# COMPUTER-GENERATED INVENTIONS

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ABSTRACT

Technological advancements in artificial intelligence have threatened the axiom that conception, the mental part of invention, is a function exclusive to the human mind. Recently, machine learning technologies have allowed artificially intelligent computers to compose patent claims that amount to patentable subject matter. This technology is similarly used by innovators to optimize design configurations beyond the scope of human capacity. The type of patent protection to be afforded to computer-assisted and computer-generated inventions with minimal to no human intervention has yet to be determined. This article illuminates how such technological advances could wreak havoc on the patent legal system as it currently stands. It then offers a proposal for a legal standard that is supported by the philosophical justifications for property rights. The structure of this proposal is derived from the human creativity framework used to analyze the copyrightability of computer-generated works – paralleling the creativity standard to an intervention standard in the inventive process. Finally, this article provides a potential legislative and judicial framework for determining the amount of human intervention required to ensure protection against computer-assisted or computer-generated inventions.

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## INTRODUCTION

Artificially intelligent technologies are currently disrupting previously sound legal and ethical conclusions. In 1970, a Japanese robotics engineer, Masahiro Mori, coined the term "Uncanny Valley." The Uncanny Valley is a term used to describe the phenomena whereby humans experience an increase in empathy toward a robot as it begins to appear more humanlike; however, as the robot's artificial human likeliness approaches the threshold of reality, humans lose this affinity toward the robot.[1] It is at this point where the robot's appearance becomes uncanny. A similar unsettling effect may also exist where computer intelligence approaches, or surpasses, the degree of intelligence once held to be a characteristic exclusive to the human mind.

A real-life "Uncanny Valley" phenomena can be experienced when viewing the artificially intelligent robot, Sophie, developed by a Hong Kong company, Hanson Robotics. In October 2017, the Kingdom of Saudi Arabia was the first country in the world to grant citizenship to this artificially intelligent humanoid.[2] This grant of citizenship is an illustrative example of an instance in which the uncanny effects of a robot's appearance merge with its superior computer intelligence. Uncanny effects on par with the idea of granting a robot human citizenship will soon be experienced in other areas of the law that are impacted by the rapid development of artificially intelligent technologies.

Technology has a tendency to develop at a rate superior to the law. As artificially intelligent technologies, particularly machine learning, continue to subsume other industrial areas, the need for legal guidance on this topic will increase exponentially.[3] One area of legal study that is particularly prone to the array of legal complexities associated with this technology is the field of intellectual property. While experts have spoken at length about the effects of computer authored work in copyright law, little conversation has taken place as to how similar technologies will disrupt patent law.[4] As

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[1] *See* Masahiro Mori, *The Uncanny Valley*, IEEE ROBOTICS & AUTOMATION MAG., June 2012, at 98-99 (Karl F. MacDorman & Norri Kageki trans.) (explaining human's positive and negative affinity toward physical appearance of artificially intelligent robots both mathematically and graphically).

[2] *See* Hussein Abbass, *An AI professor explains: three concerns about granting citizenship to robot Sophia*, THE CONVERSATION (Oct. 29, 2017, 10:18 PM), https://theconversation.com/an-ai-professor-explains-three-concerns-about-granting-citizenship-to-robot-sophia-86479 (identifying three concerns of granting citizenship to a robot: defining identity, legal rights, and social rights).

[3] *See* Mark Fenwick et al., *Regulation Tomorrow: What Happens When Technology is Faster than the Law*, 6 AM. BUS. L. REV. 1 561, 567-568, nn.24-27 (2016) (describing the difficulty associated with establishing a regulatory framework in situations where disruptive technologies, such as artificial intelligence, develops at a rate superior to corresponding regulation).

[4] *Compare* Annemarie Bridy, *Coding Creativity: Copyright and the Artificially Intelligent Author*, 2012 STAN. TECH. L. REV. 5, 2 (2012) (referencing the first computer authored work presented to the Copyright Office prior to 1965 leading to the Register of

developers gain the ability to create machine learning technologies capable of independently generating inventions, experts must examine the legal scope of inventorship by looking toward the text of the constitution, judicial decisions, legislative actions, and the philosophical reasoning behind such jurisprudence.[5] The time for legal analysis on this issue is approaching a critical point, as the concept of obtaining desired results merely by describing problems to a sophisticated software (as opposed to physically solving problems) can be seen throughout technology in what has been described as the "artificial invention age."[6]

This new approach to problem-solving is the cause of a number of legal and ethical issues. Today, machine learning may be used to create computer-generated patent claims; this computer-generated content has a wide variety of potential applications that could wreak havoc on the patent legal system as it currently stands. For example, machine learning may be used to let companies generate prior art to invalidate potential infringing devices or to allow de facto inventors improve their claim language beyond the scope of what the inventor was in actual possession of before utilizing a claim enhancing technology.[7] Artificial intelligence (AI) is similarly used to assist in the inventive process. The United States Patent and Trademark Office (USPTO) has already granted patents on inventions generated with

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Copyrights expressed concern "over the indeterminate legal status of works created with the aid of computers"), *with* Ben Hattenbach & Joshua Glucoft, *Patents in an Era of Infinite Monkeys and Artificial Intelligence*, 19 STAN. TECH. L. REV. 44 (2015) (neither Congress nor the courts have explicitly ruled on the issue of whether a "computer-conceived invention" is patentable).

[5] *See* WILLIAM FISHER, THEORIES OF INTELLECTUAL PROPERTY, IN NEW ESSAYS IN THE LEGAL AND POLITICAL THEORY OF PROPERTY 8 (Stephen Munzer ed. 2001) (indicating the influence of the prevailing theoretical justifications of intellectual property law are drawn from "the raw materials of intellectual property law -- constitutional provisions, case reports, preambles to legislation, and so forth"); *See also* Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L. J. 287 (1988-1989) (signifying the jurisprudence of intellectual property must be established by building upon the fundamental property rights during the shift in attention from tangible (real property) to intangible (intellectual property)).

[6] *See* ROBERT PLOTKIN, THE GENIE IN THE MACHINE: HOW COMPUTER-AUTOMATED INVENTING IS REVOLUTIONIZING LAW AND BUSINESS 1-3, 5 (2009) (Plotkin describes the era of the upcoming computer revolution in computer-automated inventing, where computers are capable of designing products previously requiring human ingenuity, as the "Artificial Intelligence Age." "Human inventors once responsible for every design detail of their invention" are now capable of identifying the problems they are trying to solve, and "pos[ing] those problems to artificial invention software in a language the computer can understand" and the computer will output an invention. Currently this advanced AI technology requires inventors with expertise capable of effectively describing problems to the computers, but the sophistication of this technology is rapidly developing.).

[7] *See* Hattenbach & Glucoft, *supra* note 4, at 36 (identifying potential uses of computer-generated claims in the prior art context, such as that utilized by the company Cloem, and in patent context, as utilized by inventors, patent prosecutors, and applicants). *See generally* Lamb-Weston, Inc. v. McCain Foods, Ltd., 78 F.3d 540, 549 (Fed. Cir. 1996) (Newman, J., dissenting) ("35 U.S.C. § 102(a) and (b) define prior art as what is known in the literature or deemed to be publicly available through use or sale.").

the assistance of artificially intelligent technologies.[8] To date, there has not been a known instant of an independently computer-generated invention, but these advancements raise the question – once machines are able to compose patentable subject matter entirely independent of human intervention, should they be granted property rights by the USPTO and under what circumstances should these rights be granted?

A deeper fundamental understanding of "inventorship" will be evaluated as society delves toward the inevitable depths of this "artificial invention age,"[9] to determine whether inventions made with the assistance of AI (computer-assisted or computer-generated inventions) should result in patents. To assess this issue, two topics must be considered to produce an analytical framework predicated upon the fundamental justifications for property rights. First, a spectrum for analyzing the degree of human intervention that occurs throughout a given inventive process will be established. On one hand, machine learning could be an extremely useful tool to assist inventors. On the other hand, it could enable computers to generate inventions without any human intervention or contribution. This model will frame the dynamic inventorship issue by establishing categories to represent the various degrees of human intervention that may take place throughout the inventive process.

Next, computer-assisted and computer-generated inventions will also be examined through a philosophical lens to determine the point along the spectrum at which human intervention is so minimal that the right to a patent is relinquished. [10] A core consideration for determining where this point should lie on the spectrum of intervention is what type of burden would computer-generated inventions place on society if artificially inventing without sufficient human contribution were to remain unregulated. It is likely that the burden of competing with machines in a legal environment ignorant to such a distinction would dampen the incentive to invent.[11] To help neutralize this effect, a sufficient nexus to human intervention requirement for inventorship will be implemented to determine the position of the point mentioned above. Such a nexus requirement seeks to promote innovation through the use of AI or machine

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[8] *See infra* note 63.

[9] *See* PLOTKIN, *supra* note 6.

[10] *See* FISHER, *supra* note 5, at 8-10 (indicating that the four primary theoretical perspectives that currently dominate theoretical writing in intellectual property law, in order of influence, include the utilitarian approach, the Lockean approach, the personality theory, and the social planning theory, and highlighting the weaknesses in each approach).

[11] *See generally* Ted Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341, 412 (2010) ("The reward theory of patent law generally focuses on providing direct incentives for invention, but not for the preceding step of identifying problems that need inventive solutions.") and Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 Tex. L. Rev. 1031, 1031 (2005) (indicating that "… creators will not have sufficient incentive to invent unless they are legally entitled to capture the full social value of their inventions.").

learning technologies, while simultaneously restricting the patentability of potentially monopolistic computer-generated practices.

This Article seeks to develop a framework for understanding the issue of inventorship in computer-assisted and computer-generated inventions so that computers can effectively be utilized throughout the inventive process. Part I begins by outlining the legal scope of inventorship and segues into a discussion on the current landscape of the "artificial invention age."[12] This part connects the inventorship requirement found in patent law to modern technological advancements, where defining "inventor" is not as clear as it has traditionally been. Part II addresses the deeper fundamental legal problems underlying machine learning, as applied to computer-assisted and computer-generated inventions. This part seeks to articulate the novelty of the inventorship issue by mapping the spectrum of intervention that exists in the inventive process. It will then survey the core theoretical justifications of property rights to determine the point at which inventions resulting from computer-assisted software lack a sufficient nexus to human inventorship. Part III concludes with a framework proposal for analyzing the legal issue, focusing on the requisite amount of human intervention accompanying a computer-assisted invention necessary for patentability. This proposal will better equip judges and legislators to determine the allowable degree of technological intervention throughout the inventive process required to obtain traditional patent rights.

## I. INVENTORSHIP AND ARTIFICIAL INTELLIGENCE

### *A. The Legal Scope of Inventorship*

Seeing as though technology tends to develop at a rate superior to the law,[13] neither Congress nor the courts have explicitly ruled on the issue of whether a "computer-conceived invention" is patentable.[14] As such, this section will examine how the doctrine of inventorship has traditionally been regarded. The legal scope of inventorship stems from the text of the Constitution, has been developed through legislative activity made possible by a Constitutional grant of power to Congress, and such legislation has been refined by subsequent judicial decisions.[15] These sources highlight various time-honored core values of the patent system and shed light on the doctrine of inventorship.

The Founding Fathers, in drafting Article I, Section 8, Clause 8 of the Constitution, granted Congress the power "to promote the progress of science and useful arts, by securing for limited times to authors and

[12] PLOTKIN, *supra* note 6.

[13] *See* Mark Fenwick et al., *supra* note 3.

[14] *See supra* note 4 and accompanying text.

[15] *See* Edward G. Greive, *The Doctrine of Inventorship: Its Ramifications in Patent Law*, 17 W. RES. L. REV. 1342, 1342-43 (1966) (discussing the original authority for patent law and inventorship in the United States).

*inventors* the exclusive right to their respective writings and discoveries."[16] This Patent and Copyright Clause of the Constitution sought to protect the works of authors and inventors by granting them exclusive rights to their work product. James Madison explained the utility of this Clause and discussed the issue of inventorship in The Federalist Papers; expressing that "[t]he right to useful inventions seems with equal reason to belong to the *inventors*" and indicating that "[t]he public good fully coincides . . . with the claims of individuals."[17] While there is little that can be gleaned about inventorship directly from the Constitution, acts of Congress and other historical sources speak directly on the topic of inventorship.[18]

Congress, exercising its Constitutional power to promote science and the useful arts, codified the 1952 patent act with the intent that statutory subject matter "include anything under the sun that is made by *man*."[19] This description of the breadth of patentable subject matter, however, is ambiguous on its face as it fails to account for unpatentable subject matter; such carve-outs are the product of case law.[20] The statement is also potentially misleading in that it does not identify the prosecutorial limitations on patentability. However, the phrase does indicate that such inventions should be human-made. Further guidance for defining the legal scope of inventorship, as authorized by Congress, can be discovered through the lens of statutory interpretation by examining the word "inventor" as found in Title 35.

In general, an inventor or inventors who obtain patent protection through the prosecutorial process are "grant[ed] . . . the right to exclude others from making, using, offering for sale, or selling the invention. . . ."[21] This right to exclude is granted to the inventor who may assign the exclusive right in the application or the patent to another party.[22] More precisely, on the topic of inventorship, the term "inventor" is statutorily defined as "the *individual* or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."[23] These joint inventors may apply for a patent jointly despite (1)

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[16] U.S. CONST. art. I, § 8, cl. 8. (emphasis added).

[17] THE FEDERALIST NO. 43 (James Madison) (emphasis added).

[18] *See generally* Greive, *supra* note 15 (exploring the historical origins of inventorship and identifying problems that existed with determining inventorship in 1966).

[19] S. REP. NO. 82-1979, at 5 (1952), *reprinted in* 1952 U.S.C.C.A.N. 2394, 2399 (emphasis added).

[20] *See* Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980); *see also* Peter Lee, *The Evolution of Intellectual Infrastructure*, 83 WASH. L. REV. 39, 64-65 (2008) (identifying that unpatentable subject matter exceptions are the product of case law which has been "deeply influenced by the legislative history of the 1952 Patent Act").

[21] 35 U.S.C. § 154 (2012).

[22] 35 U.S.C. § 261.

[23] 35 U.S.C. § 100(f); *see also* 35 U.S.C. § 100(h) (limiting the scope of inventorship to individuals is further exemplified in other statutory definitions such as "joint research agreement" which requires that an agreement be made between "2 or more *persons* or entities").

not having physically worked together or at the same time, (2) not making the same type or amount of contribution, or (3) not making a contribution to the subject matter of every claim of the patent.[24] In order for a person to be considered a joint inventor, they must "contribute in some significant manner to the conception or reduction to practice of the invention [and] make a contribution to the claimed invention that is not insignificant in quality, when that contribution is measured against the dimension of the full invention."[25] Furthermore, these inventors, whether an individual inventor or a joint inventor, must each be named and must execute an oath or declaration of inventorship.[26]

This oath or affirmation requirement is as old as patent law itself, and was once the focal point of the issue of inventorship in an entirely different era; one which may shed light on modern inventorship issues. In 1858, the Attorney General issued an opinion entitled *Invention of a Slave* which stated that neither a slave nor its owner can patent a machine invented by a slave.[27] The reasoning behind this was that the "slave owner could not swear to be the inventor, and the slave could not take the oath at all."[28] Historically, at least two known patent applications have been filed by slave owners for inventions created by slaves, and both applications were declined since "no one could take the required patent oath."[29] While this historical anecdote recalls a terrible part of American history, it is successful at highlighting the premise that an "inventor" must be a human capable of fulfilling the oath requirement. Thus, in light of the statutory text, case law, and history surrounding the issue of inventorship, it is evident that the word *inventor* has traditionally meant to refer to a *human individual* who is capable of contributing to the invention through conception or reduction to practice.

Throughout modern patent law, the legal confines of inventorship have remained relatively constant despite inventorship issues surrounding artificial inventing. The Leahy-Smith American Invents Act (AIA) made changes to the U.S. patent system, most notably, by switching from a "first-

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[24] 35 U.S.C. § 116.

[25] Nartron Corp. v. Schukra U.S.A., Inc., 558 F.3d 1352, 1356-57 (Fed. Cir. 2006) (citing Pannu v. Iolab Corp., 155 F.3d 1344, 1351 (Fed. Cir. 1998)).

[26] 35 U.S.C. §115(a)); *see also* 37 C.F.R. § 1.63 (2015) (An "Oath or Declaration must: (1) Identify the inventor or joint inventor by his or her legal name, (2) Identify the application to which it is directed, (3) Include a statement that the person executing the oath or declaration believes the named inventor or joint inventor to be the original inventor or an original joint inventor of a claimed invention in the application for which the oath or declaration is being submitted; and (4) State that the application was made or was authorized to be made by the person executing the oath or declaration.")

[27] Brian L. Frye, *Invention of a Slave*, 68 SYRACUSE L. REV. 181, 181 (2018).

[28] Frye, *supra* note 28 at 181-82, 199 (indicating that patent protection was unavailable to slaves at this time for two reasons: (1) slaves were unable to take the patent oath, and (2) slaves were unable to receive property rights).

[29] Frye, *supra* note 28 at 188.

to-invent" to a "first-inventor-to-file" system.[30] Along with this major change, some changes have been made that may be of interest to the overall premise of inventorship,[31] but there is no indication that the scope of inventorship should be expanded to encompass works that are not the product of human invention. The Manual of Patent Examining Procedure (MPEP) published by the USPTO indicates that despite the changes made by the AIA, "the patent laws still require the naming of the actual inventor or joint inventors of the claimed subject matter."[32] These time-honored notions of inventorship will soon encounter a rough road ahead as society traverses the new frontiers of the technological age.

### *B. The Artificial Invention Age*

To appreciate how the inventive process is shifting, an ancillary understanding of the basics of AI is essential. The concept of AI is rapidly breaking away from its long-perceived science fiction characterization and has recently infiltrated daily language, gradually becoming a term that is commonplace in nature. This idea of AI may appear novel, but the concept of AI is far from new. The term was first coined in 1956 by John McCarthy, one of the founding fathers of AI, to mean "the science and engineering of making intelligent machines especially intelligent computer programs."[33] AI has evolved into a vast discipline that subsumes nearly every conceivable industry from genetic sequencing to shipping and logistics. Jerry Kaplan, a well renowned AI expert, has defined the essence of AI and intelligence, in general, to be "the ability to make appropriate generalizations in a timely fashion based on limited data."[34] Subfields of AI include, but are not limited to, search and planning, reasoning and knowledge representation, robotics, natural language processing, and machine learning.[35] The machine learning subfield, however, is the most

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[30] Leahy-Smith America Invents Act, Public L. No. 112-29, § 3(o), 125 Stat. 284, 293 (2011) (indicating reasoning for switching from a "first to invent" system to a "first inventor to file" system).

[31] Under Pre-AIA, only the inventor(s) could be the applicant, but under AIA, the word "applicant" is expanded to refers to the inventor, joint inventors, or the person applying for the patent, who can be: "assignee, the person to whom the inventor is under an obligation to assign the invention, or the person who otherwise shows sufficient proprietary interest in the matter." 37 C.F.R. § 1.42 (2015) (AIA); 37 C.F.R. § 1.41 (2002) (pre-AIA).

[32] U.S. PATENT & TRADEMARK OFFICE, U.S. DEP'T OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE §§ 2137.01, 2157 (9th ed. rev, 7 Nov. 2015) [hereinafter MPEP] (describing the inventorship requirement and improper naming of inventors) (emphasis added).

[33] John McCarthy, *What Is Artificial Intelligence? What is Artificial Intelligence*, (Nov. 12 2007) http://www-formal.stanford.edu/jmc/whatisai/node1.html (answering the question "what is artificial intelligence" and expanding "AI does not have to confine itself to methods that are biologically observable").

[34] JERRY KAPLAN, ARTIFICIAL INTELLIGENCE: WHAT EVERYONE NEEDS TO KNOW 5 (2016) (likening the essence artificial intelligence to the essence of human intelligence).

[35] *See generally* McCarthy, *What Is Artificial Intelligence? Branches of AI* (Nov. 12 2007) http://www-formal.stanford.edu/jmc/whatisai/node2.html (listing few of the

pervasive subfield of AI; so much so that "artificial intelligence" is often colloquially used in reference to what is actually machine learning.[36]

Subsumed within the field of AI, machine learning is unique because it gives computer systems the ability to learn how to utilize the information they are given. The fundamental goal of machine learning is pattern recognition, where machines are tasked with identifying patterns, predicting outcomes, and have the ability to "'learn' or improve performance over time."[37] This concept is distinguishable from the mere storage of data that comprises a database.[38] Machine learning computer programs can do more than merely store or retrieve information; they are able to utilize this information by recognizing patterns that exist within the set of data available to them.[39] One of the most remarkable qualities of machine learning is that it has the ability to recognize correlations in datasets without human intervention; this is known as "unsupervised learning."[40] Examples of few of the practical uses of machine learning include fraud detection, predicting judicial decisions, and piloting autonomous vehicles.[41]

The numerous applications of machine learning, however, are not without limitation, nor are they free from ethical and legal concern. The polarity of opinions that exist about the future of AI, as debated by prominent technologists, indicates the societal complexities in understanding the potential ramifications of the quickly approaching artificially intelligent age. For example, Mark Zuckerberg, CEO of Facebook, and Elon Musk, CEO of SpaceX, have recently engaged in banter on the subject. Zuckerberg has publicly cautioned the use of AI, and Elon Musk responded by classifying Zuckerberg's understanding of AI as being "limited."[42] Despite the clashing opinions surrounding the mysterious future of AI, the prevalence of such technology is unavoidable.[43]

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branches of artificial intelligence indicating that the list is not all inclusive).

[36] Warren E. Agin, *A Simple Guide to Machine Learning*, BUS. L. TODAY 1, 1 (2017) (explaining "[t]he phrase 'artificial intelligence' usually to refers machine learning in one form or another").

[37] Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87, 88 (2014).

[38] KAPLAN, *supra* note 34, at 27.

[39] KAPLAN, *supra* note 34, at 27 ("As a general description, computers programs that learn extract patterns from data.").

[40] KAPLAN, *supra* note 34, at 30.

[41] *See* Surden, *supra* note 37, at 88-90, 88 n.10 (discussing the wide range of machine learning applications, including legal applications, that were previously thought to require human cognition). *See generally* IGOR KONONENKO & MATJAZ KUKAR, MACHINE LEARNING AND DATA MINING: INTRODUCTION TO PRINCIPLES AND ALGORITHMS 24-29 (2007) (describing various application areas for machine learning methods such as predicting the structure of chemical compounds).

[42] John Russel, *Elon Musk says Mark Zuckerberg's understanding of the future of AI is 'limited'*, TechCrunch (July 25, 2017), https://techcrunch.com/2017/07/25/elon-musk-mark-zuckerberg-artificial-intelligence/.

[43] *See* Matthew U. Scherer, *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies*, 29 HARV. J. L. & TECH. 353, 374 (2016) (concluding that virtually every tech company has a major AI project including Google's

Commonplace examples of machine learning applications and their potential for concern can be spotted in the way websites like Google, Amazon, or Facebook operate.[44] The software implemented by these companies are able to provide results in a way that is individually tailored to the subjective interests of the user based on preexisting data to facilitate efficient use,[45] but such a technology will undoubtedly encounter in legal and ethical issues.[46] As the number of practical applications of machine learning rapidly increase, it becomes clear that AI is bound to have an immense impact on the law in general and how the legal community operates.

### *C. Artificial Intelligence and the Law*

The practice of law has undergone an inconceivable metamorphosis throughout the technological revolution. Lawyers of yesterday did not have the luxury of today's technological advancements at their leisure; the information available for their legal analysis was limited to either memory or available literature.[47] From word processors to information and communication technologies, the profound effect technology has had on the legal profession is undisputable. As this technological revolution continues to promote innovation, it is difficult to conceptualize a ceiling for technologies such as machine learning. These technologies are only just beginning to deeply impact practical legal efficiency and test previously sound legal principles.

Currently, lawyers are gaining the capacity to use machine learning to complement their work. For example, Automation during the discovery process helps filter large amounts of documents. In general, the use of machine learning in the legal profession can be utilized in at least three highly practical areas: (1) generating legal predictions through pattern detection, used to statistically formalize the intuition of a lawyer's professional judgement in predicting outcomes for client counseling, (2) discovering hidden relationships in data (data-mining), for example

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Deep Mind, IBM's Watson, Facebook's Artificial Intelligence Research Lab, and Microsoft's Project Adam).

[44] Artificial Intelligence: Rise of the Machines, ECONOMIST (May 9, 2015), https://www.economist.com/news/briefing/21650526-artificial-intelligence-scares-peopleexcessively-so-rise-machines ("Firms such as Google, Facebook, Amazon and Baidu have got into an AI arms race, poaching researchers, setting up laboratories and buying start-ups.").

[45] *See* Deven R. Desai, *Exploration and Exploitation: An Essay on (Machine) Learning, Algorithms, and Information Provision*, 47 LOY. UNIV. CHI. L.J. 541, 556-57 (2015) (illustrating the privacy issues accompanying information providers' usage of personal information to tend to individualized user preferences).

[46] Scherer, *supra* note 43 (indicating the preexisting "calls for government regulation of Al development and restrictions on Al operation").

[47] KAPLAN, *supra* note 34, at 91 (referencing Professor Oliver Goodenough's observation that Abraham Lincoln's practice legal practice was largely limited to the number of books he could carry on his horse).

detecting "obscure variables," such as implicit racial bias or partisanship in judicial decisions, and (3) document classification and clustering, utilized in litigation docket organization.[48] However, these benefits do not come without costs. Current limitations include, but are not limited to, overgeneralizations in pattern detection, reduced accuracy resulting from incomplete data sets, and inherent limitations surrounding the use of existing data to anticipate or predict future novel legal issues.[49]

Despite current limitations, machine learning is overwhelmingly transforming the legal workplace, automating what has previously been thought of as requiring human intelligence in a multitude of "real-world commercial applications."[50] The impact of machine learning on the legal field is twofold: first, it will revolutionize the ways in which lawyers complete daily tasks; and secondly, it will test the legal limitations of existing laws that were not designed with this particular technological capability in mind. An illustrative example of both the practical efficiency and the far-reaching constitutional implications of machine learning can be appreciated by examining an example found in the area of criminal law. In this particular illustration, computer engineers have created programs capable of predicting individual criminality such as potential terrorists or sex traffickers through Automated Suspicion Algorithms (ASAs).[51] It should, therefore, come as no surprise that the majority of these applications would lend themselves to all corners of the law.

The prevalence of the legal issues surrounding machine learning, and other areas of AI, seem to be particularly common in the area of intellectual property law. Copyright, trademark, and patent law all lend themselves to the issues surrounding this technology, testing previously sound legal principles. In addition to the practical legal efficiency benefits obtained by the legal profession, the public is also able to utilize this technology to their benefit in ways that will inevitably engender a complementary legal dilemma in the field intellectual property law. Put more simply, if the public can use machine learning or artificially intelligent systems to create or

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[48] Surden, *supra* note 37, at 101-112 (presenting the applicability of three areas machine learning can be used in the law).

[49] Surden, *supra* note 37, at 105-106 (indicating the sophistication of internal statistical models in machine learning algorithms are only as good as the data they are given to analyze); *See also* Thomas C. Redman, *If Your Data Is Bad, Your Machine Learning Tools Are Useless*, HARVARD BUSINESS LAW REVIEW (Apr. 02, 2018), https://hbr.org/2018/04/if-your-data-is-bad-your-machine-learning-tools-are-useless (discussing problems in machine learning associated with poor data quality).

[50] *See* Surden, *supra* note 37, at 87, 89, 95 (listing tasks commonly associated with human intelligence which can be computed using non-intelligent computer algorithms: "higher-order cognitive skills such as reasoning, comprehension, meta-cognition, or contextual perception of abstract concepts").

[51] *See* Michael L. Rich, *Machine Learning, Automated Suspicion Algorithms, and the Fourth Amendment*, 164 U. PA. L. REV. 871, 873, 75-78 (2016) (suggesting while ASA advancements would likely lead to increased national security, the implementation of such a technology risks running afoul of the 4th Amendment).

invent, should the individuals implementing this technology be able to receive the bounties of intellectual property law?

In copyright law, it is perhaps one of the most fundamental principles that "copyright protection may extend only to those components of a work that are original to the author."[52] Protection of these original works of authorship vests initially in the author of the work.[53] The term "original" here requires the work to be more than merely new; the work must also "be the product of intellectual effort or perhaps, of the authors imagination."[54] This creativity standard seems to be necessary for copyrightability as the court in Feist has stated that mere intellectual effort or "sweat of the brow" is not enough on its own to obtain a copyright;[55] there must also be "the formation of a mental conception ultimately given tangible expression in a work of authorship."[56] Therefore, it seems as though, at least in copyright law, there is a requirement that there must be mental conception on the part of the author to receive the bounties of intellectual property law.

The issue of mental conception in authorship, however, is particularly vexing when applied to AI. Artificially intelligent systems have been described as possessing many inherently intelligent characteristics that allow the systems to independently create copyrightable works of art or produce patentable inventions. One authors list of the inherently intelligent characteristics allowing for artificial creativity and innovation includes the following: (1) innovative or creative, (2) unpredictable, (3) independent, (4) autonomous operation, (5) rational intelligence, (6) evolving and capable of learning, (7) efficient, (8) accurate, (9) goal-oriented, and (10) capable of processing free choice.[57] An example found in copyright law of a device possessing these inherently intelligent features is digital authorship in procedurally generated works, for instance, an automatic poetry generator capable of emulating human creativity.[58] It has been suggested that these works should be copyrightable because of their "sufficient nexus to human

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[52] *See* Feist Publ'ns, Inc. v. Rural Tel. Serv. Co., 499 U.S. at 342, 348.

[53] 17 U.S.C. §201(a) (2000) ("Copyright in a work protected under this title vests initially in the author or authors of the work").

[54] Alan L. Durham, *The Random Muse: Authorship and Indeterminacy*, 44 WM. & MARY L. REV. 569, 578 (2002).

[55] *See Feist*, 499 U.S. at 359-60.

[56] Durham, *supra* note 54, at 585.

[57] *See* Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law* 11-15 (March 1, 2017), CARDOZO L. REV. (forthcoming), Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2931828 (listing eight characteristics of artificial intelligence systems that allow for the independent creation of inventions); *See also* 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, 8 (2018) (listing ten characteristic of artificial intelligence systems that allow for the independent creation of original works of art).

[58] *See* Bridy, *supra* note 4, at 15 (discussing Kurzweil's Cybernetic Poet which can be used as either a "poet's assistant" or as an "automatic poetry generator").

creativity."[59] But who should receive the copyright in these computer-generated works and under what circumstances?

The current framework of copyright law is unable to grant ownership in the author-in-fact (the computer) of these computer-generated works because the author has "no legal personhood."[60] This authorship dilemma of copyright law is readily translatable to patent law where machine learning can be used to assist or completely automate the inventive process in the same way computer-generated authors have been seen to pseudo-create works mistakable for human work. In patent law, an artificially intelligent inventor, although likely an inventor-in-fact, should not be treated as the inventor-in-law.[61] Therefore, the inventorship dilemma should result in a similar manner as the authorship dilemma due to the lack of legal personhood in artificially intelligent inventors. The question that remains if artificially intelligent inventors are not to be treated as inventors-in-law is who should be treated as the inventor-in-law and under what circumstances.

## II. COMPUTER-ASSISTANCE AND COMPUTER-GENERATION

Computer-assisted inventions occur when humans utilize sophisticated software to allow the human to arrive at a desired outcome, and a computer-generated invention occurs when a software conceives novel subject matter independent of human intervention. This new approach to problem-solving is the cause of a number of legal and ethical issues. To date, there has not been a known instance of a patented independently computer-generated invention, but these advancements raise the question – once machines are able to compose patentable subject matter entirely independent of human intervention, who should be granted property rights by the USPTO and under what circumstances? To determine who or what, if anyone or anything, should receive a patent in resulting inventions, this section will consider the scholarly opinions currently available on this topic. It will then address the circumstance under which a human or entity employing AI to invent should be granted a patent.

### *A. Artificial Intelligence in the Inventive Process*

While Congress and the courts have yet to explicitly rule on the issue of whether a "computer-conceived invention" is patentable,[62] patent

[59] *See* Bridy, *supra* note 4, at 20 (indicating that the current copyright framework does not expressly require human authorship and that automatic writing cases, "despite their non-human genesis," should be regarded as "works of authorship" due to a "sufficient nexus to human creativity").

[60] Bridy, *supra* note 4, at 21.

[61] *Cf.* Frye, *supra* note 28 and accompanying text (indicating slaves were denied patentability and were not treated as inventors-in-law as they "were unable to take the patent oath" despite being inventors-in-fact of patentable subject matter; accordingly only humans inventors, capable of taking the patent oath should be considered inventors-in law).

[62] *See supra* note 4 and accompanying text.

applications that are solely the product of computer-assistance and computer-generation have already successfully been granted by the USPTO.[63] In response to these technologies and the resulting inventorship issue, a number of proposals have been offered as potential solutions.[64] As one would imagine, in addressing such a novel issue, scholars have come up with a diverse sample of suggestions. This section will begin by addressing a few of these different proposals in turn. The opinions analyzed in this section will contribute to the foundational premise for a prescriptive framework that will be developed throughout the remainder of this article.

One perspective from the limited amount of literature available addresses the patentability of computer-generated patent claims by asking two questions: first, who should be considered the inventor of subject matter initially described by computer-generated claims,[65] and second, should mechanically-generated claims be patentable?[66] After analyzing different classes of people who may seek patents resulting from improvements upon existing inventions made autonomously by a computer software, one article indicates that a key consideration is whether the "contribution helped to make the invention patentable."[67] As a result, this article concludes that companies or individuals that "invent" by sifting through mechanically generated claims or develop software for generating such claims should be rewarded a patent for their work.[68] While this strand of thinking is limited to inventions that are the byproduct of linguistic

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[63] *See* PLOTKIN, *supra* note 6, at 1-3, 51-61 (referencing inventors Stephen Thaler who used the Creativity Machine to invent the cross bristled configuration of the Oral-B Cross Action toothbrush, Gregory Hornby who used a computer software to devise a small antenna used in space missions whose configuration is so unique that no human engineer would have thought to come up with it, and John Konza who used a genetic programing software to automatically create and patent a new controller); *See* Ralph D. Clifford, *Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up?*, 71 TUL L. REV. 1675, 1677-80 (describing how the Creativity Machine uses neural networks modeled after the human brain to produce "new dance choreographies, songs, and automobile designs, and to propose construction materials that may be ultra-hard"); *See also* Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 57 B.C. L. REV. 1079, 1083-91 (2016) (detailing three examples of computers that independently generate patentable results and indicating that in 1998 a patent (U.S. Patent No. 5,852,815) was granted for an invention created by Thaler's Creativity Machine).

[64] *See* Yanisky Ravid & Liu *supra* note 57 at 8 & nn. 20-21 (summarizing the variety of proposals made by scholars in the field, and introducing an alternative approach for addressing inventions made by artificial intelligence).

[65] *See infra* text and accompanying notes 86-87 (describing a software capable of generating computer-generated claims that could result in patentable inventions).

[66] *See* Hattenbach & Glucoft, *supra* note 4, at 45-50.

[67] *See* Hattenbach & Glucoft, *supra* note 4, at 46-47 (citing Levin v. Septodont, Inc., 34 F. Appx. 65, 72 (4th Cir. 2002)) (categorizing original inventors and drafters of the "seed claim" as most likely to receive a patent, developers of the claim-generating code as less likely to be considered inventors, and computers as being highly unlikely to be granted inventorship by the courts).

[68] Hattenbach & Glucoft, *supra* note 4, at 50.

variations of pre-existing claims, it represents the perspective that individuals may be able to receive patents for inventions generated by machines in select instances.

Other scholars have differed as to whether these creative computers should be included under the statutory definition of an "inventor."[69] One scholar in particular has posited the idea that the creative computers should be considered the legal inventor, and that such a classification would lead to "new scientific advances" in the AI industry.[70] This conclusion would ultimately result in granting machines patent rights. While advanced computer programs unquestionably play a critical role in the advancement of scientific progress, computers themselves should not be treated as inventors. Suggesting such a classification for creative computers would seem to adhere the old adage, if you can't beat them, join them, as indicated in the statement "soon computers will be routinely inventing, and it may only be a matter of time until computers are responsible for most innovation."[71]

A third perspective takes a different approach altogether. It proposes that patent law in general is ill-equipped to handle inventions resulting from such AI systems - suggesting "abolishing patent protection of inventions of AI altogether" in order to keep up with this technology.[72] This perspective concludes that AI systems may not own the products they produce, and that since humans on their own are unable to receive the patent rights in inventions independently created by AI systems, patent law will not work in this new technological era.[73] This conclusion relies upon one particular flaw of the current patent system: it "fails in the multiplayer and cumulative patent environment characteristic of AI systems."[74] In order to address this

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[69] *See* Abbott, *supra* note 63, at 1081 (arguing that computers are currently responsible for the generation of patentable subject matter ("computational invention") and as such, the computer, as opposed to a human inventor, qualifies as an inventor). *But See* Clifford, *supra* note 63, at 1696-98 (claiming that the user of a creative computer cannot obtain a patent because they did not conceive the invention, and claiming that a creative computer cannot receive a patent as the legal inventor of an invention because only the actual inventor can file a patent application; the actual inventor "must be human").

[70] Abbott, *supra* note 63, at 1081.

[71] Abbott, *supra* note 63, at 1080.

[72] Yanisky Ravid & Liu, *supra* note 57 at 8.

[73] *See* Yanisky Ravid & Liu, *supra* note 57, at 16-19 (suggesting artificial inventors would be capable of receiving patents on their inventions if it were not for the current structure of patent law because they arguably satisfy many of the statutory conditions for receiving a patent, and noting U.S. patent laws do not take into consideration the possibility that there could be a nonhuman inventor and offering support from the treatment of non-human creators in the copyright context).

[74] *See* Yanisky Ravid & Liu, *supra* note 57, at 20-22; 46 (the Multiple Player Model lists a number of entities that could be considered potential stakeholders in inventions resulting from automated inventions including the software programmers, the data suppliers, the trainers/feedback suppliers, the owners or the operators of the AI system, the new employers of other players, the public, the government, the investors, and the AI system itself).

flaw, the article proposes a solution of a non patent-model that accommodates the multiple players present,[75] but the level of reform necessary for this proposal to succeed would require a massive legislative overhaul.

In line with the majority of the preceding perspectives and the statutory definition of an "inventor,"[76] this article presupposes that the current legal framework does not allow for artificial inventors to be treated as inventors-in-law. It, therefore, concludes that such inventors are unable to receive a patent. This article will proceed by approaching the analysis of the inventorship issue from the perspective of the individual or entity using the AI software as a computerized tool to assist in the inventive process. The remainder of this article will focus on the issue surrounding human assignment of inventions produced with the assistance of AI. To determine when an individual or entity should be able to patent inventions resulting from technologies produced with or by AI, an understanding of the different degrees to which AI may be used throughout the inventive process must first be appreciated.

### *B. Degrees of Artificial Contribution*

While it is indisputable that computers play a critical role in innovation, the degree of contribution in the inventive process varies on a case by case basis. Presupposing that the current legal landscape does not allow for artificial inventors to receive patents on inventions produced by them, the issue surrounding when humans should be able to receive patents in the resulting inventions remains. As such, this section attempts to classify two ways in which computers may partake in the inventive process: computer-assistance and computer-generation.[77] On one end of this spectrum, a computer-assisted invention requires some degree of human intervention in arriving at a predictable outcome, whereas a computer-generated invention is produced independent of human guidance. Computer-assisted inventions allow the inventor to sit in the driver's seat and utilize various design services, computer modeling software, or other programs to facilitate the

[75] *See* Yanisky Ravid & Liu, *supra* note 57, at 46-54 (identifying "being first in the market, electronic open source tools, and social recognition" as the best alternatives to current patent law for dealing with inventions made by AI).

[76] *See* 35 U.S.C. § 100(f).

[77] *Cf.* Kalin Hristov, *Article: Artificial Intelligence and the Copyright Dilemma*, 57 IDEA 431, 433-35 (2017) (dividing AI generated works in the field of copyright law into two main categories: (1) "works generated by AI programs with the direct guidance, assistance or input of human beings", and (2) "autonomously generated AI creations").

creation of their original idea.[78] There are, however, varying degrees in which computer-assisted inventions require human intervention.[79]

Computer-generated inventions, on the other hand, lack a human inventive component and may, therefore, spawn a technological advancement far beyond the capacity of the most innovative of engineers. One example of a computer-generated invention can be seen in Google's AutoML, an automated approach to the making of machine learning models.[80] This project utilizes AI to create more sophisticated AIs; AIs that are "more efficient and powerful than the best human-designed systems."[81] Additional examples of inventions that are the product of AI include a generatively-designed airplane cabin portion that is currently used in the Airbus A320 which was designed to be stronger and lighter than previously used cabin portions, or an even more impressive generatively-designed "ultimate car chassis."[82] To create this "ultimate car chassis," a race car driver drove a car containing a digital nervous system attached to the chassis for a week collecting up to 4 billion data points.[83] The data points were fed to a generative-design AI program called "Dreamcatcher" which produced an end car chassis design that could have never been designed by humans.[84]

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[78] *E.g.* W. J. MARX ET AL., AN APPLICATION OF ARTIFICIAL INTELLIGENCE FOR COMPUTER-AIDED DESIGN AND MANUFACTURING 1-2 (1995) (discussing the application of AI technology in the area of computer-aided design and manufacturing for the purpose of determining airframe structural components for the wing of a High Speed Civil Transport).

[79] *See infra* Part II.C.1. (examining cases of high and low human intervention computer-assisted inventions).

[80] *See* Quoc Le & Barret Zoph, *Using Machine Learning to Explore Neural Network Architecture*, GOOGLE RESEARCH BLOG (May 17, 2009), https://research.googleblog.com/2017/05/using-machine-learning-to-explore.html.

[81] Karla Lant, *Google's machine-learning software has learned to replicate itself*, BUSINESS INSIDER (Oct. 16, 2017, 8:48 PM), http://www.businessinsider.com/googles-automl-replicates-itself-artificial-intelligence-2017-10.

[82] *See* Maurice Conti, *The incredible inventions of intuitive AI*, TED, (April 9, 2016) https://www.ted.com/talks/maurice_conti_the_incredible_inventions_of_intuitive_ai/up-next#t-452273 (Humanity is currently at the cusp of a new age in human history, Until now, there have been four major historical eras defined by the way we work: the hunter gather age. the agricultural age, the industrial age, and the information age. Maurice Conti, director of strategic innovation at Autodesk, defines a new era as the augmented age where "natural human capabilities are going to be augmented by computational systems that help you think, robotic systems that help you make, and a digital nervous system that connects you to the world far beyond your natural senses." The augmentation age encompasses a time where humans can surpass the limitations of passive tools, limited to manual input, and move to an era where tools are generative. Cognitive augmentation consists of tools capable of generative-design and will soon encompass intuitive design tools as well. "Generative-design tools use a computer and algorithms to synthesize geometry" thereby coming up with new designs based on the input of the user's well defined goals and constraints. These computers are producing outputs that are purely generated from scratch.).

[83] Conti, *supra* note 82.

[84] Conti, *supra* note 82.

In addition to computer-generated inventions, there are non-inventive ways machine learning can rattle the current patent landscape. One example of this exists in the generation of prior art references.[85] A French company, Cloem, is using "algorithmic patenting" to computer-generate claim language.[86] The company operates by taking existing patent claims (or an invention description if a patent is unavailable) and creates thousands of timestamped linguistic variants of the text called cloems.[87] While this particular use of machine learning technology may benefit a singular inventor by defending him against other potential patentees who may seek to circumvent the existing invention, it could be harmful to society as a whole. Such iterations create prior art, not necessarily directly covering the submitted invention, which may prevent other potential inventors from obtaining legitimate patents; inventions that would be independently patentable. As a result, said inventor would likely not invest in developing his invention covered by an iterative claim because he is not guaranteed the protection he deserves, and the invention covered by the iteration could in effect sit unused by society.

With such a diverse array of potential AI applications, it is important to distinguish the ways in which AI is being utilized by inventors throughout the inventive process. Is the technology being used to assist humans as a design tool,[88] to solve well-defined problems,[89] to generate patent claims without accompanying enabled inventions,[90] or to independently create without human intervention.[91] All of these variables on the ways AI may assist an inventor will have a different impact on society and should therefore be treated differently. The following sections will focus on developing a model to determine where computer-assistance is too great of a contributor in the inventive process as to render the resulting invention unpatentable. In order to make this determination, two essential considerations must be examined. The following section will walk through these considerations.

### *C. Inventorship Framework*

To address the circumstance under which a human or entity employing AI to invent should be granted a patent, two topics must be considered to produce an analytical framework predicated upon the fundamental justifications for property rights. First, a spectrum for analyzing the degree of human intervention that occurs throughout a given inventive process

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[85] *See supra* note 7.

[86] CLOEM, https://www.cloem.com (last visited Oct. 29, 2017).

[87] CLOEM, *supra* note 86.

[88] *See supra* note 78.

[89] *See infra* notes 98-99; for a examples of well-defined problem;, *see* PLOTKIN *supra* note 63.

[90] *See supra* notes 86-87.

[91] *See supra* notes 80-84.

must be established. [92] One way to frame this dynamic inventorship issue is to establish categories representing the various degrees of human intervention that may take place throughout the inventive process. Next, computer-assisted and computer-generated inventions should be examined through a philosophical lens to determine the point along the spectrum at which human intervention is so minimal that the right to a patent is relinquished. [93] A sufficient nexus to human intervention requirement for inventorship seeks to promote innovation through the use of machine learning technologies, while simultaneously restricting the patentability of potentially monopolistic computer-generated practices.

1. Establishing a Spectrum of Human Intervention

To determine whether computer-assisted inventions or computer-generated inventions should be granted a monopoly right intended to be reserved for inventions conceived by human inventors, two essential issues must be examined. First, it is important to establish a spectrum of intervention that exists in the practical application of utilizing machine learning throughout the inventive process.[94] In order to establish the spectrum of human intervention that occurs in using machine learning, one must first look at the nature of the software being utilized. The next inquiry requires a consideration of what philosophical justifications exist for protecting computer-assisted and computer-generated inventions. In examining the second issue, one must compare the prevailing philosophical justifications for protecting intellectual property rights: primarily the utilitarian approach, the Lockean approach (labor theory), the personality theory, and the social planning theory.[95] This section will focus on inventorship and will establish a spectrum of intervention,[96] with the intent of designating a point at which human intervention is so minimum that the constitutional right to a patent in the invention is extinguished.

The inventive process has traditionally required conception derived from either "long toil and experimentation" or "a flash of genius"[97] to solve a problem. This time-honored notion of the inventive process operates in a systematic fashion where the traditional focus of inventorship has been geared toward solving problems; an inventor discovers a problem in need of a solution and inevitably conceives a solution for said problem. Conversely,

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[92] *See infra* Part II.C.1.

[93] *See infra* Part II.C.2.

[94] *See generally* Hattenbach & Glucoft, *supra* note 4, at 47 (identifying that the inventorship inquiry requires a determination of whether a human inventor had a significant contribution in making the invention patentable, but also indicating that the "mere fact that a computer assisted with the process" is not a bar to patentability).

[95] *See* FISHER, *supra* note 5, at 8-10.

[96] *See infra* Figure 1.

[97] 35 U.S.C. § 103 (1952) (amended 2011) (Historical and Revision Notes) ("The second sentence [of § 103] states that patentability as to this requirement is not to be negatived by the manner in which the invention was made, that is, it is immaterial whether it resulted from long toil and experimentation or from a flash of genius.").

machine learning programs of increasing prevalence are being crafted to operate in a different fashion. An individual seeking to "invent" using a machine learning software program begins by describing a well-defined problem and constraints then a computer arrives at the desired solution without the traditional requirements of human conception.[98] The concept of obtaining desired results merely by describing problems to a sophisticated software (as opposed to physically solving problems) can be seen throughout technology.[99] The fundamental legal issue that arises from these programs is determining who qualifies as an inventor; are these computer programs preprogramed systems or are they programed systems with the ability to generate their own decisions? In order to make a patentability determination, the nature of inventorship must be considered.[100]

For the purposes of the law generally, the term "individual" has understandably been treated as interchangeable with person or organization.[101] Naturally, it should follow that when a statute uses the term "individual," the definition or scope of an individual is limited to human beings. But how should the legal system cope with the idea that given activities regulated by statute can be performed by non-humans, such as animals or computers?[102] In *Naruto v. Slater*, a six-year-old crested macaque monkey, Naruto, grabbed hold of Slater's camera and captured a picture of itself (the "Monkey Selfies") through "independent, autonomous action."[103] Naruto, through Next Friend PETA, filed suit against Slater asserting that Naruto, acting as the photographer, authored and therefore owned the copyright in the photo.[104] The United States District Court for the Northern District of California dismissed the case holding that animals lack statutory standing under the Copyright Act.[105] While this decision supports the premise that some areas of the law should reserved for human actors, determining how the legal system, more specifically the patent system, should cope with the idea that given activities regulated by statute can be

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[98] *See* PLOTKIN, *supra* note 6, at 1-3 (describing the traditional inventive process of solving Problems to the computer enabled inventive process of describing problems).

[99] *See supra* note 98.

[100] For a discussion on inventorship*, see supra* Part II.C.1.

[101] *E.g.*, RESTATEMENT (THIRD) OF AGENCY §1.04(5) (AM. LAW INST., 2006) (defining person to be "(a) individual; (b) an organization or association that has legal capacity to process rights and incur obligations; (c) a government, political subdivision, or instrumentality or entity created by government; or (d) any other entity that has legal capacity to possess rights and incur obligations").

[102] *See generally* Cary Coglianese & David Lehr, *Regulating by Robot: Administrative Decision Making in the Machine-Learning Era*, 105 GEO. L.J. 1147 (2017) (discussing ways in which machine learning is currently used in administrative applications).

[103] *See* Naruto v. Slater, No. 15-cv-04324-WHO, 2016 U.S. Dist. LEXIS 11041, at *1-3 (N.D. Cal. Jan. 28, 2016).

[104] *See Id*.

[105] *See Id* at *10-11 ("Works That Lack Human Authorship" in the Compendium of the U.S. Copyright Office Practices § 313.2 (3d ed.): "[t]o qualify as a work of 'authorship' a work must be created by a human being. Works that do not satisfy this requirement are not copyrightable.").

completed by computers is not as straightforward as determining whether some activity was undertaken by an animal or not.[106]

To establish where patent rights should be cut off in the inventive process, it is helpful to examine the amount of human intervention that occurs throughout the inventive process. If there is sufficient human intervention to constitute a nexus to human inventorship,[107] then the resulting product should be deemed to fall within the zone of patentability. On the other hand, if such a minimal amount of human intervention is present in the inventive process, then the invention should fall within the zone of unpatentability. One example of a computer-assisted invention with high human intervention would be a computer aided design software used to evaluate various design constraints where the user is directly in control of the input and the output.[108] Here there would be a sufficient nexus to human inventorship. An example of a computer-assisted invention with low human intervention would be a generatively-designed product where data is fed to an AI program to create an end product that could have never been conceived by humans.[109] Here there would not be a sufficient nexus to human inventorship because the computer assistance was used not to arrive at a well-defined solution, but rather to draw up a solution that was beyond the scope of human intelligence.

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[106] *See* Hristov, *supra* note 77, at 437 (suggesting independent autonomous works are not copyrightable and should fall into the public domain since "autonomously learned behavior is something that cannot be attributed to the human programmer of an AI machine); *But See* Abbott, *supra* note 63, at 1103-08 (laying out arguments in support of and against computer inventors, but concluding that "allowing patents on computational inventions as well as computational inventors would . . . do away with the idea that only a human can be the inventor of the autonomous output of a creative computer – resulting in fairer and more effective incentives").

[107] The sufficient nexus to human inventorship described here in reference to computer-assisted inventions is analogous to the "sufficient nexus to human creativity" of computer programs utilizing AI to autonomously generate works of art in the copyright context. *See supra* notes 58-60 and accompanying text.

[108] *See infra* note 148 and accompanying text (testing human intervention framework on high a human intervention work).

[109] *See infra* note 149 and accompanying text (testing the human intervention framework on a low human intervention work); *see also* AUTODESK RESEARCH PROJECT DREAMCATCHER, https://autodeskresearch.com/projects/dreamcatcher (last visited, May 14, 2018) (depicting Project Dreamcatcher, a next generation computer aided design software capable of "generat[ing] thousands of design options that all meet [a users] specified goals").

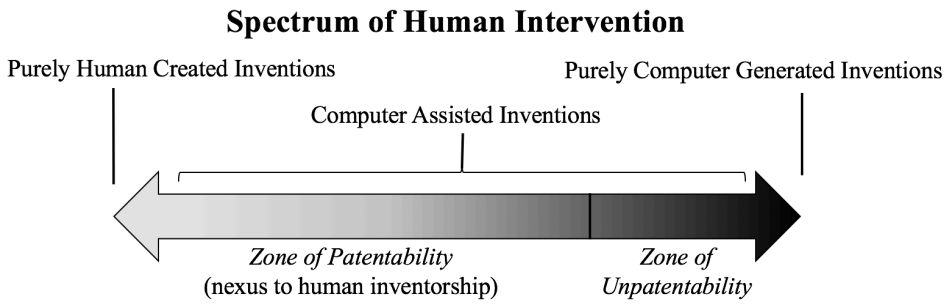


**Figure 1**: Spectrum of Human Intervention

The two examples above illustrate two different types of computer-assisted inventions that lie in opposing zones on the spectrum of human intervention" one resulting in a patent, and not the other based on the manner in which the invention was made. While Section 103 of the patent act indicates that "patentability shall not be negated by the manner in which the invention was made,"[110] the intent of this statute was to address the human inventive process, not the computer-generated inventive process.[111] Therefore it should follow that computer-assisted inventions with a sufficient nexus to human inventorship should remain patentable, whereas computer-generated inventions and computer-assisted inventions lacking the requisite minimal human intervention should not be patentable. The reasoning as to why patentability should terminate once human intervention approaches a minimum will be highlighted through the primary philosophical justifications of intellectual property law.

2. Finding a Nexus to Human Inventorship

Establishing a boundary between the zone of patentability and the zone of unpatentability may be difficult to maintain across all types of patentable subject matter. In the model being developed in this article, the point at which a computer-assisted or computer-generated invention should enter the zone of unpatentability occurs when said invention lacks sufficient human intervention to constitute a nexus to human inventorship.[112] To determine how such a nexus to human inventorship should be analyzed, this section will dissect the prevailing theoretical approaches to intellectual property law and examine purely human generated inventions, computer-assisted inventions, and computer-generated inventions through a philosophical lens to deduce where patentability should seize on the spectrum of intervention.

The four main theoretical approaches to intellectual property law will

[110] 35 U.S.C. § 103.

[111] *See* Hattenbach & Glucoft, *supra* note 4, at 44 (The legislative history suggests the "portion of Section 103 was intended to direct courts to disregard whether an invention was conceived in a 'eureka' moment or through random success. It was intended to address the process of invention undertaken by human inventors, not machines.").

[112] *See supra* Figure 1.

establish the basis for which fundamental justifications of intellectual property rights will be focused on in determining patentability.[113] The four fundamental justifications are as follows: (1) the utilitarian approach, which seeks to serve the "maximization of net social welfare"; (2) the Lockean approach, which focuses on "the proposition that a person who labors upon resources that are either unowned or 'held in common' has a natural property right in his or her efforts – and that the state has a duty to respect and enforce that natural right"; (3) the personality theory, the premise of which is that "private property rights are crucial to the satisfaction of some fundamental human need," and that policy should be developed that enables people to fulfil this need; and lastly, (4) the social planning theory, which is based on the premise that property rights should be designed to "help foster the achievement of a just and attractive culture."[114]

To maximize net social welfare in line with the utilitarian approach, Congress should allow for the patentability of most computer-assisted inventions, but not allow computer-generated inventions to be patentable. The Supreme Court has consistently held that the primary purpose of the patent system "is not the creation of private fortunes for the owners of patents but is 'to promote the progress of science and useful arts.'"[115] To promote this Constitutional requirement and serve the "maximization of net social welfare"[116] an appropriate balance must be struck between the exclusive rights offered by a patent and public enjoyment of purely human generated inventions, computer-assisted inventions, and computer-generated inventions.[117] Allowing computer-generated inventions to be patentable would surely aid in the creation of the private fortunes of those that can afford the technology to generate such inventions. As a result, computer-generated inventions should not be patentable because such a determination would favor exclusivity over public enjoyment. The question

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[113] FISHER, *supra* note 5, at 8 (outlining four main theoretical approaches to IP law).

[114] FISHER, *supra* note 5, at 2-8, 36 ("The indeterminacy of the personality and social-planning perspectives has long been recognized. That recognition is reflected, for example, in the common accusation that those perspectives are "illiberal" insofar as they seek to regulate persons' behavior on the basis of necessarily controversial "theories of the good" -- the sort of thing that governments ought not do. A closely related, equally common charge is that the social planning and personhood perspectives are "paternalistic" insofar as they curtail persons' freedom on the basis of conceptions of what is "good for them" with which they themselves may not agree. By contrast, the utilitarian and labor-desert approaches, especially the former, have enjoyed an aura of neutrality, objectivity, and above all determinacy. That aura helps to explain why courts, when presented with difficult problems of statutory interpretation, have sought guidance most often from economic arguments and least often from social-planning arguments.").

[115] Motion Picture Patents Co. v. Universal Film Mfg. Co., 243 U.S. 502, 511 (1917) (quoting Pennock v. Dialogue, 27 U.S. 1, 19 (1829) (Story, J.) ("While one great object [of our patent laws] was, by holding out a reasonable reward to inventors, and giving them an exclusive right to their inventions for a limited period, to stimulate the efforts of genius; the main object was 'to promote the progress of science and useful arts.'").

[116] FISHER, *supra* note 5, at 2.

[117] *See supra* Figure 1.

that remains is how broad should the protection of computer-assisted inventions be.

There are a number of costs associated with granting overbroad intellectual property rights and finding the correct compensation for creators or inventors; therefore, the goal of granting an intellectual property right should be to find "not merely an incentive but the right incentive."[118] Granting economic incentives to the owner of a computer program that assists in the inventive process should only take place where there is sufficient human intervention throughout the inventive process. To grant patent rights to a computer-assisted invention lacking a sufficient nexus to human inventorship would not stimulate invention and creativity in a way similar to the way patents on computer-generated inventions would prioritize exclusion over the stimulation of invention.

A similar conclusion can be drawn when the issue of computer-assisted and computer-generated inventions are examined through the Lockean labor approach. Allowing the owners or users of a computer software capable of generating an invention to obtain a 20-year monopoly[119] on their invention would offer said owners or users an unproportioned reward for their labor. According to Justin Hughes, "the limited capacities of humans put a natural ceiling on how much an individual may appropriate through labor."[120] This premise however is tested by the aided capacities of individuals utilizing computer-assistance to invent. Machine learning technologies now allow individuals to invent beyond previous natural limitations by outputting inventions that the human could never conceive independently.[121] In sum, it does not necessarily follow that the end result of a computer-assisted invention is in fact the fruit of the user's labor or ability. The primary focus of the Lockean approach is rewarding the labor of the inventor when the labor is derived from the inventor's actual handiwork.[122] Therefore, the Lockean approach supports the conclusion that computer-assisted

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[118] Lemley, *supra* note 11, at 1058-59 (listing five categories of costs associated with granting overbroad intellectual property rights: (1) "intellectual property rights distort markets away from the competitive norm, and therefore create static inefficiencies in the form of deadweight losses," (2) "intellectual property rights interfere with the ability of other creators to work, and therefore create dynamic inefficiencies," (3) "the prospect of intellectual property rights encourages rent-seeking behavior that is socially wasteful," (4) "enforcement of intellectual property rights imposes administrative costs," (5) "overinvestment in research and development is itself distortionary").

[119] 35 U.S.C. § 154(a)(2).

[120] Hughes, *supra* note 5, at 297, 300 (identifying three propositions to justify the propertizing of ideas under the Lockean approach: (1) a person's labor is required for the production of ideas, (2) these ideas come from a "common" that is not devalued by the removal of a given idea, and (3) these ideas can be propertized without becoming waste).

[121] *See supra* Section II.A.

[122] *See generally* Hughes, *supra* note 5, at 302 (discussing that human handiwork becomes the property of said human because it is the product of their "energy, consciousness, and control").

inventions lacking a sufficient nexus to human inventorship should not be patentable because there is no human labor deserving of a societal reward.

The personality theory of property proposes that "an idea belongs to its creator because the idea is the manifestation of the creator's personality."[123] If the allocation of private property rights is indeed a manifestation of the creator's personality crucial to the satisfaction of a deeper human need to flourish,[124] entitling computers or the operators of computers to benefit from the entitlements that drive this need would hinder the incentive to invent. Little human need would be satisfied by allowing purely computer-generated output to dwarf human expression. Additionally, the social planning theory, used to build desirable society with an "attractive intellectual culture,"[125] can be employed as a guide to determine whether patentability should seize in computer-assisted inventions lacking human intervention. In generating a vision for a desirable society, it is essential to balance incentive with benefit.

The benefit of using computer-assistance or computer-generation to invent would undoubtedly produce inventions that would benefit society, but the use of such computation would likely reduce the number of "inventors" to those who could afford to own such technology. As a result, the incentive to become educated or proactive in the scientific arts would likely be devastated as a consequence of a computational monopoly. In conclusion, the four prevailing theoretical justifications of intellectual property law suggest that patentability should seize if computer-assistance reduces human intervention from the inventive process, such that there is no longer a nexus of inventorship between the inventor and the invention.

## III. A HUMAN INTERVENTION REQUIREMENT

The human intervention requirement is essential to establishing a boundary between the zone of patentability and the zone of unpatentability as defined in the spectrum of intervention.[126] Such a requirement is primarily justified by the utilitarian and Lockean approaches, and need to maintain the incentive to invent. The following sections seek to develop the model framework into a workable test that can be used to provide law makers with an analytical guide for addressing this issue. Once established, the final section will run the proposed framework through a number of simulations to examine its workability and identify its faults.

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[123] Hughes, *supra* note 5, at 297.

[124] *See* Fisher, *supra* note 5, at 5-6.

[125] *See* Fisher, *supra* note 5, at 33-35 (indicating the difficulty in formulating the vision of a just and attractive culture; and offering which qualities are foundational for an attractive intellectual culture: consumer welfare, a cornucopia of information and ideas, a rich artistic tradition, distributive justice, semiotic democracy, sociability, and respect).

[126] *See supra* Figure 1.

### A. *Maintaining the Incentive to Invent*

In providing the quid pro quo required for the patent system to function, courts have explained that maintaining the incentive to invent is essential.[127] Similarly, the Report of the President's Commission on the Patent System from 1966 listed four fundamental justifications for the patent system: an incentive to invent, a stimulation of investment capital required for development and marketing, encouragement of early public disclosure of the technological information, and promoting a beneficial exchange of products.[128] The incentive to invent operates "by offering the possibility of reward to the *inventor* and to those who support him. This prospect encourages the expenditure of time and private risk capital in research and development efforts."[129] While this economic justification recognizes the costs of research and development, the rights of the inventing individual or individuals remain central to this justification; not machines as machines require no incentives or economic justifications to operate.[130]

Keeping with the trend that machine learning technology will continue to develop at an exponential rate,[131] it is essential to determine whether the current regulatory regime is capable of maintaining the incentive to invent.[132] As society enters the "artificial invention age,"[133] and computer-assisted and computer-generated inventions increase in prevalence, an established test to determine how much human intervention is required to constitute inventorship remains nonexistent. Since the law is not yet adept to handle the idea of artificially intelligent inventors, this section seeks to establish a framework for determining the scope of patentability of inventions that are the product of AI. This framework will include a

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[127] *See generally* Mazer v. Stein, 347 U.S. 201, 219 (1954) ("The economic philosophy behind the clause empowering Congress to grant patents and copyrights is the conviction that encouragement of individual effort by personal gain is the best way to advance public welfare through the talents of authors and inventors in "Science and useful Arts." Sacrificial days devoted to such creative activities deserve rewards commensurate with the services rendered.").

[128] REPORT OF THE PRESIDENT'S COMMISSION ON THE PATENT SYSTEM 10-11 (1966) [hereafter COMMISSION REPORT] (emphasis added) (listing the incentive to invent as the first "basic worth of the patent system"); *See also* ROBERT P. MERGES, PETER S. MENELL & MARK A. LEMLEY, INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 17-18 (6th ed. 2012).

[129] COMMISSION REPORT, *supra* note 128.

[130] *See* Pamela Samuelson, *Allocating Ownership Rights in Computer-Generated Works*, 47 U. PITT. L. REV. 1185, 1199 (1986) ("[I]t simply does not make any sense to allocate intellectual property rights to machines because they do not need to be given incentives to generate output.66 All it takes is electricity (or some other motive force) to get the machines into production.).

[131] *See* Mark Fenwick et al., *supra* note 3.

[132] *See* COMMISSION REPORT, *supra* note 128.

[133] *See* PLOTKIN, *supra* note 6, at 1, 10-11 (stating artificial inventing is here to say and "[t]he future . . . won't wait for patent law," and noting that if patent law fails to reform "control over artificial invention will fall to those players who are savvy enough to game the existing system to their private benefit").

requirement that demands substantive human intervention throughout the inventive process for computer-generated "inventions" to be patentable. The result of computer-generated inventions and computer-assisted inventions lacking sufficient human intervention to constitute a nexus to human inventorship should enter the public domain and remain free to be protected other areas of law such as trade secret law.

Since the current law is not well suited to determine which computer based inventions should be deemed unpatentable, the following analytical framework seeks to offer guidance to the judiciary and legislature on how to make this determination and arrive at a conclusion of patentability.[134] In step 1, determine the nature of inventorship of the claimed invention. If the claimed invention is a purely human created invention, the invention should not fail for patentability. If the claimed invention is the product of computer-assistance or computer-generation proceed to step 2A. In step 2A, determine the degree of human intervention in the claimed invention. If the claimed invention is a computer-assisted invention, containing a combination of human intervention and computer-assistance, proceed to step 2B. If, however, the claimed invention is the product of computer-generation, containing no human intervention, said invention is unpatentable. In step 2B, determine whether the degree of human intervention in the claimed computer-assisted invention has a sufficient nexus to human inventorship. If the computer-assistance is (a) designed for the particular purpose of solving a well-defined problem, and (b) used merely as a tool to assist a human inventor arrive at a predictable result, said computer-assistance should not fail for patentability. If, however, the computer-assistance is used to design or create an invention with minimal human intervention said invention is unpatentable.

Declaring that inventions lacking minimal human intervention are unpatentable does not automatically mean that innovation would be stifled as a result. In fact, Justice Breyer once said that "sometimes *too much* patent protection can impede rather than 'promote the Progress of Science and useful Arts' . . . ."[135] The justification behind this principle is "sometimes [a patent's] presence can discourage research by impeding the free exchange of information."[136] While it is true that too much patent protection may sometimes impede the incentive to invent, alternative avenues of protection exist outside of traditional patent law that may not impede such incentives. To obtain protection for devices found to be unpatentable under the spectrum of human intervention model, "being first in the market, electronic open source tools, and social recognition" have all been suggested as some potential alternatives to current patent law for

[134] *See supra* Figure 1.

[135] Lab. Corp. of Am. Holdings v. Metabolite Labs., Inc., 548 U.S. 124, 126 (2006) (referencing the justification behind not affording laws of nature patent protection despite the amount of time it may take to research or discover them or the investment that may go into such research).

[136] *Id.* at 127.

dealing with inventions made by AI.[137] While such methods may be successful at maintaining the incentive to invent, another alternative avenue of protection exists that would not require patent law reform – trade secret law. This area of the law would allow individuals to capitalize on unpatentable computer-assisted or computer-generated inventions.

There are many advantages to seeking trade secret protection over both computer-assisted and computer generated inventions. Seeking trade secret protection over either type of artificially produced inventions would mitigate the risk of disclosing sensitive information pertaining to the software that developed the patentable invention, and would limit the amount of information available for competitor use upon rejection of an application.[138] Additionally, if individuals utilizing such computer programs attempt to patent their inventions, nothing would prevent other countries from using the resulting invention if patented.[139] As such, trade secret law is a valuable option to those works that fall within the zone of unpatentability.[140] However, trade secret law has limitations in the scope of protection it may offer – such as reverse engineering.[141] Generally, works unable to obtain or maintain trade secret protection are left to the public.

If patent protection is unavailable, and trade secret law also fails to afford protection, remaining works should be left for the public to use. Here, the result of computer-generated inventions and computer-assisted inventions lacking a sufficient degree of human intervention should, as suggested by Ralph D. Clifford, appear in the public domain in the same way works generated by creative computers, where no human creativity exists in the creative process, should appear in the public domain.[142] Courts have traditionally been motivated to allow works to enter the public domain in trademark and copyright cases to balance "concerns over productivity

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[137] Yanisky Ravid & Liu, *supra* notes 75 and accompanying text.

[138] Frank A. DeCosta, III & Aliza G. Carrano, *Intellectual Property Protection for Artificial Intelligence*, WESTLAW JOURNAL INTELLECTUAL PROPERTY 1, 4 (2017) (indicating that "[t]rade secret protection may be particularly well-suited for rapidly developing and changing AI inventions, where refinements and improvements are fluid").

[139] *Id.*

[140] *See supra* Figure 1.

[141] *See* Pamela Samuelson; Suzanne Scotchmer, *The Law and Economics of Reverse Engineering*, 111 YALE L.J. 1575, 1664 (2002) (expressing "reverse engineering has always been a lawful way to acquire a trade secret, as long as 'acquisition of the known product... [is] by a fair and honest means, such as purchase of the item on the open market.'").

[142] *See* Clifford, *supra* note 63, at 1690, 95, 98 (suggesting that both seemingly patentable and copyrightable computer-generated works produced by the Creativity Machine should appear in the public domain since the creation or invention has no claimant); *See generally* § 1 J. THOMAS MCCARTHY, MCCARTHY ON TRADEMARKS AND UNFAIR COMPETITION § 1.23 (5th ed. 2017) ("'Public Domain' is the status of an invention, creative work, commercial symbol, or any other creation that is not protected by any form of intellectual property. Legally protected zones of exclusive rights, such as patents, trademarks and copyrights, are exceptions to the general principle of free copying and imitation.")

losses from intellectual monopolies."[143] The same principle has been applied in patent cases to incentivize inventive activity.[144] In the case of computer-assisted and computer-generated inventions, the most effective way to maintain an incentive to invent would be to allow works lacking a sufficient nexus to human inventorship to fall into the public domain.[145] The following section seeks to test the inventorship framework developed in this paper with the intent that the incentive to invent is not restricted.

### *B. Testing the Human Intervention Framework*

The human intervention requirement for inventorship allows for the spectrum of intervention previously discussed[146] to be tested on real world examples. The resulting framework examines how much intervention is necessary for such works to be patentable, and the intended result of this framework is to prescribe ways to disincentivize individuals or companies from gaining a monopoly[147] over computer-assisted inventions that are the product of minimal human intervention. Regulating computer-assisted or computer-generated inventions of this nature will help maintain the incentive for individuals or companies to use machine learning by offering predictability for inventors during the patent prosecution process. Maintaining the incentive to use machine learning in the inventive process also seeks to ensure the general welfare of society is not hindered. This section will run the proposed framework through three simulations to examine its workability and identify its faults. The first case will test a computer-assisted invention with high human intervention, the second case will test a computer-assisted invention with low human intervention, and the third case will test a purely computer-generated invention.

In the first case of a computer-assisted invention with high human intervention, examples can be seen in almost every mechanically based engineering design as little design work is done without the help of a computer aided design (CAD) software.[148] Upon examination of step 2A, an invention resulting from the assistance of such a technology contains a

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[143] Lee, *supra* note 20.

[144] *See* Lee, *supra* note 20 (indicating the importance of "[m]aintaining intellectual infrastructure in the public domain" as it "promotes inventive activity").

[145] *See* Samuelson, *supra* note 130, at 1226 (Weighing the pros and cons of granting no ownership rights in the raw output of computer generated works found in copyright law. On one hand, if the authorship dilemma surrounding computer generated works is unable to be resolved, it may be best to allow the works to enter the public domain because there is no human author and therefore no human in need of motivation to create. On the other, if someone should be given an incentive to publicize the work, it should be the user of the work because they are best suited to further the Constitutional purpose. If a "flawless work" created by a computer program were deemed to be unprotectable for the reason that there is no human author, there would be little incentive to publicize the work only to have the work to fall into the public domain.).

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

[147] *See supra* note 119 and accompanying text.

[148] *See* MARX, *supra* note 78 and accompanying text.

combination of human intervention and computer-assistance and should be examined under step 2B. Under step 2B, the resulting invention should not fail for patentability because the technology is simply a tool used for the particular purpose of solving a well-defined problem and assisting the inventor arrive at a desired result, such as calculating the tolerances of their design and making an economic decision in selecting design materials. The result of this test case conforms to the desired result of the human intervention framework and the accompanying policy considerations.

The second case of a computer-assisted invention with low human intervention, can be seen in the generatively-designed "ultimate car chassis" where data points were fed to a generative-design AI program called "Dreamcatcher" which produced an end car chassis design that could have never been designed by humans.[149] Upon examination of step 2A, such a claimed invention also contains a combination of human intervention and computer-assistance and should be examined under step 2B. Under step 2B, the resulting invention should fail for patentability and exist in the public domain because the computer assistance was not used as a tool to help the inventor arrive at a predicted and well-defined design solution, but rather arrive at a design that could have never been dreamt up by human inventors.

The third case of a purely computer-generated invention can be seen in Stephen Thaler's Creativity Machine which was used to independently invent the cross bristled configuration of the Oral-B Cross Action toothbrush,[150] or in Google's AutoML, the automated approach to the making of machine learning models.[151] Upon examination of step 2A, such claimed inventions do not contain a combination of human intervention and computer-assistance and should therefore be unpatentable and exist in the public domain. While the Creativity Machine may have received an input that led to the resulting invention, the invention lacks all of the essential traditional components of invention.

The result of the second and third cases also conform to the desired result of the human intervention framework and the accompanying policy considerations, but they expose potential setbacks in achieving the result the framework seeks to obtain. One of the potential enforcement difficulties that exists is the likelihood that a given computer-assisted invention with low human intervention or a purely computer-generated invention may lack distinction from computer-assisted inventions with high human intervention in the eyes of an outside examiner. Within the currently proposed human intervention framework, there is no way to accurately determine the level of computer-assistance that takes place during the inventive process from the view of a patent examiner, particularly since current patent law states that "patentability shall not be negated by the manner in which the invention

[149] Conti, *supra* note 82.
[150] *See supra* note 63.
[151] *See supra* notes 80-81.

was made."[152] Aside from the potential difficulty in implementing this framework in close call cases, the overall value of the proposal endures as a tool to enable courts and legislators to examine what protection should be granted to inventions output from artificially intelligent computers.

## CONCLUSION

AI is developing with such rapidity that regulation related to corresponding areas of the law are left lagging behind. This revolutionary technology continues to subsume nearly every industrial area, and the need for legal guidance on this topic is increasing exponentially, particularly in the area of patent law. As developers and inventors gain the ability to create machine learning technologies capable of independently generating inventions, a novel issue of inventorship emerges; are computers capable of being inventors? If not, who, if anyone, may claim the rights to inventions resulting from artificially intelligent inventors. To answer such a question, this article examined the inventorship requirement and established three ways in which an invention may be made: pure human generation, computer-assistance, or pure computer-generation.

The product of such an inquiry is a framework derived from the prevailing theoretical justifications for intellectual property rights. This framework analyzes the spectrum of human intervention to determine the requisite amount of intervention necessary to constitute inventorship. In order to distinguish between patentable and unpatentable computer-assisted and computer-generated inventions, the spectrum incorporates a point at which a computer-assisted invention enters a zone of unpatentability. This occurs when said invention lacks sufficient human intervention to constitute a nexus to human inventorship. If a nexus to human inventorship is lacking, the resulting invention should enter the public domain. This proposal will assist judges and legislators in their determination of the allowable degree of technological intervention required to obtain traditional patent rights by designating a point at which human intervention is so minimal that the constitutional right to a patent in the invention is extinguished.

[152] 35 U.S.C. § 103. *See also* Durham, *supra* note 54, at 587-88 (listing examples of instances in which inventions were discovered accidentally; highlighting the need for 35 U.S.C. § 103).