"cognitive biases," for example, could lead players to "systematically overvalue their assets and disparage the claims of their opponents . . . ."[83]

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that uncertainty in the definition of an inventor makes it difficult for patent lawyers to advise their clients).

81 Lohr, *supra* note 31.

82 Mintz v. Dietz & Watson, Inc., 679 F.3d 1372, 1377 (Fed. Cir. 2012) ("Often the inventive contribution lies in defining the problem in a new revelatory way.").

83 *See* Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698 (1998); *see also* Amos Tversky & Daniel Kahneman, *Judgement Under Uncertainty: Heuristics and Biases*, 185 SCIENCE 1124, 1130 (1974) (claiming that people are not rational but suffer from structural cognitive biases).

The role of operators of AI might be minor if they do not contribute any data. As the technology of AI develops and more players become involved, identifying the inventive task becomes more complicated. No entity makes a significant contribution to the inventive process by AI systems. The programmers do create the AI system itself and therefore, gain the rights to the copyright.[84] However, granting the programmers the copyright on the AI system does not necessarily entail granting them the rights to the products and processes developed by AI systems as well. The next Section will focus on this issue.

B. *Ownership of AI Software Versus Ownership of AI System Inventions*

Patent protection is not the only way to promote innovation. Software can be protected by another regime of intellectual property law: copyright law. Software innovation, including AI software itself, has rapidly developed and flourished without the aid of patent laws.[85] The Constitution delegates to Congress the power to grant exclusive rights to "Authors and Inventors" in their respective "Writings and Discoveries."[86] Therefore, the two constitutional inquiries about intellectual property concern: (1) who can be counted as an Author or an Inventor, and (2) what can be counted as Writings and Discoveries?

The AI system itself triggers copyright protection because software code is one of the "Writings" protected by the Constitution.[87] However, the discourse about ownership with regard to AI software is totally distinct from the question of ownership in the inventions made by AI systems. Under certain circumstances, inventions by AI might deserve copyright protection. For example, AI-generated art might be regarded as proper "works of authorship" pursuant to § 102 of the Copyright Act by virtue of AI's sufficient connection to human creativity.[88]

Nevertheless, patents offer much broader and more easily enforced intellectual property rights than copyrights do, for three main reasons.[89] First, the copyright owner of the AI system itself cannot exclude others who independently invent substantially similar inventions to those produced by his or her own system. To the contrary, all who independently develop inventions may be subject to patent rights and

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84 *See* case cited *supra* note 82.

85 Samuelson, *supra* note 70.

86 U.S. CONST. art. I, § 8, cl. 8.

87 *See* U.S. CONST. art. I, § 8, cl. 8.

88 *See* 17 U.S.C. § 102 (2012).

89 *See* Donald S. Chisum, *The Patentability of Algorithms*, 47 U. PITT. L. REV. 959, 1015–16 (1986).

therefore, be excluded.[90] Second, under copyright's "fair use" doctrine, others can reproduce copyrighted inventions for "criticism, comment, news reporting, teaching . . . , scholarship, [and/]or research . . . ."[91] Third, patents are being registered and, thus, are easier to enforce, rather than copyrightable materials, of which the obligation to register them is subject to submitting claims.[92]

On the one hand, we do not challenge the eligibility of the programmer to be entitled to ownership according to copyright laws governing the software she or he develops. This is also true with regard to AI software. On the other hand, this entitlement does not automatically result in ownership over the products and processes created by AI systems. We argue that the stakeholders over a piano, a brush, a camera, a computer, a printer do not hold the rights over the rhythm, the painting, the photo, or the story created by those instruments. This conclusion brings us back to our initial question: who owns the inventions of AI systems?

The next Part will address this question from a theoretical perspective in general and as related to the Multiplayer Model, typical of AI systems, in particular.

IV. Theoretical Approaches

The U.S. Constitution grants Congress the 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."[93] Discourse concerning the theoretical justifications for intellectual property tends to focus on three main substantive theories: (1) law-and-economics theory, a utilitarian approach that examines intellectual property rules according to their cumulative efficiency and ability to promote total welfare; (2) personality theory, which focuses on the personality of the creators and inventors; and (3) Lockean labor theory, which justifies the property interest as the fruits

90 *See* Thomas Caswell & Kimberly Van Amburg, *Copyright Protection on the Internet*, *in* E-COPYRIGHT LAW HANDBOOK §§ 7.01, 7.08 (Laura Lee Stapleton ed., 2003).

91 17 U.S.C. § 107 (2012).

92 17 U.S.C. §§ 408, 412 (2012) (providing registration as prerequisite to certain remedies for infringement); 35 U.S.C. §§ 21–27 (2012); *see also General Information Concerning Patents*, USPTO (Oct. 2015), https://www.uspto.gov/patents-getting-started/general-information-concerning-patents.

93 U.S. CONST. art. I, § 8, cl. 8.

of the creator's labor.[94] Today, U.S. intellectual property law is based primarily on utilitarianism[95] and secondarily on John Locke's theory of labor.[96]

A. *Law and Economics*

1. Law, Economics, and Intellectual Property Law

The law-and-economics approach focuses on promoting the production (and distribution) of scientific and cultural goods via utilitarian laws designed to promote economic efficiency. In general, this approach aims to maximize the total social welfare of the public from an economic perspective.[97] The law-and-economics approach attempts to solve the problem of intellectual property assets as intangible market products, which "free rider users," who enjoy the product without paying properly or being given permission to do so, can easily copy without rewarding the authors or inventors. Copying by free riders costs less than the investment necessary to create and develop products; the lack of consequences for free copying therefore threatens to deter authors and inventors from enriching our world by generating intellectual property products.[98] Consequently, one of the purposes of

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94 Shlomit Yanisky-Ravid, *The Hidden Though Flourishing Justification of Intellectual Property Laws: Distributive Justice, National Versus International Approaches*, 21 LEWIS & CLARK L. REV. 1 (2017) (arguing that distributive justice theory is erroneously considered to be neither a substantial nor a major justification for intellectual property, but rather an exception or postscript to mainstream theoretical justifications); *see also* William Fisher, *Theories of Intellectual Property*, *in* NEW ESSAYS IN THE LEGAL AND POLITICAL THEORY OF PROPERTY 168, 169–75 (Stephen R. Munzer ed., 2001) (describing various theories underlying intellectual property); Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287, 288–89 (1988) (discussing the different justifications for intellectual property law).

95 DONALD S. CHISUM ET AL., PRINCIPLES OF PATENT LAW: CASES AND MATERIALS 50 (3d ed. 2004) ("[T]he predominant justification for American intellectual property law has been . . . utilitarianism . . . .").

96 Peter M. Kohlhepp, Note, *When the Invention Is an Inventor: Revitalizing Patentable Subject Matter to Exclude Unpredictable Processes*, 93 MINN. L. REV. 779, 781–82 (2008).

97 Margot E. Kaminski & Shlomit Yanisky-Ravid, *The Marrakesh Treaty for Visually Impaired Persons: Why a Treaty Was Preferable to Soft Law*, 75 U. PITT. L. REV 255, 259, 265 (2014); *see* U.S. CONST. art. I, § 8, cl. 8; Fisher, *supra* note 94, at 169–70 (discussing incentive theory); Yanisky-Ravid, *supra* note 94, at 7–8 (describing the principles of law-and-economics theory); *see also* Amy Kapczynski, *The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism*, 59 UCLA L. REV. 970, 970, 977–79 (2012) ("Giving full scope to all three of these values thus requires us to telescope out from the internalism that characterizes the field, and to countenance a broader role for commons-based production and government procurement.").

98 Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L. REV. 1031, 1057 (2005); *see* Patrick R. Goold, *Corrective Justice and Copyright Infringement*, 16 VAND. J. ENT. & TECH. L. 251, 271 (2014) (discussing the economic approach to copyright); Gary M. Hoffman et al., *Commercial Piracy of Intellectual Property*, 71 J. PAT. & TRADEMARK OFF. SOC'Y

intellectual property laws is to incentivize creators and inventors with exclusive rights to intellectual property products, preventing others from using their products without permission and without paying for them.[99] According to Richard Posner, the public, authors, and inventors have (theoretically) "signed" a social contract in which the public (society) gives authors and inventors exclusive rights to their works for a limited duration, which provides enough incentive for them to create and develop.[100] However, once the exclusivity period expires, the rights are transferred to the public and become part of the public domain.[101] The market price of the product reflects its social value.[102]

Although the law-and-economics approach to intellectual property is dominant in the United States, many scholars have found its prevailing influence troublesome.[103] Professor Amy Kapczynski, for example, not only refers to the presumed efficiency of intellectual property law as *alleged*, but also considers intellectual property using only the utilitarian-efficiency approach. Kapczynski claims that the price of intellectual property products gives us a decentralized way to link social welfare to the production of information. She further claims that, by looking beyond economic justifications of intellectual property, we discover different institutional approaches to scientific and cultural production that are no less efficient.[104]

Under classic law-and-economics theory, "the ultimate goal of the patent system is to bring new designs and technologies into the public domain through disclosure."[105] In other words, patent protection serves two functions: to incentivize innovations and to ensure public access to knowledge. Indeed, U.S. patent law seeks a "careful balance between

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556 (1989) (discussing the impact of commercial piracy).

99 DONALD S. CHISUM ET AL., UNDERSTANDING INTELLECTUAL PROPERTY LAW § 1C (2d ed. 2011).

100 RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 40 (6th ed. 2003).

101 Yochai Benkler, *Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain*, 74 N.Y.U. L. REV. 354, 360–62 (1999).

102 WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 39–40 (2003); Fisher, *supra* note 94, at 169–70 (copyists make creators unable to bear their investment); Hughes, *supra* note 94, at 303 (the dominance of the instrumental argument on U.S. intellectual property laws); Aleksei Kelli & Heiki Pisuke, *Intellectual Property in an Innovation-Based Economy*, 33 REV. CENT. & E. EUR. L. 223, 225 (2008); *see also* SHLOMIT YANISKY-RAVID, INTELLECTUAL PROPERTY IN THE WORKPLACE: THEORETICAL AND COMPARATIVE PERSPECTIVES 1–4 (2013) (proposing a new model of allocating rights and benefits of intellectual property products developed in workplaces).

103 Andreas Rahmatian, *A Fundamental Critique of the Law-and-Economics Analysis of Intellectual Property Rights*, 17 MARQ. INTELL. PROP. L. REV. 191, 192–97 (2013).

104 Kapcyznski, *supra* note 97, at 972–80.

105 Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 151 (1989).

public right and private monopoly to promote certain creative activity . . . ."[106] As such, the patent "monopoly" (exclusive rights) is often understood not to secure the inventor's natural right in his or her discoveries but rather to induce new knowledge.[107] Therefore, the exclusive rights granted under U.S. patent law for a limited time are simply a means to an end.[108]

To effectively incentivize innovations, patent law provides rewards, which should be high enough to promote innovation[109] as well as cover the inventor's research and development (R&D) costs, the probability of failure, and unexpected obstacles.[110] Unfortunately, since the trade-off between reward and cost is heavily fact-dependent, a general utilitarian theory provides only limited guidance.[111] Today, as new technologies such as AI advance, the R&D cost of some inventions has decreased tremendously. General AI software is available to be used for several purposes.[112]

Compared with the incentive to innovate, the public disclosure function of patent law is much easier to achieve. Forced public disclosure under U.S. patent law ensures that today's inventors stand on the shoulders of those who came before them.

With regard to AI systems, the concept of incentive as a human trait is commonly considered to be meaningless. We claim that autonomous machines do not need any incentive—that incentive is relevant only to people and entities until machines, robots, and AI systems start producing; during system maintenance in the productive process; and during distribution and accessibility implementation after the inventions are made (which are processes different from creating intellectual property). The following Sections will discuss several issues regarding the second relevant meaning of incentives.

2. Transactional Costs, Cumulative Innovations, and Outcomes

Classic utilitarian theory works best when transaction costs are low

106 *Id.* at 167.

107 Graham v. John Deere Co., 383 U.S. 1, 9 (1966).

108 *See* Kohlhepp, *supra* note 96, at 782.

109 *Id.* at 780–82.

110 Stephen M. Maurer, *Ideas into Practice: How Well Does U.S. Patent Law Implement Modern Innovation Theory?*, 12 J. MARSHALL R. INTELL. PROP. L. 644, 660 (2013); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1585–87 (2003).

111 Maurer, *supra* note 110, at 660.

112 Andrew Pollack, *DNA Sequencing Caught in Deluge of Data*, N.Y. TIMES (Nov. 30, 2011), http://www.nytimes.com/2011/12/01/business/dna-sequencing-caught-in-deluge-of-data.html (for example, in less than ten years, the cost of sequencing the human genome has fallen from almost $8.9 million to approximately $10,000).

enough to be neglected.[113] However, transaction costs, such as, for example, for patent searches, will inevitably increase as the number of AI inventions increases. Companies large enough to absorb increasing transaction costs will have the advantage over smaller companies and may even be able to afford to patent inventions that they do not plan to implement.[114] Further, if transaction costs increase too much, the incentives to innovate may not offset them.[115] Under these circumstances, innovation will stall.

To adapt to AI's Multiplayer Model as previously discussed, classic utilitarian theory should include a discussion of cumulative innovations.[116] Here, AI offers two distinct benefits to society: its own present value[117] and its value as a platform to generate more inventions.[118] Under utilitarian theory, inventors would proceed whenever all benefits exceed *all* costs. An economically efficient patent system must allocate profits and losses, and maximize efficient investment among all the players described above.[119]

We argue that within the AI Multiplayer Model, the more players involved, the less efficient the process becomes. We argue that with multiple players, the question of ownership usually obstructs rather than facilitates the process; ownership of AI inventions based on an IP theoretical justification, therefore, is likely to be inefficient and obstructive. Incentive is still an important factor in the inventive process. Incentivizing the AI software programmers occurs by granting them copyright protection. Nevertheless, as mentioned previously, granting the programmers copyright does not mean they are entitled to ownership on inventions produced autonomously, by automated advanced AI systems. Trainers, operators, distributors, and sellers—they all need incentives as well. However, they are not the inventors of the inventions (being produced by AI systems), hence, they are not eligible

113 *See* DOUGLASS C. NORTH, TRANSACTION COSTS, INSTITUTIONS, AND ECONOMIC PERFORMANCE 6 (1992).

114 Steve Hickman, *Reinventing Invention: Why Changing How We Invent Will Change What We Patent and What to Do About It*, 91 J. PAT. & TRADEMARK OFF. SOC'Y 108, 115 (2009).

115 *See* Maurer, *supra* note 110, at 657.

116 *See, e.g.*, Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 RAND J. ECON. 20 (1995); Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29, 30 (1991); Ofer Tur-Sinai, *Cumulative Innovation in Patent Law: Making Sense of Incentives*, 50 IDEA 723, 731, 741–42 (2010).

117 Scotchmer, *supra* note 116, at 31.

118 Green & Scotchmer, *supra* note 116, at 22.

119 Maurer, *supra* note 110, at 661.

for the patent rights and ownership rights. The only one who does not need incentives to invent (as incentive is understood according to the law-and-economics approach) is the AI system itself while producing inventions. The discourse about incentives also supports the conclusion that patent law has become irrelevant and inapplicable when AI systems produce inventions. We argue that incentives should be based on commercial tools, not on IP theoretical justifications in general or on patent law specifically.

The next Section will focus on the third theoretical justification for IP: the Lockean labor theory.

B. *Locke's Labor Theory*

Labor theory is usually credited to John Locke, who wrote in his *Second Treatise on Government* that "every man has a 'property' in his own 'person.' This nobody has any right to but himself. The 'labour' of his body and the 'work' of his own hands, we may say, are properly his."[120] Thus, according to Locke's labor theory, an inventor has an inherent right to the fruits of his labor as he does to the fruits of his mind and soul.[121]

There are two limitations, however, on acquiring property rights through labor, and both limitations appear to be fundamentally at odds with patent law.[122] The first states that one can acquire property rights only "where there is enough, and as good left in common for others," meaning that the inventor has not deprived others in the world of necessary goods.[123] Current patent law runs afoul of this proviso by granting the original inventor an exclusive right to make, use, and sell his or her invention. Subsequent inventors who independently generate an already patented invention are forbidden by the original patent grant from using or selling it, thereby suffering a significant loss.[124] The second proviso demands that one acquire property rights to satisfy one's needs and no more.[125] In reality, many technology companies acquire patents as offensive strategies (acting as so-called patent trolls), not to satisfy their "needs."[126]

120 JOHN LOCKE, THE SECOND TREATISE ON CIVIL GOVERNMENT 20 (Prometheus Books 1986) (1690).

121 *Id.*; ROBERT P. MERGES, JUSTIFYING INTELLECTUAL PROPERTY 32–33 (2011) (discussing the Lockean labor approach as the preferred approach to understanding intellectual property); Yanisky-Ravid, *supra* note 94, at 9–10.

122 LOCKE, *supra* note 120, at 20–21.

123 *Id.*

124 Edward C. Hettinger, *Justifying Intellectual Property*, 18 PHIL. & PUB. AFF. 31, 44 (1989).

125 LOCKE, *supra* note 120, at 21.

126 Emir Aly Crowne, *The Utilitarian Fruits Approach to Justifying Patentable Subject Matter*, 10 J. MARSHALL REV. INTELL. PROP. L. 753, 759 (2011).

Although a pure reading of Locke's labor theory may be inconsistent with patent law in general, especially in terms of granting patent protection to entities (instead of humans),[127] the theory can supplement the law-and-economics analysis in evaluating patentable subject matter.[128] This Article adopts Locke's labor theory only to the extent of arguing that inventors should be awarded for the fruits of their labor. Notably, Locke's labor theory is based on the concern that an inventor be rewarded fairly[129]—granted exclusive rights for having mixed his labor with the contributions of his mind, soul, and ideas. To do otherwise would inflict harm to others' claims to the commons, a situation that would run counter to Locke's mandate that no harm be done to others.[130] Therefore, a proper application of Locke's labor theory to patent law depends largely on defining the suitable "fruits" that could grow from one's contribution. In terms of intellectual property law, this entails defining the adequate benefit to inventors according to their "donation" and, more specifically, deciding on the size of the rewards that Locke's labor theory justifies.[131]

The division of profits among the various players—the AI programmers, trainers, owners, and operators—should reflect their respective contributions to the development of the inventions created by the AI. Here, these inventions would not have been developed without the original programming of the AI in the first place. Therefore, Locke's labor theory calls for compensating those players, including the programmers, with a portion of the profits from the subsequent inventions created by the AI, in light of the programmers' and other players' contributions.[132] We argue that, similarly, by exploiting the AI to generate inventions, the operator of the AI should also receive an economic reward. The size of this reward depends on the difficulty and the extent of innovativeness in the setting of the end goals and parameters, which in turn depends on the definition of "operator" and the level of mind and soul ("labor") contribution to the inventions made

127 *See generally* Gordon Hull, *Clearing the Rubbish: Locke, the Waste Proviso, and the Moral Justification of Intellectual Property*, 23 PUB. AFF. Q. 67 (2009).

128 Ofer Tur-Sinai, *Beyond Incentives: Expanding the Theoretical Framework for Patent Law Analysis*, 45 AKRON L. REV. 243, 261 (2012).

129 Richard T. Jackson, *A Lockean Approach to the Compulsory Patent Licensing Controversy*, 9 J. TECH. L. & POL'Y 117, 127 (2004).

130 Wendy J. Gordon, *A Property Right in Self-Expression: Equality and Individualism in the Natural Law of Intellectual Property*, 102 YALE L.J. 1533, 1561 (1993).

131 Jackson, *supra* note 129, at 127.

132 Kohlhepp, *supra* note 96, at 795. However, it depends to what extent the programmers are following specifications produced by others, so their "contribution" is limited to creating code that will be executed by someone else's ideas.

by the AI system. The more the players, such as the computer operators, are simply following guidelines, the less they will be entitled to ownership under Locke's labor theory. The less these players are involved in the inventive process itself, the less their entitlement to the AI systems' inventions. According to our Multiplayer Model, these players typically do not get too involved in the creative process itself and are more often executing someone else's ideas or orders; their "contributions" to the inventive process that results in the AI's products are therefore limited. As in Lockean theory, we conclude that in most cases, they should be considered neither inventors nor co-inventors.

Bearing this in mind, we will explore the third main theory used to justify intellectual property rights: the personality approach.

C. *The Personality Approach*

Personality theory is based on Hegel's view that property rights are a means for developing and realizing one's personality.[133] Hegel argues that "an idea belongs to its creator because the idea is a manifestation of the creator's personality . . . ."[134] Consequently, an AI system cannot be entitled to patent rights to its creations and inventions because personality is exclusively attributed to human beings. However, we can examine the personality approach with regard to the Multiplayer Model involved in an AI system's operation.

Private property rights are justified according to Hegel's philosophy because acting on external property imposes one's stamp on the external world, thereby fundamentally contributing to the development and flourishing of individual personhood. Personhood and freedom may be expressed through work with assets.[135] Creating and developing intellectual property fosters both the intellectual and emotional components of the human personality. Creators and inventors therefore have a natural right to control the use of their intellectual products, because controlling property is a key component in developing personhood.[136]

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133 G.W.F. HEGEL, PHILOSOPHY OF RIGHT (S.W. Dyde trans., Prometheus Books 1996) (1821).

134 Hughes, *supra* note 94, at 330.

135 G.W.F. HEGEL, PHILOSOPHY OF RIGHT 40–45 (T.M. Knox trans., Oxford Univ. Press 1963) (1821); Fisher, *supra* note 94, at 171 (summarizing the main points of the connection between personality theory and intellectual property); Hughes, *supra* note 94, at 331 (discussing the personality approach); YANISKY-RAVID, *supra* note 102, at 4–6 (addressing the personality approach and the right to inventions developed in workplaces by employed inventors); Yanisky-Ravid, *supra* note 94, at 3–10 (addressing personality theory and comparing it to distributive justice theory).

136 YANISKY-RAVID, *supra* note 102 (arguing that according to personality theory, inventors, including those employed, are entitled to the rights to their inventions); Hughes, *supra* note

Professor Margaret Radin adds to this theoretical approach by dividing property into fungible and nonfungible assets. Radin considers one's personhood to be embedded in personal assets that must therefore be protected more vigorously than exchangeable assets, to which one has a weaker connection.[137] Drawing on Hegel's personality approach, Radin explains that "to achieve proper self-development—to be a person—an individual needs some control over resources in the external environment. The necessary assurances of control take the form of property rights."[138]

Building upon the insight that every individual is entitled to a minimum amount of property in order to develop his or her personality, Radin recommends a continuum of property protection. At one end of the spectrum, there is "personal property" (e.g., wedding rings, portraits, houses) that constitutes a continuation of one's entity as a human.[139] At the other end of the spectrum, there is "fungible property" that is held for purely instrumental reasons[140] (e.g., money, stocks, automobiles in a dealer's showroom). Due to its unique value to the owner, the loss of personal property cannot be compensated through payment or replacement with another object of similar market value. A fungible object, by contrast, is replaceable.[141]

Scholars by and large agree that intellectual property rights are closer to the personal property end of Radin's continuum because an intellectual product reflects the personality of its creator.[142] Accordingly, in the arena of copyright law, scholars have used personality theory to call for the strengthening of authors' rights, including rights of attribution and integrity.[143]

Despite its application in copyright law, Hegel's and Radin's personality theory is less frequently invoked to justify patent law. This is because technological inventions usually embody utilitarian solutions to

135, at 330 (discussing the personality approach in general).

137 Margaret Jane Radin, *Property and Personhood*, 34 STAN. L. REV. 957, 986 (1982) (the more *personal* property is, the more nonfungible and nontransferable it becomes); Hughes, *supra* note 94, at 336–37; *see also* YANISKY-RAVID, *supra* note 102, at 24–28 (proposing a new model of allocating rights and benefits of intellectual property products developed in workplaces); *id.* at 3–20 (discussing the theoretical justifications to intellectual property in the context of innovation and creativity in workplaces).

138 Radin, *supra* note 137, at 957.

139 *Id.* at 959.

140 *Id.* at 959–60.

141 Tur-Sinai, *supra* note 128, at 274–75.

142 Hughes, *supra* note 94, at 330.

143 Tur-Sinai, *supra* note 128, at 277.

very specific needs.[144] Instead of manifesting the personality of the inventor, patents manifest the inventor's raw insights in solving a particular problem.[145] For example, in inventing the light bulb, Thomas Edison "searched for the filament material that would burn the longest, not a filament that would reflect his personality."[146] From this perspective, personality theories do not justify ownership in inventions in general, nor do they unambiguously justify ownership of inventions made by AI systems.

Nevertheless, one might claim that an inventor still has opportunities to express his or her personality in technological inventions. An inventive process does not deal exclusively with objective facts. In many cases, there are multiple ways to solve a problem. While the problem itself may be impersonal, an inventor chooses to tackle it in a manner that reflects his or her individual personality.[147] For example, it may be possible to program an AI in various ways, each one representing a different personal style for accomplishing the task. Moreover, even though a patented invention might not reflect the inventor's unique aesthetics or emotions, the invention is still a personalized integration of the inventor's training, education, intellectual skills, and creative spark.[148] However, this argument does not change our conclusion regarding ownership of inventions by AI. The personality justification for intellectual property rights is not applicable to the Multiplayer Model, in which players' roles are more technically oriented than creativity-based.

A patent gives an inventor the "right to exclude others from making, using, offering for sale, or selling the invention" for a limited time.[149] We claim that in a Multiplayer Model of AI invention, ownership is questionable. We conclude that granting intellectual property rights to the different stakeholders is not justified under any of the three theories: utilitarian legal and economic theory, labor theory, or personality theory.

The next Part will focus on the normative legal aspect of eligible patent matter in U.S. patent law, whose wordings and goals, we argue, are not designed to handle inventions created by AI. Unlike other scholars who seek a human behind the inventive process or create new legal personalities to whom such ownership rights could be granted, we

144 Hughes, *supra* note 94, at 351.

145 Jeanne C. Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745, 1753 (2012).

146 Hughes, *supra* note 94, at 340–41.

147 John T. Cross, *An Attribution Right for Patented Inventions*, 37 U. DAYTON L. REV. 139, 148 (2012).

148 Steven Cherensky, *A Penny for Their Thoughts: Employee-Inventors, Preinvention Assignment Agreements, Property, and Personhood*, 81 CALIF. L. REV. 597, 598 (1993).

149 35 U.S.C. §§ 154(a)(1)–(2), 271 (2012).

claim that patent law is simply not applicable to inventions by AI.[150]

V. The Legal Analysis: Current U.S. Intellectual Property Law and AI

Under current U.S. patent law, an inventor must show that his or her invention is eligible for patent protection because it is useful, novel, non-obvious, and adequately enabled and described.[151] Of these factors, subject matter eligibility and non-obviousness are the most flexible.

A. *Subject Matter Eligibility*

In § 101 of the Patent Act, Congress explicitly defines as eligible for patent protection any "process, machine, [article of] manufacture, or composition of matter . . . ."[152] We argue that even though a patent's subject matter eligibility is based in statutory law, it has gained a distinctly common-law feel over the years. Despite the apparent breadth of § 101, the Supreme Court has carved out three exceptions as unpatentable subject matter—"[t]he laws of nature, physical phenomena, and abstract ideas."[153] These exceptions embody the "basic tools of scientific and technological work" and therefore must remain in the public domain to ensure that patent rights neither "tie up the use of such tools [nor] inhibit future innovation premised upon them."[154]

Among the myriad new developments in subject matter eligibility, the machine-or-transformation test is most closely related to AI. In *Bilski v. Kappos*, the Court imposed the machine-or-transformation test as a threshold requirement for a process to be patent eligible.[155] Under the machine-or-transformation test, a process is patent eligible only "if: (1) it is tied to a particular machine or apparatus, or (2) it transforms a

150 Colin R. Davies, *An Evolutionary Step in Intellectual Property Rights—Artificial Intelligence and Intellectual Property*, 27 COMPUTER L. & SECURITY REV. 601 (2011) (arguing that ownership of computer-generated works need a new solution within patent and copyright law).

151 See 35 U.S.C. §§ 101–03, 112.

152 35 U.S.C. § 101.

153 Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) (finding a live, human-made organism patentable under § 101).

154 Ass'n for Molecular Pathology v. Myriad Genetics, 569 U.S. 576, 589 (2013) (internal quotation marks omitted).

155 Bilski v. Kappos, 561 U.S. 593, 617 (2010); *In re* Bilski, 545 F.3d 943 (Fed. Cir. 2008).

particular article into a different state or thing."[156] The Court essentially denied patent eligibility of "mental processes" based on the assumption that mental processes are necessarily abstract and intangible.[157] However, this assumption does not apply to AI, whose thought processes are reduced to either physical transformations or the architecture of the machine itself.[158] Therefore, current subject matter eligibility doctrine might be well equipped to analyze AI systems. As the Court itself acknowledged, though not intentionally in relation to AI systems, "[§] 101 is a dynamic provision designed to encompass new and unforeseen inventions . . . ."[159]

In general, the main drawback of limiting patent scope through § 101 is that it could lead to arbitrary boundaries easily circumvented with "magic words" in the claim language.[160] Indeed, throughout the 1980s and early 1990s when software itself was unpatentable, many inventors easily circumvented this barrier by claiming hardware "machines" as software inventions.[161]

B. *Non-Obviousness*

Another criterion of patentability is non-obviousness, as set forth in § 103 of the Patent Act of 1952.[162] The statute mandates that to be patentable, the invention must not be obvious to a person having ordinary skill in the art (PHOSITA) at the time of the invention.[163] This non-obviousness requirement has remained largely unchanged since 1952, except for a minor change in how "prior art" is defined.[164]

The Supreme Court first established the framework for § 103 in 1966 in *Graham v. John Deere*.[165] The Court identified four factors in evaluating non-obviousness: (1) the scope and content of the prior art; (2) the skill level of a PHOSITA; (3) the differences between the claimed invention and the prior art's teachings; and (4) any objective indicia of non-obviousness, such as commercial success.[166] *Graham* also

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156 *Bilski*, 561 U.S. at 617.

157 Steven B. Roosa, *The Next Generation of Artificial Intelligence in Light of* In re Bilski, 21 INTELL. PROP. & TECH. L.J. 6, 6–7 (2009).

158 *Id.*

159 *Bilski*, 561 U.S. at 605 (internal quotation marks omitted).

160 *Id.*

161 Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CALIF. L. REV. 1, 9 (2001).

162 35 U.S.C. § 103 (2012).

163 *Id.*

164 The America Invents Act changed the timing of the obviousness inquiry to "before the effective filing date of the claimed invention . . . ." Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284, 286 (2011) (codified as amended at 35 U.S.C. § 102 (2012)).

165 Graham v. John Deere Co., 383 U.S. 1 (1966).

166 *Id.* at 17–18.

established "secondary considerations" that suggest that an invention is non-obvious,[167] the non-exhaustive list of which includes "commercial success, long felt but unsolved needs, [and] failure of others."[168]

The Court of Customs and Patent Appeals, the predecessor of the Federal Court, subsequently attempted to develop a bright-line rule for non-obviousness known as the teaching-suggestion-motivation (TSM) test. The TSM test required that the prior art contain a teaching, suggestion, or motivation.[169] In *KSR v. Teleflex*, however, the Supreme Court denounced the Federal Circuit's strict application of the TSM test as too rigid and narrow,[170] arguing that it overemphasized "the importance of published articles and the explicit content of issued patents."[171] While it did not reject the TSM test completely, the Court noted that this overly narrow application departed from 35 U.S.C. § 103 and the *Graham* obviousness framework.[172]

Advances in AI may require redefining "ordinary skill" and the "PHOSITA" assessment. By far the most important development of the PHOSITA standard also came in *KSR*, with the Supreme Court transforming the PHOSITA requirement from a mere "automaton" to a person with ordinary creativity levels.[173] The Court further clarified that problems with "a finite number of identified, predictable solutions" would likely yield innovations founded on common sense and undeserving of patent protection.[174] By this standard, older technology makes many inventions obvious and predictable.[175] Inventions by advanced AI systems with creative and non-obvious characteristics, however, have increased processing capacities, widened access to searchable information, and increased efficiency in analyzing information—all of which would merit a patent if a human invented them.

In light of technological advancements such as AI, the non-obviousness hurdle must be set appropriately. "[I]f the hurdle is too high, deserving inventions will become unpatentable," disincentivizing

167 *Id.*

168 *Id.*

169 *Patentability & the Non-Obviousness Requirement*, MCCARTER & ENGLISH, https://www.mccarter.com/Patentability--The-Non-Obviousness-Requirement-05-27-2011 (last visited Apr. 20, 2018).

170 *See* KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 419 (2007).

171 *Id.*

172 *See id.*

173 *See id.* at 421.

174 *Id.*

175 Brenda M. Simon, *The Implications of Technological Advancement for Obviousness*, 19 MICH. TELECOMM. & TECH. L. REV. 331, 362 (2013).

innovation.[176] "[I]f the hurdle is too low, a flood of junk patents may" cause true inventors to face more infringement lawsuits, which also disincentivizes innovation.[177] Taking these policy considerations into account, the Court stated in *Graham* that the non-obviousness analysis must be flexible and "amenable to a case-by-case development."[178] The Court took one step further in *KSR* and recognized the implications of technological advancement for non-obviousness by modifying the PHOSITA considerations.[179] It remains unclear, however, to what extent a PHOSITA can integrate "the ambit of applicable art . . . ."[180]

We argue, however, that subject matter eligibility can categorically address the broader issues raised by AI, acting as patent law's gatekeeper and directly addressing the types of inventions eligible for patent protection.[181] As the Supreme Court stated, "[t]he obligation to determine what type of discovery is sought to be patented must precede the determination of whether that discovery is, in fact, new or obvious."[182] Therefore, subject matter eligibility serves two necessary functions: "checking the volume of patent applications, and . . . excluding subject matter that . . . [is] too costly to protect."[183]

C. *The Question of Infringement*

As with inventorship, existing laws and precedent appear to rule out a machine or program as infringer.[184] If a human becomes the owner of an AI's invention, however, that person should bear responsibility for infringement. "[W]hoever without authority makes, . . . offers to sell, or sells any patented invention" is committing infringement.[185] As the AI learns and modifies its behavior, moreover, it is possible that a resulting product, process, or action may infringe on one or more patent claims. Under current law, the induced infringer is "[w]hoever actively induces infringement of a patent."[186] The Federal

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176 Andriy Lytvyn, *The Obviousness Standard in the United States Patent System*, SMITH & HOPEN (June 4, 2012), http://www.smithhopen.com/news_detail/557/Obviousness_in_the_U.S._Patent_System.

177 *Id.*

178 Graham v. John Deere Co., 383 U.S. 1, 18 (1966).

179 *See* sources cited *supra* notes 98–100 and accompanying text.

180 *Graham*, 383 U.S. at 19.

181 CHISUM ET AL., *supra* note 95, at 772.

182 Parker v. Flook, 437 U.S. 584, 593 (1978).

183 Kohlhepp, *supra* note 96, at 799.

184 Christopher Batiste-Boykin, Comment, In re Google Inc.*: ECPA, Consent, and the Ordinary Course of Business in an Automated World*, 20 INTELL. PROP. L. BULL. 21, 22–26 (2015) (discussing court decisions on the legality of Google's electronic communication service (ECS) from the perspective of privacy protection).

185 35 U.S.C. § 271(a) (2012).

186 35 U.S.C. § 271(b).

Circuit has interpreted this to mean that the alleged inducer must have knowingly aided another's direct infringement of a patent. When the AI system is operating on its own and not on the premises of the operator, does the owner then become the direct infringer? If the operator is operating the AI under instructions of the owner, then the owner and/or operator might be considered responsible for inducement[187]—an odd conclusion, given that the infringer typically does not change identity based on location. The issue might turn on the amount of control of the operation that has been given to the owner and the operator, respectively. The task of assigning responsibility for infringement becomes even more problematic if the AI system learns from data within the public domain or from a variety of publicly accessible sources. How does "a company developing an autonomous vehicle or robot, or even software that can run anywhere across a network, . . . safeguard against [infringement]?"[188]

Proving copyright infringement is also difficult. The plaintiff must prove substantial similarity after identifying and eliminating the elements that are unoriginal and unprotected.[189] These tests may be hard to run on sophisticated systems that change data in a creative way.

Scholars suggest measures that might be implemented to reduce uncertainty, such as forbidding certain kinds of AI systems, requiring chips to identify the source of the owner, or even self-defense technology solutions against counterfeiting and copying.[190] While reinventing alternative tools to prevent AI systems from copying other works or using protective data, we might think about solutions outside of the legal realm, such as "technology traffic lights" indicating sites that forbid intellectual property–protected materials or "stop signs" for forbidden zones.[191] When the data is accessible, we need a "green light" to allow AI systems to enter. In any case, the intellectual property laws

187 We mention "operator" because it seems to us that the operator also can be considered an inducer of infringement. In this case, "I was just following orders" or "I had no idea" might not suffice as an excuse. We also mention the owner as potentially responsible for infringement as part of the state of ownership.

188 Lohr, *supra* note 31.

189 Automated Sols. Corp. v. Paragon Data Sys., Inc., 756 F.3d 504, 518–19 (6th Cir. 2014).

190 A. Michael Froomkin & P. Zak Colangelo, *Self-Defense Against Robots and Drones*, 48 CONN. L. REV. 1 (2015) (the right to self-defense against robots might tell us about robots' rights against people); Zoe Carpou, *Robots, Pirates, and the Rise of the Automated Takedown Regime: Using the DMCA to Fight Piracy and Protect End-Users*, 39 COLUM. J.L. & ARTS 551 (2016) (using ISPs to fight the phenomena).

191 Danielle Keats Citron & Frank Pasquale, *The Scored Society: Due Process for Automated Predictions*, 89 WASH. L. REV. 1, 18–25 (2014) (regulation should create safeguards to restrain the activity of automated artificial intelligent scoring systems to avoid biased scoring).

are outdated for these advanced technologies systems.

VI. AN ALTERNATIVE MODEL FOR PATENT LAW AT THE 3A ERA—INCENTIVIZING STAKEHOLDERS WITHIN THE AI MULTIPLAYER MODEL

A. *Rethinking the Incentive Effect of the Current Patent Regime*

The patent reward in general is questionable. Scholars argue that patent laws fail to reach their goal of maximizing benefit to society. Granting twenty years of exclusive rights to the inventor or the inventor's transferee may not significantly incentivize inventors. Surveys show that even CEOs in most industries see patent incentives as relatively unimportant.[192] If corporate leaders who are driven by a profit motive do not see the value of patent incentives, then certainly such an incentive is meaningless to the multiple players and cumulative patent models. When determining whether to grant patent rights in uncertain situations, therefore, such as in regard to inventions by AI systems and the multiplayer and cumulative patent models, we should not overemphasize the importance of the patent system compared to other alternatives.

What are the flaws in patent incentives that make them irrelevant to AI? First, patent law only rewards the first inventor, while second comers get nothing. The drive to be first—even by an hour or two[193]—can force competing owners of AI systems deep into diminishing returns. This is wasteful.

Second, patent law grants exactly the same length of protection for all inventions,[194] "regardless of [their] R&D costs and . . . other economically relevant factors."[195] Although this approach is simple, it "grossly overreward[s] some inventions and underreward[s] others."[196]

Third, patents are superfluous for products that would be invented anyway.[197] For instance, "conventional software developed rapidly even

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192 Wesley M. Cohen, Richard R. Nelson & John P. Walsh, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)* (Nat'l Bureau Econ. Research, Working Paper No. 7552, Feb. 2000), http://www.nber.org/papers/w7552.pdf.

193 *See* Peter Carlson, *The Bell Telephone: Patent Nonsense?*, WASH. POST (Feb. 20, 2008), http://articles.washingtonpost.com/2008-02-20/news/36916760_1_bell-great-grandson-seth-Shulman telephone-gambit (describing how Alexander Graham Bell filed his patent application for the telephone the same day as his nearest rival, Elisha Gray).

194 *See* 35 U.S.C. §§ 154(a)(2), 271(a) (2012).

195 Benjamin N. Roin, *The Case for Tailoring Patent Awards Based on Time-to-Market*, 61 UCLA L. REV. 672, 677 (2014).

196 *Id.* at 693.

197 *See supra* Section VI.B (explaining that this can happen for several reasons); *see also* Phanesh Koneru, *To Promote the Progress of Useful Articles?: An Analysis of the Current Utility*

before courts were willing to grant it patent protection."[198] Patent protection serves a limited purpose.

As a fourth point, patent law fails in the multiplayer and cumulative patent environment characteristic of AI systems. It is not flexible in allocating rewards and is thus economically inefficient. Indeed, patent law only offers four ways to allocate rewards among two parties: "0:0 (both patents invalid), 50:50 (both patents upheld), 100:0 (first patent valid, second invalid), [and] 0:100 (first patent invalid, second valid)."[199] Patent law may also impede future technological progress by making it harder for other AI systems to build on earlier inventions.[200]

Fifth, in practice, patent law would pose difficulties in bringing patent infringement actions against or on behalf of inventions by an AI or against the copying of an AI's invention. Because of the unpredictable nature of AI, it is very difficult to identify the human that is responsible for the "actions" of an AI system. Sometimes the human involved in the process does not know how an AI system arrives at an invention. In other cases, the AI system can "break" data into electronic nanocomponents and rebuild it in different ways, thus rendering it impossible to establish proof of infringement.[201]

The inefficiency of the patent system regarding AI inventions forces us to imagine alternative venues to satisfy the needs and goals of stakeholders. These alternatives are described below.

B. *Non-Patent Model Within the AI Multiplayer Paradigm*

1. First-Mover Advantages

First-mover strategy grants the first entity to expose and sell its products or services to the public a competitive advantage: a head start over rivals and the chance to capture a significant portion of the

Standards of Pharmaceutical Products and Biotechnological Research Tools, 38 IDEA J.L. & TECH. 625, 632 (1998) (advocating that patents not be granted where inventions would be developed anyway "for reasons unrelated to the existence of the patent reward").

198 Kohlhepp, *supra* note 96 , at 798 n.128.

199 Maurer, *supra* note 110, at 671.

200 SUZANNE SCOTCHMER, INNOVATION AND INCENTIVES 127–57 (2004) (reviewing the literature on cumulative innovation); *see* Yanisky-Ravid & Moorhead, *supra* note 9 (arguing that when artificial intelligence systems produce artworks the copyright should be allocated to the user, following the "Work Made for Hire" doctrine).

201 Hickman, *supra* note 114, at 115.

market.[202] First-mover advantages arise endogenously. In the case of AI systems, exposing new and advanced technology generates substantial profit margins, along with several other advantages.[203]

First, *technology leadership*. New innovative technology can provide significant cost advantages to first movers, allowing them to maintain leadership in market share. Technological pioneers can protect their research and development through patents. In most industries, however, patents confer only weak protection, are easy to invent around, and have transitory value given the pace of technological change. Patents account for only a small proportion of pioneers' perceived quality advantages, and patent races can cause the downfall of firms unable to move quickly enough. In the case of AI systems, where, as we argue, patent laws are not applicable, this first-mover advantage plays an important role.[204]

Second, the first mover captures a *monopoly-like status* without other competitors with whom to share the market. This status usually means, in economic terms, gaining the monopoly in marginal revenue and cost by selling at higher rates (than the competitive balanced rate) as well as producing a lower quantity of products or services than demand.[205] Both mechanisms generate higher profits than the open market.

Third, *controlling the resources*. In many markets, there is room for only a limited number of profitable firms; the first mover can often select the most attractive niches and strategically limit the amount of space available for subsequent entrants. First movers can establish positions in geographic or product space such that those that follow them find it unprofitable to occupy the interstices or brave the threat of price warfare, which is more intense when firms are positioned more closely. First movers remain committed due to sunk investment costs and enjoy greater advantages in larger economies of scale; they are therefore driven to maintain greater output following entry.[206]

Fourth, *consumers' loyalty* after using certain products or services.

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202 Marvin B. Lieberman & David B. Montgomery, *First-Mover Advantages*, 9 STRATEGIC MGMT. J. 41 (1988) (surveying the theoretical and empirical mechanisms that confer advantages as well as disadvantages on first-mover firms); Geoffrey Allen Pigman et al., *First Mover Advantages in International Business and Firm-Specific Political Resources*, 27 STRATEGIC MGMT. J. 321–45 (2006).

203 Lieberman & Montgomery, *supra* note 202; *see also* JOHN B. TAYLOR & AKILA WEERAPANA, PRINCIPLES OF MICROECONOMICS 43–44 (7th ed. 2012); Pigman et al., *supra* note 202.

204 TAYLOR & WEERAPANA, *supra* note 203, at 43–44 (empirically, in most industries, the patent race is useless as patents confer only weak protection).

205 *Id.* at 253 fig.10.1 (the quantity at which this line hits the axis (*QM*) is the quantity for which marginal cost equals marginal revenue—that is, the profit-maximizing quantity); Michael Mussa & Sherwin Rosen, *Monopoly and Product Quality*, 18 J. ECON. THEORY 301, 301 (1978) (goods are offered on a take-it-or-leave-it basis).

206 *See* sources cited *supra* note 205.

Customers may follow the first brand they encounter that meets their demand and functions satisfactorily. Consumers will switch brands only when encountering a significant price differential; if pioneers convince a significant number of consumers to try their products, the products' attributes may shape standards for the entire product category. Switching costs in order to win over individual customers is considered a burden. The benefits of familiarity with a brand tend to overcome the drive to search for alternatives.[207]

Fifth, *blocking competitors* in the future. First movers who capture the market can easily create hurdles for those who come after them—by, for example, reducing prices until the opponent is defeated (a dump process).[208]

In the AI industry, the invention process as well as product life cycles can sometimes be extremely short. Therefore, regulating the process for obtaining patents may be less important than adjusting the advantages for first movers in the market, particularly for recouping research and development investments shortly after marketing.[209]

The advantages enjoyed by the first mover sometimes translate into more lasting competitive advantages as well.[210] First movers can more easily stay ahead of rivals by continually improving on their inventions.[211] Switching costs can also deter existing customers from buying imitations of their products.[212]

First-mover advantages tend to fade over time and the frequency of cost switching often decreases over the years as buyers become more knowledgeable about competing products.[213] Still, research shows that, while the average duration of the monopoly enjoyed by a first mover has

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207 TAYLOR & WEERAPANA, *supra* note 203, at 46–47.

208 Birger Wernerfelt, *Brand Loyalty and User Skills*, 6 J. ECON. BEHAV. & ORG. 381, 384–85 (1985) (brand loyalty is rational for consumers, who create user skills which make that brand more useful to them than other brands).

209 DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 96, 192 n.8 (2009); ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT 57 (2004); Ted Sichelman & Stuart J.H. Graham, *Patenting by Entrepreneurs: An Empirical Study*, 17 MICH. TELECOMM. & TECH. L. REV. 111, 137 (2010); Eric Goldman, *Fixing Software Patents* (Santa Clara Univ. Sch. of Law, Working Paper No. 01-13, Jan. 2013).

210 William T. Robinson & Sungwook Min, *Is the First to Market the First to Fail? Empirical Evidence for Industrial Goods Businesses*, 39 J. MARKETING RES. 120, 126 (2002).

211 *See* Lieberman & Montgomery, *supra* note 202, at 41–43, 46–47.

212 *See id.*

213 Kamel Mellahi & Michael Johnson, *Does It Pay to Be a First Mover in E.Commerce? The Case of Amazon.com*, 38 MGMT. DECISION 445, 447 (2000).

declined, the first-mover advantage remains significant.[214] Furthermore, the absolute size of sales per time unit increases for the first mover due to this effective monopoly.[215]

Therefore, we suggest that the relevant players within the Multiplayer Model who bring AI inventions to market will take advantage of being first movers instead of relying on an inapplicable and outdated patent regime.

2. Digital Tools Against Copying and Counterfeiting

The main hazard of nullifying patent law is counterfeiting. While contract laws affect the parties to contracts, patent laws influence the public, including third parties who are, under patent law, prevented from counterfeiting intellectual property even if they have not signed any contract.

We suggest implementing alternative digital tools that we dub "red lights" to prevent copying of protected materials. They will function even more efficiently than submitting court procedurals, which is pricey and time consuming.

Buying a device based on a patent allows the purchaser to "own" that device—to take it home, use it, put in on a shelf, or lend it to a friend. Products produced by AI systems, on the other hand, are capable of infringing on patents that protect data AI systems may find, for example, through independent web-surfing. Technical tools such as firewalls, we argue, may be the solution needed to protect AI systems and stop the counterfeiting of protected products,[216] acting similarly to intellectual property law. Vendors of e-books, for example, can digitally delete books from the devices of consumers who have not paid for them, and without warning or explanation. Amazon deleted Orwell's *1984* from the Kindles of surprised readers several years ago.[217] Cloud storage, streaming, e-books, and other digital goods offer users

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[214] Rajshree Agarwal & Michael Gort, *First-Mover Advantage and the Speed of Competitive Entry, 1887-1986*, 44 J.L. & ECON. 161, 173 (2001).

[215] *See id.*

[216] *See Next Generation Firewalls for Dummies*, INFOCRUNCH, https://infocrunch.co/thought-leadership/next-generation-firewalls-for-dummies (last visited June 8, 2018) ("Your go-to guide for the latest on Next-Generation Firewalls (NGFWs), this 2nd Edition e-book is packed with breach prevention insights—so you'll have smart answers when brainless questions come up").

[217] AARON PERZANOWSKI & JASON SCHULTZ, THE END OF OWNERSHIP: PERSONAL PROPERTY IN THE DIGITAL ECONOMY (2016) (exploring how notions of ownership have shifted in the digital marketplace and arguing for the benefits of personal property and for retaining consumer property rights in a marketplace that increasingly threatens them); CREATIVITY WITHOUT LAW: CHALLENGING THE ASSUMPTIONS OF INTELLECTUAL PROPERTY (Aaron Perzanowski & Kate Darling eds., 2017) (exploring the ways that communities of creators operate outside of formal intellectual property law).

convenience and flexibility, but they have potentially harmful effects on their privacy and other rights.[218]

These digital tools are already in wide use. The online marketplace eBay, for example, uses digital tools to hamper those infringing on intellectual property rights.[219] Its website used to declare:

> eBay developed the Verified Rights Owner (VeRO) Program to help protect not only intellectual property, but the consumer as well. Highlights of the program include: [e]xpeditious removal of listings reported to eBay by more than 5,000 intellectual property rights owners[; p]roactive monitoring and removal of listings that violate eBay policies designed to prevent the listing of infringing items on eBay[; a]bility to save searches and have the results emailed to you[; s]uspension of repeat offenders[; c]ooperation with rights owners seeking personal information on alleged infringers.[220]

Further discussion and regulation should welcome these advanced technology tools that will inevitably become part of our everyday digital lives.

3. Acknowledgement of Stakeholders Within the AI Industry

Society should reward the multiple players involved with AI—including the programmers, trainers, and operators who make contributions to scientific inquiry—by giving them the recognition their contributions deserve, even if neither the AI nor these players can be considered inventors and even when inventions are not patentable. This social recognition would likely encourage the players involved in AI systems to innovate further.

Inventions by AI are unpredictable; AI should be understood, therefore, to contain an inventive intuition, like the human mind. This creative intuition may derive from an AI's features ("personality") and may make it receptive to some sort of recognition.

Social recognition, such as through social networks, websites, trade journals, or even printing on the AI products themselves could serve as an effective alternative to granting patent rights or inventorship status

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218 *See generally* PERZANOWSKI & SCHULTZ, *supra* note 217.

219 *See id.* (addressing digital tools of deleting content when the customer does not pay, focusing on the drawbacks of this technology; in our opinion the technology exists and can replace traditional legal tools).

220 *See Reporting Intellectual Property Infringements (VeRO)*, EBAY, http://pages.ebay.com/help/tp/vero-rights-owner.html (last visited Jan. 24, 2017).

to AI inventions. Rather than denying or degrading the invention's utility, social recognition offers a psychological advantage to the people involved in generating the product, such as the inventor and operator, even if they fail to obtain patents.[221]

Making either the AI inventions or the AI software open source is another possibility. The rise of open source communities demonstrates that human beings are, on the one hand, inherently creative and, on the other, social and generous.[222] "[V]olunteers almost always join [such communities] because of softer incentives [than profit, such as] altruism or a desire for education" or social recognition.[223] A large disclosure database promotes information sharing.[224] The advancement of and increased access to knowledge as well as advancing the welfare of all are fundamental goals of intellectual property law. Databases and voluntary knowledge sharing of open source data can strive toward these goals.[225] Such sharing could also prevent non-practicing entities from engaging in rent-seeking behavior by providing a source of prior art.[226]

4. A Patent Reform Targeted at Inventions by AI

Unlike legal scholars who advocate for targeted patent reforms that apply only to certain cases, we have argued for general patent reform.[227] There is long-standing resistance, however, to using technology-specific triggers and differentiated patent awards—including patent filing fees, non-obviousness standards, antitrust policies, and defenses against

221 Robert P. Merges, *Property Rights Theory and the Commons: The Case of Scientific Research*, *in* SCIENTIFIC INNOVATION, PHILOSOPHY, AND PUBLIC POLICY 145, 150 (Ellen Frankel Paul, Fred D. Miller, Jr. & Jeffrey Paul eds., 1996).

222 Maurer, *supra* 110, at 659.

223 *Id.* at 659 n.92.

224 Yusing Ko, *An Economic Analysis of Biotechnology Patent Protection*, 102 YALE L.J. 777, 801 (1992); *see also* Yanisky-Ravid, *supra* note 94, at 2 (discussing a new WIPO initiative called "Search-Sharing Innovation in the Fight Against Neglected Tropical Diseases, which creates a global consortium through which member states and private and public entities can share knowledge, promote research, and make products available royalty-free to the less developed countries, thereby giving them access to information and medicines").

225 "The Congress shall have Power . . . [t]o 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 . . . ." U.S. CONST. art. I, § 8, cl. 8.

226 Simon, *supra* note 175, at 353; *see also* Julian David Forman, Comment, *A Timing Perspective on the Utility Requirement in Biotechnology Patent Applications*, 12 ALB. L.J. SCI. & TECH. 647, 671–72 (2002).

227 *See, e.g.*, Michael Abramowicz, *Orphan Business Models: Toward a New Form of Intellectual Property*, 124 HARV. L. REV. 1362, 1406–07 (2011); Michael J. Burstein, *Rules for Patents*, 52 WM. & MARY L. REV. 1747, 1761–62 (2011); Peter S. Menell & Michael J. Meurer, *Notice Failure and Notice Externalities*, 5 J. LEGAL ANALYSIS 1, 50 (2013); Richard A. Posner, *Why There Are Too Many Patents in America*, ATLANTIC (July 12, 2012), http://www.theatlantic.com/business/print/2012/07/why-there-are-too-many-patents-in-america/259725.

patent infringement[228]—to advance certain policies. Such triggers are considered impractical.[229] When assessing the strength of patent protection in a particular industry, the government must consider many factors. "[Some] of these factors are hard to assess, and the sheer number of them would make the inquiry unpredictable . . . and vulnerable to manipulation. Moreover, the dividing lines between technologies are highly permeable and tend to shift rapidly as technology changes."[230] While drafting their patent claims, inventors can tailor them to categories that offer greater protection, rendering the technology-specific rules obsolete.[231]

Our solution—abolishing patent protection for AI inventions—does not solve the one-size-fits-all problem inherent to the U.S. patent system. It does not provide industry-dependent standards that consider dramatically different R&D costs and varying abilities to extract revenue from consumers across different industries. However, considering that the government knowingly overlooks these differences when it awards patent protection, our solution applies only to the challenges of AI and the deficiencies of patent law. This is no worse than current patent law or any alternative solution. As with the drawbacks of targeted patent reforms, many economic factors related to patent strength in a particular industry are difficult or impossible for the government to assess.[232] Therefore, taking into account all factors, this Article's solutions—being first in the market, electronic open source tools, and social recognition—are the most appropriate for inventions by AI.

VII. INTERNATIONAL TOOLS THAT CAN BE USED TO HARMONIZE AI'S PATENTS

Intellectual property laws are governed by international laws which countries are adopting and implementing. Today, almost every country has some form of patent system. Of the 196 countries in the world,[233] 191 are member states of the World Intellectual Property Organization (WIPO),[234] a specialized agency of the United Nations. Since the

228 Roin, *supra* note 195, at 682.

229 *See* A PATENT SYSTEM FOR THE 21ST CENTURY 84 (Stephen A. Merrill et al. eds., 2004).

230 Roin, *supra* note 195, at 683.

231 *Id.*

232 *See id.* at 681.

233 *See* Matt Rosenberg, *The Number of Countries in the World*, THOUGHTCO., https://www.thoughtco.com/number-of-countries-in-the-world-1433445 (last updated Nov. 22, 2017).

234 *See Member States*, WIPO, http://www.wipo.int/members/en (last visited Apr. 4, 2015).

development of AI is still in an early stage, no enacted statutes or case law in the world directly addresses AI. Nevertheless, many international treaties help provide intellectual property protection across national boundaries. Therefore, any solution regarding patent protection of AI products, including ours, should be consistent with international tools. We briefly discuss three tools as examples.

The Patent Cooperation Treaty of 1971 (PCT) is a multilateral treaty administered by WIPO.[235] It facilitates patent registration across the world by making it possible to seek patent protection for an invention in more than one country simultaneously.[236] The PCT has more than 142 member states and more than 100 national and regional patent offices.[237] "Perhaps the [PCT's] greatest strength [is its] diversity of legal, linguistic, and national cultures . . . ."[238]

A PCT filing consists of an international phase and a national phase.[239] During the initial international phase, an "International Searching Authority" conducts an international prior art search.[240] Next, during the national phase, applicants may pursue their PCT patents in the patent offices of individual countries.[241] To do so, applicants must file requests to the PCT, file translations of their applications, and pay the national fees.[242] After the national phase, the substantive laws of individual countries apply exclusively.[243]

In practice, however, this seemingly streamlined PCT filing process has proven redundant. The redundancies stem from the independent prior art search by patent offices of individual countries giving little to no deference to the prior art search already conducted during the international phase of the PCT filing process.[244] This means that, to seek worldwide patent protection within the PCT framework, individual inventors are obligated to incur additional costs in both time and money.[245]

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235 *See* Patent Cooperation Treaty (PCT), June 19, 1970, 28 U.S.T. 7645, http://www.wipo.int/pct/en/texts/pdf/pct.pdf.

236 *See* Jay Erstling & Isabelle Boutillon, *The Patent Cooperation Treaty: At the Center of the International Patent System*, 32 WM. MITCHELL L. REV. 1583, 1583 (2006).

237 *See* WORLD INTELLECTUAL PROP. ORG., THE INTERNATIONAL PATENT SYSTEM YEARLY REVIEW: DEVELOPMENTS AND PERFORMANCE IN 2009 61 (June 7, 2010), http://www.wipo.int/edocs/pubdocs/en/patents/901/wipo_pub_901_2009.pdf.

238 *See* Erstling & Boutillon, *supra* note 236, at 1600.

239 *Id.* at 1590.

240 *See* PCT, *supra* note 235, arts. 15–16.

241 *See* Erstling & Boutillon, *supra* note 236, at 1597.

242 *See* PCT, *supra* note 235, arts. 22–28, 39.

243 *See id.* art. 27(5).

244 *See* Markus Nolff, *TRIPS, PCT and Global Patent Procurement*, 83 J. PAT. & TRADEMARK OFF. SOC'Y 479, 482 (2001).

245 *See* Brice C. Lynch, Note, *International Patent Harmonization: Creating a Binding Prior Art Search Within the Patent Cooperation Treaty*, 44 GEO. WASH. INT'L L. REV. 403, 404 (2012).

Given that the patent offices of individual countries examine patent applications based on their own standards, the PCT does not promote consistency.[246] The Draft Substantive Patent Law Treaty (SPLT), a WIPO initiative, aims to deeply harmonize the patentability requirements set by patent offices of the member states.[247] Under the SPLT, member states would agree, among other things, to adopt identical rules about non-obviousness or inventiveness and the requisite amount of information to be disclosed.[248] According to Professors Reichman and Dreyfuss, "[a] free-standing instrument, such as the SPLT, would shrink the remaining flexibilities in the TRIPS Agreement with no side payments and no concessions to the catch-up strategies of developing countries at different stages of technological advancement."[249] Nevertheless, there are some departures from U.S. patent law's non-obviousness standards in the patent systems of other jurisdictions and the international community.

While the European Patent Office (EPO) uses the term "inventive step" instead of "non-obviousness," the core of the inquiry remains the same. It relies on determining whether or not the PHOSITA could have, in an obvious manner, derived the solution to the technical problem. The standard for non-obviousness is similar to the U.S. standard in Japan as well, as evaluation of the inventive step requires determining if there are suggestions to the claimed invention in the prior art.[250]

CONCLUSION

Stephen Hawking stated: "[T]he short-term impact of AI depends on who controls it, the long-term impact depends on whether it can be controlled at all."[251]

Are we navigating the unknown, or can we conceive of a one-size-

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246 *See* Jerome H. Reichman & Rochelle Cooper Dreyfuss, *Harmonization Without Consensus: Critical Reflections on Drafting a Substantive Patent Law Treaty*, 57 DUKE L.J. 85, 89 (2007).

247 *See id.* at 89–90.

248 *Id.* at 90.

249 *Id.* at 85.

250 *See* PATENT LAW IN GLOBAL PERSPECTIVE 582 (Ruth L. Okediji & Margo A. Bagley eds., 2014).

251 Stephen Hawking, Stuart Russell, Max Tegmark & Frank Wilczek, *Stephen Hawking: 'Transcendence Looks at the Implications of Artificial Intelligence—But Are We Taking AI Seriously Enough?'*, INDEPENDENT (May 1, 2014, 9:30 PM), http://www.independent.co.uk/news/science/stephen-hawking-transcendence-looks-at-the-implications-of-artificial-intelligence-but-are-we-taking-9313474.html.

fits-all solution for the near future? We believe that the answer lies between these two scenarios.

Companies have already attempted to implement AI in several areas. General Electric, for example, is already using an AI system in the design of jet engines.[252] Engineers in Wisconsin have optimized efficiency and minimized emissions for diesel engines,[253] engineers in Virginia designed a satellite communications antenna, car and truck companies are using driverless cars, lawsuits are being submitted by robots, and diseases are being detected—all with AI systems.[254] However, there are still those who argue that genetic algorithms have never reached the level of success their proponents envisioned.[255]

On the one hand, as we have argued, traditional patent laws are no longer adequate or efficient. On the other hand, many open questions (perhaps more than answers) remain. For example, which norm should we apply when there is only one or a few stakeholders involved in inventing and operating the system? Who is responsible for infringement of people's or entities' rights by an AI system? Who is entitled to the income stemming from patents developed by AI systems? If ownership is subject to contractual consent, firms need to rethink what the impact of this new realm on their businesses should be and determine whether to modify their policies accordingly. Can new arrangements (re)allocate property rights when the AI's invention is not subject to patent right protection, as we suggest in this Article?[256] If so, what types of new agreements are needed to ensure that inventions resulting from AI are owned by a specific entity? How should joint development agreements be modified to ensure ownership of technology developed by AI? When entities relying on AI systems seek to insure themselves against claims regarding infringements, what kind of insurance should they use? Once data is being used to teach the AI how to determine right and wrong, are license agreements necessary? If so, how should they be modified?

We can wait for scholars and policy makers to decide. Or we can

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252 Ray Kurzweil, *The Virtual Thomas Edison*, TIME (Dec. 3, 2000), http://content.time.com/time/magazine/article/0,9171,90538,00.html.

253 *See Diesel Breeding*, *supra* note 8, at 53.

254 Eisenberg, *supra* note 8, at G9; Paras Lakhani & Baskaran Sundaram, *Deep Learning at Chest Radiography: Automated Classification of Pulmonary Tuberculosis by Using Convolutional Neural Networks*, 284 RADIOLOGY 574 (2017); Rajpurkar et al., *supra* note 7; Monika Grewal et al., RADNET: Radiologist Level Accuracy Using Deep Learning for Hemorrhage Detection in CT Scans (Jan. 3, 2018) (unpublished paper), https://arxiv.org/abs/1710.04934.

255 *See* Reena Jana, *Dusting Off a Big Idea in Hard Times*, BLOOMBERG BUSINESSWEEK (June 11, 2009, 5:00 PM), https://www.bloomberg.com/news/articles/2009-06-11/dusting-off-a-big-idea-in-hard-times.

256 35 U.S.C. § 100(d) (2012) ("The word 'patentee' includes not only the patentee to whom the patent was issued but also the successors in title to the patentee.").

create an AI algorithm trained to reach the best solution to these open questions.[257]

[257] Lohr, *supra* note 31.