PROTECTING VIRTUAL THINGS: PATENTABILITY OF ARTIFICIAL INTELLIGENCE TECHNOLOGY FOR THE INTERNET OF THINGS

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ABSTRACT

The Internet of Things (IoT) welcomes physical everyday objects into the connected digital world. Existing IoT devices include virtual assistants, smart thermostats, and fitness trackers. IoT innovation is booming, bringing to market increasingly sophisticated devices with immense potential for improving human well-being in the areas of smart cities, efficient manufacturing, and personalized healthcare. The true engine behind the IoT revolution is artificial intelligence (AI) which uses computing power to learn from big data generated by IoT sensors to deliver smart solutions and accurate predictions—furnishing IoT devices with their value. To gain a bird's eye perspective on the future development of AI applications for IoT (termed AI-IoT in this Article), one important consideration is whether such technology can enjoy intellectual property protection in the form of patents, and what the consequences are of such patents on the AI-IoT innovation landscape. Part I of this Article introduces the concepts of AI and machine learning and describes criteria for

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obtaining a patent under United States intellectual property law. Part II of this Article covers the historical background of the subject matter eligibility of software patents through jurisprudential and policy developments with a focus on implications for the patentability of AI-IoT. Part III of this Article addresses innovation policy consequences of proliferation of AI-IoT patents. The Article finds that AI-IoT patents present a unique set of tangible inventions that may circumvent the "abstract idea" obstacle to subject matter eligibility faced by many software patents. However, current evidence is ambiguous as to whether the growth of such patents would stimulate or dampen AI-IoT innovation. In any case, AI-IoT patents should be welcomed as current patent law does not have a clear legal test for exempting such patents and a technologically-neutral approach to intellectual property should be embraced.

I. INTRODUCTION

The Internet gave rise to a virtual world, and the Internet of Things (IoT) will merge that virtual world with the physical one. IoT consists of networks of physical devices connected to the Internet which gather data from their environment using sensors, share information across the network, and allow for intelligent data analysis.[1] Digitization of the physical world through IoT is expected to drive the fourth industrial revolution.[2] Bain estimated that the global IoT market will grow from $235 billion in 2017 to $520 billion by 2021.[3] The main areas of application of IoT technology include smart cities for managing traffic and other public infrastructure, autonomous vehicles, worksite infrastructure for predictive

[1] Amy JC Trappey et al., *A Review of Essential Standards and Patent Landscapes for the Internet of Things: A Key Enabler for Industry 4.0*, 33 ADVANCED ENGINEERING INFORMATICS 208, 208 (2017).

[2] Jean-Marc Frangos, *The Internet of Things will Power the Fourth Industrial Revolution. Here's How*, WORLD ECON. FORUM (June 24, 2017) https://www.weforum.org/agenda/2017/06/Internet-of-things-will-power-the-fourth-industrial-revolution [https://perma.cc/Q2C2-UWV5].

[3] Ann Bosche et al., *Unlocking Opportunities in the Internet of Things*, BAIN (Aug. 7, 2018), https://www.bain.com/insights/unlocking-opportunities-in-the-internet-of-things [https://perma.cc/VN5H-HPBX].

maintenance, security, precision farming, and connected health through wearables.[4] As a practical example of a smart city IoT application, the cities of Doha, Sao Paulo, and Beijing use sensors attached to water infrastructure to monitor and mitigate water loss.[5] Since 2014, there are more IoT devices in use than the world's human population.[6]

A. Artificial Intelligence for IoT Devices (AI-IoT)

Despite the significant promise of IoT for both economic and social benefit, the full potential of IoT remains unrealized. IoT devices gather massive amounts of complex data, with only a small portion of that data being analyzed for practical ends. For example, McKinsey Global Institute claimed that less than one percent of the data being collected by thirty thousand sensors on a specific oil rig are used in decision-making.[7] The key to extracting the maximum value from such "big data" (i.e., large datasets with many sources and variables) is through intelligent data processing and analysis using artificial intelligence (AI).[8] AI is defined as "the capability of a machine to imitate intelligent human behavior [and

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[4] LexInnova, *Internet of Things: Patent Landscape Analysis*, WIPO 1, 2–3 (2014), https://www.wipo.int/edocs/plrdocs/en/internet_of_things.pdf [https://perma.cc/K4CF-LL48].

[5] *Id.*

[6] *See* Trappey et al., *supra* note 1, at 209.

[7] James Manyika et al., *Unlocking the Potential of the Internet of Things*, MCKINSEY GLOBAL INSTITUTE (June 2015), https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world [https://perma.cc/7DVY-NJTF].

[8] Mohammad Saeid Mahdavinejad et al., *Machine Learning for Internet of Things Data Analysis: A Survey*, 4 DIGITAL COMM. & NETWORKS 161, 161 (2017).

intuition]."[9] AI algorithms are applied to big data to extract meaning from these data by categorizing information, finding patterns, and making predictions. To truly appreciate the power of AI for analyzing big data, it is important to understand that while AI imitates "human intuition," unlike AI, human intuition fails at extracting relevant patterns from big data and drawing accurate conclusions based on these patterns. Most AI technology finds its applications in analyzing big data on the Internet.[10] Researchers were able to predict flu trends using data obtained from Twitter, Facebook uses AI for facial recognition of users' image posts, and Netflix uses AI to make personally catered movie/show recommendations to subscribers.[11] Such AI-based analysis is arguably the most critical component of IoT. AI is essential for training autonomous vehicles to make decisions, predicting health issues from data obtained by wearable devices, and regulating congestion from traffic data. It is therefore the combination of IoT and AI that marks the entry point to the next industrial revolution. This Article examines the current and future innovation landscape for IoT technology, with a specific focus on AI software development for IoT (*AI-IoT*). Longstanding legal theory suggests that intellectual property rights are essential for incentivizing creation by giving creators/inventors a time-limited monopoly on the fruits of their labor in exchange for public dissemination of knowledge. Under this framework, the Article asks whether AI-IoT inventions can enjoy patent

[9] *Artificial Intelligence*, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/artificial+intelligence [https://perma.cc/24UH-MR3Z] (last visited Nov. 10, 2019).

[10] Hidemichi Fujii & Shunsuke Managi, *Trends and Priority Shifts in Artificial Intelligence Technology Invention: A Global Patent Analysis*, 58 ECON. ANALYSIS & POL'Y 60 (2018).

[11] Hyunjong Ryan Jin, *Think Big! The Need for Patent Rights in the Era of Big Data and Machine Learning*, 7 N.Y.U. J. INTELL. PROP. & ENT. L. 78, 102 (2018).

protection under United States' law. The focus is on patents since patents protect the functional aspects of the invention, while copyright protection is concerned with the literal copying of software code. The Article assumes that the true value of AI-IoT applications is its technical function which can be protected through patents. The focus is also on U.S. law since the majority of both IoT and AI patents are filed in the US.[12] The last part of the Article turns to policy considerations discussing the advantages and drawbacks of using patent law for incentivizing innovation in the AI-IoT space.

B. Artificial Intelligence and Machine Learning

Before delving into whether AI technologies are patentable, it is crucial to understand in some detail how AI algorithms work. The term AI is most often used to refer to a specific category of algorithms called machine learning (ML) that allows computers to learn from data without being explicitly programmed or "hard-coded."[13] ML algorithms are "trained" on complex data sets and are able to learn relevant patterns and correlations from "experience."[14] There are three main categories of ML: supervised, unsupervised, and reinforcement learning. In supervised learning, the input data (i.e., the "training data") is labeled with the correct response and the algorithm learns the relationship between the data and the labels to make predictions on new, previously unseen data.[15] An example of supervised learning is an algorithm that is trained on many pictures labeled as either containing or not containing a cat, to then be able to identify a cat picture that

[12] Trappey et al., *supra* note 1, at 219.
[13] Mahdavinejad et al., *supra* note 8, at 165.
[14] Jin, *supra* note 11, at 88.
[15] Jin, *supra* note 11, at 89.

it has not previously seen. In unsupervised learning, the algorithm is fed a complex data set, but without any labels. The algorithm finds interesting patterns in the data without being shown any correct solutions. An example of this is an algorithm that is given a compilation of news articles and the algorithm learns to group all the articles about the same news event into one cluster.[16] In the context of AI-IoT, an algorithm fed heart rhythm data from a wearable could be trained to recognize abnormal heart activity either through supervised learning by being shown previously labeled examples of abnormal heart signals, or through unsupervised methods by using the data to categorize different heart activity patterns into groups without labels (a person will then decide which group contains the abnormal heart rhythms). Reinforcement learning involves algorithms learning sequences of actions to be taken for a given situation in order to maximize payoff, such as training a robot to make a series of complex decisions when playing soccer.[17]

The steps involved in developing a ML algorithm are (1) obtaining high-quality data for training the algorithm, such as data acquired by sensors on IoT devices; (2) pre-processing data including cleaning data by removing outliers or reducing dimensions; (3) training a ML algorithm on the data (the ML algorithm is either an off-the-shelf algorithm commonly used or a newly developed one); and (4) obtaining a final trained algorithm (i.e., the model) which gives output data (solutions) when shown new input data.[18] While it is true that ML algorithms learn from the data and come up with a final model spontaneously, the developer's ingenuity still plays a major role. Many human decisions need to be made during

[16] Jin, *supra* note 11, at 89.
[17] Mahdavinejad et al., *supra* note 8, at 165.
[18] Jin, *supra* note 11, at 92.

the development process including choosing which ML method(s) to employ for a given problem, how to curate the training data, which algorithm parameters to select, and how to test the model for accuracy. When considering a patent for an AI/ML invention, an inventor may seek protection for either a single development step, or more commonly, a series of these steps presented as a whole.

C. What is a Patent?

Section 101 of the Patent Act allows for four types of inventions to receive patent protection: (1) processes; (2) machines; (3) manufactures; and (4) compositions of matter.[19] AI-IoT would fall under either process (e.g., steps in algorithm implementation) or machine (e.g., AI combined with a physical IoT device). The term of a patent is twenty years from the date on which the application for the patent was filed in the United States.[20] In order to obtain a patent under one of these categories, an invention needs to meet all of the following criteria: it must be (1) patent-eligible subject matter; (2) useful; (3) novel; and (4) non-obvious.[21] The courts have interpreted patentable subject matter to mean that almost any invention is eligible except for laws of nature, natural phenomena, and abstract ideas.[22] Useful means that the invention has a practical application, not merely a theoretical application in the future. Novel means that the invention does not repeat "prior art" (i.e., previously patented inventions), has not been publicly disclosed, and is not generally known. Non-

[19] 35 U.S.C. § 101 (2018).
[20] 35 U.S.C. § 154(a)(2) (2018).
[21] 35 U.S.C. § 101 (patentable subject matter and utility); 35 U.S.C. § 102(a) (2018) (novelty); 35 U.S.C. § 103 (2018) (non-obviousness).
[22] Allen Clark Zoracki, *When Is an Algorithm Invented? The Need for a New Paradigm for Evaluating an Algorithm for Intellectual Property Protection*, 15 ALB. L.J. SCI. & TECH. 579, 589 (2004).

obvious inventions are those that would not have been obvious to others "skilled in the art" (i.e., experts in the field). Therefore, requiring some kind of creative insight rather than simply combining previous inventions/knowledge in a standard way is a prerequisite to being patentable. For AI-related inventions, eligible subject matter represents the largest hurdle to overcome since algorithms and mathematical formulae have been traditionally considered to be abstract ideas.[23]

II. ARE AI-IOT INVENTIONS PATENTABLE SUBJECT MATTER?

The U.S. Supreme Court has stated that "phenomena of nature, though just discovered, mental processes, and abstract intellectual concepts are not patentable, as they are the basic tools of scientific and technological work."[24] The courts are against issuing patents for such work since "monopolization of those tools through the grant of a patent might tend to impede innovation more than it would tend to promote it."[25] Although advanced AI technology, and its use in IoT, is relatively new, the courts have been grappling with the patentability of computer software inventions for almost half a century.

Prior to the 1980s, it was generally accepted that software represented abstract mathematical concepts and remained unpatentable subject matter.[26] In 1981, the Supreme Court ruled in *Diamond v. Diehr* that a formula, implemented on a digital computer, for curing rubber was

[23] *Id.* at 588.
[24] Gottschalk v. Benson, 409 U.S. 63, 67 (1972).
[25] *See* Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289, 1293 (2012).
[26] *See Gottschalk*, 409 U.S. at 67.

patentable.[27] The patent included the process of "installing rubber in a press, closing the mold, constantly determining the temperature of the mold, constantly recalculating the appropriate cure time through the use of the formula and a digital computer, and automatically opening the press at the proper time."[28] Given that the computer software improved a physical-industrial process as a *whole*, the Court did not view the invention as abstract, and therefore it was upheld as valid.[29] Following this decision, the United States Court of Appeals for the Federal Circuit became more open to accepting that software can be patent-eligible subject matter. In *Alappat*, the Federal Circuit accepted the validity of a software patent that processed data to allow for the display of a smooth waveform on a digital oscilloscope.[30] The court viewed the patent as creating a machine in which a general-purpose computer was turned into a special-purpose computer when running the software to digitize the waveforms.[31]

In *State Street Bank and Trust Company v. Signature Financial Group, Inc.*, the Federal Circuit found that an algorithm used to calculate a share price was patent-eligible since it constituted a practical and tangible application of a mathematical formula that could be used for recording and reporting purposes.[32] In *State Street Bank*, the court also articulated the "machine-or-transformation" test which provided that an algorithm or software is patentable if (1) it is tied to a particular machine or apparatus; or (2) it transforms a particular article into a

[27] *See* Diamond v. Diehr, 450 U.S. 175 (1981).
[28] *Id.* at 187.
[29] *Id.* at 191–92.
[30] *See In re Alappat*, 33 F.3d 1526, 1544 (Fed. Cir. 1994).
[31] *See id.*
[32] *See* State St. Bank & Trust Co. v. Signature Fin. Grp., Inc., 149 F.3d 1368 (Fed. Cir. 1998).

different state or thing. Later, in *Bilski v. Kappos*, the Supreme Court clarified that the "machine-or-transformation" test was useful but not the sole criterion for determining subject matter eligibility.[33] Following *State Street Bank,* the United States Patent and Trademark Office (USPTO) saw a proliferation of software- and Internet-related patent applications.[34] The decision opened a can of worms, more than doubling the annual number of software patent applications in the years following the decision, including patent applications implementing basic calculations on a computer, as well as "business method" patents.[35] The most famously known business method patent granted following *State Street Bank* is Amazon's "one-click" patent allowing customers to make single-click purchases based on previously stored payment information.[36]

A. The Alice Decision

The Supreme Court did not return to the question of software subject matter eligibility for almost two decades until the case of *Alice Corp. v. CLS Bank International* in 2014, marking a major turning point in the fate of software patents.[37] The patent in question involved a computerized method of mitigating settlement risk by keeping track of each party's account balance to prevent one party from

[33] *See* Bilski v. Kappos, 561 U.S. 593 (2010).
[34] Fabio E. Marino & Teri H. P. Nguyen, *From Alappat to Alice: The Evolution of Software Patents*, 9 HASTINGS SCI. & TECH. L.J. 1, 6 (2017).
[35] Christopher W. Quinn, *The 20 Year War On Patents: When Will It End?*, *LEXOLOGY* https://www.lexology.com/library/detail.aspx?g=8cdd3dd7-1fb3-48dc-a7ba-b6ffb0076e8e [https://perma.cc/9UZT-UBXY] (last visited Nov. 10, 2019).
[36] U.S. Patent No. 5,960,411.
[37] *See Alice Corp. v. CLS Bank Int'l*, 573 U.S. 208 (2014).

reneging on the deal.[38] The Court developed a two-step test for determining subject matter eligibility: (1) determine whether the claims are directed to a patent-ineligible subject matter, such as an abstract idea; and if so, (2) determine whether the claims as a whole transform the patent ineligible subject matter into a patentable invention through an inventive concept.[39] In this case, the *Alice* patents failed step one since the invention did nothing more than implement the abstract idea of mitigating settlement risk on a generic computer.[40] The major concern with the *Alice* decision is that the Court failed to provide a definition of "abstract idea," leaving the state of software patents in muddled confusion.[41]

B. The Aftermath of the Alice Decision

In the aftermath of the *Alice* decision, lower courts were left to interpret the meaning of abstract in applying the two-step framework. A host of post-*Alice* decisions began to rely on the "mental steps" doctrine for assessing patent eligibility which posits that if a software program/algorithm is performing a process that could be performed by a person using solely his or her mind or by using a pen and paper, then the patent will be presumed ineligible subject matter.[42] In contrast, a series of Federal Circuit decisions pointed toward the willingness to uphold the validity of software that improved "computer function."

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[38] *Id.* at 212.
[39] *Id.* at 218–21.
[40] *Id.* at 221.
[41] Robert Daniel Garza, *Software Patents and Pretrial Dismissal Based on Ineligibility*, 24 RICH. J.L. & TECH. 1, ¶ 29 (2017).
[42] Ben Hattenbach & Gavin Snyder, *Rethinking the Mental Steps Doctrine and Other Barriers to Patentability of Artificial Intelligence*, 19 COLUM. SCI. & TECH. L. REV. 313, 317–18 (2017).

In *DDR Holdings LLC v. Hotels.com LP*, the invention concerned integrating third-party merchant web content with the "look and feel" of a host webpage which prevented the host webpage from losing visitor traffic when directed to the content of an advertiser.[43] The court decided that this invention was not directed to an abstract idea under the first step of the *Alice* test since it solved a problem in computer networks. Similarly, in *McRO Inc. v. Bandai Namco Games America Inc.*, the Federal Circuit upheld a patent for software that automatically synchronized the facial expressions and lip movements of three-dimensional animated characters.[44] The court determined that this invention was not abstract because it improved computer animation technology.[45] In attempt to fill the gaps in the *Alice* ruling, the courts seem to favor certain software patents over others, particularly those that "improve computer technology" in ways distinguished from human "mental processes." The next section will discuss how this current state of software subject matter eligibility affects the patentability of AI technology for IoT.

C. Patentability Challenge and Promise for AI-IoT

In response to the *Alice* decision, the USPTO issued a guidance document on subject matter eligibility which defined four broad categories of inventions that represent "abstract ideas": (1) those that emulate mental processes; (2) those that can be replaced with pen and paper; (3) those that focus on human interaction; and (4) those that solve a problem which existed before the invention of the

[43] *See* DDR Holdings, LLC v. Hotels.com, L.P., 773 F.3d 1245 (Fed. Cir. 2014).
[44] *See* McRO, Inc. v. Bandai Namco Games America Inc., 837 F.3d 1299 (Fed. Cir. 2016).
[45] *Id.* at 1316.

Internet.[46] The guidance appears problematic for AI inventions since AI learns through experience with data which parallels human learning through "mental processes," and attempts to solve a host of problems that existed before the Internet (e.g., traffic, medical diagnosis, etc.). The human interaction category would also potentially exclude patentability of any AI-IoT technologies that connect to social networks, make phone calls, and so forth.

The USPTO abstract idea categories are at the very heart of what AI is designed to do. AI is being developed to understand human language, identify patterns, and make accurate predictions with increasing sophistication—tasks traditionally performed by the human brain. In *Blue Spike LLC v. Google Inc*, the patent at issue created an AI-based method of identifying and comparing digital signals with high accuracy.[47] For example, the algorithm could be fed a piece of digitally-stored music and identify that it contained a cover of an original, copyrighted song.[48] A California District Court held that the patent was abstract since it concerned the mental processes of identifying and recognizing signals on computers (i.e., a person could listen to a song and identify it as a cover). Similarly, in *Purepredictive Inc. v. H20.AI Inc.*, the same California District Court found that a patent based on AI predictive analytics is abstract since it covers "mental processes."[49]

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[46] *See* Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 74,618 (Dec. 16**,** 2014).

[47] *See* Blue Spike, LLC v. Google Inc., No. 14-cv-01650-YGR, 2015 U.S. Dist. LEXIS 119382 (N.D. Cal. Sept. 8, 2015).

[48] *Id.* at *2–5.

[49] *See* Purepredictive, Inc. v. H2O.AI, Inc., No. 17-cv-03049-WHO, 2017 U.S. Dist. LEXIS 139056 (N.D. Cal. Aug. 29, 2017) at *13.

The USPTO guidance and the above-mentioned court decisions seem to conflate human cognition with AI technology without clear distinctions, leaving many unanswered questions about the patentability of AI. While it is true that AI addresses problems that human cognition can also be used to address, does the exact *method* of solving those problems matter for patent eligibility? What about the *accuracy* of solutions produced by AI compared to humans? While a physician uses cognition to diagnose tumors in breast biopsy images, an AI system can identify tumors using complex "black box" patterns and correlations that are highly unlikely to match the *method* of human cognitive processing. AI is also able to arrive at a larger number of accurate diagnoses.[50] The Federal Circuit seemed to have answered the second question by stating that "relying on a computer to perform routine tasks more quickly or more *accurately* is insufficient to render a claim patent eligible."[51] The answer to the question of the *method* used to arrive at a solution remains unanswered.

With respect to AI that is specific to IoT, there is an added physical component of the invention relating to the IoT device itself. In this case, the "machine-or-transformation" test from *State Street Bank* would perhaps lean in favor of finding AI-IoT patents as subject matter eligible and non-abstract.[52] In accordance with this view, patent attorney Vincent Spinella-Mamo said that when preparing AI-related patent applications he tends to include tangible sources of data such as "physical sensors, data

[50] DAYONG WANG ET AL., DEEP LEARNING FOR IDENTIFYING METASTATIC BREAST CANCER (2016), https://arxiv.org/pdf/1606.05718.pdf [https://perma.cc/Z4MX-CUB8].
[51] *See* OIP Techs., Inc. v. Amazon.com, Inc., 788 F.3d 1359, 1361 (Fed. Cir. 2015) (emphasis added).
[52] *State St. Bank*, 149 F.3d at 1373.

derived from physical sensors, etc."[53] Although there is virtually no established law on the patentability of AI-IoT, it seems that tying the AI technology to physical devices provides a more secure path to eligibility.

Despite the legal ambiguity, the USPTO has a patent classification, class 706, that is exclusively designated for AI data-processing inventions, which at least inadvertently admits that AI *could* be patentable.[54] In the past six years, the USPTO has seen a five hundred percent increase in the number of patents under class 706.[55] Google has filed the largest number of AI patent applications to date, with Amazon in second place—most of these patents are in IoT in the areas of self-driving cars, robotics, delivery drones, AI assistants, and health-related wearables.[56]

In April 2018, Andrei Iancu, the director of the USPTO, spoke before the U.S. Senate Judiciary Committee on various intellectual property issues including that of patent subject matter eligibility. His comments were highly

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[53] Vincent Spinella-Mamo, *Patenting Algorithms: IP Case Law and Claiming Strategies*, IP FOLIO, http://blog.ipfolio.com/patenting-algorithms-ip-case-law-and-claiming-strategies [https://perma.cc/5532-4HDT] (last visited Nov. 10, 2019).

[54] *Class 706 Data Processing - Artificial Intelligence*, USPTO, https://www.uspto.gov/web/patents/classification/uspc706/defs706.htm [https://perma.cc/LBW4-W2L8] (last visited Nov. 10, 2019).

[55] Frank A. DeCosta, *Intellectual Property Protection for Artificial Intelligence*, FINNEGAN (Aug. 30, 2017), https://www.finnegan.com/en/insights/intellectual-property-protection-for-artificial-intelligence.html [https://perma.cc/2C22-VD6A].

[56] *Winners and Losers in the Patent and Innovation Wars Between Amazon, Google, Facebook, Apple, and Microsoft*, CB INSIGHTS RES. (Nov. 16, 2017), https://www.cbinsights.com/research/innovation-patents-apple-google-amazon-facebook-expert-intelligence [https://perma.cc/GF6C-ZVM8].

suggestive of a shift in the USPTO's perspective on AI inventions. He stated:

> This is one place where I believe courts have gone off the initial intent. There are human-made algorithms, human-made algorithms that are the result of human ingenuity that are not set from time immemorial and that are not absolutes, they depend on human choices. Those are very different from [abstract mathematical concepts such as] $E=mc^2$ and they are very different from the Pythagorean theorem.[57]

More clarity is needed on how the USPTO, courts, and legislators intend to interpret subject matter patentability in the age of AI and IoT. Nevertheless, Iancu's recent statements combined with the physical nature of IoT devices suggests that AI-IoT may increasingly become recognized as patentable subject matter, offering some clarity for inventors.

III. INNOVATION POLICY PERSPECTIVE ON PATENTING AI-IOT

Even if AI-IoT technologies are likely to fall within the scope of patentable subject matter, is it desirable from an innovation policy perspective to have a proliferation of such patents? The ongoing dialogue on subject matter eligibility appears to be a legal disguise for an innovation policy-based concern of permitting software and AI patents. Intellectual property rights are protected in the

[57] *Statement of Director Andrei Iancu Before the S. Comm. on the Judiciary*, USPTO (Apr. 18, 2018), at 1:07, https://www.judiciary.senate.gov/meetings/oversight-of-the-us-patent-and-trademark-office [https://perma.cc/4Z8Y-6KE7].

U.S. Constitution, "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."[58] The economic idea behind intellectual property protection is to incentivize the investment and risk-taking required for innovation by granting a time-limited monopoly on an invention.[59] However, intellectual property protection is a double-edged sword as overprotection can stifle downstream innovation by increasing the transaction costs associated with building off of protected inventions. It appears that courts and the USPTO have been implicitly concerned about the second possibility for software and AI. Empirical evidence on the role of AI patents in innovation exists for both sides of the debate. The following sections focus on AI and software innovation in general given that little research currently exists for AI-IoT-specific technologies.

A. Evidence for Negative Impact of Software/AI Patents on Innovation

A study by Ronald Mann found that software start-up firms do not engage in a "prior art" search of existing patents before beginning product development, suggesting that software patents do not directly promote downstream innovation.[60] Another study using data from over one thousand AI start-ups found that only twenty-one percent of AI start-ups applied for a patent, with just eleven percent being granted at least one patent.[61] The larger and more

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[58] U.S. CONST. art. I, § 8, cl. 8.

[59] Zoracki, *supra* note 22, at 583.

[60] Ronald J. Mann, *Do Patents Facilitate Financing in the Software Industry*, 83 TEX. L. REV. 961, 1004 (2004).

[61] *Cortica, Numenta Hold Top Patents in Artificial Intelligence*, CB INSIGHTS RES. (Apr. 27, 2017) https://www.cbinsights.com/research/top-artificial-intelligence-startup-patent-holders [https://perma.cc/B6VY-JRB5].

established technology companies are dominating the software and AI patent landscape, but not necessarily for the purpose of promoting innovation.[62] The head of the patent department of Cisco made the following statement to the Federal Trade Commission: "The time and money we spend on patent filings, prosecution, and maintenance, litigation and licensing could be better spent on product development and research leading to more innovation. But we are filing hundreds of patents each year for reasons unrelated to promoting or protecting innovation."[63] Cisco's statement points to the idea that large companies are seeking software patents for defensive reasons (i.e., to avoid being accused of infringement) rather than as a reward for innovation. For these same reasons, the League for Programming Freedom has stood in opposition to patenting software since the 1990s.[64]

One proposed reason for why software patents may stifle innovation is that software innovations are highly incremental, cumulative, and collaborative rather than competitive.[65] This situation in the software industry is in stark contrast to the pharmaceutical industry with a much smaller number of players and resulting patentable products given the massive expense and timeframe of drug development. On the other hand, collaborative software development websites such as GitHub and Stackoverflow, as well as open source deep learning packages such as

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[62] *Id.*

[63] *Statement from Robert Barr to the Fed. Trade Commission*, at 677–78, FOUNDATION FOR A FREE INFORMATION INFRASTRUCTURE (Feb. 28, 2002) http://swpat.ffii.org [https://perma.cc/LMU9-LRVE].

[64] *Against Software Patents,* THE LEAGUE FOR PROGRAMMING FREEDOM (Feb. 28, 1991), https://groups.csail.mit.edu/mac/projects/lpf/Patents/against-software-patents.html [https://perma.cc/4PHM-CVBJ].

[65] Anton Hughes, *Avoiding the Software Patent Problem: An Alternative Fix for TRIPS Junkies*, 14 MURDOCH U. ELECTRONIC J.L. 100, 105 (2007).

TensorFlow and PyTorch, make AI development incremental and accessible to any programmer with a general computer at hand.[66] Moreover, a twenty-year patent exclusivity period can be considered too long in the fast-paced software industry where a product lifecycle is around three to five years.[67] Although currently unexplored, it is possible that AI-IoT may fall closer to the laborious drug development process than the rapid incremental classical AI development process given that AI-IoT includes the additional hurdle of integrating the AI invention with a physical device. If that were the case, perhaps AI-IoT patents would be more likely to promote innovation without overprotecting.

Another issue that tips the balance between promoting and stifling innovation is how narrow or broad a patent is construed. If a patent is too narrow, covering a very specific AI invention, it will fail to adequately protect the invention, and others can easily circumvent infringement with slight modifications. This situation would theoretically interfere with the incentive to innovate given that the afforded protection would be negligible. On the other hand, if the patent is too broad, it will restrict downstream innovation by creating a monopoly over a large area of AI development. The issue of overly broad patents is particularly pervasive in software and Internet-related fields.[68] A subsidiary of Alphabet, DeepMind, recently filed patents titled "Generating Video Frames Using Neural Networks" and "Reinforcement Learning

[66] *Software Patents are Obsolete in the Age of AI*, BHARATH RAMSUNDAR (June 10, 2017), http://rbharath.github.io/software-patents-are-obsolete-in-the-age-of-ai [https://perma.cc/APQ8-7Z6T].
[67] Hughes, *supra* note 65, at 105.
[68] Zoracki, *supra* note 22, at 586.

Systems" which appear to be extremely broad.[69] While it is not yet clear if these particular patents will be granted, Google has successfully obtained a patent on a broad machine-learning technique called Dropout which is a general method for addressing overfitting in a neural network (overfitting is an issue for *all* machine-learning development).[70]

B. Evidence for the Positive Impact of Software/AI Patents on Innovation

When it comes to measuring innovation through software start-up financing and long-term success, a study by Mann found that obtaining patents was positively correlated with the number of successful venture capital financing rounds, total investment amount, and longevity of the company.[71] The 2008 Berkeley Patent Survey found that while only one-third of software entrepreneurs filed for patents, the majority of venture-backed software start-ups had obtained patents.[72] Admittedly, these findings are correlational and it is not clear whether patents themselves contribute to success or whether it is merely the expectation of investors for start-ups to obtain patents.

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[69] Mike James, *Google's DeepMind Files AI Patents*, I PROGRAMMER (June 11, 2018), https://www.i-programmer.info/news/105-artificial-intelligence/11884-googles-deepmind-files-ai-patents.html [https://perma.cc/BN4C-E8NT].

[70] U.S. Patent No. 9,406,017.

[71] Ronald J. Mann & Thomas W. Sager, *Patents, Venture Capital, and Software Start-Ups*, 36 Res. Pol'y 193, 200–03 (2007), https://scholarship.law.columbia.edu/faculty_scholarship/1380 [https://perma.cc/M7JS-NXKN].

[72] Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKLEY TECH. L.J. 1255, 1277 tbl.1 (2009).

Another important factor in understanding the impact of patents on downstream innovation is the full lifecycle of a patent which includes its litigation history and its sale and licensing history. While litigation can be seen as a net negative for innovation given its high transactional cost, sale and licensing activities can be seen as a net positive since they represent the transfer and dissemination of knowledge. A study by Chien using a limited dataset of patents with publicly available historical information, demonstrated that a software patent is much more likely to be sold than it is to be litigated over its lifetime.[73] On the issue of licensing, the vast majority of agreements (eighty-eight percent) included not only patent rights but also the additional exchange of various trade-secrets, know-how, source code, bug-fixing guidance, and other proprietary information.[74] Taken together, Chien's study implies that software patents are a net positive for innovation, supporting the transfer of knowledge through the sale and licensing of patent rights, including the flow of additional intellectual property in licensing agreements not directly connected to the patent itself. In summary, evidence points in both directions when considering how software/AI inventions impact downstream innovation over time.

IV. CONCLUSION

Considering the mixed and incomplete evidence from software/AI patents, it is difficult to predict whether the expansion of AI-IoT patents will enhance or hamper fruitful progress in the AI/IoT space. Regardless, this Article puts forward the proposition that restricting AI-IoT patents based on subject matter ineligibility does not have a clear and unambiguous legal basis at the current time.

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[73] Colleen V. Chien, *Software Patents as a Currency, Not Tax, On Innovation*, 31 BERKELEY TECH. L.J. 1669, 1700 (2016).
[74] *Id.* at 1715–19.

Courts and the USPTO have gone back and forth in trying to establish clear tests for subject matter eligibility, and the undefined concept of abstract ideas has made matters increasingly complicated for understanding AI patentability. The lack of legal clarity can create barriers to entry for emerging AI-IoT innovators.

From a pragmatic point of view, it is therefore recommended that AI-IoT patents be evaluated under the other eligibility criteria (i.e., utility, novelty, non-obviousness). It is also imperative to approach patent applications with a technical understanding of the underlying technology since the abstract idea concept seems to misunderstand the differences between AI technology and human brain function, as well as the overall advantage of AI. As well, it is imperative to consider patentability in a technologically-neutral manner. The abstract idea criteria are clearly biased against AI technology. Intellectual property law was never developed to reward or deny protection based on specific forms of technology, but rather promises to grant protection for inventions that meet eligibility criteria regardless of the technology at hand. This is an especially important consideration in the digital age given that new technological forms are increasingly unpredictable and unprecedented.

As the AI-IoT industry matures, further empirical evaluation on the relationship between patents and innovation can be assessed. Depending on the consensus from such investigation, legislators and policymakers can step in to provide clear and consistent legal and policy rules on issues of patentability without technological bias to ensure continued promotion of AI-IoT development. AI-IoT innovation holds much promise across a swath of applications from ecological conservation to industrial

efficiency to promotion of human health. A careful application of intellectual property law is a key piece in realizing that potential.