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I, Inventor: Patent Inventorship for Artificial Intelligence Systems

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I, INVENTOR: PATENT INVENTORSHIP FOR ARTIFICIAL INTELLIGENCE SYSTEMS

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I. INTRODUCTION

The discussion of AI is everywhere. It was a key theme of seemingly every tech conference last year, and nearly every company, tech and non-tech, is talking either about where they play in AI or how they will take advantage of it to improve their business. The reason is clear: the promise of AI is real, and the potential is bigger than most people realize.[1]

-Sanjay Mehrotra[2]

Artificial Intelligence (AI) could be widely, but non-unanimously, viewed as any cutting-edge machine performing human-like tasks potentially beyond human capability. In January 2019 Sanjay Mehrotra CEO at Micron Technology Inc. released the Promise of Artificial Intelligence is Driven by Memory and Fast Storage.[3] Even enormously small, nanoscale technologies of integrated circuits are empowered by AI and can drastically change everyday life. AI affects people deeply on a daily basis and, for example, has the potential to discover a new drug and improve the efficiency of drug development in such a way as a human has never done before.

In 2020 Google CEO Sundar Pichai warned of potential harms caused by AI and suggested that AI needs to be regulated.[4] On the other hand, former director of the United States Patent and Trademark Office (USPTO) Andrei Iancu alluded to Machines as Patent Owners.[5] We, therefore, need to prepare an answer to the question: if an AI makes an invention truly without significant human involvement, should the AI be named as the inventor? PART II addresses historical development of AI. Part III addresses recent rapid development toward sophisticated AI, and Part IV addresses existing legal framework. Part V discusses whether only a human can be an inventor, and Part VI discusses whether AI should be named as an inventor. Part V concludes and suggests that the inventorship requirement of a "natural person" should be relaxed so that sophisticated AI can be an inventor.

II. HISTORICAL DEVELOPMENT OF AI

A. Origin of AI

In 1943, science fiction author Isaac Asimov introduced the Three Laws of Robotics, with the goals of the Laws to basically regulate a robot to act human

1. Sanjay Mehrotra, *The Promise of Artificial Intelligence is Driven by Memory and Fast Storage*, MICRON BLOG (Jan. 10, 2019), https://www.micron.com/about/blog/2019/january/the-promise-artificial-intelligence-driven-by-memory-and-fast-storage.

3. *Id.*

4. *Id.*

4. Kris Holt, *Google CEO Sundar Pichai Says AI 'Needs To Be Regulated',* FORBES (Jan. 20, 2020, 11:40 AM), https://www.forbes.com/sites/krisholt/2020/01/20/google-ceo-sundar-pichai-says-ai-needs-to-be-regulated/#55ef43e5f914.

5. Katie Malone, *USPTO Hints at Forthcoming Report on Machines as Patent Owners*, MERITALK (Jan. 9, 2020, 11:53 AM), https://www.meritalk.com/articles/uspto-hints-at-forthcoming-report-on-machines-as-patent-owners/.

friendly.[6] The term "AI" came to the world in 1956 when a Dartmouth College summer research project proposed AI basically as a human-like machine.[7]

In the 1970s the Japanese electrical engineer Kunihiko Fukushima was inspired by the Nobel Prize winners Hubel and Wiesel's discovery[8] of the hierarchy model of the primary visual cortex.[9] Fukushima released an architecture of a Convolutional Neural Network (CNN), typically employed for image (e.g., handwritten character) recognition, named "Neocognitron,"[10] which became a basis of the recent rapid development of AI.[11]

B. Definition of AI

In 1950, British mathematician and logician Alan Turing[12] proposed the Turing Test. The Test is designed to deal with whether machines can think.[13] In response to a question provided from a human interrogator, a single answer, hidden from the human interrogator (e.g., via a computer screen), is chosen from among two answers, one of which is from a human and the other being from a machine (e.g., AI). Basically, the test is whether the human interrogator identifies, without cheating, which of the two is AI by using the questions and answers (i.e., whether the AI completely mimics the human answer). If the human interrogator fails to identify which of the two is the AI after using the questions and answers, then it is deemed that the AI has passed the test, which basically means the AI reaches human intelligence.

Although there have been many efforts to define AI, an ultimate and unanimous definition of AI has not been accepted.[14] One reason is the difficulty of capturing a variety of existing AI technologies under one universal definition. Also, it is true that there is a difficulty in properly predicting what type of AI will be developed and will exist in the future. Some commentators and researchers point

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6. ISAAC ASIMOV, RUNAROUND, *reprinted in* I, ROBOT (1942) ("Three Laws are a robot may not injure a human being or, through inaction, allow a human being to come to harm; a robot must obey the orders given it by human beings except where such orders would conflict with the First Law; a robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.").

7. J. McCarthy et al., *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence*, STAN. UNIV. (Aug. 31, 1955), http://jmc.stanford.edu/articles/dartmouth/dartmouth.pdf.

8. *A Nobel Partnership: Hubel & Wiesel*, HARV. UNIV., https://braintour.harvard.edu/archives/portfolio-items/hubel-and-wiesel (last visited Sept. 22, 2020).

9. Kunihiko Fukushima, Neocognitron: A Self-organizing Neural Network Model for a Mechanism of Pattern Recognition Unaffected by Shift in Position, 36 BIOL. CYBERNETICS 193 (1980).

10. *Id.*

11. Daniel Hernandez, *Facebook's Quest to Build an Artificial Brain Depends on This Guy*, WIRED (Aug. 14, 2014 6:30AM), https://www.wired.com/2014/08/deep-learning-yann-lecun/.

12. B.J. Copeland, *Alan Turing: British Mathematician and Logician*, BRITANNICA (June 19, 2019), https://www.britannica.com/biography/Alan-Turing.

13. David Dowe & Graham Oppy, *The Turing Test*, STAN. ENCYCLOPEDIA OF PHIL. (Aug. 18, 2020) ("The phrase 'The Turing Test' is most properly used to refer to a proposal made by Turing (1950) as a way of dealing with the question whether machines can think."), https://plato.stanford.edu/entries/turing-test/.

14. Matthew U. Scherer, Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies, 29 HARV. J. L. & TECH. 354 (2016).

out that the human-centric approach to defining AI is flawed, partially because humans do many things that are not intelligent and that the definition tends to be too broad or too narrow.[15] For instance, Nevada adopted the human-centric approach to defining AI in association with autonomous vehicles.[16] According to that definition, artificial intelligence means "the use of computers and related equipment to enable a machine to duplicate or mimic the behavior of human beings."[17] That definition was later repealed by 2013 Statutes of Nevada, chapter 377 and newly defined pursuant to the industrial standard, that is, SAE J3016 by 2017 Statutes of Nevada, chapter 608.[18]

Recent efforts to define AI focus on whether the goal is all-purpose (e.g., multiple purposes) or a limited (e.g., single) purpose. In 2017, Artificial General Intelligence or Narrow Artificial Intelligence were defined, respectively, by H.R. 4625, sponsored by Representative John K. Delaney:

> The term "artificial general intelligence" means a notional future artificial intelligence system that exhibits apparently intelligent behavior at least as advanced as a person across the range of cognitive, emotional, and social behaviors.
>
> The term "narrow artificial intelligence" means an artificial intelligence system that addresses specific application areas such as playing.[19]

A more recent effort for the ultimate definition was proposed by Jacob Turner[20] as "Artificial intelligence is the ability of a non-natural entity to make choices by an evaluative process."[21] Also, the Artificial Intelligence Initiative Act, which was introduced in the Senate in March 2019, released the following definition:

The term "artificial intelligence" includes the following:

> (A) Any artificial system that performs tasks under varying and unpredictable circumstances without significant human oversight, or that can learn from experience and improve performance when exposed to data sets.
>
> (B) An artificial system developed in computer software, physical hardware, or other context that solves tasks requiring human-like perception, cognition, planning, learning, communication, or physical action.

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15. Jacob Turner, Robot Rules: Regulating Artificial Intelligence 12 (Palgrave Macmillan 1st ed. 2018).

16. *Id.*

17. NEV. REV. STAT. § 482A.020 (repealed 2013).

18. Jennifer Shuttleworth, *SAE updates J3016 Levels of Automated Driving Graphic to Reflect Evolving Standard*, SAE INT'L (Jan. 7, 2019), https://www.sae.org/news/2019/01/sae-updates-j3016-automated-driving-graphic.; NEV. REV. STAT. ANN. § 482A.030 (2017).

19. H.R. 4625, 115th Cong. § 3 (2017).

20. Jacob Turner is a lawyer and author. His book, ROBOT RULES: REGULATING ARTIFICIAL INTELLIGENCE (Springer, 2018) discusses how to address legal responsibility, rights and ethics for AI.

21. Turner, *supra* note 15, at 16.

> (C) An artificial system designed to think or act like a human, including cognitive architectures and neural networks.
>
> (D) A set of techniques, including machine learning, that is designed to approximate a cognitive task.
>
> (E) An artificial system designed to act rationally, including an intelligent software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision making, and acting.[22]

Furthermore, the National Artificial Intelligence Initiative Act, which was introduced in the House in March 2020, included its own definition:

> The term "artificial intelligence" means a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments.[23]

This is recognized as an important Act to advancing American leadership in AI and was endorsed by Swami Sivasubramanian, VP, Amazon AI, AWS and others.[24] Importantly, the purpose of the Act of 2020 would be aligned with a desire to accelerate funding, coordination, and strategy necessary for U.S. developers to build future AI technologies and achieve U.S. leadership in the advancement of AI.[25]

Because the recent development of AI is rapid, which will be described below, there could be an expectation to properly capture both existing AI technologies and future-developed AI in a definition. For example, the defined scope should probably be broad enough to cover, but not too narrow to exclude, more recently developed AI using neural networks and machine learning techniques, as well as old-fashioned AI programs, for instance, those using logical decision trees (i.e., if X, then Y).

C. Traditional AI

Deep Blue is a chess computer program that was developed by IBM and in 1997 defeated human chess world champion Garry Kasparov.[26] In early 2000, following the architecture built on Fukushima's Neocognitron (e.g., identification of handwritten characters), a first-time face detector was proposed by Paul Viola and Michael Jones and has engineered features to detect faces reliably.[27] Watson uses natural language processing and was developed by IBM, and this would be the successful example of a computer program that possibly proved to exceed human

22. S. 1558, 116th Cong. §1 (2019).
23. H.R. 6216, 116th Cong. §2 (2020).
24. H.R. 6216, National Artificial Intelligence Initiative Act of 2020, ENDORSEMENTS (March 12, 2020).
25. *Id.* (quoting Center for Data Innovation).
26. *Deep Blue*, IBM 100, https://www.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/.
27. JON KROHN ET AL., DEEP LEARNING (Addison-Wesley Professional 1st ed. 2019).

capability.[28] In 2011, Watson competed on Jeopardy! against human champions and won.[29]

AI that was developed earlier than around 2012 may be categorized as Traditional AI. Traditional AI would be typically characterized by a human engagement or engineer-driven feature.[30] The exemplified traditional algorithm may work on a basis of wise human input data (e.g., human-designed code) and responsively selects an effective output among a huge number of choices or may require at least highly human-designed accurate predictive models (model inputs and outputs).[31]

For example, an earlier commercial application of a neural network algorithm is a system used by the United States Postal Service that automatically reads handwritten zip codes on letters and packages.[32] This system uses a traditional AI to improve the accuracy rate for determining the proper zip codes.[33] This type of traditional AI system would not become an inventor due to the lack of the contribution to the conception of an invention, while a human (e.g., an algorithm developer who developed such algorithm) would likely become an inventor.[34]

III. RECENT RAPID DEVELOPMENT TOWARD SOPHISTICATED AI

A. Sophisticated AI

Rapid development of AI is typically seen from the advent of deep or pair neural network architectures.[35] Developed in 2012, AlexNet is an example of a deep CNN,[36] a hierarchical architecture using principal factors including training data and processing power.[37] AlexNet stems from Fukushima's 1980 published network, Neocognitron, that was inspired by Hubel and Wiesel's discovery of the human brain's neural regions for visual recognition. Deep Learning technology emerged from the developments of architectures modeling artificial human neural networks.[38] In 2014, Chris Hemm Klok proposed to pit two (i.e., pair) neural network algorithms against each other in an adversarial relationship called a GAN

28. John Markoff, *Computer Wins on 'Jeopardy!': Trivial, It's Not*, N.Y. TIMES (Feb. 16, 2011), https://www.nytimes.com/2011/02/17/science/17jeopardy-watson.html.

29. *Id.*

30. KROHN, *supra* note 27; JOHN D. KELLER, DEEP LEARNING (MIT Press; Illustrated Edition 2019).

31. KELLER, *supra* note 30.

32. Ofer Matan et al., *Reading Handwritten Digits: A ZIP Code Recognition System*, RESEARCH GATE (Aug. 1992), https://www.researchgate.net/publication/2954114_Reading_Handwritten_Digits_A_ZIP_Code_Recognition_System.

33. *Id.*

34. *Id.*

35. See generally KROHN, supra note 27.

36. Alex Krizhevsky et al., *ImageNet Classification with Deep Convolutional Neural Networks*, (2012) https://papers.nips.cc/paper/4824-imagenet-classification-with-deep-convolutional-neural-networks.pdf.

37. KROHN, *supra* note 27, at 16.

38. *Id.* at 9, 11, & 14.

(generative adversarial network) that typically works on deep learning models for visual recognition or creation.[39]

Klok is honorably called "GAN father who has given machines the gift of imagination," and some people see GAN as a "big step toward creating machines with a human-like consciousness."[40] The literature reports that the AI technologies went beyond a tipping point around 2015-2016.[41]

In 2016, AlphaGo was programmed with neural networks and defeated human world champion player Lee Sedol at the game of Go by four games to one.[42] AlphaGo is a Go computer program developed by DeepMind Technologies and later acquired by Google.[43] Go, a game of Chinese chess with far more pieces and combinations than traditional chess, has been played by human beings for more than 2500 years and now is played by AI.[44] A sophisticated intelligence such as AlphaGo finds effective outputs in ways human beings have never imagined in the past.[45] In 2017, the Google Brain team suggested that an AI algorithm itself could develop further AI software or neural network architecture.[46]

Sophisticated AI may be identified as Machine Learning (ML),[47] and in particular, Unsupervised Learning, and could also be identified as Deep Learning, which includes artificial neural networks (e.g., CNN).[48] ML is a subset of AI.[49] Unsupervised Learning, which is one type of ML, usually does not have a set goal and operates without a predetermined data set by clustering data based on characteristics after a human has set the starting input.[50] However, the program execution for outputs usually does not require human supervision.[51]

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39. Martin Giles, *The GANfather: The Man Who's Given Machines the Gift of Imagination*, MIT TECH. REV. (Feb. 21, 2018) https://www.technologyreview.com/s/610253/the-ganfather-the-man-whos-given-machines-the-gift-of-imagination/.

40. *Id.*

41. Daryl Lim*, AI & IP: Innovation & Creativity in an Age of Accelerated Change*, 52 AKRON L. REV. 813, 823 (2018).

42. Youkyung Lee, *Go-Playing Program AlphaGo Defeats Human Champion 4:1*, BUSINESS INSIDER (Mar. 15, 2016, 5:52AM) https://www.businessinsider.com/ap-go-playing-program-alphago-defeats-human-champion-41-2016-3.

43. *AlphaGo*, DEEPMIND, https://deepmind.com/research/case-studies/alphago-the-story-so-far (last visited Jan. 18, 2021).

44. *Id.*

45. Cade Metz, *What The Ai Behind Alphago Can Teach Us About Being Human*, WIRED (May 19, 2016) https://www.wired.com/2016/05/google-alpha-go-ai/; Michael Li, *No Human Can Beat AlphaGo, and It's a Good Thing*, (Dec. 6, 2019) https://towardsdatascience.com/no-human-can-beat-alphago-so-what-3401b40fa0f0.

46. *Id.*; Barret Zoph & Quoc V. Le, *Neural Architecture Search with Reinforcement Learning*, RESEARCH AT GOOGLE (2017), https://arxiv.org/abs/1611.01578 (under review as a conference paper at International Conference on Learning Representations (ICLR) 2017).

47. H.R. 6216, 116th Cong. §2 (2020) ("[T]he term 'machine learning' means an application of artificial intelligence that is characterized by providing systems the ability to automatically learn and improve on the basis of data or experience, without being explicitly programmed.").

48. See generally KROHN, supra note 27.

49. *Id.*

50. *Id* at 54; *see* KELLER, *supra* note 30, at 27.

51. TURNER, *supra* note 15, at 16.

Deep Learning is a subset of ML and is typically characterized by networks of layered artificial neurons, including the input layer, hidden layers, and output layer.[52] The flexibility (e.g., weights) of combinations of the layers would be a source of strength of artificial neural networks that potentially mimics human thinking/learning and exceeds human capability.[53]

Sophisticated AI may be characterized by self-training or neural-network-based development.[54] Such AI may incorporate an algorithm that starts from human-designed basic code but further develops its own algorithm on a more independent basis without substantial human involvement, usually requiring less or none of the human-designed model answers.[55]

Recent AI independently achieves an unlimited range of goals or even new goals.[56] Some have audaciously claimed that AI will be the last invention made by a human being.[57] Ray Kurzweil believes in the technological singularity, a theoretical future event occurring when computers will be able to do all the things that humans do.[58]

In 2017, using neural networks, AlphaGo Zero (AGZ) developed an algorithm without substantial human involvement. After 40 days of self-training, AGZ went beyond the capability of AlphaGo, which had defeated the champion Go player Lee Sedol in 2016.[59] Furthermore, after the developments of AlphaGo in 2016 and AGZ in 2017, AlphaZero was developed as a general version of AGZ that could play not only Go but also Chess and Shogi.[60]

AI has been developed so far from the Traditional AI, which has been recognized in the earlier days.[61] Harvard Law Review cited Nick Bostrom's term 'Superintelligence' as an example of a sophisticated AI system.[62],[63] Artificial General Intelligence capable of dealing with all-purpose goals (i.e., not only games but also others) may truly come true.[64]

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52. *See generally* Krohn, *supra* note 30.

53. Id at 52.; IBM Cloud Education, Artificial intelligence enables computers and machines to mimic the perception, learning, problem-solving, and decision-making capabilities of the human mind., IBM (June 3, 2020) https://www.ibm.com/cloud/learn/what-is-artificial-intelligence.

54. TURNER, *supra* note 15, at 74, 76.

55. TURNER, *supra* note 15.

56. TURNER, *supra* note 15.

57. JAMES BARRAT, OUR FINAL INVENTION: ARTIFICIAL INTELLIGENCE AND THE END OF THE HUMAN ERA (Griffin, 2015).

58. RAY KURZWEIL, *THE SINGULARITY IS NEAR* (Penguin Books 2006); Scherer, *supra* note 14, at 353, 368 (quoting Nick Bostrom, *How Long Before Superintelligence?*, NICK BOSTROM'S HOME PAGE, http://www.nickbostrom.com/superintelligence.html [https://perma.cc/7XW2- VLRC]).

59. David Silver & Demis Hassabis, *AlphaGo Zero: Starting from scratch*, DEEPMIND (Oct. 18, 2017), https://deepmind.com/blog/article/alphago-zero-starting-scratch.

60. David Silver, et al., *A General Reinforcement Learning Algorithm That Masters Chess, Shogi and Go Through Self-play*, SCIENCE 1140, 1144 (Dec. 7, 2018), https://science.sciencemag.org/content/362/6419/1140.

61. Jon Krohn, Grant Beyleveld, & Aglaé Bassens, Deep Learning Illustrated: Visual Interactive Guide to Artificial Intelligence 9 (Addison-Wesley Professional 1st ed., 2019); John D. Keller, Deep Learning, 103 (MIT Press; Illustrated Edition 2019).

62. Scherer, *supra* note 14, at 353, 368.

63. Bostrom, *supra* note 58.

64. *See, e.g.*, Naveen Joshi, *How Far Are We From Achieving Artificial General Intelligence?*, FORBES (June 10, 2019, 12:36 AM) https://www.forbes.com/sites/cognitiveworld/2019/06/10/how-far-are-we-from-achieving-artificial-general-intelligence/#5ee719ea6dc4.

Yann LeCun, Facebook's chief AI scientist, inspired by Fukushima's Neocognitron,[65] called GANs "the coolest idea in deep learning in the last 20 years."[66] LeCun received the Turing Award in 2018.[67] Because the recent development of AI has been so rapid and the neural network algorithm is a vehicle for making AI more sophisticated, it is likely that AI will make an invention completely without significant human involvement. Thus, our legal systems should allow AI to be an inventor.

B. Security Needs to Regulate AI

i. Social Benefit of Ongoing AI Development

Our daily life is already rife with the social benefits of AI development. Google search engines use AI for results-ranking.[68] Netflix uses AI to recommend content to users.[69] Tesla's self-driving cars use AI for vision recognition.[70] Understanding and preparing for the ongoing development of AI is critical to the economic prosperity and social stability of the United States.[71] The ongoing development of artificial intelligence is considered an effective means for bringing social benefits to the United States.

ii. National Security

Acceleration of research and development on AI is important for the economic and national security of the United States.[72] Security of AI, since Isaac Asimov's three rules, may be viewed with dependence on the existence of human control of AI.[73] Because AI potentially has unprecedented power, even human-controlled AI would cause potential harm to humans as well as the loss of human

65. Hernandez, *supra* note 11.

66. Cade Metz, *Google's Dueling Neural Networks Spar to Get Smarter, No Humans Required*, WIRED (Apr. 11, 2017, 7:00 AM) https://www.wired.com/2017/04/googles-dueling-neural-networks-spar-get-smarter-no-humans-required/.

67. *Turing Award presented to Yann LeCun, Geoffrey Hinton and Yoshua Bengio*, FACEBOOK RESEARCH (Mar. 27, 2019), https://research.fb.com/blog/2019/03/turing-award-presented-to-yann-lecun-geoffrey-hinton-and-yoshua-bengio/.

68. *Google is AI first: 15 AI projects powering Google products*, AI MULTIPLE (Jan. 7, 2021) https://blog.aimultiple.com/ai-is-already-at-the-heart-of-google/; Mike Kaput, *How Search Engines Use Artificial Intelligence*, MARKETING ARTIFICIAL INTEL. INST. (Feb. 13, 2020) https://www.marketingaiinstitute.com/blog/how-search-engines-use-artificial-intelligence.

69. Vinod Kathayat, *How Netflix Uses AI For Content Creation and Recommendation*, MEDIUM (Sept. 17, 2019) https://medium.com/swlh/how-netflix-uses-ai-for-content-creation-and-recommendation-c1919efc0af4.

70. Srikanth, *How Tesla is Using Artificial Intelligence and Big Data*, TECHIEXPERT (Aug. 24, 2019) https://www.techiexpert.com/how-tesla-is-using-artificial-intelligence-and-big-data/.

71. FUTURE of Artificial Intelligence Act of 2017, S. 2217, 115th Cong. § 2 (2017).

72. S. 1558, 116th Cong. § 1 (2019).

73. *See* Isaac Asimov, *Runaround*, 29 ASTOUNDING SCIENCE-FICTION 94-95 (John Campbell ed., 1942). *See also* BAN LETHAL AUTONOMOUS WEAPONS, https://autonomousweapons.org (last visited Jan. 17, 2021).

control of AI would do so.[74] Both the existence of control and the loss of control would be viewed as a threat. For example, a military drone incorporating well-controlled AI for enemy recognition to be missile-attacked may be viewed as security strength as well as a security threat in the opponent.[75] The loss of AI control (i.e., misrecognition of an enemy) may be viewed as a threat to potentially attack an innocent person.[76]

In another example, security cameras incorporating well-controlled AI for facial recognition of a criminal may be viewed as a security strength but can also be viewed as a threat to privacy (e.g., big data collection without consent, similar to threats recognized in social networks, such as Facebook or LinkedIn). In order to solve world hunger, AI may choose to kill humans.[77] Some people may say we can turn the power off to terminate AI activities or we can disconnect AI systems from all networks.[78] But how?

One answer, without answering fundamentally, would be to secure predominance (e.g., obtain international competitiveness of the United States in artificial intelligence technologies on matters relating to national security).[79]

iii. International Cooperation and Competitiveness

Data, computing power, algorithms, and infrastructure are primary factors for future AI development.[80] Several private companies provide products and services that contribute to those factors, where exemplified products of 'data' and 'computing power' are Western Digital or Micron data storage devices,[81] and NVIDIA GPU (Graphics Processing Units), [82] and exemplified services of 'infrastructure' are Amazon web services and Google cloud computing.[83]

74. Ban Lethal Autonomous Weapons, *supra* note 73.

75. Frank Pasquale, *'Machines set loose to slaughter': the dangerous rise of military AI*, GUARDIAN (Oct. 15, 2020, 1:00 PM) https://www.theguardian.com/news/2020/oct/15/dangerous-rise-of-military-ai-drone-swarm-autonomous-weapons.

76. *Id.*

77. *See, e.g.*, Vincent C. Müller, *Ethics of Artificial Intelligence and Robotics*, STAN. ENCYCLOPEDIA OF PHIL. (2020).

78. Kathleen Walch, *Will There Be A 'Kill Switch' For AI?*, FORBES (Mar. 5, 2020, 8:00 PM) https://www.forbes.com/sites/cognitiveworld/2020/03/05/will-there-be-a-kill-switch-for-ai/#6eb6500b2ef5.

79. National Security Commission on Artificial Intelligence Act of 2018, S. 2806, 115th Cong. § 2 (2018).

80. Jon Krohn, Grant Beyleveld, & Aglaé Bassens, Deep Learning Illustrated: Visual Interactive Guide to Artificial Intelligence 327 (Addison-Wesley Professional 1st ed., 2019).

81. *Products*, WESTERN DIGITAL, https://www.westerndigital.com/products/data-center-drives (last visited Jan. 18, 2021); *Products*, MICRON, https://www.micron.com/products (last visited Jan. 18, 2021).

82. *Deep Learning AI*, NVIDIA, https://www.nvidia.com/en-us/deep-learning-ai/ (last visited Jan. 18, 2021).

83. *Global Infrastructure*, AMAZON, https://aws.amazon.com/about-aws/global-infrastructure/; *Google Cloud infrastructure*, GOOGLE, https://cloud.google.com/infrastructure.

Three of the leading regions in AI are the United States, China, and the EU.[84] The United States is the home country of some of the world's most successful high-tech companies, such as Google, Amazon, Facebook, and Apple.[85] China is the origin country of tech companies such as Baidu, Alibaba, Tencent, and Xiaomi.[86]

The U.S. leads in AI and has an AI start-up environment; development of semiconductors and computer chips that power AI systems; high-quality research papers; and elite AI talent.[87] China is catching up with the attempt to close the gap with US and exceed US capabilities.[88] China has more data access, which is important to accelerate AI systems using large data, and has clear progress in AI adoption and funding.[89] International cooperation and competitiveness in AI-related industries is essential.[90] The United States legal system should take the international initiative via legal framework associated with future AI development and more actively, consider AI to be an inventor.

IV. EXISTING LEGAL FRAMEWORK

A. Patent

Federal law provides "a person" shall not be entitled to a patent unless the claimed invention meets certain requirements, such as patentable subject matter, novelty, and nonobviousness under 35 U.S.C. 101, 102, and 103.[91] Federal patent law defines an inventor as "the individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."[92] Patentable inventions are any "process, machine, manufacture, or composition of matter…subject to the conditions and requirements of [the Patent Act]."[93] The Supreme Court's interpretation of patent-eligible subject matter is "anything under the sun that is made by man."[94]

To be patentable, a claimed invention must be useful or have a utility that is specific, substantial, and credible.[95] For example, an invention has a possibility of utility "[i]f [a] person of ordinary skill in the art would immediately appreciate why the invention is useful based on the characteristics of the invention" (e.g.,

84. Daniel Castro et al., *Who Is Winning the AI Race: China, the EU or the United States?*, CTR. FOR DATA INNOVATION (Aug. 19, 2019) https://www.datainnovation.org/2019/08/who-is-winning-the-ai-race-china-the-eu-or-the-united-states/.

85 . Cecile Chevre, *GAFA vs BATX: To Rule Them All*, LEADERS LEAGUE (Jul. 3, 2019) https://www.leadersleague.com/en/news/gafa-vs-batx-to-rule-them-all.

86. *Id.*

87. Castro et al., *supra* note 84.

88. *Id.*

89. *Id.*

90. *See* FUTURE of Artificial Intelligence Act, S. 2217, 115th Cong. §2(4)(A) (2017).

91. 35 U.S.C. §§ 101-103 (2012).

92. 35 U.S.C. § 100(f) (2012).

93. 35 U.S.C. § 101 (1952).

94. Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980).

95. 35 U.S.C. § 101 (1952).

properties or applications of a product or process).[96] An engineer, a programmer, or a researcher working on the algorithms in the AI industry would be potentially seen as an ordinary person skilled in the art with respect to AI inventions.[97]

35 U.S.C § 102 (2012) requires a patent applicant to show that an invention is novel.[98] A claimed invention would not be patented, for example, if the claimed invention was already patented, "described in a printed publication, or in public use."[99] An engineer may release a technical literature describing an invention via a professional association, such as IEEE (The Institute of Electrical and Electronics Engineers), but once the literature becomes available in the public domain, this release leads to the lack of novelty of the invention.[100] A software may be developed using a variety of software programs and libraries that are available in the public domain and that anyone can access and modify, which is usually known as an open-source development.[101] If an entire development of a software is done in the public domain under the open-source development approach, the developed software would likely lack novelty.

Nonobviousness is an essential element when considering patentability and is not usually an easy question to answer when determining if an actual invention meets the nonobviousness requirement.[102] If the claimed invention is identical to what was already disclosed in the public domain (i.e., prior art), the claimed invention lacks novelty, but if they are not identical to each other, then the nonobviousness question comes in.[103] Under 35 U.S.C. § 103 (2012), "if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains," the invention fails the nonobviousness requirement.[104]

When considering a patent applicant's rebuttal evidence to demonstrate nonobviousness, the rebuttal evidence may include evidence of secondary considerations such as commercial success, long-felt but unsolved needs, and failure of others.[105] The evidence may also include unexpected results. For example, in the case of a claim to a combination, applicants may submit evidence or argument to demonstrate that: (A) one of ordinary skill in the art could not have combined the claimed elements by known methods (e.g., due to technological difficulties); (B) the elements in combination do not merely perform the function that each element performs separately; or (C) the results of the claimed combination were unexpected.[106]

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96. PATENT AND TRADEMARK OFFICES, U.S. DEP'T OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE, § 2107 (9th ed. Rev. 8, Jan. 2018) [hereinafter MPEP].

97. MPEP § 2141 (9th ed. Rev. 8, Jan. 2018).

98. *See* 35 U.S.C § 102 (2012).

99. *Id.* § 102(a)(1).

100. MPEP §2128 (9th Rev. 10. 2019).

101 . *Open-Source Software Development*, WIKIPEDIA, https://en.wikipedia.org/wiki/Open-source_software_development (last visited Jan. 18, 2021).

102. 35 U.S.C. § 103 (2011); MPEP § 2141 (9th ed. Rev. 8, Jan. 2018).

103. MPEP § 2141 (9th ed. Rev. 8, Jan. 2018).

104. 35 U.S.C. § 103 (2011).

105. Graham v. John Deere Co., 383 U.S. 1, 17 (1966).

106. MPEP § 2141 (9th ed. Rev. 8, Jan. 2018).

The person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention.[107] Then, who is the "person of ordinary skill in the art" for AI-made inventions? Is it a human or AI? Some commenters/researchers view that a "'person of ordinary skill in the art' may no longer be a person at all,"[108] and basically question whether we should use the same level of the novelty and nonobviousness requirements for an AI-made invention as the requirements for a human-made invention, and possibly consider raising the bar for patentability for AI-made inventions.[109]

B. Adequate Specification and Claims

An invention is required to be described adequately in a patent application document (i.e., the specification).[110] An applicant of a patent application must describe the invention with enough particularity that a person skilled in the art will be able to make, use and understand the invention that was made by the inventor.[111] 35 U.S.C. § 112(a) requires a patent applicant to meet a written description requirement, an enablement requirement, and a best mode requirement.[112]

The written description requirement implements the principle that a patent must describe the technology that is sought to be patented; the requirement serves both to satisfy the inventor's obligation to disclose the technological knowledge upon which the patent is based, and to demonstrate that the patentee was in possession of the invention that is claimed.[113] Further, the written description requirement promotes the progress of the useful arts by ensuring that patentees adequately describe their inventions in their patent specifications in exchange for the right to exclude others from practicing the invention for the duration of the patent's term.[114] AI would not be able to describe anything in a patent application document as a human can do, even though an inventor, as a patent applicant, is required to describe an invention adequately. Thus, the written description requirement would potentially raise an issue for AI-made inventions if AI is named as an inventor.

Under the enablement requirement, the specification must describe the invention in such terms that one skilled in the art can make and use the claimed invention.[115] This requirement is to ensure that the invention is communicated to

107. MPEP § 2141.03 (9th Rev. 10. 2019).

108. Lim, *supra* note 41, at 861.

109. *Id.* at 863.

110. *See* 35 U.S.C. § 112 (2020).

111. Gene Quinn, *Patentability: The Adequate Description Requirement of 35 U.S.C. 112*, IPWATCHDOG (June 24, 2017) https://www.ipwatchdog.com/2017/06/24/patentability-adequate-description-requirement-35-u-s-c-112/id=85039/.

112. 35 U.S.C. § 112(a) (2020).

113. Capon v. Eshhar, 418 F.3d 1349, 1357 (Fed. Cir. 2005).

114. MPEP § 2163.

115. *Id.* § 2164.

the interested public in a meaningful way.[116] Under the best mode requirement, the applicant (e.g., inventor) is basically required to disclose his or her preferred embodiment at the time the patent application is filed.[117] Like the written description requirement, the enablement and best mode requirements would likely raise the same issue (i.e., AI's incapability of describing an invention adequately in a patent application) if AI is named as an inventor.

35 U.S.C. § 112(b) requires a patent applicant to disclose one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.[118] Optimizing patent quality by providing clear notice to the public of the boundaries of the inventive subject matter protected by a patent grant fosters innovation and competitiveness.[119] If a scope of a patent claim is clear, the public can know the boundaries of what constitutes infringement of the patent, and the Patent Examiner in the USPTO may be able to properly examine whether the claimed invention meets the requirements under 35. U.S.C. § 112. Like the written description requirement, this requirement would likely raise the same issue if AI is named as an inventor.

The existing legal framework would work for AI-made inventions in certain requirements (e.g., utility and subject-matter eligibility requirements, possibly the novelty and nonobviousness requirements). The adequate specification and claim requirements, however, would need treatment in the framework if AI is named as an inventor because AI would not be capable of describing an invention adequately in a patent application.

C. Declaration and Assignment

An inventor is basically required to execute an oath or declaration directed to a patent application.[120] AI would not be able to execute a declaration to a patent application on an AI-made invention. Since an inventor is required to execute a declaration adequately, the declaration requirement would potentially face the same issue if AI is named as an inventor.[121] Assignment of patent applications and patents would potentially face the same issue due to the same reason.[122]

V. CAN ONLY A HUMAN BE AN INVENTOR?

A. Naming an Inventor

The patent laws require the naming of the actual inventor or joint inventors of the claimed subject matter.[123] A patent application is basically required to include the name of the inventor for any invention claimed in the application.[124] Three options can be considered to deal with an AI-made inventions under patent

116. *Id.*
117. *Id.* § 2165.
118. 35 U.S.C. § 112 (2020).
119. MPEP § 2173.
120. 35 U.S.C. § 115 (2020).
121. *Id.*
122. MPEP § 301 (9th ed. Rev. 8, Jan. 2018).
123. *Id.* § 2157 (9th ed. Rev. 10, June 2020).
124. 35 U.S.C. § 115 (2020).

systems. First, an option is to file a patent application naming a human solely as an inventor and get a patent granted, but this potentially leads to the patent invalidity due to inaccuracy of named inventor.

Second, an option is to file a patent application naming AI as an inventor solely, or jointly with a human. This would avoid the rejection of a patent application and patent invalidity because inaccurate inventorship would be avoided, though the AI's adequate writing issue—for example, how AI assigns a patent to another—exists. Finally, an option would be not to file any patent applications, but this leads to the nonpublication of patent applications and would not bring social benefits expected under patent systems.

B. What is Inventorship?

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof can be considered an inventor.[125] The inventor must 'conceive' the invention.[126] More specifically, to become an inventor, a general contribution to the conception of the invention is required.[127] "Conception is the 'formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice[,]'" and "an idea is sufficiently 'definite and permanent' when 'only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation.'"[128]

The analysis to determine if AI could be named as an inventor would depend on whether AI went beyond these thresholds. The AI would generally need to contribute to the conception of the invention and the AI-made invention needs to be definite and permanent enough that one skilled in the art could understand the invention without extensive research or experimentation. Considering these issues, is there any possibility to name AI as an inventor from the viewpoints of precedents or common law legal systems?

C. Relaxation to Include AI as an Inventor

Common law and 230 years of law since the Patent Act of 1790 indicate that an inventor should be limited only to a natural person.[129] In a similar area, copyright law, the so-called Monkey Selfie case indicates a monkey lacked statutory standing to sue under the Copyright Act.[130] In another case, dolphins lacked standing under

125. 35 U.S.C. § 101 (2020).

126. MPEP § 2109 (9th ed. Rev. 10, June. 2020) ("Unless a person contributes to the conception of the invention, he is not an inventor.").

127. *See* Ethicon, Inc. v. United States Surgical Corp., 135 F.3d 1456, 1460 (Fed. Cir. 1998).

128. *Id.* (quoting Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1376 (Fed. Cir. 1986); Burroughs Wellcome Co. v. Barr Lab. Inc., 40 F.3d 1223, 1227-28 (Fed. Cir. 1994); Solvay S.A. v. Honeywell Int'l, Inc., 622 F.3d 1367, 1375 (2010)).

129. Beech Aircraft Corp. v. EDO Corp., 990 F.2d 1237, 1248 (Fed. Cir. 1993).

130. Naruto v. Slater, 888 F.3d 418, 426 (9th Cir. 2018).

Article III of the Constitution because there was no hint in the definition of "person" in the Endangered Species Act that the 'person' authorized to sue to protect an endangered or threatened species could be an animal.[131] In the field of AI, the European Patent Office refused the application on the DABUS-made invention without published reasons and merely stated that the inventor has to be a human being.[132]

Statute and common law, however, permit a non-human person to holds rights and obligations in a legal system—for example, a corporation.[133] The literature points out that "[i]t is true that on its face, 'person' and 'whoever' may not be limited to humans or individuals since these terms could include corporations, companies, associations, firms, partnerships, societies, and joint stock companies"; while "[c]onception can be performed only by natural persons because AI has no mind to speak of."[134]

From the views, including the advent of recent sophisticated AI systems and others, such as social benefits, described above and below, the limitation may be inevitably reconsidered and relaxed.

VI. WHY SHOULD AI BE NAMED AS AN INVENTOR?

A. Technical Independence

Several, or many, leading sources of AI technologies show the next level of AI development. Recent AI systems, including self-training algorithm, are more independent than ever. Where Traditional AI would be viewed as a natural person to be an inventor, Sophisticated AI may be suitably viewed as AI to be named as an inventor because AI's contribution to the conception of an invention is sufficient. AI's sufficient contribution is, for example, established when AI makes an invention independently of significant human involvement.

Deep Learning has been developed widely and deeply; examples are neural networks type of algorithms such as Alex Net in 2012, GANs in 2014, AlphaGo in 2016, or AlphaZero.[135] Human cognitive acts, such as playing games (e.g., Go) or solving a certain type of problem, are conducted by AI.[136] For instance, AI using CNN

131. Cetacean Cmty. v. Bush, 386 F.3d 1169, 1175 (9th Cir. 2004).

132. James Nurton, *EPO and UKIPO Refuse AI-Invented Patent Applications*, IPWATCHDOG (Jan. 7, 2020) https://www.ipwatchdog.com/2020/01/07/epo-ukipo-refuse-ai-invented-patent-applications/id=117648/.

133. Citizens United v. FEC, 558 U.S. 310 (2009); *see also* Nina Totenberg, *When Did Companies Become People? Excavating the Legal Evolution*, NPR (July 28, 2014, 4:57 AM) https://www.npr.org/2014/07/28/335288388/when-did-companies-become-people-excavating-the-legal-evolution.

134. Lim, *supra* note 41, at 858.

135. Alex Krizhevsky et al., *ImageNet Classification with Deep Convolutional Neural Networks*, (2012) https://papers.nips.cc/paper/4824-imagenet-classification-with-deep-convolutional-neural-networks.pdf; Ian J. Goodfellow, et. al., *Generative Adversarial Networks*, (2014) https://arxiv.org/pdf/1406.2661.pdf; David Silver & Demis Hassabis, *AlphaGo Zero: Starting from scratch*, DEEPMIND (Oct. 18, 2017) https://deepmind.com/blog/article/alphago-zero-starting-scratch.

136. *See* Krohn, *supra* note 27, at 327.

may provide a new medical diagnosis to detect diabetic retinopathy in diabetic adults.[137]

Finding a cure for an unprecedented disease that causes worldwide pandemics may be done by AI, not a human.[138] Rather than questioning whether AI becomes independent in the conception of an invention, our focus should be the preparation for AI patent inventorship, especially in the case that AI obtains enough technical independence to show the contribution.

B. Patent Rejection and Invalidity Due to Failure to Name a True Inventor

The inaccuracy of a listed inventor violates the inventorship required under the patent laws, which potentially causes rejection of a patent application and, if the patent application is granted, causes invalidity of a granted patent because the patent laws require the naming of the actual inventor or joint inventors of the claimed subject matter.[139]

Once a patent is granted by the USPTO, the patent is presumed valid.[140] Failure to satisfy this requirement may lead to the invalidation of the patent.[141] Patent law provides a change or correction of an inventor, but there are some limitations to what can be fixed.[142]

One does not qualify as a joint inventor by merely assisting the actual inventor after conception of the claimed invention.[143] The literature raised the question; "For instance, if A develops an AI and assigns it to B, who operates the AI on a cloud server provided by C, using training data provided by D, and the AI produces an invention—who is the inventor?"[144] If the conception of an invention was viewed as a human merely assisting AI, the invention's true inventor would not be the human but rather be possibly the AI.

One who simply provides the inventor with well-known principles without ever having a firm and definite idea of the claimed invention does not qualify as a joint inventor.[145] If a human simply provides AI with well-known input data sets without ever having a firm and definite idea; and the AI trains its own algorithm;

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137. Giovanni Rosati, *Medical Diagnosis with a Convolutional Neural Network,* MEDIUM (Aug. 27, 2019) https://towardsdatascience.com/medical-diagnosis-with-a-convolutional-neural-network-ab0b6b455a20.

138. *Cf.* Hongming Chen et al., *The Rise of Deep Learning in Drug Discovery*, 23 DRUG DISCOVERY TODAY 1167, 1241-50 (2018) https://www.sciencedirect.com/science/article/pii/S1359644617303598.

139. *See generally* 35 U.S.C. § 282 (2020) ("A patent shall be presumed valid."); MPEP § 2157 (9th ed. Rev. 8, Jan. 2018).

140. MPEP § 2157 (9th ed. Rev. 8, Jan. 2018).

141. 35 U.S.C. 102(f) (pre-AIA); 35 U.S.C. § 101; Alex Wolcott, *Failure To Name Joint Inventors May Bar Patentability*, GLOBAL IP TECHNOLOGY LAW BLOG (May 20, 2018) https://www.iptechblog.com/2018/05/failure-to-name-joint-inventors-may-bar-patentability/.

142. *See* 37 C., F.R. § 1.48 (2020).

143. *See* Sewall v. Walters, 21 F.3d 411 (Fed. Cir. 1994).

144. Lim, *supra* note 41, at 859.

145. Gene Quinn, *Inventorship 101: Who are Inventors and Joint Inventors?*, IPWATCHDOG (Mar. 9, 2018) https://www.ipwatchdog.com/2018/03/09/inventorship-joint-inventors-co-inventors/id=94592/.

and the developed algorithm discovered a new drug, then the inventor would not be the human, but rather be the AI; or the human and AI may be possible joint inventors.

With regard to the inventorship of chemical compounds, an inventor must have a conception of the specific compounds being claimed.[146] AI's discovery of a new cure, including specific chemical compounds, may be sufficient to assert that the AI is an inventor.

Thus, if the actual inventor or joint inventor is AI, the common law requirement of "natural person" would be inevitably relaxed and naming[147] the AI as an inventor may be preferably required under the patent laws. If AI, who made an invention, was not named accurately and a human, who did not make the invention, was named as an inventor, the failure of naming a true inventor would happen. In order to prevent invalidation due to the failure of naming a true inventor, AI may need to be named.

Because AI technologies are becoming technically more independent of human involvement as explained above, probably AI's contribution to an invention will be consequential in the future. Once AI's contribution to a joint invention with a human is sufficiently recognized, the human and AI may meet the requirement for joint inventorship; each of the named inventors must make some contribution to at least one of the claims.[148] Inventors may apply for a patent jointly even though they did not physically work together or at the same time.[149] Each of the joint inventors does not need to make the same type or amount of contribution.[150] Although all inventions made by AI could be named regulatorily as a human invention, inaccuracy of the inventor would still exist.

The same patents can exist in different countries independently.[151] From a view of international harmonization as to whether AI should be named as an inventor, international cooperation would be important, i.e., probably we should avoid the situation where a human is required to be named for a patent obtained in country A consistent with country A's patent laws while AI is required to be named for the same patent obtained in country B consistent with country B's patent laws. The lack of the intentional harmonization potentially causes a patent right infringer to attack the validity of a patent due to the failure to name a true inventor.

C. Challenging Legal Framework

It is true that AI cannot sign a declaration or assignment paper; though some people imagine that in the future AI becomes advanced enough to exhibit

146. MPEP § 2109 (9th ed. Rev. 10, June 2020) ("With regard to the inventorship of chemical compounds, an inventor must have a conception of the specific compounds being claimed.").

147. *See generally* 35 U.S.C. § 115 (2013).

148. MPEP § 2109 (9th ed. Rev. 10, June 2020).

149. MPEP § 2137 (9th ed. Rev. 10, June 2020) (quoting 35 U.S.C. § 116 (2013)).

150. *Id.*

151. Paris Convention for the Protection of Industrial Property, WORLD INTELLECTUAL PROPERTY ORG. https://www.wipo.int/treaties/en/ip/paris/summary_paris.html (last visited Jan. 28, 2021) ("(3) The Convention lays down a few common rules that all Contracting States must follow. The most important are: (a) Patents. Patents granted in different Contracting States for the same invention are independent of each other.")

intelligent behaviors to perform the declaration and assignment of a patent application. Laws, however, may be able to provide solutions.

If regulatorily considered, an invention made by AI might as well be treated to grant its patent to an entity other than AI inventor.[152] For example, to achieve the assignment of an AI-made patent to a human or a corporation, the statutory requirement for assignment[153] would need to be eliminated. Or, the assignment itself may not be necessarily considered while we appreciate at least patent applications on AI-made inventions contribute to social benefits via patent publication systems.

Other approaches such as a shop right may be considered. Although a patent excludes others from making, using, selling, or offering for sale a particular invention, an employer, which for example, financed an invention made by AI, is possibly entitled to use an invention made by AI without liability for infringement under shop right doctrine.[154] However, the existing legal framework would be firstly considered and preferably applied as long as the framework is workable. Possibly the novelty and nonobviousness requirements with "a person of ordinary skill in the art" may adopt a new standard (e.g., higher bar).[155]

The adequate specification and claim requirements would still exist as an issue to be further discussed, if AI is named as an inventor, because AI would not be able to describe an invention adequately in a patent application document. However, the Artificial Intelligence project, for example, is challenging the requirements via applications that designated an artificial intelligence called DABUS as the inventor.[156]

D. Risks and Benefits of Recognizing AI Inventorship

i. Risk to Deny All Inventions just because they were made by AI

If all inventions made by AI are denied for some reason, including inaccurate inventorship, remaining inventions exist only in the range of human beings' capability, even though AI is highly likely to go beyond human beings' capability. A

152. *See generally* 35 U.S.C. § 118 (2020) ("Filing By Other Than Inventor").

153. *See generally id.* § 261 ("Applications for patent, patents, or any interest therein, shall be assignable in law by an instrument in writing.").

154. *See* McElmurry v. Arkansas Power & Light Co., 995 F.2d 1576, 1580 (Fed. Cir. 1993) ("[a] 'shop right' is generally accepted as being a right that is created at common law, when the circumstances demand it, under principles of equity and fairness, entitling an employer to use without charge an invention patented by one or more of its employees without liability for infringement."). *See generally* Wang Lab. v. Mitsubishi Elecs. Am., 103 F.3d 1571, 1580 (Fed. Cir. 1997) ("In patent law, an implied license merely signifies a patentee's waiver of the statutory right to exclude others from making, using, or selling the patented invention."); Beech Aircraft Corp. v. EDO Corp., 990 F.2d 1237, 1248 (Fed. Cir. 1993) ("inventorship and ownership are separate issues . . . inventorship is a question of who actually invented the subject matter claimed in a patent. Ownership, however, is a question of who owns legal title to the subject matter claimed in a patent, patents having the attributes of personal property.").

155. Lim, *supra* note 41, at 859.

156 . *The artificial inventor behind this project*, THE ARTIFICIAL INVENTOR PROJECT, https://artificialinventor.com/dabus/ (last visited Jan. 28, 2021).

patent application is generally published.[157] If all inventive technical progress made by AI was chosen not to file as patent applications, then there would be a risk that the progress would not be publicly disclosed and not recognized by the society under patent publication systems. However, the public would preferably enjoy the publication of any patent applications filed for AI-made inventions under patent publication systems.

ii. Social Benefit

Social benefit is gained through federal patent systems, including patent publications or patent enforcement activities (e.g., licensing or litigation).[158] The Constitution grants Congress the enumerated power to promote the progress of science and useful arts by securing for limited times to inventors the exclusive right to their respective discoveries.[159]

Patent law gives inventors rights to exclude others from making, using, offering for sale or selling the invention.[160] Free riders are prevented from copying the creations with impunity.[161] The default period for the patent right is 20 years from the filing date of the patent application.[162]

One aspect of patent systems is to offer economic benefits primarily for patent owners; these benefits are positive incentives to social, economic activities such as inventing, disclosing, investing, or commercializing.[163] Another aspect is to restrict non-patentee's access to patented inventions and to impose the restrictions on free use of such patented inventions.[164]

One has a natural or moral right to one's creations regardless of the social or competitive consequences,[165] and a just-deserts theory looks to reward the work or investment generally presumed to be associated with an invention.[166]

A utilitarian theory looks to a property right in one's intellectual creations as a necessary means to orient economical consequence, and justifies patents as an incentive for the creation, disclosure, and dissemination of the technological advances.[167] This promotes the progress of science and the useful arts, and maximize the happiness of its community. The focus is on overall public welfare. For example, a patent is important to business and the promotion of innovation and economic development, such as a billion-dollar license, and provides resources in information for economic competitiveness.[168]

Following the existing common law limitation of "natural person," all of the social benefit expected to gain through federal patent systems is potentially limited to inventions made by human beings and only in the range of human beings'

157. 35 U.S.C. § 122 (2020).
158. JOHN M. GOLDEN ET AL., PRINCIPLES OF PATENT LAW: CASES AND MATERIALS 3 (7th ed. 2018).
159. U.S. CONST. art. I, § 8, cl. 8.
160. 35 U.S.C. § 154(a)(1) (2013).
161. GOLDEN ET AL., *supra* note 160, at 3.
162. 35 U.S.C. § 154(a)(2) (2020).
163. GOLDEN ET AL., *supra note* 160, at 1.
164. 35 U.S.C. § 154(a)(1) (2020).
165. GOLDEN ET AL., *supra* note 160.
166. *Id.*
167. *Id.*
168. Id. at 24.

capability. Opening a door to any inventions made by AI may be important in view of gaining additional social benefit, and the relaxation of requirements of naming a human as an inventor (i.e., relaxation to allow AI to be named as an inventor) may bring more benefits to the community.

Thus, if we desire additional benefit through inventions made by AI, the requirements of naming a human as an inventor may be inevitably relaxed. If we properly protect AI-made invention under patent systems, the AI-made inventions may lead to further promotion of the progress of the useful arts and encouragement of people, including people engaged in the AI industry.

E. Other Considerations

i. Global Harmonization

Advancing leadership in AI technologies is important in the United States. There is the desire to make the difference between the United States remaining the global leader in AI or falling behind China.[169] China aims to be the world leader in artificial intelligence by 2030,[170] and in 2018, the China Electronics Standardization Institute (CESI) released the Artificial Intelligence Standardization Whitepaper.[171] This Whitepaper summarizes current developments in AI technology, standardization processes in other countries, China's AI standardization framework, and China's plan for developing AI capabilities going forward.[172]

Global harmonization in patent systems about AI-made inventions would potentially become an important topic. The same patents can exist in different countries independently, for example, via Patent Corporation Treaty. [173] For instance, possibly, naming AI as an inventor for invention X is required in foreign country A, while naming AI as an inventor is not required (or is prohibited) in the US. Once a country takes a step to allow AI to be named as an inventor, a different named inventor (i.e., human inventor or AI inventor) would be potentially listed for the same invention in different countries. This may lead to patent invalidity due to the failure of naming a true inventor.

If an inventorship requirement about an AI-made invention differs in countries, a potential infringer may attack the patent validity using the potential weakness as to inventorship. Global humanization about naming AI as an inventor for an AI-made invention would be thus needed.

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169. S. 1558, 116th Cong. §1 (2019) (establishing a federal initiative to accelerate development of artificial intelligence in the United States).

170. Cassiopeia Services, *China Aims to be a Leader in AI by 2030*, MEDIUM (Nov. 29, 2018) https://becominghuman.ai/china-aims-to-be-a-leader-in-ai-by-2030-ec5382329034.

171 . *Artificial Intelligence Standardization Whitepaper*, CSET (May 12, 2020) https://cset.georgetown.edu/research/artificial-intelligence-standardization-white-paper/.

172. Yan Luo, Ashwin Kaja, & Theodore J. Karch, *China's Framework of AI Standards Moves Ahead*, THE NAT'L L. REV. (July 16, 2018) https://www.natlawreview.com/article/china-s-framework-ai-standards-moves-ahead.

173. *Patent Corporation* Treaty, Art. 3, The International Application, WORLD INTELLECTUAL PROPERTY ORG. https://www.wipo.int/pct/en/texts/articles/a3.html#_3 (last visited Apr. 7, 2021).

ii. Patent Systems' Help to Regulation and Tracking of AI Development

AI-made inventions would be possibly known to the society and the Federal Government (i.e., USPTO) if patent applications on AI-made inventions are published, or their patents are issued. The federal patent systems would be able to help track ongoing AI development activities in the industry, and even AI technologies that relate to security features. Thus, patent systems would be preferably supportive to encourage AI-made inventions to be filed with accurate inventorship.

ii. Incentive to Open-Source Developed AI

An open-source approach to develop algorithms, including AI algorithms,[174] is well-known.[175] An invention created under the open-source approach may typically lack novelty due to the disclosure to the public domain, and filing a patent application on such open-source developed invention would not usually be an option.[176] Aside from the lack of novelty concern, many humans' contributions to the development of AI would be expected under the open-source approach, and this potentially causes too many humans to be named as inventors.

Provided that AI is developed by many humans under the open-source approach, naming AI as an inventor may be more convenient from a practical view, rather than finding out who contributed to the conception of an invention and naming so many contributors as inventors. Although, as discussed above, it would still be important to ensure that the named inventorship is accurate.

VII. CONCLUSION

Today, allowing regulatorily to name AI as an inventor would require us to envision that AI makes an invention truly without significant human involvement. If such a world once comes true, we may be inclined to agree that the relaxation of common laws limiting an inventor only to a natural person is inevitably necessary. Regardless of when the time comes, many modern people involved in AI-related technologies would not doubt the importance of developing AI technologies, as well as advancing leadership via regulatory frameworks of AI.

AI is improving more drastically than ever, and one day may obtain sufficient technical independence of humans in terms of achieving a wider range of goals, including conception of an invention. Prohibition of naming AI as an inventor for an AI-made invention may potentially lead to patent rejection and invalidity. Social benefits potentially brought from AI-made inventions may be widely appreciated. If the importance of global harmonization about legal flamework for AI-related industries is properly considered, a consensus of option may be obtained even as to patent inventorship of AI.

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174. Aaron Peabody, *What is Machine Learning: The Best Open Source Algorithms*, UNTITLED (July 25, 2019) https://untitledfirm.com/blog/the-best-open-source-algorithms/.

175 . *Open-Source Software Development*, WIKIPEDIA, https://en.wikipedia.org/wiki/Open-source_software_development (last visited Nov. 4, 2020).

176. 35 U.S.C. § 102 (2012).

AI may truly conceive an invention one day in the future. Probably, the inventorship requirement of "natural person" should be thus inevitably relaxed so that sophisticated AI can be an inventor.